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Draft - Groundwater Risk Assessment Report on behalf of Darwin Ltd.

Address: Plas Isaf Lodge Park, Caerwys Hill, Mold, Caerwys, CH7 5AD.

Date: 3rd October 2022

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1 Introduction

The CDS Group were appointed by Darwin (Plas Isaf) Ltd to undertake a site specific groundwater risk assessment in line with requirements set out by National Resource Wales in response to the application to discharge treated effluent into an onsite drainage field (ref. PAN-018353).

The design and the effluent calculations for the sewage treatment plant and associated drainage field have been undertaken by RA Dalton who are responsible for the design and compliance of the system and who will be undertaking the discharge permit application on behalf of Darwin (Plas Isaf) Ltd.

The purpose of this report is to provide a groundwater risk assessment, which contains ground investigation logs, groundwater monitoring data and pollutant assessment modelling.

2 Site Location

The site is situated to the east of Plas Isaf Lodge Park, Caerwys Hill, Mold, Caerwys, CH7 5AD. At the time of our investigation the site was in the process of being redeveloped into a larger holiday lodge park, with existing buildings in the process of redevelopment and new roads and concrete bases for lodges being developed across the site.

The location of the proposed drainage field at this point in time is flexible and would be subject to the results of the initial ground investigation works, assessing suitability based on the ground conditions encountered and depth to groundwater.



Figure 1. OS map of the site (boundary indicated in red)



Figure 2. Aerial Image of the site (boundary indicated in red)

3 **Background and Development Proposals**

The scope of the development is to refurbish and extend an existing holiday lodge park to facilitate new lodges and onsite facilities. As part of the refurbishment/redevelopment works a drainage strategy was required to address the increased volumes of domestic foul effluent being generated by the new lodges.

Three options were considered during the early stages of the development which included:

1. Use of existing offsite connection via a private sewer.
2. Construction of new offsite connection linking to an existing foul network at an agreed location with Welsh Water.
3. Development of an onsite package treatment plant with onsite disposal via a drainage field.

We understand that the developers and the drainage consultants (RA Dalton) have been investigating the use of the existing on site connection, which comprises a privately owned sewer, which runs through other existing privately owned holiday lodge parks.

Our client and their appoint engineers have been liaising with Welsh Water with regards to the potential options for a new offsite connection, assessing the feasibility of the connection and the capacity of the local network to receive additional volumes.

This report seeks to address the third option, which comprises the use of an onsite package treatment plant to treat domestic effluent from the holiday lodges only, before being pumped to a drainage field elsewhere on site.

4 **Development Proposal – Foul Drainage**

As previously mentioned the proposal for the foul water drainage solution for this site is being designed by RA Daltons. For reference we have summarised the information below as supporting information to aid the reader of this report:

- The development comprises 57 holiday lodges for which a new foul water drainage system is required. Planning consent was given for the use of an onsite package treatment plant.
- The discharging effluent is classified as **domestic effluent**, as it comprises sewage waste only from the 57 lodges.
- Treatment stages – Primary and Secondary treatment provided by the Kingspan BN Biodisc and an additional 34m³ settlement tank.
- Tertiary treatment provided by the proposed drainage field through aerobic digestion by bacteria within the gravel surround.
- Calculated peak daily flow, assuming a maximum of 4 people per lodge is 34200 litres (34.2m³).
- Pumping rate from the discharge point from the package treatment plant to the drainage field is 2l/s, reducing down to 1l/s in the demarcation/break chamber.
- The frequency and duration of discharge is proposed to be intermittent, with the aim of the system to provide little and frequent volumes rather than larger volumes.
- Calculated population equivalent (PE) for organic, hydraulic and ammonia is 228.

- The proposed system is designed to meet a worst case scenario of 20/30/5 parameters.
 - Effluent Discharge Standard: 95% Percentile
 - BOD5: 20mg/L
 - Suspended solids: 30 mg/L
 - Ammoniacal nitrogen: 5 mg/L
 - The unit details comprise a BN Biodisc, with the additional of a 34m³ balance tank upfront (providing one whole days storage in the system) to receive flows and offer further settlement protection. This system provides both Primary and Secondary treatment, details of which can be found in Appendix C.
 - The drainage field area is based on percolation test values (carried out by others), population equivalents and building regulations. The following calculation indicates that the development would require **1434** sqm drainage field.
 - 57 units all with possible 4 occupants = 224 PE (all other foul connected to existing discharge)
 - VP results @ 32s/mm
 - PE x VP x 0.2
 - $224 \times 32 \times 0.2 = 1433.4\text{m}^2$
 - Infiltration rate calculated at 0.024 metres per day based on 34.2m³ discharging into a 1434m² drainage field.
-

5 Site Assessment

5.1 Historical Land Use and Contamination Risk

The site and surrounding area is first shown on the 1871 map to comprise predominantly open rural land, with a corn mill shown on the sites western boundary and a cluster of what are assumed to be farm buildings listed as Plas Isaf to the south of the mill. In the surrounding area a series of quarries and Limekilns are mapped approximately 250m north of the site and a series of sluices are mapped, which appear to control the water level in the mill pond to the north, which then feeds a stream which runs south through the corn mill, before continuing to the south via a series of further ponds and sluices where it joins the River Wheeler.

By the 1899 map, a series of disused clay pits are mapped in close proximity to the corn mill, through which the controlled stream flows via a waterfall, which then is shown to spout downstream into woodland. To the south, along the route of the managed watercourse, a series of further active and disused clay pits are mapped. The remainder of the site and surrounding area has essentially remained unaltered and comprised a mixture of open rural land and woodland.

The 1912-1913 map shows no major changes on the site itself, however the land directly to the south of the site has been heavily quarried and excavated as part of a Portland Cement works, with large scale excavations, tramlines and buildings constructed. The previous controlled water course which formerly flowed through this land via a stream, series of sluices and ponds are no longer discernible within the areas of earthworks in the cement works.

By the 1965 map, the mill pond, which was situated to the north of the corn mill, is no longer mapped and appears to have infilled/silted up as the land is now mapped as woodland. The stream which originates from springs upslope of the former mill pond is still mapped and continues to flow down past the mill, through the subject site and through the cement works to the south.

Within the site itself, a new building has been constructed behind the row of farm buildings, which are mapped adjacent to the Plas Isaf farmhouse.

The 1987-1991 map shows that a further additional building has been developed adjacent to the existing farm buildings, however other than that, no significant changes were noted on site. The cement works to the south appears to be no longer operational, with the earthworks still mapped albeit overgrown/mapped as woodland and the former infrastructure such as the buildings and tramlines removed. A series of ponds are mapped along with a series of 'issues' and 'sinks' which appear to follow the route of the former sluiced watercourse.

The last 1:2500 map is dated 1994, which showed no significant changes on site or in the immediate area.

The 1:10000 maps were also obtained, however due to their scale they offer little in the way of note. The only major change observed onsite occurs between 2006 and 2021 when the land to the south of the former corn mill was excavated to form the pond which exists on site to date. Freely available aerial imagery shows that this pond was excavated at some point between 2006 and 2009.

The historical maps have highlighted that there were no known on site historical land uses which would have led to significant onsite contamination. In addition, off site land uses are also not considered to pose a risk to the site, as the former Portland Cement works to the south is downslope of the site and does not appear to have been infilled.

5.2 Geology

The following headings cover the aspects of geology of the immediate area of the proposed development.

5.2.1 Artificial Ground

This is ground at or near the surface that has been modified by man. It includes ground that has been deposited (Made Ground), landscaped, disturbed, excavated (Worked Ground) or some combination of these.

As can be seen in Figure 3 below, there are no mapped artificial soils mapped on site. Despite the large scale earthworks associated with the former cement works directly south of the site, this area has not been mapped to contain made ground or reworked ground.

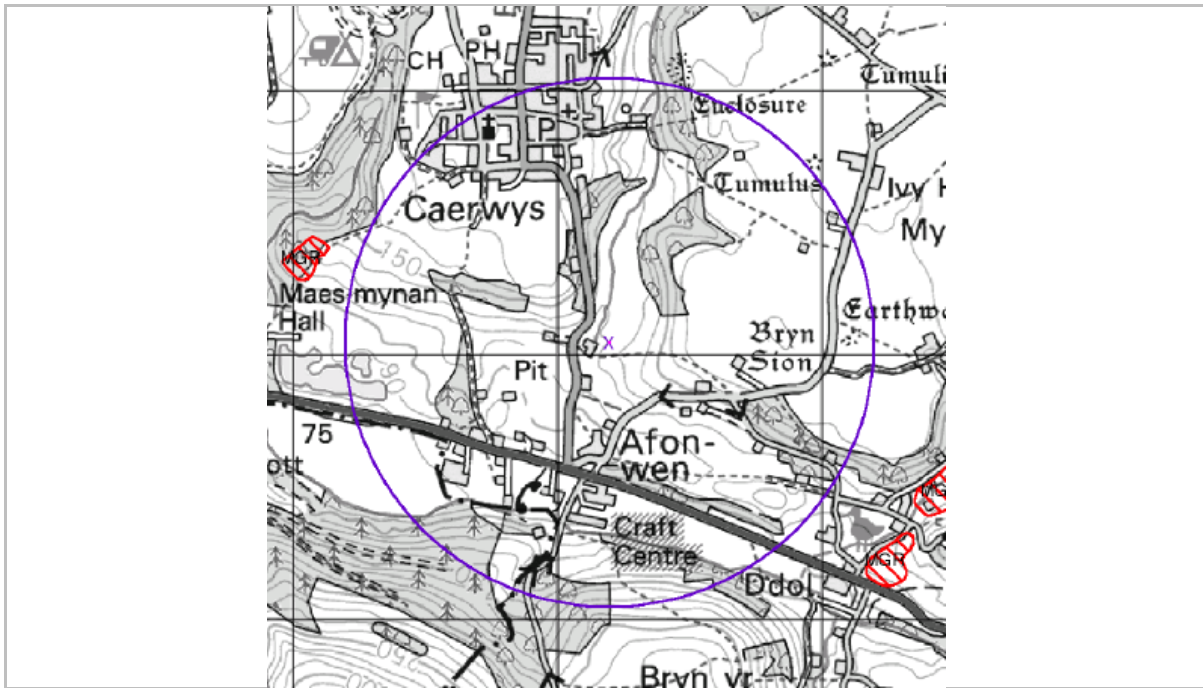


Figure 3. Artificial deposits within the vicinity of the site.

5.2.2 Superficial Deposits









These are relatively young geological deposits formerly known as 'Drift', which lie on the bedrock in many areas. They include deposits such as unconsolidated sands and gravels formed by rivers and clayey tills formed by glacial action. They may be overlain by landslide deposits, by artificial deposits or both.

As can be seen in Figure 4 below, the majority of the site is mapped on Alluvial soils and Tufa, with bands of Glaciofluvial Ice Contact Deposits and Glacial Till in the eastern half of the site.



Figure 4. Superficial deposits within the vicinity of the site.

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Not Supplied - Holocene
	GFCD	Glaciofluvial Ice Contact Deposits, Devensian	Sand and Gravel	Not Supplied - Devensian
	TILLD	Till, Devensian	Diamicton	Not Supplied - Devensian
	TUFA	Tufa	Tufa, Calcareous	Not Supplied - Quaternary
	HEAD	Head	Clay, Silt, Sand and Gravel	Not Supplied - Quaternary
	ALF	Alluvial Fan Deposits	Sand and Gravel	Not Supplied - Quaternary
	RTDU	River Terrace Deposits (Undifferentiated)	Sand and Gravel	Not Supplied - Quaternary
	LDE	Lacustrine Deposits	Clay and Silt	Not Supplied - Quaternary

5.2.3 Bedrock Geology

Bedrock forms the ground underlying the whole of an area, commonly overlain by superficial deposits, landslide deposits or artificial deposits, in any combination.

As can be seen in Figure 5 below, the northern half of the site is mapped on the Llamarmon Limestone, the southern half of the site is underlain by the Foel Formation. The land to the south of the site, where the Portland Cement works is situated is mapped on the Elwy Formation.

Of note, a fault runs broadly north/south through the site, which generally follows the route of the mapped stream.

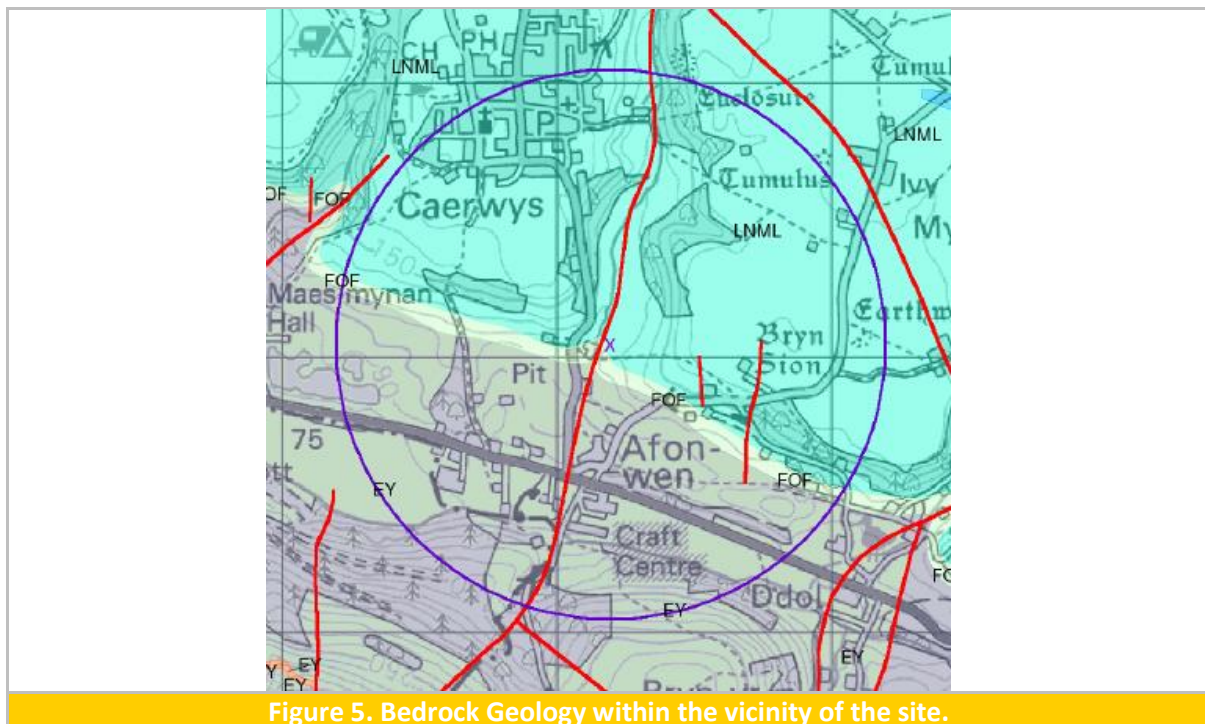









Figure 5. Bedrock Geology within the vicinity of the site

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	LGHL	Loggerheads Limestone Formation	Limestone	Not Supplied - Viséan
	CFML	Cefn Mawr Limestone Formation	Limestone and [Subequal/Subordinate] Argillaceous Rocks, Interbedded	Not Supplied - Viséan
	LNML	Llanamnon Limestone Formation	Limestone	Not Supplied - Viséan
	LEEL	Leete Limestone Formation	Limestone	Not Supplied - Viséan
	FOF	Foel Formation	Limestone and [Subequal/Subordinate] Argillaceous Rocks, Interbedded	Not Supplied - Viséan
	EY	Elwy Formation	Mudstone, Siltstone and Sandstone	Not Supplied - Ludlow
	EY	Elwy Formation	Sandstone	Not Supplied - Ludlow

5.3 Site Topography

A detailed topographic survey of the site was undertaken prior to the start of construction and is available if required. Figure 6 below shows that the site falls from east to the west, from a maximum elevation of 150m AOD down to 115m AOD where the former farm buildings, corn mill and pond are situated. The land to the northwest of the site also comprises a ridge which falls towards the site, whereas the land to the west and south continues to fall away to a level of 85m AOD where the River Wheeler is situated.

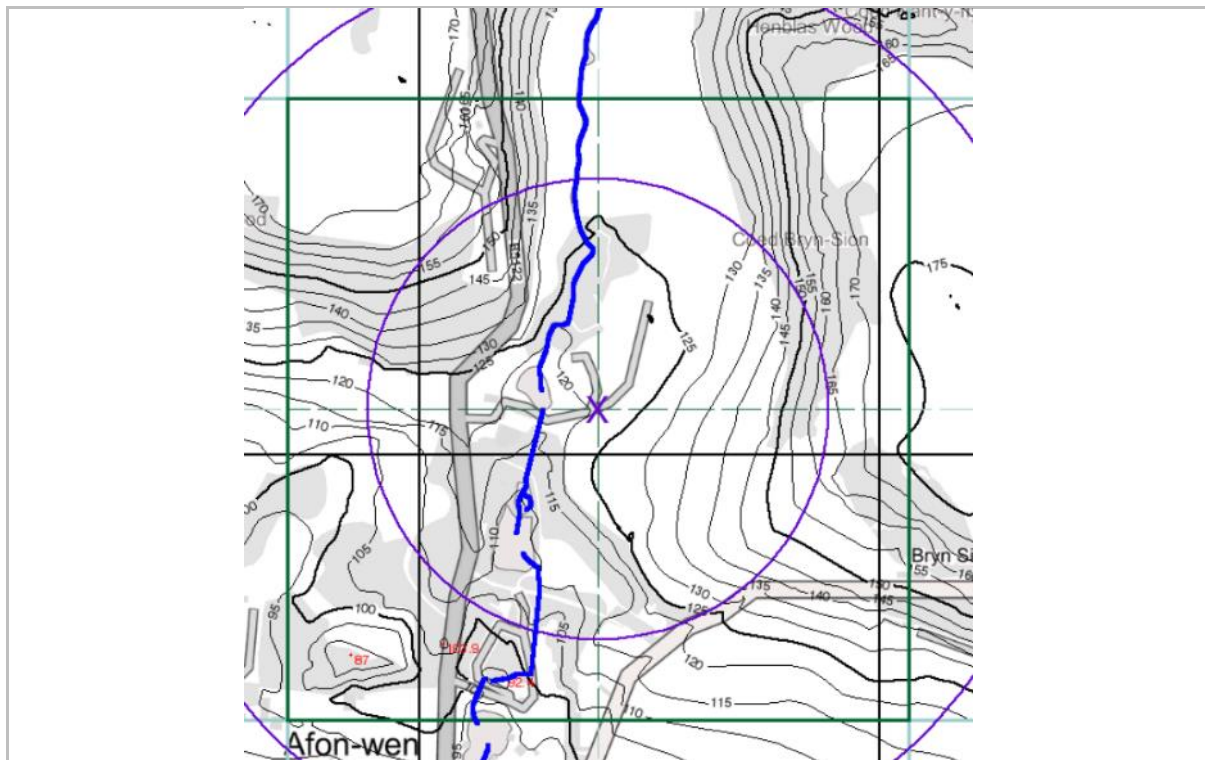


Figure 6. Site Topography

5.4 Hydrogeology

In lowland areas of the UK with little topographic variation, groundwater is likely to be found at shallow depths of only a few metres. Water table fluctuations will be small as they will be constrained by the ground surface and the base level of the local perennial streams and rivers. In upland areas, precipitation is usually high and the dominantly metamorphic and igneous rocks often have relatively shallow groundwater levels.

This is due to preferential groundwater storage in near-surface weathered and fractured zones with limited drainage into the underlying un-weathered lower permeability rock. Exceptions can occur where higher permeability rocks, such as sandstone or limestone, allow faster throughflow of groundwater towards the nearest stream or other discharge point.

Perched water tables occur where a less permeable horizon (e.g. a clay layer) in an otherwise permeable sequence retains a body of groundwater above the level of the regional water table. They usually occur at shallow depths in alluvial and glacial sediments and can be difficult to identify or to delimit.

An aquifer becomes confined when it is overlain by a less permeable horizon that restricts the upward movement of groundwater. When this less permeable horizon is penetrated (e.g. by drilling), the groundwater level rises above where struck to a level controlled by the hydrostatic pressure. If this is above ground level, overflowing artesian conditions will be encountered. Confined conditions should be anticipated, where possible, in order to plan for the problems they can generate.

Individual sites will always require more detailed assessments to determine the specific impact on groundwater resources. The maps represent conditions only at the ground surface. Where the soil and/or underlying formations have been disturbed or removed the vulnerability class may have been changed and site-specific data will be required. Sites in urban areas and restored or current mineral workings are classified as having high (urban) soil leaching potential until proved otherwise.

Table 1. Hydrogeology summary

Geological unit	Groundwater potential	Water level and strikes	Environment Agency Groundwater vulnerability classification
Alluvium	Given that this mapped geology coincides with the route of the fault line and spring fed water course, it is likely that any shallow alluvial soils will be water bearing.	N/A - Absence of suitable local borehole data to assess groundwater levels.	Secondary A aquifer of High Vulnerability.
Glaciofluvial Ice Contact Deposit	Given that this mapped geology is likely to be in direct continuity with the alluvial soils, it is likely that soils on a similar elevation will be water bearing.	N/A - Absence of suitable local borehole data to assess groundwater levels.	Secondary A aquifer of High Vulnerability.

Glacial Till	These soils are expected to be predominantly clay based and as such would not be considered water bearing. However, if granular (sand/gravel) layers persist, perched water of variable volume maybe encountered.	N/A - Absence of suitable local borehole data to assess groundwater levels.	Secondary B aquifer of High Vulnerability.
Llamarmon Limestone	Given the principal aquifer designation and the likely fractured nature of the bedrock, it is likely that this unit will support a mobile groundwater resource.	N/A - Absence of suitable local borehole data to assess groundwater levels.	Principal Aquifer of High Vulnerability

5.5 Groundwater Vulnerability

This section reviews all components of hydrology, geology and topsoil surface water drainage to assess risk notably to groundwater.

5.5.1 Source Protection Zones

The position of the site relevant to current groundwater protection zones is shown below in Figure 7. The proposed development site sits outside of the groundwater source protection zones. The nearest SPZ is mapped approximately 2km to the north of the site, with a second mapped 4km to the southwest

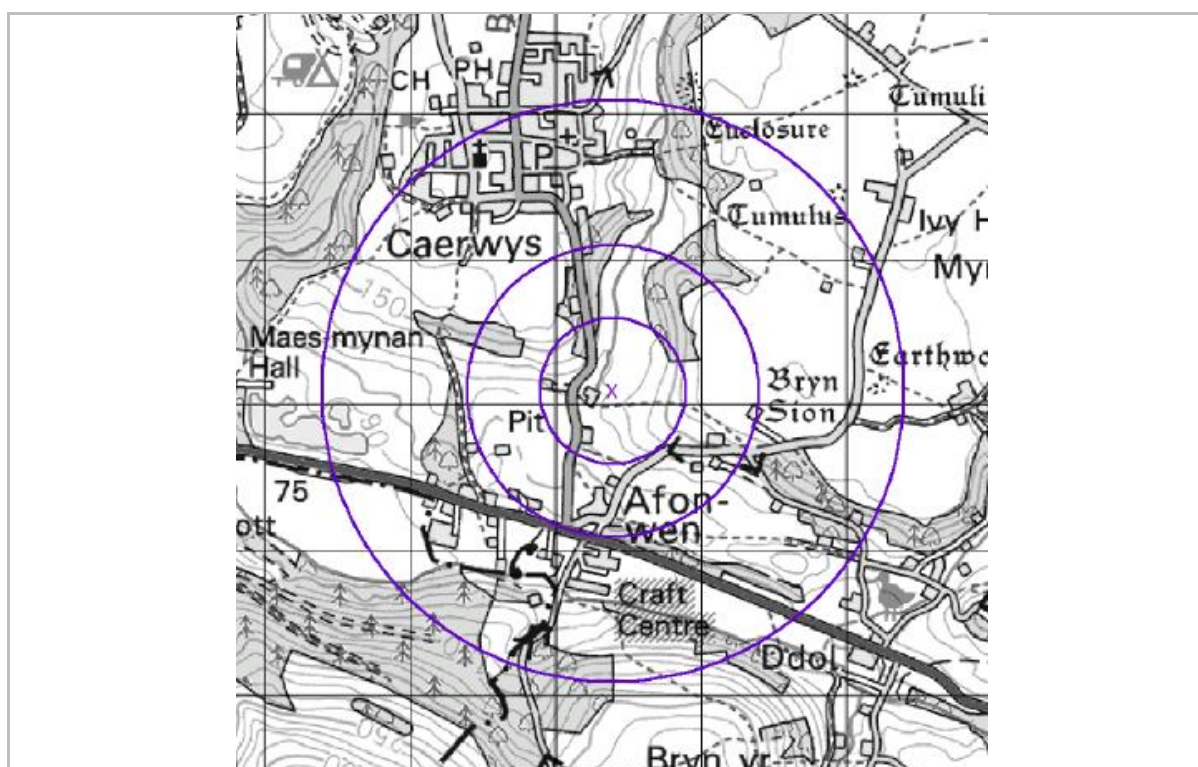


Figure 7. Groundwater Source Protection Zones associated with the site.

Source Protection Zones (SPZs) provide an indication of the risk to groundwater supplies that may result from potentially polluting activities and accidental releases of pollutants. Generally, the closer the activity or release is to a groundwater source the greater the risk. Three zones (an inner, outer and total catchment) are usually defined although a fourth zone (zone of special interest) is occasionally defined.

The Agency has subdivided groundwater source catchments into four zones. Two of these are determined by the travel time of potential pollutants, the third by the source catchment area itself and the fourth is a "Zone of Special Interest". This fourth zone highlights areas where known local conditions mean that potentially polluting activities could impact on a groundwater source even though the area is outside the normal catchment of that source.

- *Zone I (Inner Protection Zone)* - This zone is defined by a travel time of 50-days or less from any point within the zone at, or below, the water table. Additionally, the zone has, as a minimum, a 50-meter radius. It is based principally on biological decay criteria and is designed to protect against the transmission of toxic chemicals and water-borne disease.
- *Zone II (Outer Protection Zone)* - This zone is defined by the 400-day travel time, or 25% of the source catchment area, whichever is larger. The travel time is derived from consideration of the minimum time required to provide delay, dilution and attenuation of slowly degrading pollutants.
- *Zone III (Total catchment)* - This zone is defined as the total area needed to support the abstraction or discharge from the protected groundwater source.

5.5.2 Aquifer Vulnerability

The Groundwater Vulnerability maps are produced at a 1:100,000 scale. They show, by means of colour coding, those areas of the country where water-bearing rocks (aquifers) are present. They also show the vulnerability of groundwater to pollution. The aquifers are classified into Principal, Secondary and unproductive aquifers according to their physical properties and their consequent value as a resource.

The classification of the land surface reflects the ability of contaminants to leach through the covering soils and pose a potential risk to groundwater at depth. The maps also indicate areas where the presence of low permeability drift may provide additional groundwater protection.

These maps can therefore be used for an initial screening assessment of the vulnerability of groundwater to contaminants applied to the surface of the ground. They do not provide all information relevant to the determination of vulnerability, such as the depth to water table or nature of the drift deposits. Site-specific information would always be needed for a detailed assessment of vulnerability at a given location. The original groundwater vulnerability maps were produced some time ago.

Groundwater Vulnerability Maps provide information on how significant the ground waters are likely to be and if they are vulnerable to pollution occurring at the land surface. The maps have descriptions on them to explain the different aquifer and soil types.

Areas shown as principal aquifers have strategic significance for water resource; they often support large abstractions for the public water supply.

Secondary aquifers have a more localised significance to domestic, agricultural and industrial users (although they may still be used for drinking water). Unproductive aquifers do not store significant amounts of groundwater. However, in some areas they can support local supplies: e.g. small springs feeding individual properties.

5.5.3 Superficial Aquifer Designation

Figure 8 below shows that the Alluvium, Tufa and Glaciofluvial Ice Contact Deposit mapped on site are designated as a Secondary A Aquifer, such soils comprise *'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers'*.

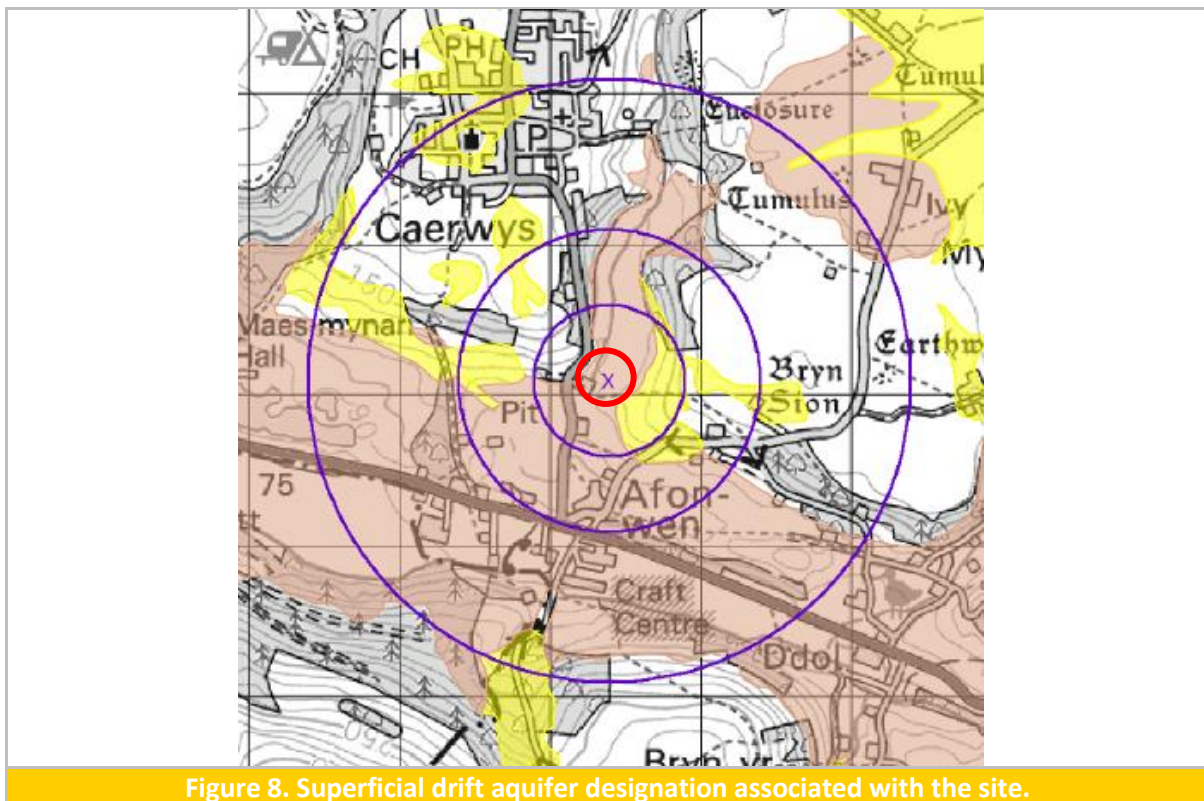
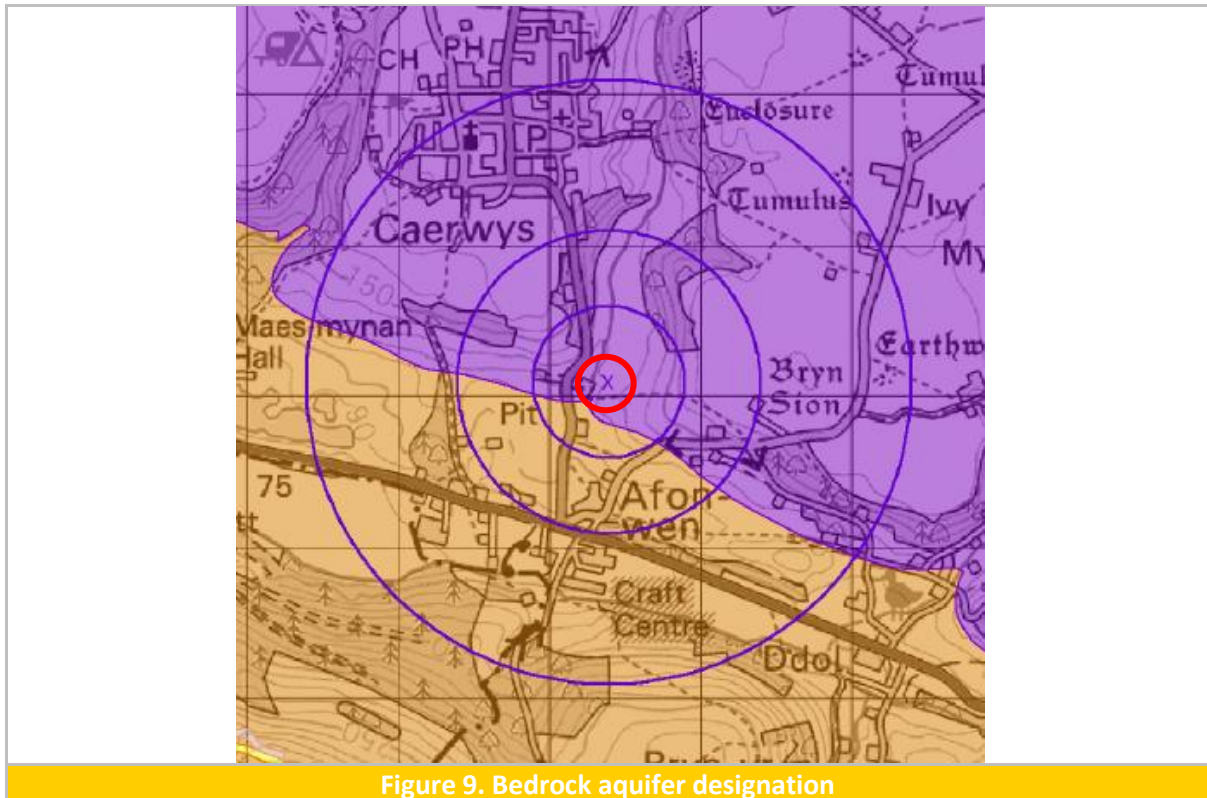


Figure 8. Superficial drift aquifer designation associated with the site.

5.5.4 Bedrock Aquifer Designation

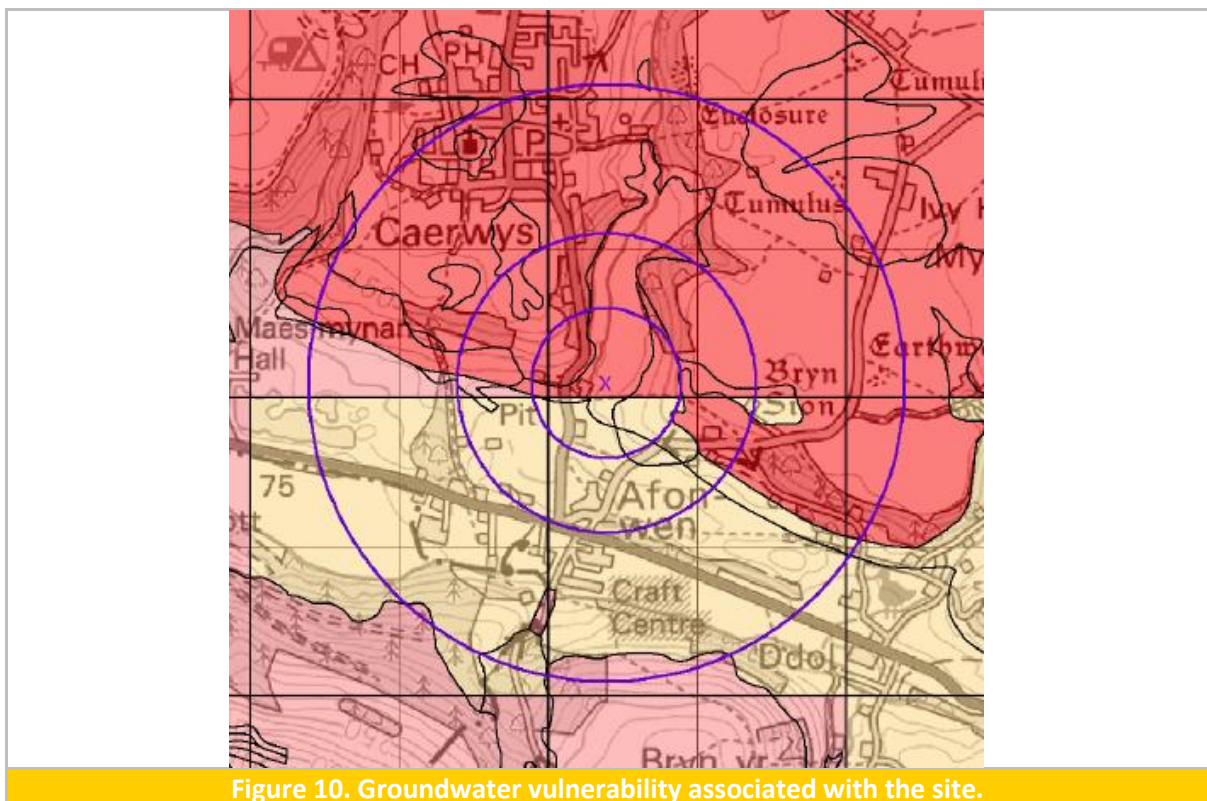
Figure 9 below shows that the Llamarmon Limestone is designated as a Principal Bedrock Aquifer, such soils *'have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifers'*.

However, there are no mapped abstraction points or groundwater source protection zones in close proximity to the subject site, indicating that the Principal aquifer underlying the site is not considered to be highly sensitive at this location.



5.5.5 Groundwater Vulnerability

Figure 10 below indicates that the site should be considered to be a high vulnerability Principal aquifer with regards to the bedrock, whilst the superficial deposits are listed as Secondary aquifer with high vulnerability.



5.5.6 Flood Risk

The site is predominantly situated within Flood Zone 1 land which is at low risk- less than 1 in 1,000 in any given year (Figure 11). A section of the site, in close proximity to the stream is mapped in Flood Zone 3 land. If areas of impermeable surfaces such as buildings, roads etc. are constructed on a greenfield site, a surface water management system designed in accordance with the principles of Sustainable Urban Drainage Schemes (SUDS) will be required.



Figure 11. Map of Flood Risk Zones

5.5.7 Wells in the vicinity of the site

There are no known listed wells or abstraction points mapped within close proximity to the site.

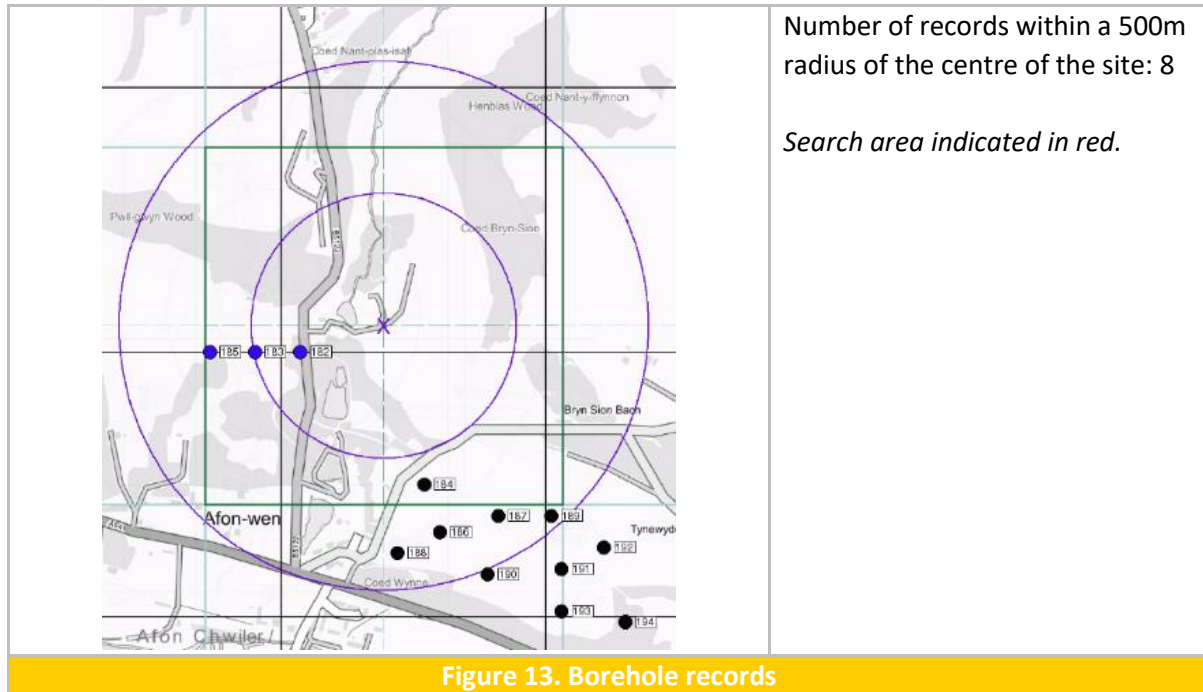


Number of records within a 500m radius of the centre of the site: 0

Figure 12. Well records

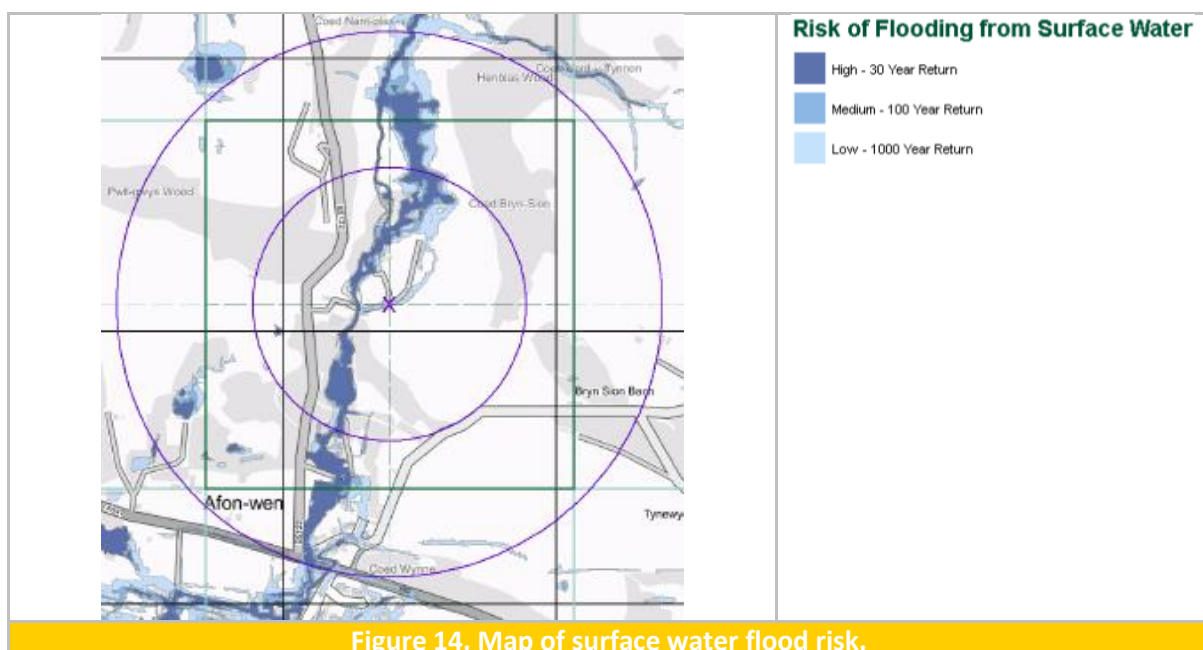
5.5.8 Borehole records in the vicinity of the site

There are 8 boreholes listed within 500m of the site, the boreholes to the southeast are confidential, whilst the boreholes to the west of the site do not contain any meaningful information.



5.6 Surface Water Issues

As shown in Figure 14 below, there is a surface water exceedance route which follows the topography and route of the existing surface water feature to the south. A second low risk surface water exceedance follows the route of the existing roadway before joining into the watercourse. Any works which might increase the risk of flooding on or off site needs to be identified and the risks assessed and mitigated using a suitable SUDS compliant approach.



6 Intrusive Investigations

Two phases of site investigation have been undertaken on the subject site, assessing different parcels of land for suitability of use for the proposed drainage field as shown in Figure 15 below



Figure 15. Site Investigation Location Plan

The first phase comprised a series of trial pits which were excavated on the 23rd August within the area bounded by the red line and the second phase comprised a series of windowless sampler boreholes which were drilled on the 7th September 2022 within the area bounded by the blue line.

6.1 Groundwater Investigation – Trial Pitting – August 2022

A series of 6 No. trial pits were excavated in two fields mapped to the east of the new road which provides access to the new holiday lodges. Both of these fields sit at a higher elevation (129m AOD to 124m AOD) than the water course and pond to the west which flows through site, which sits at approximately 118m AOD.

The trial pits were excavated at the locations shown below to maximum depths of 3.5m bgl. The trial pits were distributed across the entire site to assess soil variability and depth to groundwater.



Figure 16. Trial Pitting Location Plan

6.1.1 Soils as Found

Detailed soil logs are attached in Appendix A to which the reader is referred given the significant variability observed between trial pit locations.

The trial pits were excavated to maximum depths of 3.5m bgl and encountered highly variable soils generally comprising a covering of sandy Topsoil over interbedded white calcareous Silt, over dark brown saturated fibrous to pseudofibrous Peat which in turn overlies orange brown silty Sand or orange brown gravelly Sand.

It was noted during the excavation of the trial pits in the first field (TP101, TP102 and TP103) that the ground was soft underfoot and that during the excavation of the trial pits and subsequent tracking of the machine (13T) the soils were noted to dilate, causing significant vibration and ground movement. This could be indicative of very soft soils and/or saturated ground. This ground movement was not noted in the field to north where TP104, TP105 and TP106 were excavated.

Detailed images of the trial pits and associated arisings are attached in Appendix B.

6.1.2 Groundwater

During the excavation of the trial pits numerous shallow perched water strikes and more substantial water strikes were observed which are detailed in the attached trial pit logs and summarised in the table below:

Table 2. Water Strikes – Trial Pitting

Location	Comments
TP101	Soils were noted to be fully saturated below 1.4m bgl, especially the PEAT layers. Numerous water strikes were observed below 2.6m from all sides of the pit, slow to moderate ingress.
TP102	Soils were noted to be fully saturated below 2.3m bgl, especially the PEAT layer. Numerous water strikes were observed below 1.7m from all sides of the pit, slow to moderate ingress.
TP103	Soils were noted to be fully saturated below 1.2m bgl, especially the PEAT layer. Numerous water strikes were observed below 2.8m from all sides of the pit, slow to moderate ingress.
TP104	Soils were noted to be fully saturated below 2.0m bgl, especially the PEAT layer. Numerous water strikes were observed below 2.0m from all sides of the pit, slow to moderate ingress.
TP105	Soils were noted to be fully saturated below 2.0m bgl, especially the PEAT layer. Numerous water strikes were observed below 2.6m from all sides of the pit, slow to moderate ingress.
TP106	Soils were noted to be fully saturated below 2.0m bgl, especially the PEAT layer. Numerous water strikes were observed below 2.6m from all sides of the pit, slow to moderate ingress.

6.1.3 Trench Stability

The trial pits were observed to be generally stable in nature during the excavation of the pit and subsequent backfilling. It is likely however that trial pits left open for even a short period of time would be unstable and lead to unheralded sidewall collapses due to the weak and saturated nature of the soils encountered.

6.1.4 Land Gas

Land gas monitoring was not part of the scope of our investigation given the absence of an identified source. However we would note that within the Peat layers identified on site a strong organic and eggy odour was noted during the excavation of the trial pits.

6.1.5 Initial Recommendation

On the basis of the ground conditions encountered within the lower fields directly east of the new access road, we would consider these fields to be generally unsuitable for the proposed use as drainage field due to the potential for a shallow water table in wetter winter months and the highly variable ground conditions which would impact upon the calculated Vp rates across the drainage field.

If these areas are to be considered further, we would recommend installing groundwater monitoring wells to assess changes in water levels across the wet winter months. Once the peak depth to groundwater has been established, consideration could be given to raising ground levels with specific imported soils with a suitable percolation rate (V_p) to support the use of a drainage field at this location.

6.2 Groundwater Investigation – Windowless Sampling – September 2022

A series of 11 No. windowless sampler boreholes were drilled across the field to the east of the field initially investigated in August 2022 due to the unsuitable nature of the ground conditions.

In addition, as part of this work, a series of groundwater monitoring wells were installed to assess the potential shallow superficial groundwater table identified in the earlier trial pitting exercise in the lower field to the west (location of WLS108)



6.2.1 Soils as Found

Detailed soil logs are attached in Appendix A to which the reader is referred given the significant variability observed between boreholes locations.

The boreholes were drilled to maximum depths of 5.0m bgl and in general, with the exception of WLS108 which matches the earlier soils sequence identified in TP101-103, the soils comprised a mixture of reddish brown gravelly Clay and reddish brown gravelly Sand, which are considered to represent the Glacial Till soils which are shown to be mapped on this part of the site.

The soils, whilst consistent in composition were found to be highly varied in sequence and layering as commonly encountered within Glacial Till deposits. The nature of the identified soils would suggest that any aquifer within the superficial deposits may potentially be layered and contain numerous isolated perched water tables especially in the wetter winter months.

Table 3. Soils as Found – Windowless Sampler Boreholes

Depth m bgl (Top to Base)	Soil Type	Description
GL to 0.2m/0.3m	Topsoil	Grass over dark brown slightly clayey TOPSOIL with frequent fine roots.
0.2m to 1.0m (WLS102)	Sand	Reddish brown mottled grey gravelly silty SAND. Gravels comprise fine to coarse subangular limestone and mudstone.
0.2m/1.0m to 1.0m/4.0m	Gravelly Clay	Firm to stiff, reddish brown mottled grey silty CLAY. Gravels comprise fine to coarse subangular mudstone and limestone. Occasional thin lenses and laminations of fine SAND.
1.0m/4.0m to 5.0m+	Silty Sand	Reddish brown mottled grey gravelly silty SAND. Gravels comprise fine to coarse subangular limestone and mudstone.

At the location of WLS103, the Clay and the Sand layers were found to be reversed, with the sand layer being underlain by the clay layer.

6.2.2 Groundwater

During the drilling of the boreholes numerous isolated perched water strikes and potential groundwater strikes were observed, which are detailed in the attached borehole logs and summarised in the table below:

Table 4. Water Strikes – Boreholes

Location	Comments	Installation
WLS101	Dry on completion.	Yes to 5m bgl
WLS102	Seepages observed below 3.5m.	No - backfilled
WLS103	Dry on completion.	No - backfilled
WLS104	Dry on completion.	Yes to 5m bgl
WLS105	Seepages noted at 3.2m, 4.2m and 5.0m bgl.	Yes to 5m bgl
WLS106	Seepages noted at 1.9m bgl.	No - backfilled
WLS107	Seepages noted at 4.8m bgl.	Yes to 5m bgl
WLS108	Seepages noted below 1.2m bgl, moderate waterstrike at 4.2m.	Yes to 5m bgl
WLS109	Seepages noted at 3.1m bgl.	No - backfilled
WLS110	Dry on completion.	No - backfilled
WLS111	Dry on completion.	No - backfilled

6.2.3 Groundwater Monitoring

A initial groundwater monitoring visit was undertaken on the 21st September 2022, following a two week period where the monitoring wells were left to equilibrate following the drilling works. The table below summarises the results of the monitoring.

Table 5. Groundwater Monitoring – 21st September 2022

Location	Comments
WLS101	Dry
WLS104	Dry
WLS105	Dry
WLS107	Dry
WLS108	0.64m bgl

6.2.4 Land Gas

Following the identification of potentially gaseous soils in the previous investigation, a monitoring well has been installed at the location of WLS108 to facilitate any potential future land gas monitoring if deemed necessary.

6.2.5 Recommendation

On the basis of the ground conditions encountered within the higher field to the east of the previously investigated field, the identified ground conditions and recorded depths to water strikes in this field are generally considered to be suitable for use as a drainage field. We understand that the drainage designers, have undertaken Vp tests at this location to confirm suitability from a design perspective.

Groundwater monitoring wells have been installed in the shallow superficial soils and will be monitored on a regular basis throughout the winter months if required. However, if monitoring of the underlying bedrock aquifer at depth is requested by the NRW, then additional deeper boreholes will need to be drilled to depths of approximately 30-40m bgl based on our understanding of the likely depth to groundwater in this area. However, given the conditions encountered on site we would consider the superficial aquifer and the surface water features to the west to be the most likely receptors at risk.

7 Groundwater Risk Assessment

7.1 Site Specific information

The geological and Hydrogeological conditions beneath the site are set out in detail in Sections 5 and 6 of this report.

Of note, the site is situated on a Secondary A Aquifer which directly overlies a Principal bedrock aquifer. The site sits outside of any designated groundwater source protection zone, the nearest one is mapped approximately 2km to the north of the site, with a second mapped 4km to the southwest.

Intrusive investigations have identified that the proposed drainage field, which is 1434m² in area, will be situated on an area of ground where interbedded Glacial Till soils comprising reddish brown silty Clay and reddish brown silty Sand have been encountered. Initial groundwater monitoring of 5m deep boreholes have identified that these soils are dry to the base of each well and would therefore provide a significant unsaturated zone thickness beneath the proposed drainage field.

7.2 Drainage Field

The proposed drainage field has been designed in accordance with the calculated effluent volumes and the measured Vp rates at the proposed field location. In accordance with the criteria set out in (<https://www.gov.uk/guidance/infiltration-systems-groundwater-risk-assessments#risk-assessment-approach>), the site is required to meet the minimum criteria as set out below:

'The most important requirements to protect groundwater are that the discharge to a drainage field should not take place on land:

- 1. within 10m of the nearest watercourse*
- 2. within 50m of a well, spring, borehole or other source of water intended for human consumption*
- 3. that's steeply sloping or waterlogged*
- 4. where there's less than 1.2m depth to water table below the invert of the drainage pipes*
- 5. where percolation rates fall outside an upper and lower range of values*

1) Our walkover survey and desk top study has confirmed that the nearest surface water feature is 140m west of the site, comprising a spring fed stream which originates to the north of the site and flows to the south, through a former cement works where it joins the River Wheeler.

2) There are no known wells or springs within 50m of the site. The nearest spring originates upslope of the site to the north at an elevation of approximately 140m AOD and at a distance of approximately 400m from the proposed drainage field at its closest point.

3) The proposed drainage field sits at its highest point along the eastern boundary (147m AOD) and falls to the west down to 130m AOD along the fields western boundary. The average slope angle is 10.3 degrees, however we understand the proposed drainage field will be benched into the slope at a suitable level for the operation of a drainage field in accordance with the guidance. No evidence of waterlogging was noted in the proposed field, which comprises the eastern most field where the windowless sampler boreholes were drilled.

4) Site investigation and subsequent groundwater monitoring have identified no measurable water table to depths of upto 5m below the site level. Given the anticipated depth of the drainage field being approximately 0.6m bgl, the site is currently providing an unsaturated zone in excess of 4m thick.

5) Vp tests have been undertaken at the location of the drainage field which have been found to fall within the required range of values and are therefore considered to be suitable.

On the basis of the above, the proposed drainage field location meets all of the relevant criteria and is considered to be suitable.

7.3 Source of Potential Contamination

As part of any site development a conceptual model with regards to the source-pathway-receptor linkage is considered the best approach to understand the potential risks of onsite contamination, the pathway for migration and the receptor which would be considered at risk.

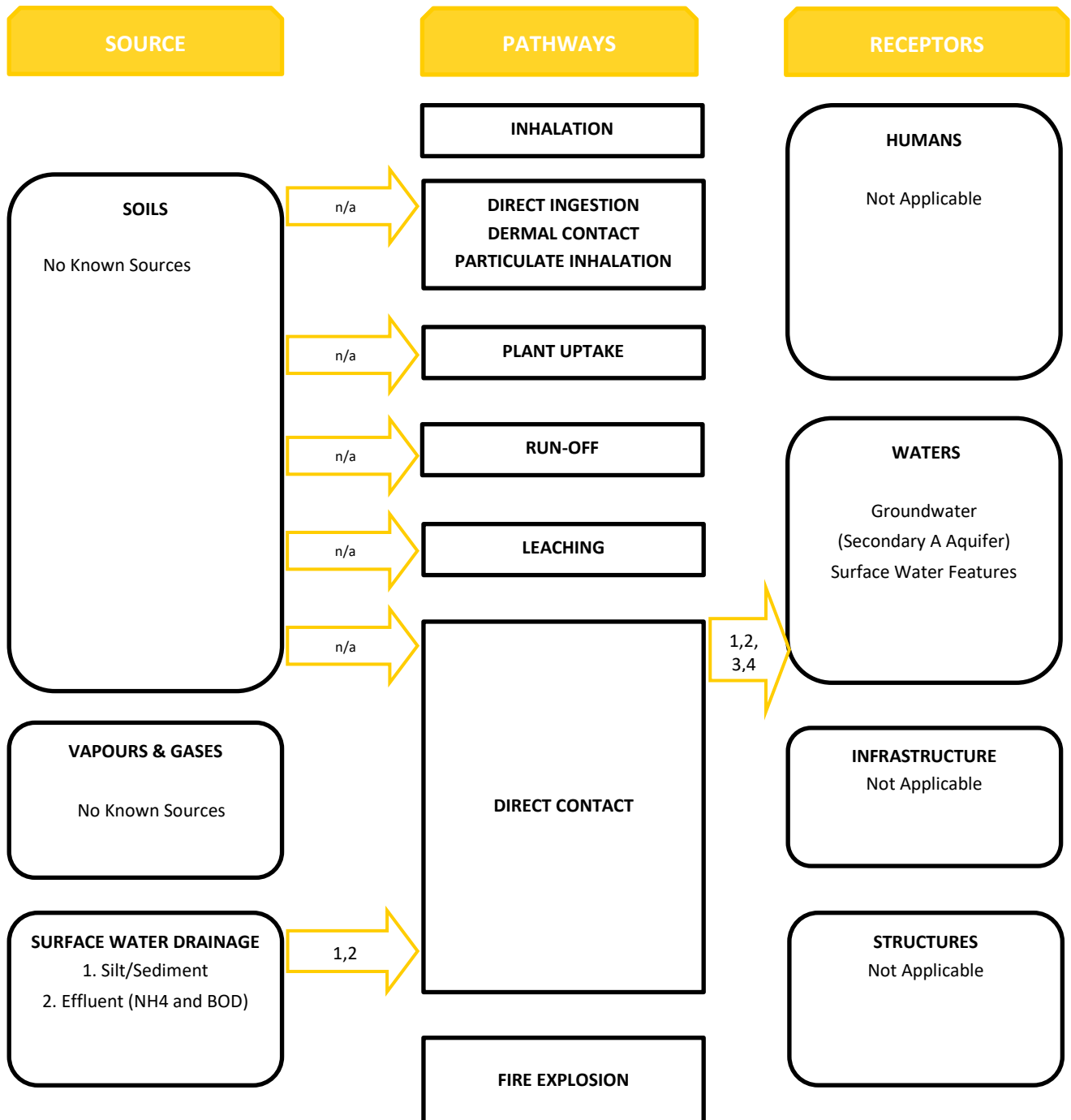
With respect to this development, the pathway is considered to be drainage field itself and the associated percolation through the underlying soils. The receptor, given the sites mapped geology and

topography, is considered to be the underlying Secondary A Superficial aquifer which is considered to be potentially in hydraulic continuity with the spring fed stream, which flows through the site and down the valley to the south where it meets the River Wheeler.

The identified sources of contamination are as follows:

- Ammonia and BOD from the discharge of the package treatment plant.
- Suspended Solids from the discharge of the package treatment plant

The following diagram identifies the known sources, pathways and potential receptors which are applicable the site.



7.3.1 Ammonia

A site specific pollutant assessment has been undertaken by LMB Geosolutions Ltd (LMB), on behalf of The CDS Group and the full report including calculation sheets is attached in Appendix F.

The assessment was based on the ground conditions identified during the intrusive investigation carried out by The CDS Group and assesses the impact of the primary pollutant, ammoniacal nitrogen on the off site receptors.

The following provides an extract from the risk assessment report:

The assessment of potential impacts associated with Ammoniacal Nitrogen on the underlying groundwater has been undertaken with the aid of the Environment Agency Groundwater risk assessment for treated effluent discharges to infiltration systems worksheet (InfWS) and associated user manual.

*The groundwater beneath the site is designated a Secondary (A) Aquifer but in this case is considered to be primarily a pathway to the River Wheeler which is considered to be the main receptor. The key risk driver is a non-hazardous pollutant and as such a compliance point of up to 250m could be considered. However, within this assessment a conservative approach has been adopted and an initial **compliance point of 50m** has been set in considering local surface water features as potential receptors.*

50m Compliance Point

The results of the InfWS risk assessment model for a 50m compliance point are appended and summarised in the table below:

Table 6. 50m Compliance Point Assessment

Key Risk Driver	Predicted Concentration (mg/l)		
Ammoniacal Nitrogen	Base of UZ	Groundwater below Drainage Field	Groundwater at 50m compliance
	4.94	4.87	0.855

The predicted concentration at the 50m compliance point is 0.855mg/l which is slightly above the relevant EQS of 0.75mg/l and would result in a provisional environmental permit limit of 4.39mg/l.

However, the upper field where the drainage field is proposed is approximately 135m east of the River Wheeler (from its western boundary).

60m Compliance Point

The results of the InfWS risk assessment model for a 60m compliance point are appended and summarised in the table below:

Table 7. 60m Compliance Point Assessment

Key Risk Driver	Predicted Concentration (mg/l)		
Ammoniacal Nitrogen	Base of UZ	Groundwater below Drainage Field	Groundwater at 50m compliance
	4.94	4.87	0.701

The predicted concentration at the 60m compliance point is 0.701mg/l which is below the relevant EQS of 0.75mg/l and would result in a provisional environmental permit limit of 5.35mg/l.

Conclusions & Recommendations

The results of the assessment suggest that potential impacts from the proposed drainage system on groundwater within the Secondary (A) Aquifer would be minimal and that impacts to the River Wheeler would be negligible. On this basis the proposed discharge concentration of 5mg/l of Ammoniacal Nitrogen is considered to be appropriate.

8 Maintenance Schedule

The operators of the site, Darwin (Plas Isaf) Ltd, will be responsible for the maintenance and upkeep of the foul water system to the manufacturers requirements.

8.1 Foul Drainage System

Maintenance procedures should be put in place to ensure that the functionality of the foul water drainage system is not compromised.

Foul water drainage features that require maintenance:

1. Manholes, inspection chambers, dissipation chambers, pipework etc
2. 1 No. Foul water pump chamber.
3. 1 No. Sewage treatment plant.

For that reason, it is proposed the following maintenance plan and schedule is adopted:

Table 8. Maintenance plan and schedule

Maintenance Schedule	Required Action	Recommended Frequency	Feature ID
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then every 6 months thereafter.	1 2 3
	Manholes, inspection chambers, dissipation chambers, pipework, etc	At least once a year, once always after Autumn. Or as required.	1
	Wash down and clean out of pump sumps.	Once every 6 months. Or as required.	2
	Regular maintenance of sewage treatment plant to ensure it is kept in working order.	As per manufacturers guidance.	3
Monitoring	Inspect/check all inlets, outlets etc to ensure they are in good condition and operating as designed.	Every month for 3 months and then every 6 months.	1 2 3

Maintenance Schedule	Required Action	Recommended Frequency	Feature ID
	Visual inspection survey at every inspection point (followed by CCTV if necessary).	After every significant storm event and every 3 years.	1 2 3
	Inspection of pumps to ensure they are in working order and operating as designed.	Weekly	3
	Inspection of sewage treatment plant to ensure proper operation.	As per manufacturers guidance.	3
Remedial Actions	Repair/rehabilitation of inlets, outlets etc	As required.	1 2 3
	Repair/service/replacement of pumps if they cease to operate as designed.	As required.	2
	Repair of sewage treatment plant in the event of the system breaking down.	As required.	3

The checks and inspections carried out within the running in period should determine the frequency of the future inspections and the above is subject to change if areas of the drainage systems are deemed to require more regular maintenance.

The maintenance plan and schedule will be the responsibility of the site owner and/or operator.

8.2 Package Treatment Plant

The Kingspan BN Biodisc, which is designed to serve a PE of 300 with a maximum daily flow of 60000l is proposed to be configured to reduce the Ammonia levels to 5mg/l in comparison to the usual 20mg/l. The plant will require desludging and maintenance in line with the manufacturers requirements , or more frequently if required. Water samples should be taken from the sampling chamber or discharge pipe regularly to ensure the plant is operating as required and is meeting the reduced Ammonia level of 5mg/l.

9 Conclusion

The result of our ground investigation works to date has identified that the lower field, where the trial pitting works were undertaken is not considered suitable for use due to the identified ground conditions and potential shallow water table in the Peat soils. The eastern most field, which sits at a higher elevation, was found to be more suited to the proposed use for a drainage field, and meets the requirements set out in the government guidance document.

Subsequent monitoring has identified that soils are dry to a depth of upto 5m bgl.

Based on the site specific data, a Hydrogeological Risk Assessment of the potential pollutant impact has been undertaken which shows that the proposed drainage field and calculated pollutant loading of 5mg/l ammoniacal nitrogen is considered to be appropriate and would not pose a significant risk to the River Wheeler to the southwest or to the underlying Secondary A superficial aquifer.

10 Reporting Details


Report Author: Darryl Kelly MGeol FGS

Verification: Peter Steele MEng GMICE

Date: 3rd October 2022


APPENDIX A

SOIL LOGS

			Project Name:		Trial Pit Log		Hole ID:	TP102
			Plas Isaf Lodge Park				Hole Type:	TP
			Project Location:				Level:	123.50m AOD
			Caerwys Hill, Mold, Caerwys, CH7 5AD		Project ID:	CDS-Plas Isaf-22	Logged By:	DK
			Client:		Contractor:	The CDS Group	Scale:	1:20
			Darwin (Plas Isaf) Ltd		Date:	23/08/2022	Page No:	Sheet 1 of 1

Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	Vertical Scale
▼	0.20	123.30	(0.20m)		Grass over brown fine sandy TOPSOIL with occasional brick and pottery and fine rootlets.	0.5
			(0.30m)		Stiff, dry, orange brown fine sandy SUBSOIL with frequent fine roots.	
	0.50	123.00		(0.30m)		
			0.80		122.70	
▼	2.30	121.20	(1.20m)		Soft to firm, saturated pale grey brown clayey fine to medium SAND. Dilating <i>Mottled orange brown in places and occasional stiff grey clay lenses.</i>	2.5
					Below 3.0m occasional layers of fine to coarse subrounded limestone gravel.	
	3.50	120.00			End of Trial Pit at 3.000m	3.5

Dimensions		Trial Pit Support and Stability			Groundwater Strikes
Pit Length (m)	Pit Width (m)	Pit Stability	Shoring Used	Remarks	Remarks
3.50	1.30	Stable in the short term	None		

Remarks Soils saturated below 2.3m, dilating. Numerous waterstrikes below 1.7m bgl, from all sides of the pit. Waterstrikes speeding up over time from slow to moderate ingress. Likely to be unstable in open excavation if left open unsupported.	
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<div>CDS</div> <div>Environmental Solutions</div>			Project Name:		Trial Pit Log		Hole ID:	TP103	
			Plas Isaf Lodge Park				Hole Type:	TP	
			Project Location:				Level:	122.40m AOD	
			Caerwys Hill, Mold, Caerwys, CH7 5AD		Project ID:	CDS-Plas Isaf-22	Logged By:	DK	
			Client:		Contractor:	The CDS Group	Scale:	1:20	
			Darwin (Plas Isaf) Ltd		Date:	23/08/2022	Page No:	Sheet 1 of 1	
Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description		Vertical Scale		
▼	0.30	122.10	(0.30m)		Grass over brown fine sandy TOPSOIL with occasional gravel and fine rootlets.		0.5		
	0.95	121.45	(0.65m)		Firm, off white mottled black calcareous sandy SILT with occasional fine roots and thin laminations of dark brown organic materials.				
					Soft/Loose, dark brown mottled black highly organic amorphous to fibrous PEAT. Organic material comprises fibrous roots, bark and branches/ trunks. Occasional rectangular wood fragments.				
					<i>Soils soft and unconsolidated. Very strong eggy odour and damp from 1.0m.</i>				
▼	2.80	119.60	(1.85m)		Very soft, saturated, off white fine gravelly sandy SILT with occasional grey clay lenses. Dilating.		1.0		
	3.40	119.00			(0.60m)	<i>Waterstrikes below 2.8m, slow ingress.</i>		1.5	
						End of Trial Pit at 3.400m		2.0	
								2.5	
Dimensions		Trial Pit Support and Stability				Groundwater Strikes			
Pit Length (m)	Pit Width (m)	Pit Stability		Shoring Used	Remarks	Remarks			
3.50	1.30	Stable in the short term		None					
Remarks									
Soils saturated below 1.2m, dilating. Numerous waterstrikes below 2.8m bgl, from all sides of the pit. Waterstrikes speeding up over time from slow to moderate ingress. Likely to be unstable in open excavation if left open unsupported.									

CDS

Environmental Solutions

Project Name:

Plas Isaf Lodge Park

Project Location:

Caerwys Hill, Mold, Caerwys, CH7 5AD

Client:

Darwin (Plas Isaf) Ltd

Trial Pit Log

Project ID:

CDS-Plas Isaf-22

Contractor:

The CDS Group

Date:

23/08/2022

Hole ID:

TP104

Hole Type:

TP

Level:

124.40m AOD

Logged By:

DK

Scale:

1:20

Page No:

Sheet 1 of 1

Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	Vertical Scale
▼	0.30	124.10	(0.30m)		Grass over brown fine sandy loamy TOPSOIL with occasional fine gravel and roots.	0.5
	0.70	123.70	(0.40m)		Firm orange brown mottled grey silty CLAY with fine subrounded limestone gravel.	
					Firm, off white mottled orange fine sandy SILT.	
	1.10	123.30	(0.40m)		Firm, highly organic, dark brown clayey PEAT with abundant pseudofibrous to fibrous plant and wood remains.	
					Firm, off white mottled orange fine sandy SILT with occasional lenses of Peat and charcoal.	
	1.90	122.50	(0.40m)		Firm, orange brown mottled grey clayey, gravelly fine to medium SAND. Gravels comprise fine to medium subrounded dark grey limestone and igneous materials. <i>Soils damp with occasional pockets of organic SAND.</i>	
▼	2.50	121.90	(0.60m)		Loose (est) grey, fine to coarse sandy GRAVEL. Gravels comprise fine to coarse and cobble sized subrounded dark grey limestone and igneous materials. <i>Running sands encountered along with fast water strike.</i>	2.0
	3.30	121.10	(0.80m)		End of Trial Pit at 3.300m	2.5
						3.5

Dimensions		Trial Pit Support and Stability			Groundwater Strikes
Pit Length (m)	Pit Width (m)	Pit Stability	Shoring Used	Remarks	Remarks
3.50	1.30	Stable in the short term	None		

Remarks

Soils saturated below 2.0m, dilating. Numerous waterstrikes below 2.0m bgl, from all sides of the pit. Waterstrikes speeding up over time from slow to moderate ingress. Likely to be unstable in open excavation if left open unsupported.

CDS

Environmental Solutions

Project Name:

Plas Isaf Lodge Park

Project Location:

Caerwys Hill, Mold, Caerwys, CH7 5AD

Client:

Darwin (Plas Isaf) Ltd

Trial Pit Log

Project ID:

CDS-Plas Isaf-22

Contractor:

The CDS Group

Date:

23/08/2022

Hole ID:

TP105

Hole Type:

TP

Level:

125.20m AOD

Logged By:

DK

Scale:

1:20

Page No:


Sheet 1 of 1

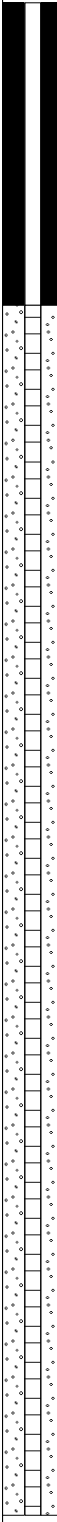

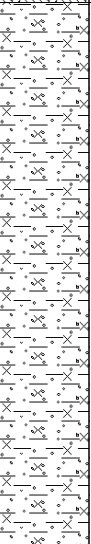
Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	Vertical Scale
<div>▼</div> <div>▼</div>	0.25	124.95	(0.25m)		Grass over brown fine sandy loamy TOPSOIL with occasional fine gravel and roots.	<div>0.5</div> <div>1.0</div> <div>1.5</div> <div>2.0</div> <div>2.5</div> <div>3.0</div> <div>3.5</div>
	0.35	124.85	(0.10m)		Firm orange brown mottled grey silty CLAY with fine subrounded limestone gravel.	
					Firm, off white mottled orange sandy fine gravelly calcareous SILT with frequent fine roots.	
					Soils damp and saturated below 1.2.	
			(2.25m)		At 1.6m pockets of organic Peat.	
	2.60	122.60	(0.40m)		Soft/Loose, dark brown mottled black highly organic amorphous to fibrous PEAT. Organic material comprises fibrous roots, bark and branches/trunks.	
	3.00	122.20			Rapid water strike at 2.6 Strong eggy odour noted.	
			(0.50m)		Firm, grey brown, organic rich silty CLAY with fibrous organic remains.	
	3.50	121.70			End of Trial Pit at 3.500m	

Dimensions		Trial Pit Support and Stability			Groundwater Strikes
Pit Length (m)	Pit Width (m)	Pit Stability	Shoring Used	Remarks	Remarks
3.50	1.30	Stable in the short term	None		

Remarks


Soils saturated below 2.0m, dilating. Numerous waterstrikes below 2.6m bgl, from all sides of the pit. Waterstrikes speeding up over time from slow to moderate ingress. Likely to be unstable in open excavation if left open unsupported.

		Project Name:		Windowless Sampler Borehole Log				Hole ID:		WLS101	
		Plas Isaf Lodge Park						Hole Type:		WLS	
		Project Location:						Level:		143.10m AOD	
		Caerwys Hill, Mold, Caerwys, CH7 5AD		Project ID:		CDS-Plas Isaf-22		Logged By:		CW	
		Client:		Contractor:		The CDS Group		Scale:		1:25	
		Darwin (Plas Isaf) Ltd		Date:		07/09/2022		Page No:		Sheet 1 of 1	

Well	Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	
		0.30	142.80	(0.30)		Dark brown slightly clayey TOPSOIL with fine rootlets	1
		2.10	141.00	(1.80)		Red-brown / grey mottled gravelly silty CLAY. Gravels consist of fine to coarse sub-angular mudstone & limestone.	
						Red-brown / grey mottled gravelly sandy silty CLAY. Gravels consist of fine to coarse sub-angular mudstone & limestone. Lenses of fine red-brown SAND.	
						4.70	138.40
		5.00	138.10	End of Borehole at 5.000m			

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks									
Dry upon completion									



CDS

Environmental Solutions

Project Name:

Plas Isaf Lodge Park

Project Location:

Caerwys Hill, Mold, Caerwys, CH7 5AD

Client:

Darwin (Plas Isaf) Ltd

Windowless Sampler Borehole Log

Project ID:

CDS-Plas Isaf-22

Contractor:

The CDS Group

Date:

08/09/2022

Hole ID:

WLS102

Hole Type:

WLS

Level:

131.50m AOD

Logged By:

CW

Scale:

1:25

Page No:


Sheet 1 of 1



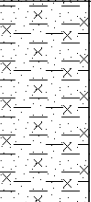
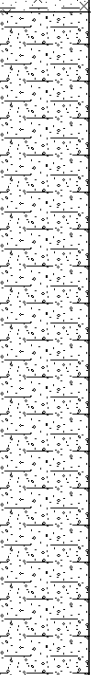
Well	Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	
		0.20	131.30	(0.20)		Dark brown slightly clayey TOPSOIL with fine rootlets	<div>1</div> <div>2</div> <div>3</div> <div>4</div> <div>5</div>
		1.00	130.50	(0.80)		Red-brown slightly clayey very gravelly SAND. Gravels consist of fine to coarse sub-angular limestone / mudstone.	
				(1.10)		Red-brown / grey mottled gravelly silty sandy CLAY. Gravels consist of fine to coarse sub-angular mudstone & limestone.	
				(2.90)		Red-brown slightly clayey very gravelly SAND. Gravels consist of fine to coarse sub-angular limestone / mudstone.	
		5.00	126.50			End of Borehole at 5.000m	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks


Seepage at 3.50m bgl

		Project Name:		Windowless Sampler Borehole Log				Hole ID:		WLS103	
		Plas Isaf Lodge Park						Hole Type:		WLS	
		Project Location:						Level:		135.40m AOD	
		Caerwys Hill, Mold, Caerwys, CH7 5AD		Project ID:		CDS-Plas Isaf-22		Logged By:		CW	
		Client:		Contractor:		The CDS Group		Scale:		1:25	
		Darwin (Plas Isaf) Ltd		Date:		08/09/2022		Page No:		Sheet 1 of 1	

Well	Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	
		0.20	135.20	(0.20)		Dark brown slightly clayey TOPSOIL with fine rootlets	1
		0.90	134.50	(0.70)		Red-brown silty sandy CLAY	
				(2.20)		Red-brown slightly clayey very gravelly SAND. Gravels consist of fine to coarse sub-angular limestone / mudstone. Scattered red-brown CLAY bands	
		3.10	132.30				
5.00	130.40				End of Borehole at 5.000m	5	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks
Dry upon completion



CDS

Environmental Solutions

Project Name:

Plas Isaf Lodge Park

Project Location:

Caerwys Hill, Mold, Caerwys, CH7 5AD

Client:

Darwin (Plas Isaf) Ltd

Windowless Sampler Borehole Log

Project ID:

CDS-Plas Isaf-22

Contractor:

The CDS Group

Date:

07/09/2022

Hole ID:

WLS104

Hole Type:

WLS

Level:

128.50m AOD

Logged By:

CW

Scale:

1:25

Page No:

Sheet 1 of 1

Well	Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	
		0.30	128.20	(0.30)		Dark brown slightly clayey TOPSOIL with fine rootlets	
		1.00	127.50	(0.70)		Red-brown sandy gravelly CLAY with rootlets. Gravels consist of fine to medium limestone	
				(4.00)		Red-brown slightly clayey very gravelly SAND. Gravels consist of fine to coarse sub-angular limestone / mudstone. Occasional cobbles.	
					End of Borehole at 5.000m		
		5.00	123.50				

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

Dry upon completion

CDS

Environmental Solutions

Project Name:

Plas Isaf Lodge Park

Project Location:

Caerwys Hill, Mold, Caerwys, CH7 5AD

Client:

Darwin (Plas Isaf) Ltd

Windowless Sampler Borehole Log

Project ID:

CDS-Plas Isaf-22

Contractor:

The CDS Group

Date:

07/09/2022

Hole ID:

WLS105

Hole Type:

WLS

Level:

136.30m AOD

Logged By:

CW

Scale:

1:25

Page No:

Sheet 1 of 1

Well	Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	
		0.30	136.00	(0.30)		Dark brown slightly clayey TOPSOIL with fine rootlets	1
				(1.60)		Red-brown / grey mottled gravelly silty CLAY. Gravels consist of fine to coarse sub-angular mudstone & limestone.	
		1.90	134.40	(1.00)		Red-brown slightly clayey very gravelly SAND. Gravels consist of fine to coarse sub-angular limestone / mudstone.	2
		2.90	133.40	(0.20)		Red-brown / grey mottled gravelly silty CLAY. Gravels consist of fine to coarse sub-angular mudstone & limestone.	3
	▼	3.10	133.20	(1.40)		Red-brown slightly clayey very gravelly SAND. Gravels consist of fine to coarse sub-angular limestone / mudstone.	
						Red-brown silty CLAY	4
						Red-brown silty CLAY	
						Red-brown / grey mottled gravelly silty CLAY. Gravels consist of fine to coarse sub-angular mudstone & limestone.	
	▼	4.50	131.80	(0.50)		Red-brown SAND lense	5
	▼	5.00	131.30			End of Borehole at 5.000m	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

Seepages recorded at 3.20, 4.20 & 5.00m bgl.

C

D

S

Environmental Solutions

Project Name:

Plas Isaf Lodge Park

Project Location:

Caerwys Hill, Mold, Caerwys, CH7 5AD

Client:

Darwin (Plas Isaf) Ltd

Windowless Sampler Borehole Log

Project ID:

CDS-Plas Isaf-22

Contractor:

The CDS Group

Date:

08/09/2022

Hole ID:

WLS106

Hole Type:

WLS

Level:

130.80m AOD

Logged By:

CW

Scale:

1:25

Page No:

Sheet 1 of 1


Well	Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	
	▼	0.30	130.50	(0.30)		Dark brown slightly clayey TOPSOIL with fine rootlets	1
				(1.20)		Red-brown gravelly silty slightly sandy CLAY. Gravels consist of fine to coarse sub-angular limestone. Scattered quartzite cobbles.	
		1.50	129.30	(0.40)		Red-brown fine SAND	2
		1.90	128.90	(1.00)		Red-brown very sandy silty CLAY	
		2.90	127.90	(2.10)		<div>Ironstone staining</div> <div>Red-brown slightly clayey very gravelly SAND. Gravels consist of fine to coarse sub-angular limestone / mudstone.</div>	
5.00	125.80			End of Borehole at 5.000m	5		

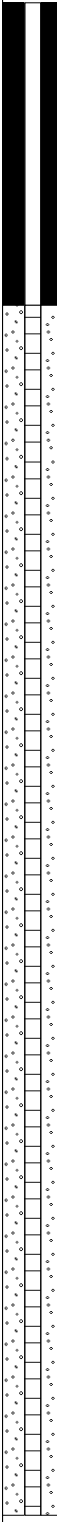

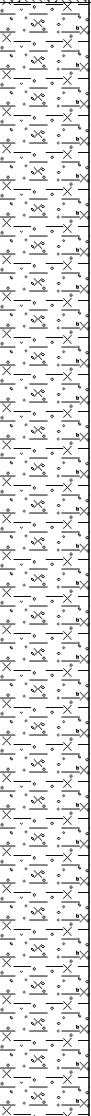
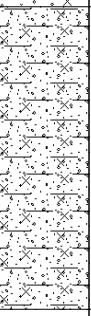
Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks


Seepage at 1.90m bgl

AGS

		Project Name:		Windowless Sampler Borehole Log				Hole ID:		WLS107	
		Plas Isaf Lodge Park						Hole Type:		WLS	
		Project Location:						Level:		128.10m AOD	
		Caerwys Hill, Mold, Caerwys, CH7 5AD		Project ID:		CDS-Plas Isaf-22		Logged By:		CW	
		Client:		Contractor:		The CDS Group		Scale:		1:25	
		Darwin (Plas Isaf) Ltd		Date:		07/09/2022		Page No:		Sheet 1 of 1	

Well	Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	
		0.30	127.80	(0.30)		Dark brown slightly clayey TOPSOIL with fine rootlets	1
						Red-brown / grey mottled gravelly silty CLAY. Gravels consist of fine to coarse sub-angular mudstone & limestone.	
		4.00	124.10	(3.70)			2
						Red-brown slightly clayey very gravelly SAND. Gravels consist of fine to coarse sub-angular limestone / mudstone.	3
		5.00	123.10	(1.00)			4
						End of Borehole at 5.000m	5

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks Seepage at 4.80m bgl										

CDS

Environmental Solutions

Project Name:

Plas Isaf Lodge Park

Project Location:

Caerwys Hill, Mold, Caerwys, CH7 5AD

Client:

Darwin (Plas Isaf) Ltd

Windowless Sampler Borehole Log

Project ID:

CDS-Plas Isaf-22

Contractor:

The CDS Group

Date:

07/09/2022

Hole ID:

WLS108

Hole Type:

WLS

Level:

122.70m AOD

Logged By:

CW

Scale:

1:25

Page No:

Sheet 1 of 1

Well	Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description		
		0.40	122.30	(0.40)		Brown clayey silty TOPSOIL with fine rootlets	1	
				(1.60)		Soft, dark brown / black, highly organic clayey PEAT with fibrous plant and wood remains.		
		2.00	120.70	(0.50)		Soft, saturated off white mottled grey and orange fine gravelly SILT with occasional thin laminations of black peat.	2	
				(0.50)		Soft, dark brown, highly organic clayey PEAT with plant and wood remains and rare shell fragments.		
		3.00	119.70	(0.30)		Soft, saturated off white mottled grey and orange fine gravelly SILT with occasional thin laminations of black peat.	3	
				(0.50)		Soft, dark brown, highly organic clayey PEAT with fibrous plant and wood remains.		
		3.80	118.90	(0.40)		Soft, saturated off white mottled grey and orange fine gravelly SILT with occasional thin laminations of black peat.	4	
				(0.80)		Light brown very clayey fine SAND		
		5.00	117.70	End of Borehole at 5.000m				5

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

Seepage at 1.20m bgl. Slow becoming moderate water strike at 4.20m bgl.

<div>CDS</div> <div>Environmental Solutions</div>		Project Name:		Windowless Sampler Borehole Log				Hole ID:		WLS109	
		Plas Isaf Lodge Park						Hole Type:		WLS	
		Project Location:						Level:		131.90m AOD	
		Caerwys Hill, Mold, Caerwys, CH7 5AD		Project ID:		CDS-Plas Isaf-22		Logged By:		CW	
		Client:		Contractor:		The CDS Group		Scale:		1:25	
		Darwin (Plas Isaf) Ltd		Date:		08/09/2022		Page No:		Sheet 1 of 1	
Well	Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description					
<div></div>	<div></div>	0.30	131.60	(0.30)	<div></div>	Dark brown slightly clayey TOPSOIL with fine rootlets					
		2.90	129.00	(2.60)	<div></div>	Red-brown very sandy silty CLAY with scattered angular limestone gravels.					
				(2.10)	<div></div>	Red-brown fine SAND with occasional red-brown silty CLAY bands					
5.00	126.90			End of Borehole at 5.000m							
Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation
Remarks										<div>AGS</div>	
Seepage at 3.10m bgl											

CDS

Environmental Solutions

Project Name:

Plas Isaf Lodge Park

Project Location:

Caerwys Hill, Mold, Caerwys, CH7 5AD

Client:

Darwin (Plas Isaf) Ltd

Windowless Sampler Borehole Log

Project ID:

CDS-Plas Isaf-22

Contractor:

The CDS Group

Date:

08/09/2022

Hole ID:

WLS110

Hole Type:

WLS

Level:

130.50m AOD

Logged By:

CW

Scale:

1:25

Page No:

Sheet 1 of 1

Well	Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	
		0.20	130.30	(0.20)		Dark brown slightly clayey TOPSOIL with fine rootlets	<div>1</div> <div>2</div> <div>3</div> <div>4</div> <div>5</div>
				(3.00)		Red-brown slightly clayey very gravelly SAND. Gravels consist of fine to coarse sub-angular limestone / mudstone.	
		3.20	127.30	(0.80)		Red-brown very gravelly SAND. Gravels consist of fine to coarse angular limestone & mudstone	
		4.00	126.50			End of Borehole at 4.000m	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

Dry upon completion

AGS

CDS

Environmental Solutions

Project Name:

Plas Isaf Lodge Park

Project Location:

Caerwys Hill, Mold, Caerwys, CH7 5AD

Client:

Darwin (Plas Isaf) Ltd

Windowless Sampler Borehole Log

Project ID:

CDS-Plas Isaf-22

Contractor:

The CDS Group

Date:

08/09/2022

Hole ID:

WLS111

Hole Type:

WLS

Level:

128.70m AOD

Logged By:

CW

Scale:

1:25

Page No:

Sheet 1 of 1

Well	Water Strikes	Depth (m)	Level (m)	Thickness (m)	Legend	Stratum Description	
		0.50	128.20	(0.50)		Dark brown slightly clayey TOPSOIL with fine rootlets	1
				(2.50)		Red-brown very gravelly SAND. Gravels consist of fine to coarse angular limestone & mudstone	
		3.00	125.70			End of Borehole at 3.000m	3
							4
							5

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

Dry upon completion

APPENDIX B

PHOTOGRAPHS



TP101 – Upper 1m profile



TP101 – Organic Peat laminations



TP101 – Organic Peat soils



TP101 – Water strike from saturated soils



TP102 - Upper 1m profile



TP102 – Highly organic clayey soils



TP102 – Organic Peat overlying saturated sand



TP102 – Seepages from sand layer



TP103 – Upper 1m profile



TP103 – Organic Peat laminations



TP103 – Organic Peat soils



TP103 – Running sands



TP104 – Upper 1m profile



TP104 – Peat layers



TP104 – Water strike in sand/gravel



TP104 – Side wall collapse due to running sands



TP105 – Upper 1m profile



TP105 – Organic Peat soils



Existing pond and siphon drain



View of drainage field to the east of the site



Former Stone Quarry near old corn mill



Shallow stream feeding into pond



Shallow stream feeding into pond




Downslope outfall from siphon drain in pond

APPENDIX C









ENVIROCHECK REPORT

Geology 1:50,000 Maps Legends








Artificial Ground and Landslip





Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	MGR	Made Ground (Undivided)	Artificial Deposit	Not Supplied - Holocene

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Not Supplied - Holocene
	GFCD	Glaciofluvial Ice Contact Deposits, Devensian	Sand and Gravel	Not Supplied - Devensian
	TILLD	Till, Devensian	Diamicton	Not Supplied - Devensian
	TUFA	Tufa	Tufa, Calcareous	Not Supplied - Quaternary
	HEAD	Head	Clay, Silt, Sand and Gravel	Not Supplied - Quaternary
	ALF	Alluvial Fan Deposits	Sand and Gravel	Not Supplied - Quaternary
	RTDU	River Terrace Deposits (Undifferentiated)	Sand and Gravel	Not Supplied - Quaternary
	LDE	Lacustrine Deposits	Clay and Silt	Not Supplied - Quaternary

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	LGHF	Loggerheads Limestone Formation	Limestone	Not Supplied - Visean
	CFML	Cefn Mawr Limestone Formation	Limestone and [Subequal/Subordinate] Argillaceous Rocks, Interbedded	Not Supplied - Visean
	LNML	Llanarmon Limestone Formation	Limestone	Not Supplied - Visean
	LEEL	Leete Limestone Formation	Limestone	Not Supplied - Visean
	FOF	Foel Formation	Limestone and [Subequal/Subordinate] Argillaceous Rocks, Interbedded	Not Supplied - Visean
	EY	Elwy Formation	Mudstone, Siltstone and Sandstone	Not Supplied - Ludlow
	EY	Elwy Formation	Sandstone	Not Supplied - Ludlow

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	EY	Elwy Formation	Slumped Mudstone, Slumped Siltstone and Slumped Sandstone	Not Supplied - Ludlow
	NGF	Nantglyn Flags Formation	Mudstone and Siltstone	Not Supplied - Wenlock
	NGF	Nantglyn Flags Formation	Sandstone	Not Supplied - Wenlock
		Faults		

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Geology 1:50,000 Maps

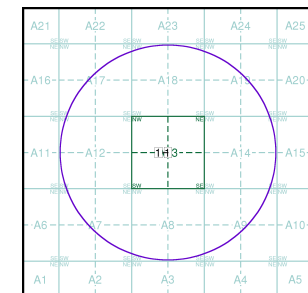
This report contains geological map extracts taken from the BGS Digital Geological map of Great Britain at 1:50,000 scale and is designed for users carrying out preliminary site assessments who require geological maps for the area around the site. This mapping may be more up to date than previously published paper maps.

The various geological layers - artificial and landslip deposits, superficial geology and solid (bedrock) geology are displayed in separate maps, but superimposed on the final 'Combined Surface Geology' map. All map legends feature on this page. Not all layers have complete nationwide coverage, so availability of data for relevant map sheets is indicated below.

Geology 1:50,000 Maps Coverage

Map ID: 1
Map Sheet No: 108
Map Name: Flint
Map Date: 1999
Bedrock Geology: Available
Superficial Geology: Available
Artificial Geology: Available
Faults: Not Supplied
Landslip: Available
Rock Segments: Not Supplied

Geology 1:50,000 Maps - Slice A



Order Details:

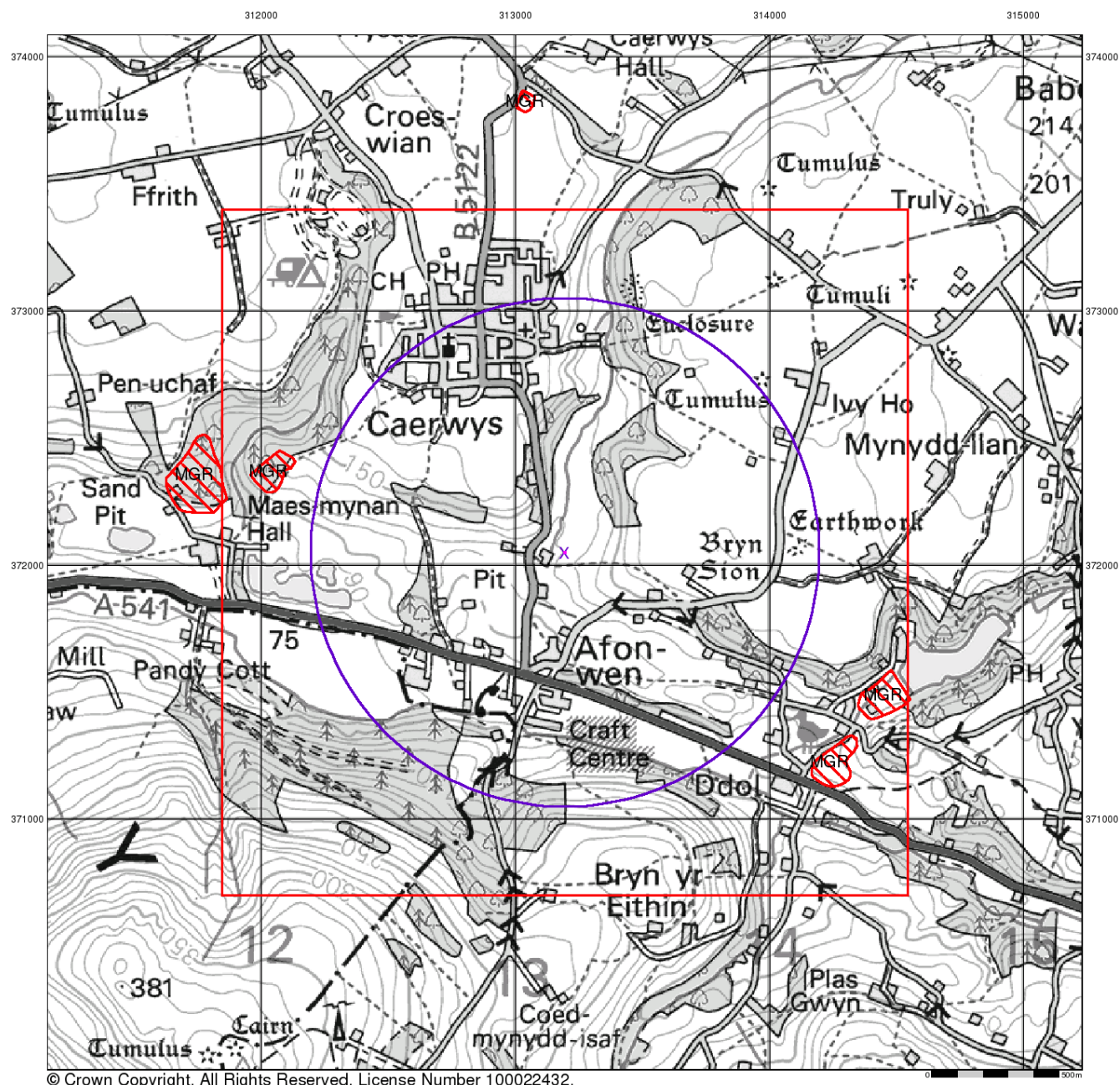
Order Number: 301428802_1_1
Customer Reference: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details:

Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541 Junction, AFONWEN, CH7 5AD

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Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



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Artificial Ground and Landslip

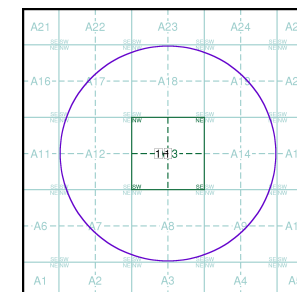
Artificial ground is a term used by BGS for those areas where the ground surface has been significantly modified by human activity. Information about previously developed ground is especially important, as it is often associated with potentially contaminated material, unpredictable engineering conditions and unstable ground.

Artificial ground includes:

- Made ground - man-made deposits such as embankments and spoil heaps on the natural ground surface.
- Worked ground - areas where the ground has been cut away such as quarries and road cuttings.
- Infilled ground - areas where the ground has been cut away then wholly or partially backfilled.
- Landscaped ground - areas where the surface has been reshaped.
- Disturbed ground - areas of ill-defined shallow or near surface mineral workings where it is impracticable to map made and worked ground separately.

Mass movement (landslip) deposits on BGS geological maps are primarily superficial deposits that have moved down slope under gravity to form landslips. These affect bedrock, other superficial deposits and artificial ground. The dataset also includes foundered strata, where the ground has collapsed due to subsidence.

Artificial Ground and Landslip Map - Slice A



Order Details:

Order Number: 301428802_1_1
 Customer Reference: CDS-Plas Isaf -22
 National Grid Reference: 313190, 372050
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details:

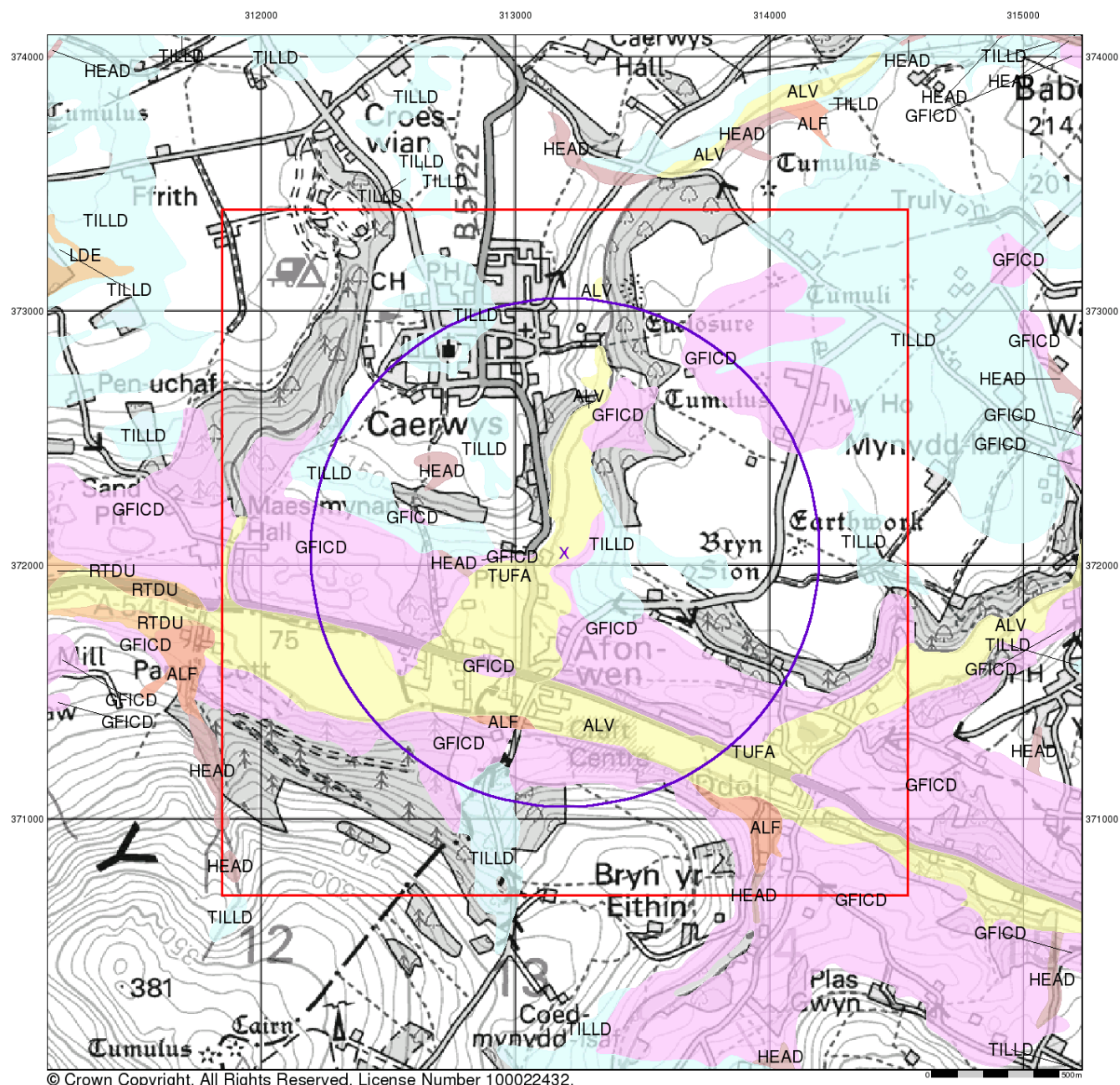
Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541 Junction, AFONWEN, CH7 5AD

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v15.0 20-Sep-2022

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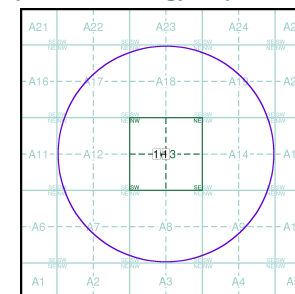
Superficial Geology

Superficial Deposits are the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 1.8 million years from the present.

They rest on older deposits or rocks referred to as Bedrock. This dataset contains Superficial deposits that are of natural origin and 'in place'. Other superficial strata may be held in the Mass Movement dataset where they have been moved, or in the Artificial Ground dataset where they are of man-made origin.

Most of these Superficial deposits are unconsolidated sediments such as gravel, sand, silt and clay, and onshore they form relatively thin, often discontinuous patches or larger spreads.

Superficial Geology Map - Slice A



Order Details:

Order Number: 301428802_1_1
 Customer Reference: CDS-Plas Isaf -22
 National Grid Reference: 313190, 372050
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details:

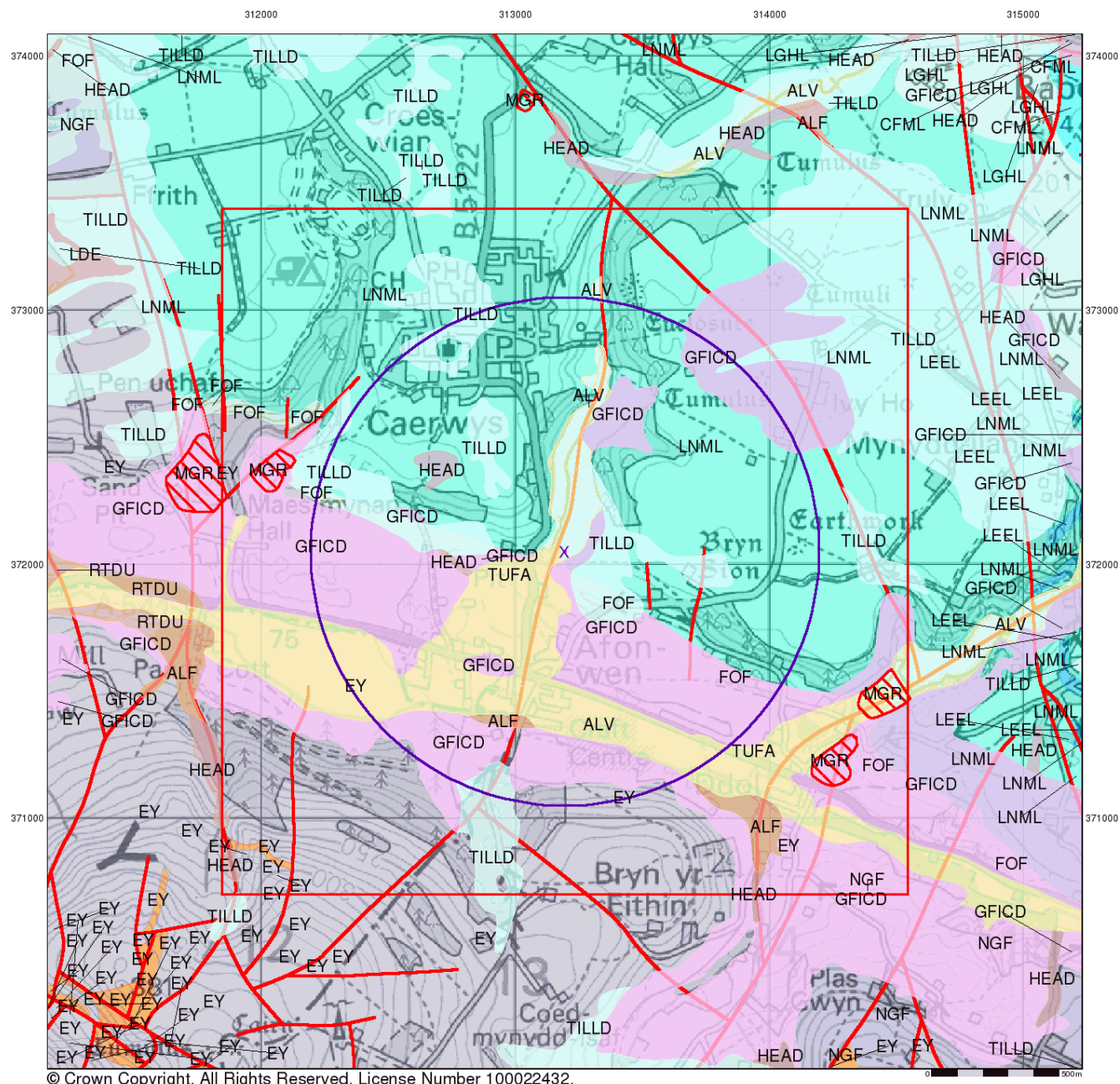
Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541 Junction, AFONWEN, CH7 5AD

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 Fax: 0844 844 9951
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Combined Surface Geology

The Combined Surface Geology map combines all the previous maps into one combined geological overview of your site.

Please consult the legends to the previous maps to interpret the Combined "Surface Geology" map.

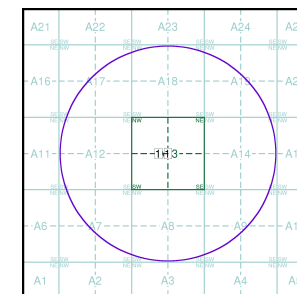
Additional Information

More information on 1:50,000 Geological mapping and explanations of rock classifications can be found on the BGS website. Using the LEX Codes in this report, further descriptions of rock types can be obtained by interrogating the 'BGS Lexicon of Named Rock Units'. This database can be accessed by following the 'Information and Data' link on the BGS website.

Contact

British Geological Survey
Kingsley Dunham Centre
Keyworth
Nottingham
NG12 5GG
Telephone: 0115 936 3143
Fax: 0115 936 3276
email: enquiries@bgs.ac.uk
website: www.bgs.ac.uk

Combined Geology Map - Slice A



Order Details:

Order Number: 301428802_1_1
Customer Reference: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details:

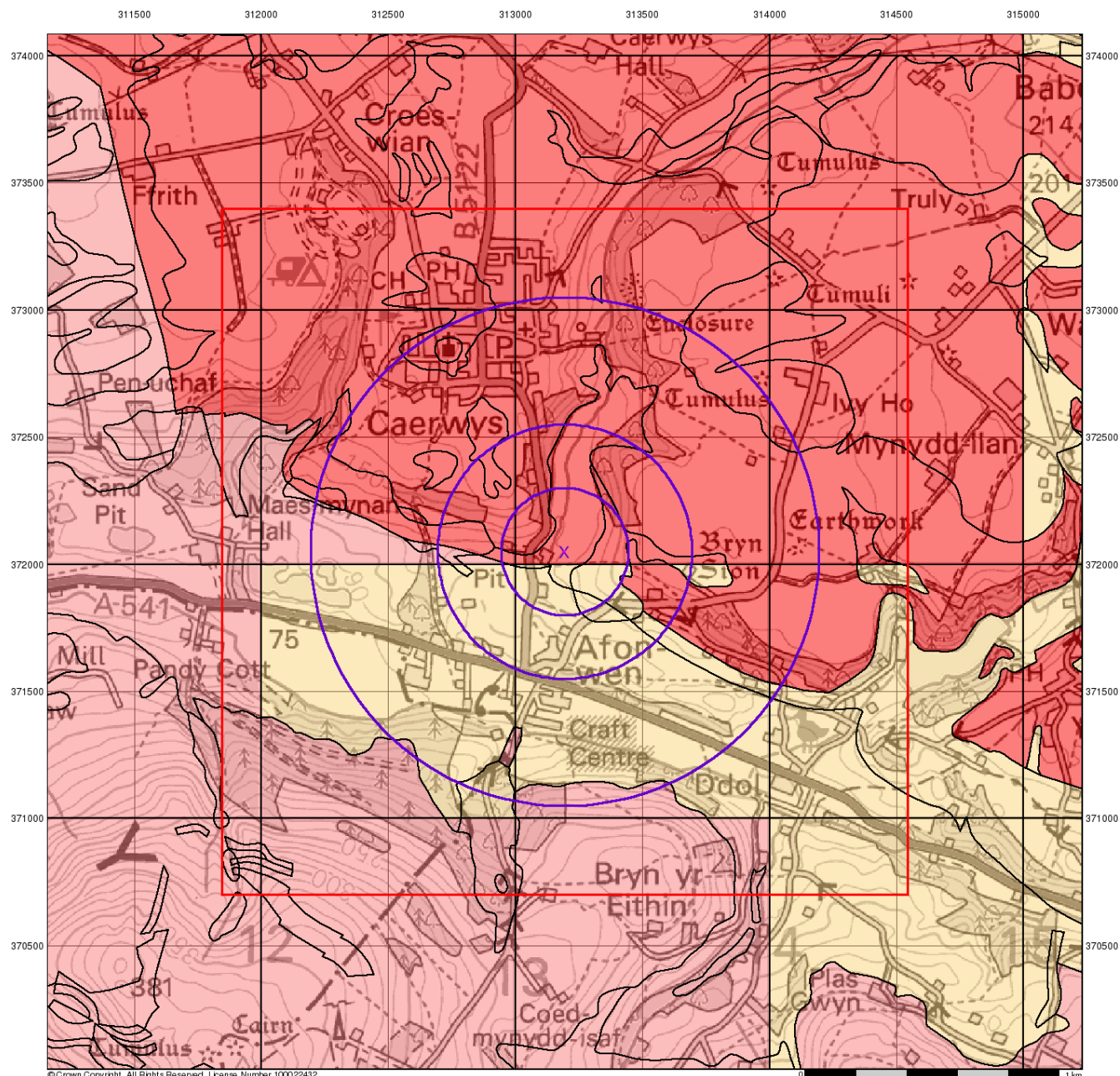
Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541 Junction, AFONWEN, CH7 5AD

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Groundwater Vulnerability

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Agency and Hydrological

Bedrock Aquifers

- High Vulnerability, Principal Aquifer
- High Vulnerability, Secondary Aquifer
- Medium Vulnerability, Principal Aquifer
- Medium Vulnerability, Secondary Aquifer
- Low Vulnerability, Principal Aquifer
- Low Vulnerability, Secondary Aquifer

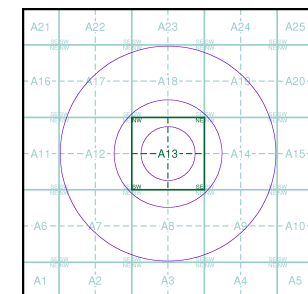
Superficial Aquifers

- High Vulnerability, Principal Aquifer
- High Vulnerability, Secondary Aquifer
- Medium Vulnerability, Principal Aquifer
- Medium Vulnerability, Secondary Aquifer
- Low Vulnerability, Principal Aquifer
- Low Vulnerability, Secondary Aquifer

Unproductive Aquifer

Soluble Rock

Site Sensitivity Context Map - Slice A



Order Details

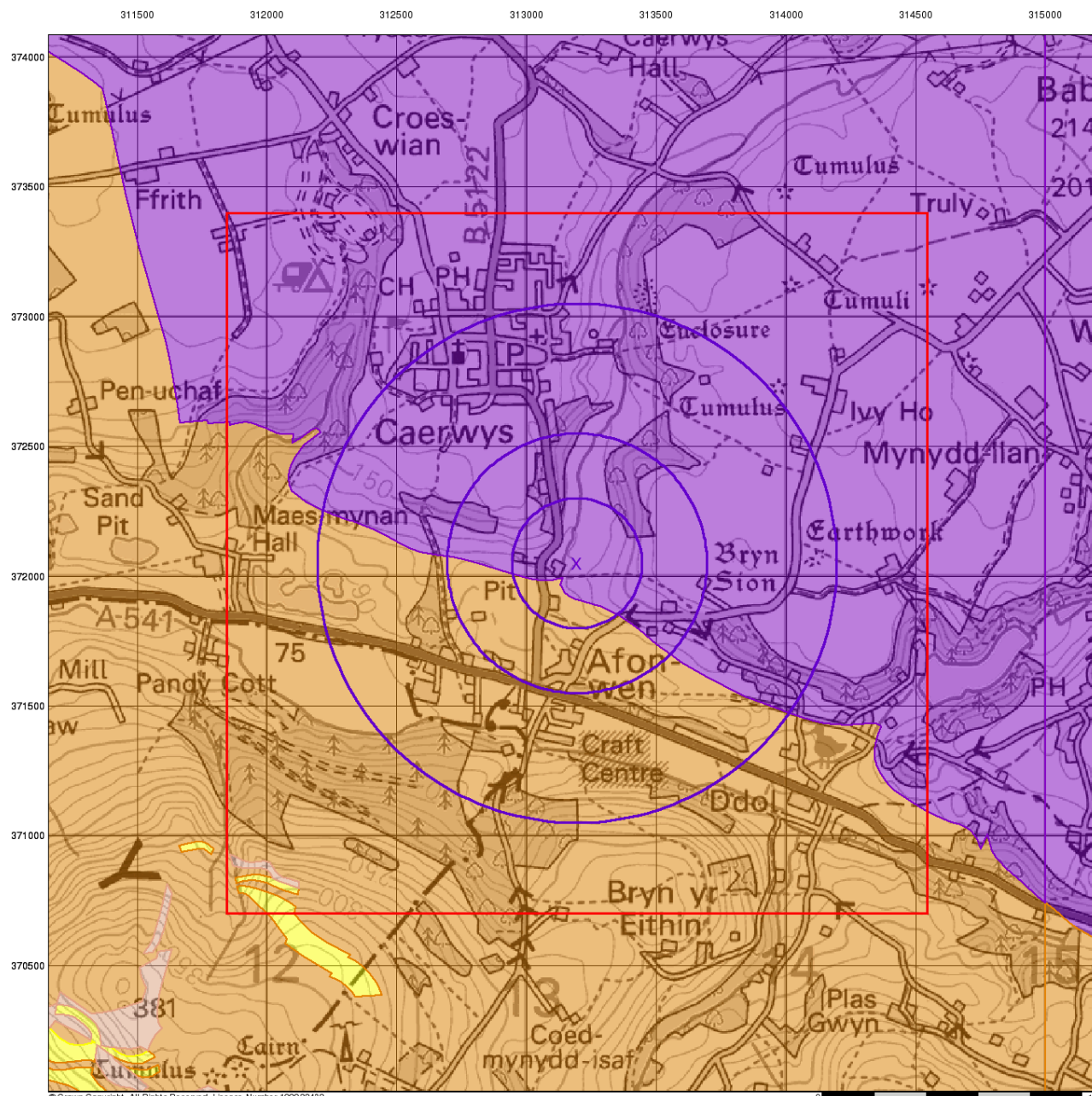
Order Number: 301428802_1_1
 Customer Ref: CDS-Plas Isaf -22
 National Grid Reference: 313190, 372050
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details

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0 1 km

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Bedrock Aquifer Designation

General

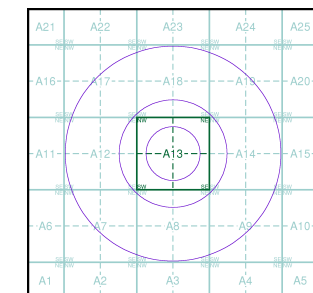
- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A



Order Details

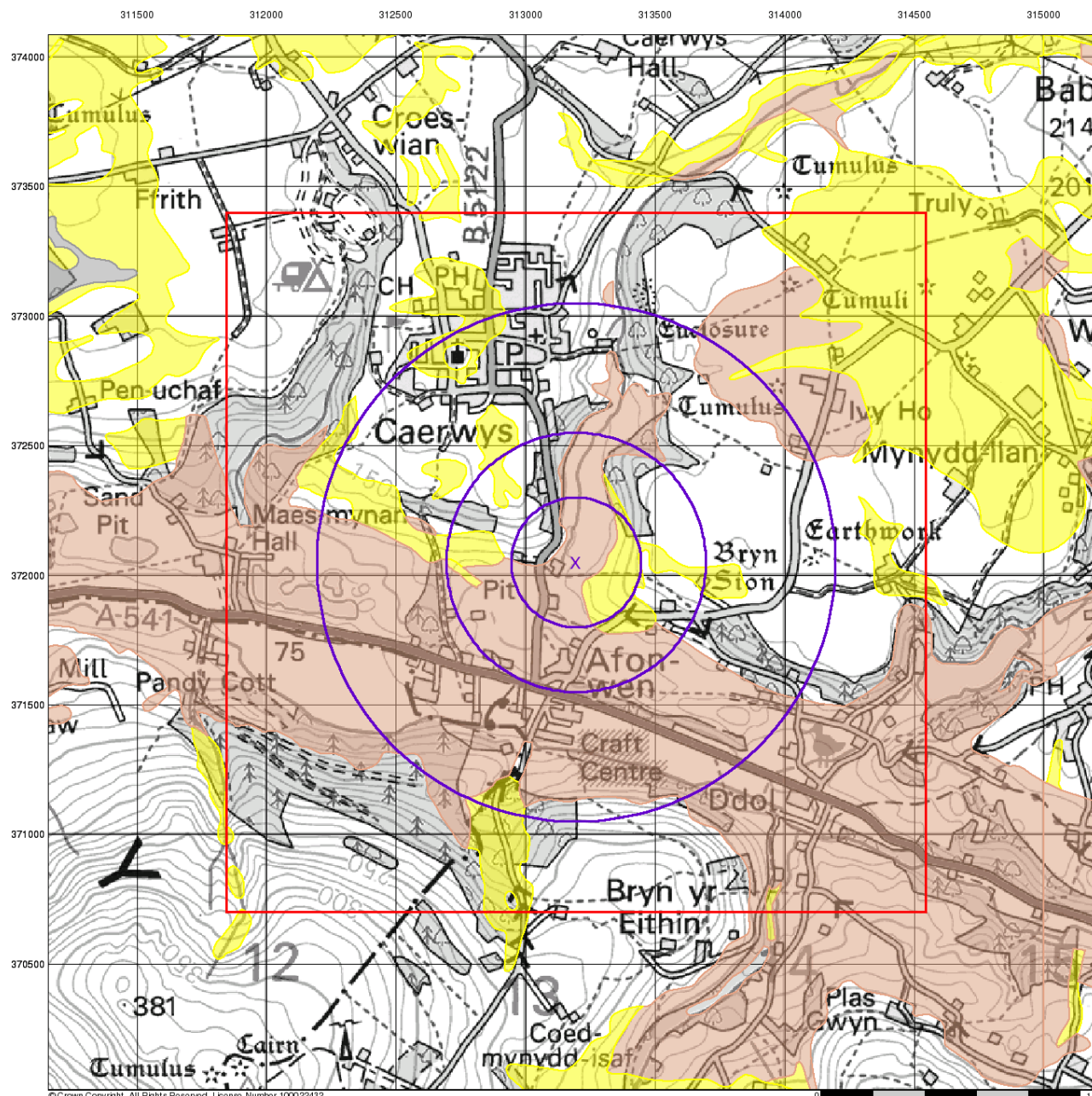
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 Customer Ref: CDS-Plas Isaf -22
 National Grid Reference: 313190, 372050
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

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Superficial Aquifer Designation

General

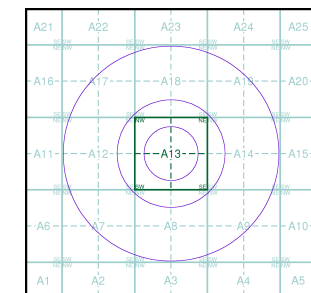
- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A



Order Details

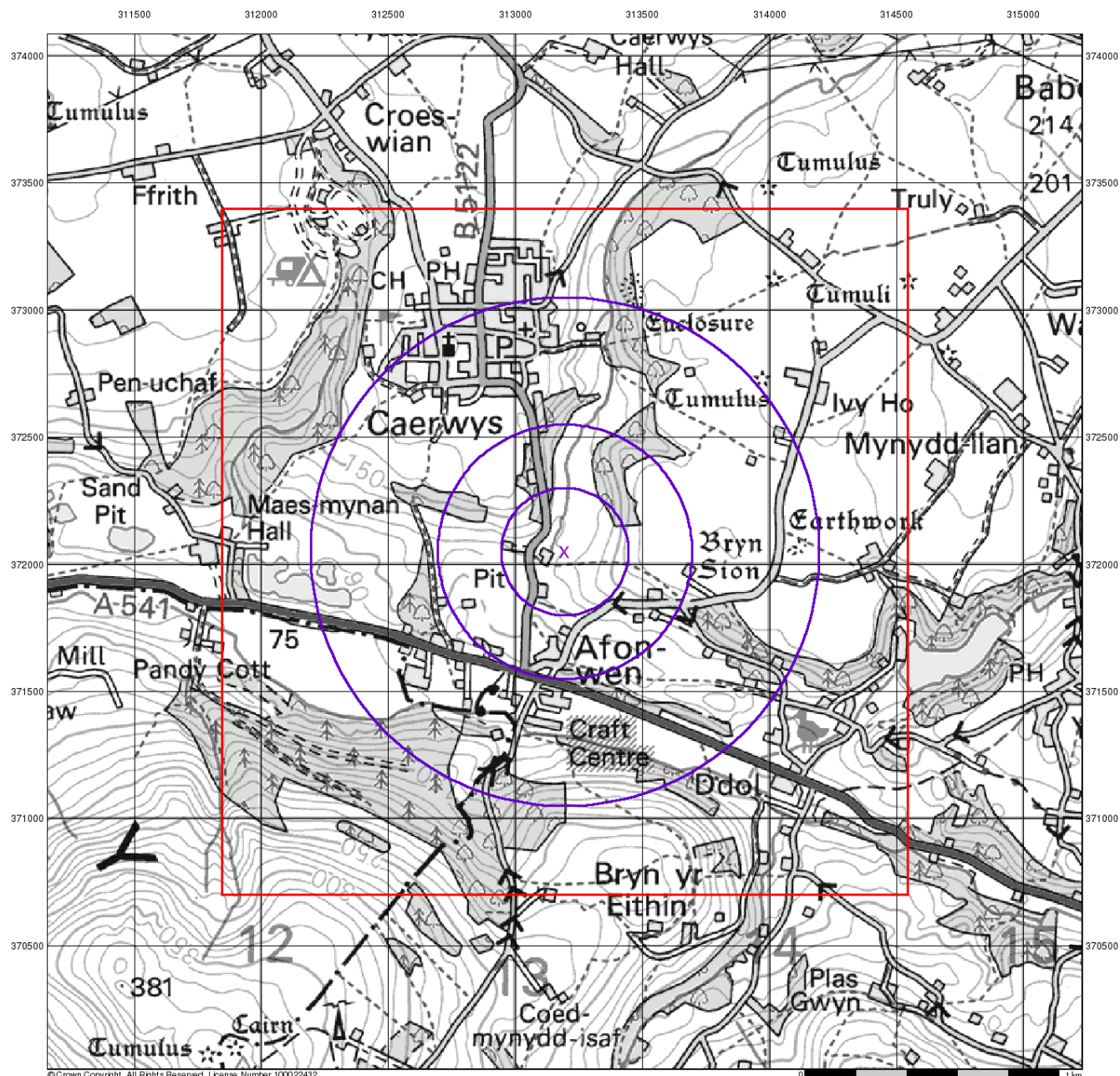
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 Customer Ref: CDS-Plas Isaf -22
 National Grid Reference: 313190, 372050
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details

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Source Protection Zones

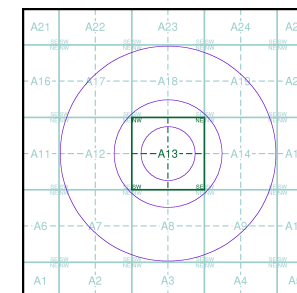
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Agency and Hydrological

- Inner zone (Zone 1)
- Inner zone - subsurface activity only (Zone 1c)
- Outer zone (Zone 2)
- Outer zone - subsurface activity only (Zone 2c)
- Total catchment (Zone 3)
- Total catchment - subsurface activity only (Zone 3c)
- Special interest (Zone 4)

Site Sensitivity Context Map - Slice A



Order Details

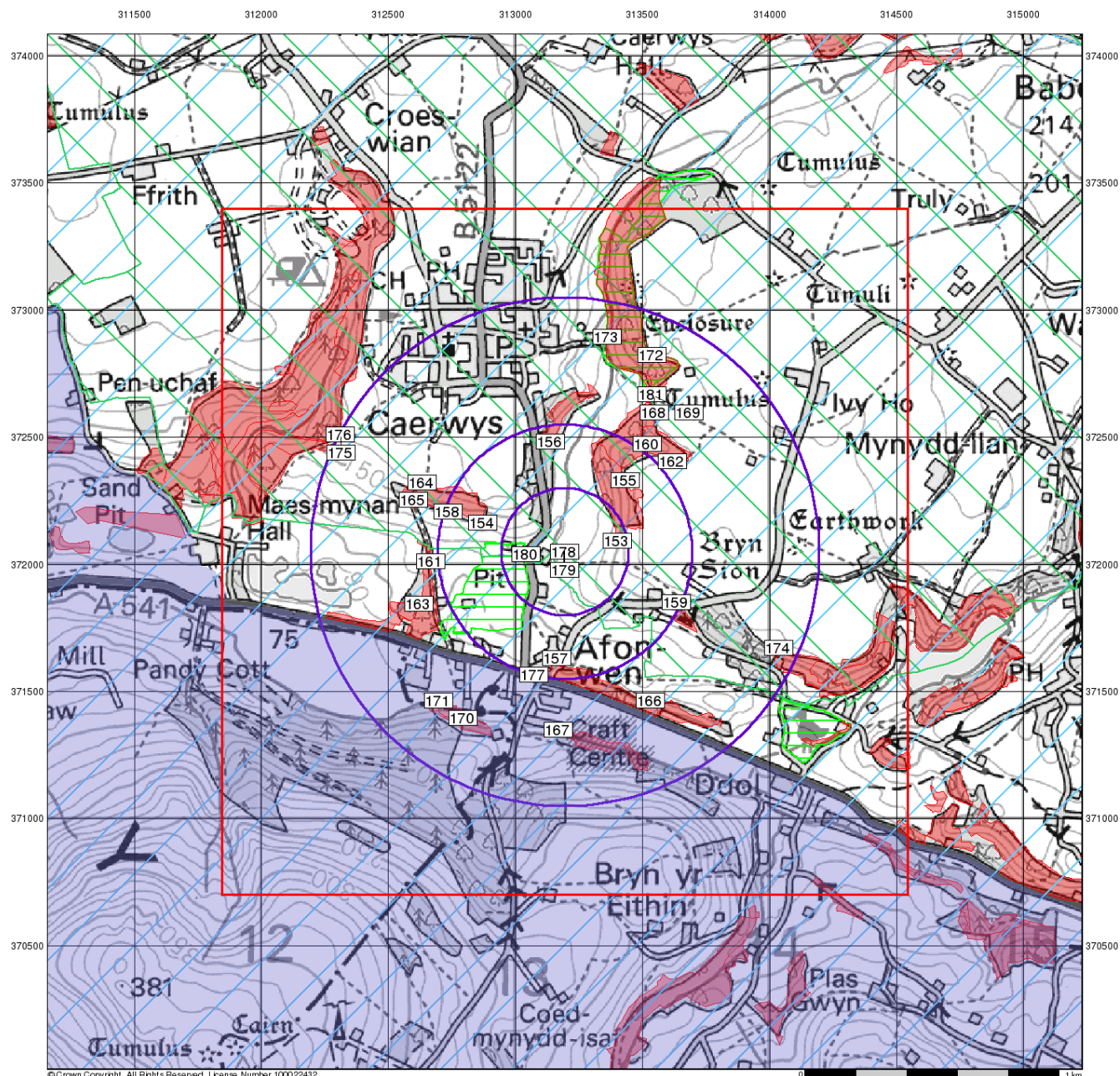
Order Number: 301428802_1_1
 Customer Ref: CDS-Plas Isaf -22
 National Grid Reference: 313190, 372050
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details

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Sensitive Land Uses

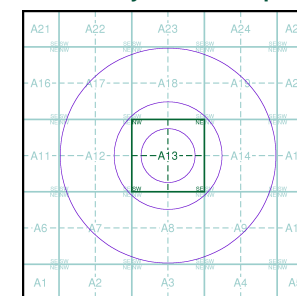
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Sensitive Land Uses

- Ancient Woodland
- Area of Adopted Green Belt
- Area of Unadopted Green Belt
- Area of Outstanding Natural Beauty
- Environmentally Sensitive Area
- Forest Park
- Local Nature Reserve
- Marine Nature Reserve
- National Nature Reserve
- National Park
- Nitrate Sensitive Area
- Nitrate Vulnerable Zone
- Ramsar Site
- Site of Special Scientific Interest
- Special Area of Conservation
- Special Protection Area
- World Heritage Sites

Site Sensitivity Context Map - Slice A



Order Details

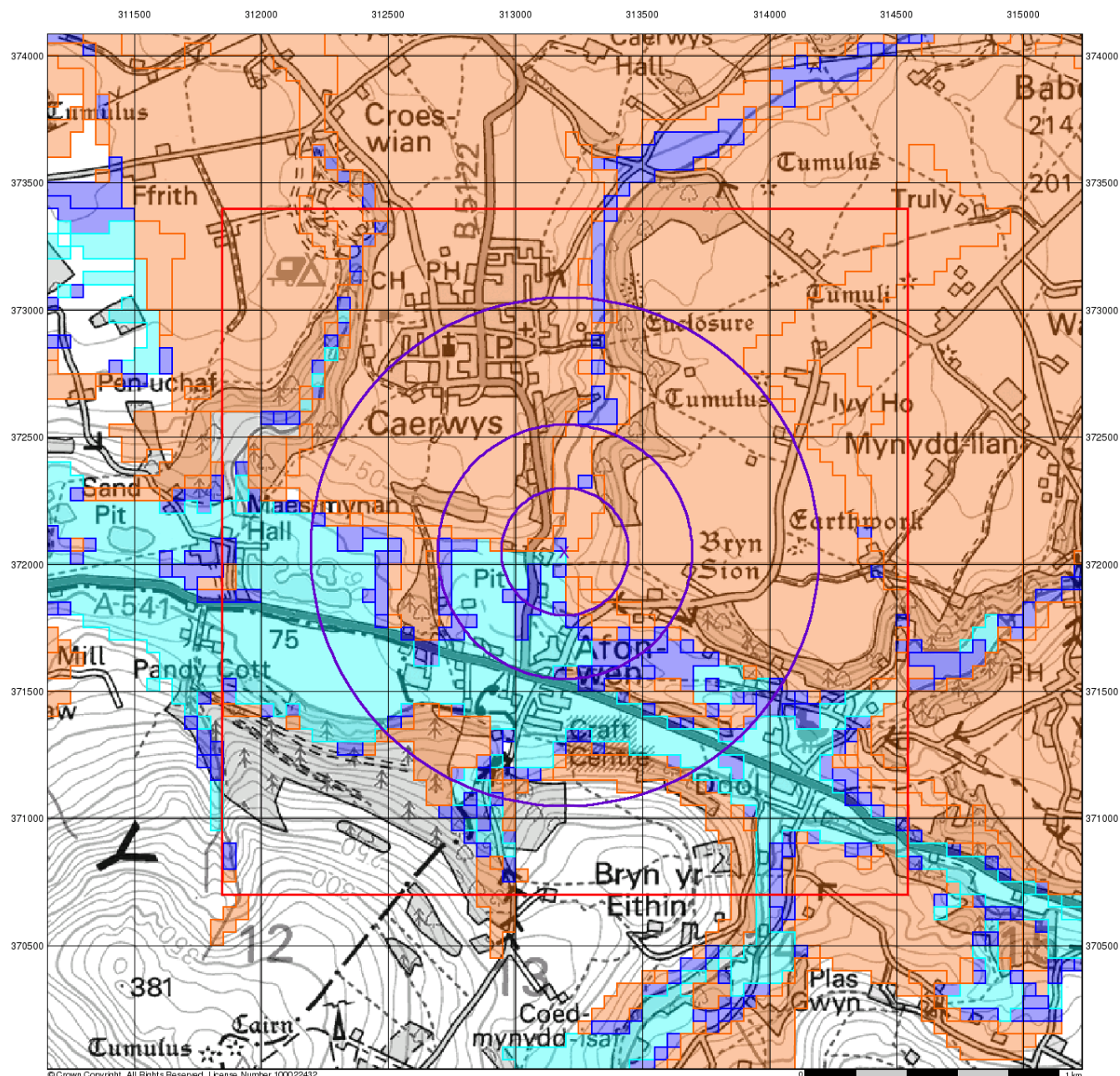
Order Number: 301428802_1_1
 Customer Ref: CDS-Plas Isaf -22
 National Grid Reference: 313190, 372050
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details

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BGS Flood GFS Data

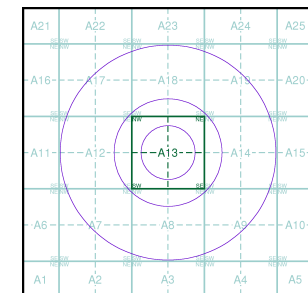
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice

Agency and Hydrological (Flood)

- Limited Potential for Groundwater Flooding to Occur
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Potential for Groundwater Flooding to Occur at Surface

Site Sensitivity Context Map - Slice A



Order Details

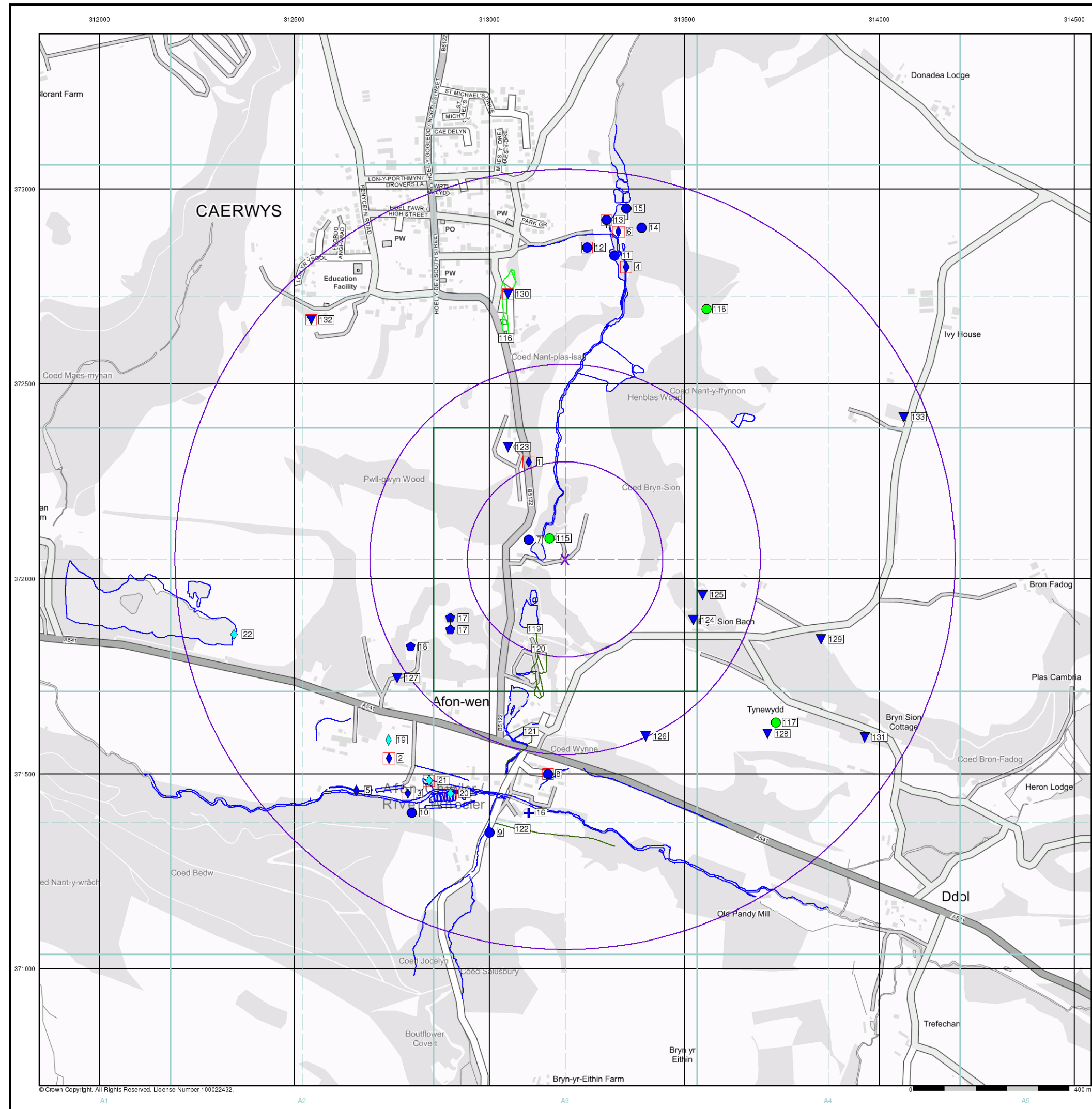
Order Number: 301428802_1_1
 Customer Ref: CDS-Plas Isaf -22
 National Grid Reference: 313190, 372050
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details

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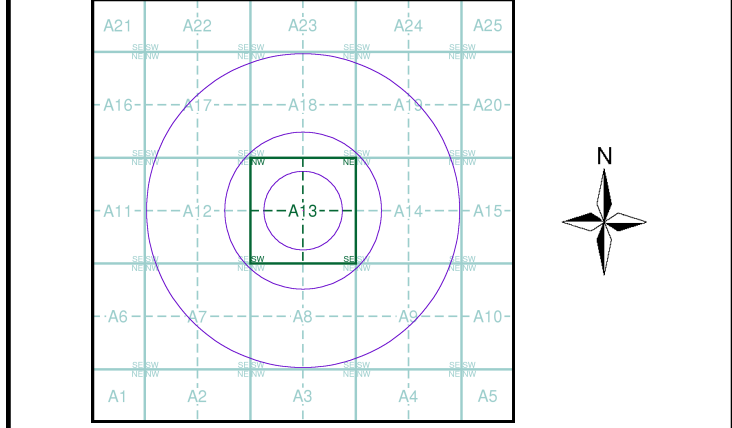
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- General**
 - Specified Site
 - Specified Buffer(s)
 - Bearing Reference Point
 - Map ID
 - Several of Type at Location
- Agency and Hydrological**
 - Contaminated Land Register Entry or Notice (Location)
 - Contaminated Land Register Entry or Notice
 - Discharge Consent
 - Enforcement or Prohibition Notice
 - Integrated Pollution Control
 - Integrated Pollution Prevention Control
 - Local Authority Integrated Pollution Prevention and Control
 - Local Authority Pollution Prevention and Control
 - Local Authority Pollution Prevention and Control Enforcement
 - Pollution Incident to Controlled Waters
 - Prosecution Relating to Authorised Processes
 - Prosecution Relating to Controlled Waters
 - Registered Radioactive Substance
 - River Network or Water Feature
 - River Quality Sampling Point
 - Substantiated Pollution Incident Register
 - Water Abstraction
 - Water Industry Act Referral
- Hazardous Substances**
 - COMAH Site
 - Explosive Site
 - NIHHS Site
 - Planning Hazardous Substance Consent
 - Planning Hazardous Substance Enforcement
 - BGS Recorded Mineral Site
- Waste**
 - BGS Recorded Landfill Site (Location)
 - BGS Recorded Landfill Site
 - EA Historic Landfill (Buffered Point)
 - EA Historic Landfill (Polygon)
 - Integrated Pollution Control Registered Waste Site
 - Licensed Waste Management Facility (Landfill Boundary)
 - Licensed Waste Management Facility (Location)
 - Local Authority Recorded Landfill Site (Location)
 - Local Authority Recorded Landfill Site
 - Potentially Infilled Land (Non-water)
 - Potentially Infilled Land (Non-water)
 - Potentially Infilled Land (Non-water)
 - Potentially Infilled Land (Water)
 - Potentially Infilled Land (Water)
 - Potentially Infilled Land (Water)
 - Potentially Infilled Land (Water)
 - Registered Landfill Site (Location)
 - Registered Landfill Site (Point Buffered to 100m)
 - Registered Landfill Site (Point Buffered to 250m)
 - Registered Waste Transfer Site (Location)
 - Registered Waste Transfer Site
 - Registered Waste Treatment or Disposal Site (Location)
 - Registered Waste Treatment or Disposal Site

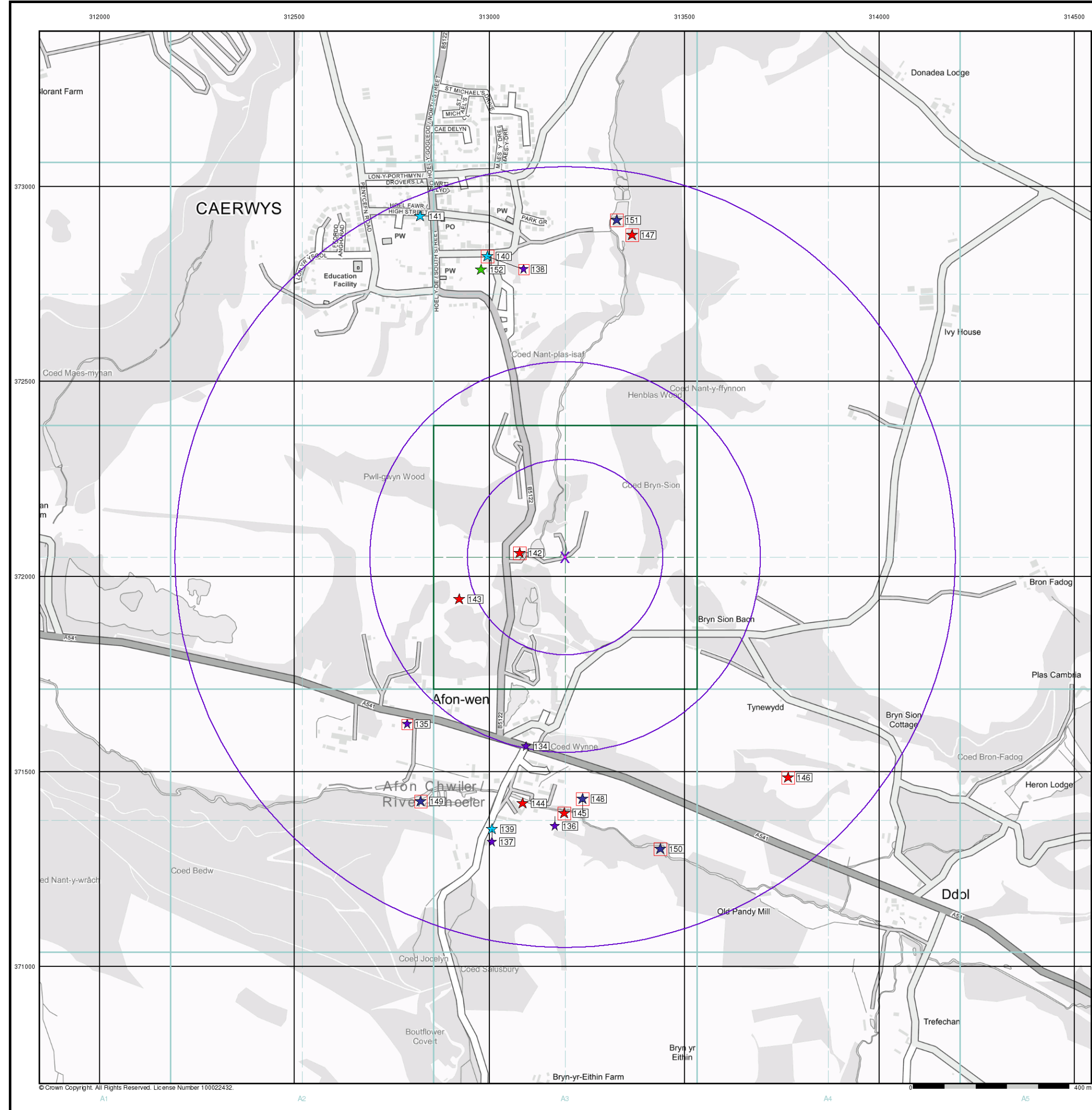
Site Sensitivity Map - Slice A



Order Details
Order Number: 301428802_1_1
Customer Ref: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details
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Industrial Land Use Map

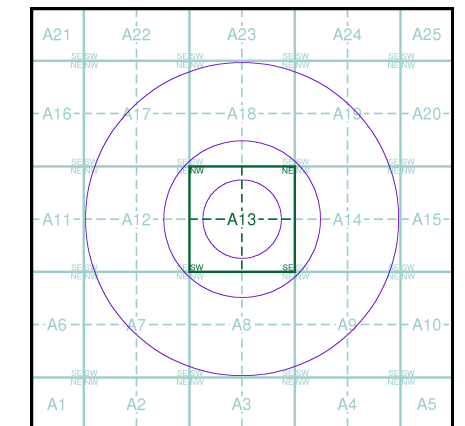
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Industrial Land Use

- Contemporary Trade Directory Entry
- Fuel Station Entry
- Gas Pipeline
- Points of Interest - Commercial Services
- Points of Interest - Education and Health
- Points of Interest - Manufacturing and Production
- Points of Interest - Public Infrastructure
- Points of Interest - Recreational and Environmental
- Underground Electrical Cables

Industrial Land Use Map - Slice A



Order Details

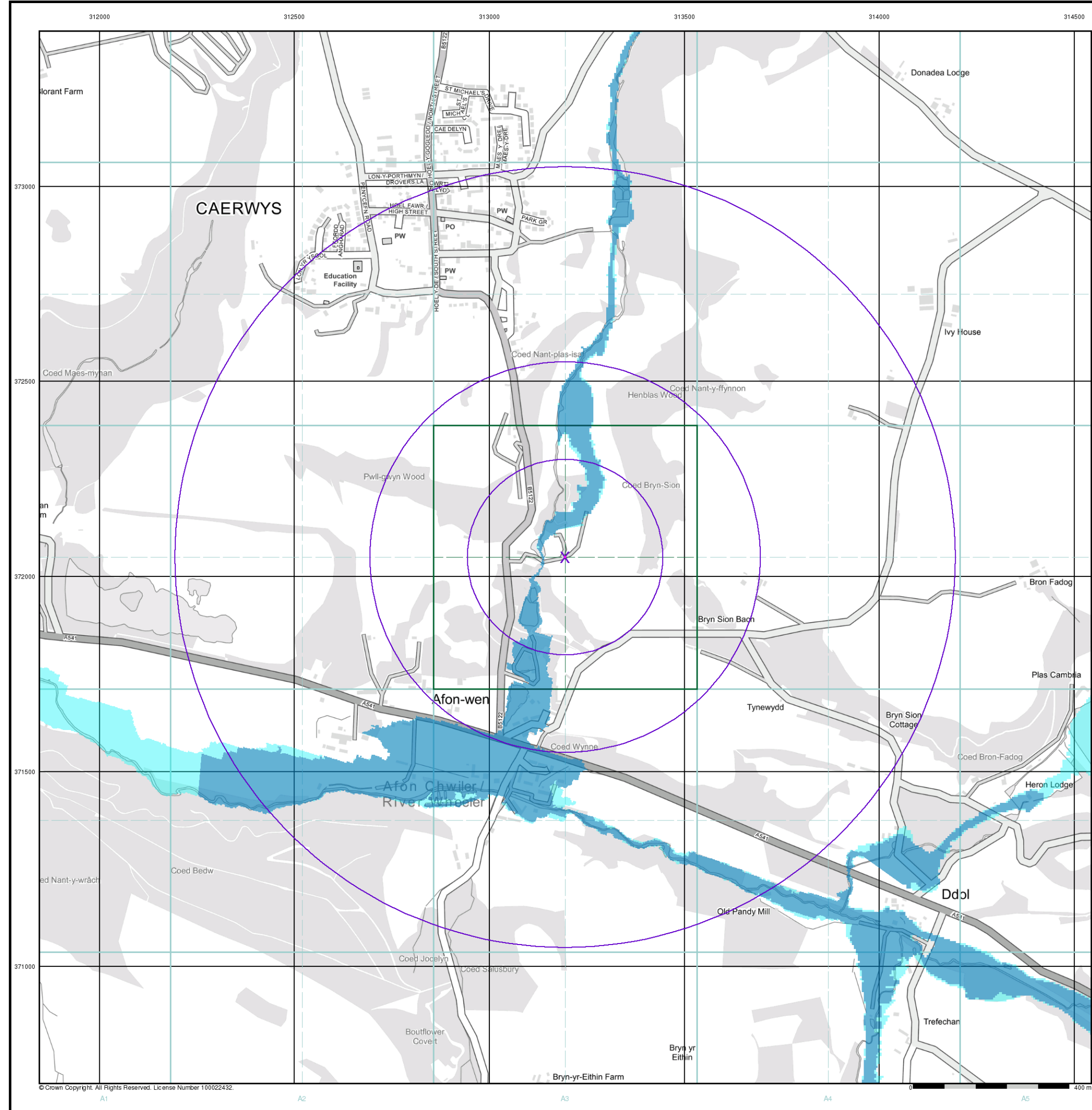
Order Number: 301428802_1_1
Customer Ref: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details

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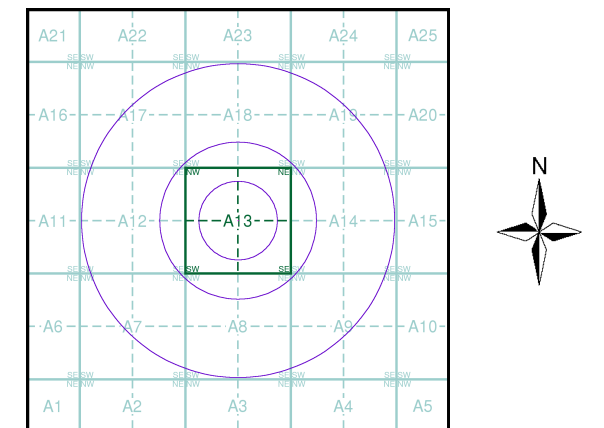
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Agency and Hydrological (Flood)

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Flood Map - Slice A

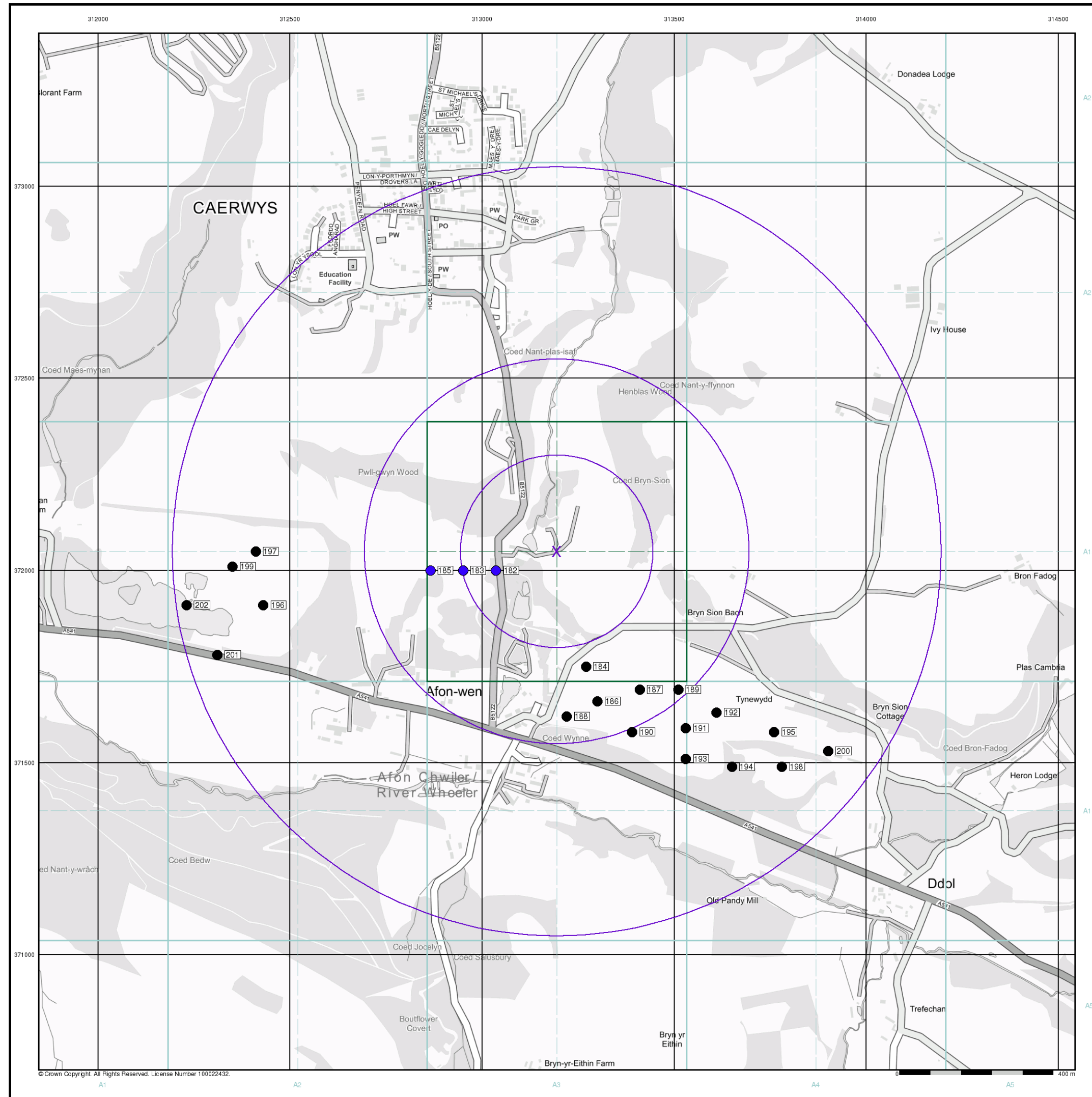


Order Details

Order Number: 301428802_1_1
Customer Ref: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details

Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541 Junction, AFONWEN, CH7 5AD



General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID
- Several of Type at Location

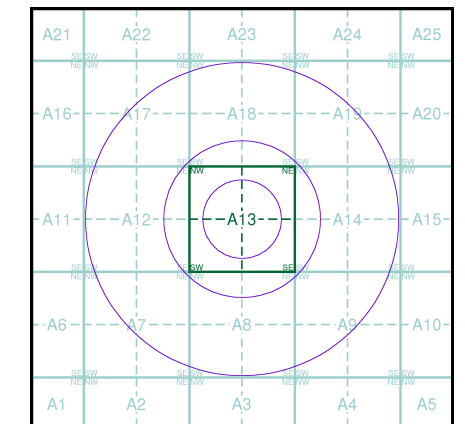
Agency and Hydrological (Boreholes)

- BGS Borehole Depth 0 - 10m
- BGS Borehole Depth 10 - 30m
- BGS Borehole Depth 30m +
- Confidential
- Other

For Borehole information please refer to the Borehole .csv file which accompanied this slice.

A copy of the BGS Borehole Ordering Form is available to download from the Support section of www.envirocheck.co.uk.

Borehole Map - Slice A

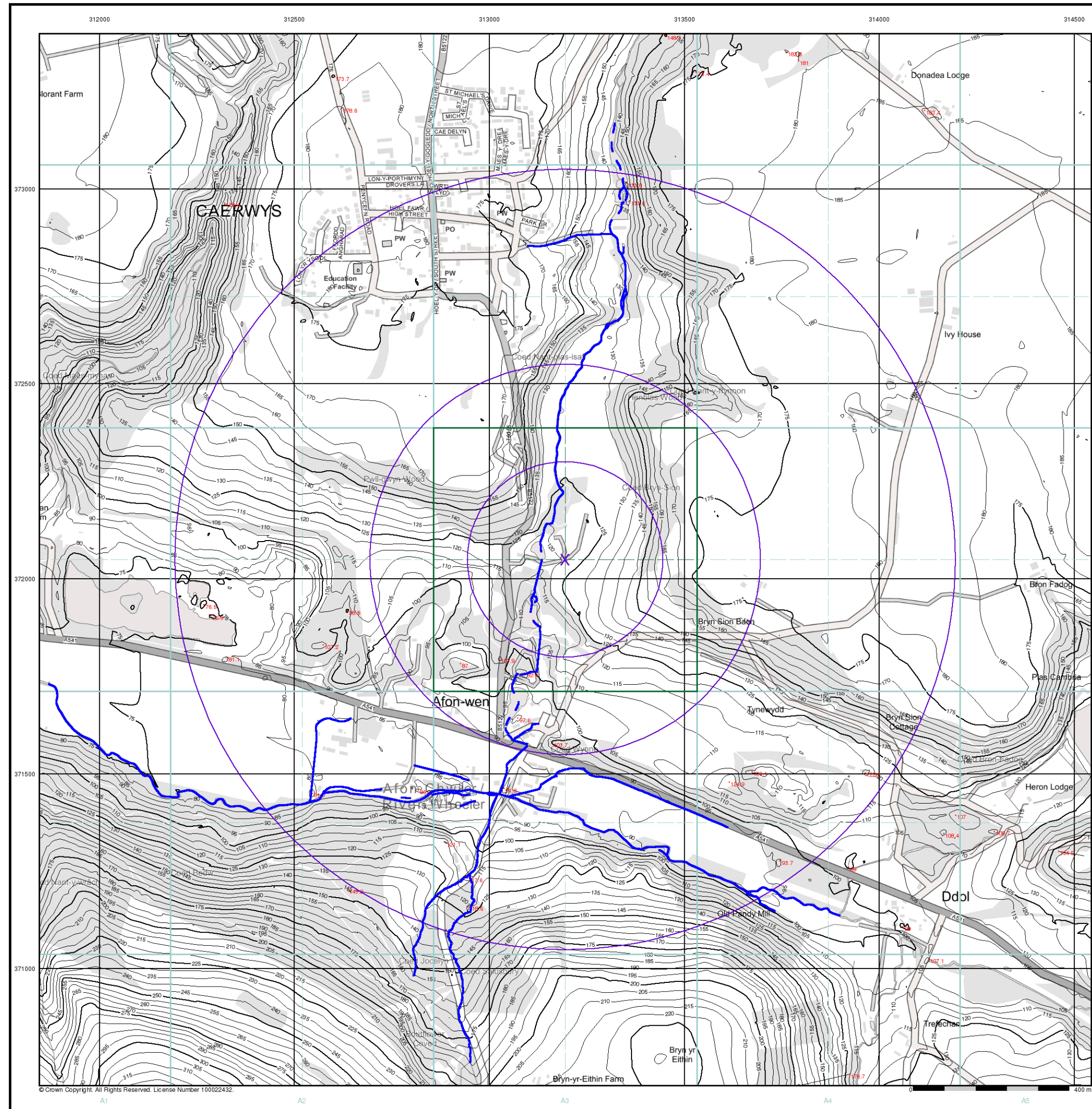


Order Details

Order Number: 301428802_1_1
Customer Ref: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details

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General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

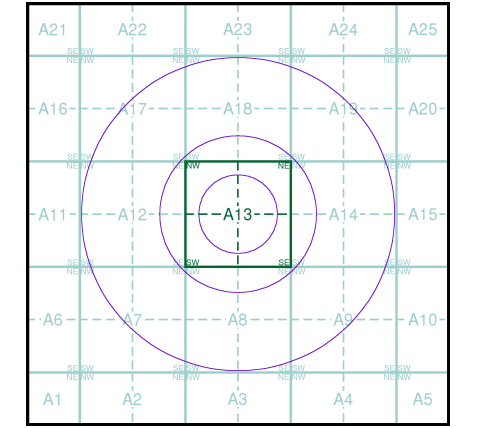
OS Water Network Data

- | | |
|--------------|-------------------------|
| Canal | Drain |
| Reservoir | Other |
| Foreshore | Lake |
| Marsh | Transfer |
| Tidal River | Lock Or Flight Of Locks |
| Inland River | Sea |

Contours (height in meters)

- Standard Contour: 105, 100, 95
- Master Contour: 105, 100, 95
- Spot Height: 167.3
- MLW: Mean Low Water
- MHW: Mean High Water

OS Water Network Map - Slice A



Order Details

Order Number: 301428802_1_1
Customer Ref: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details

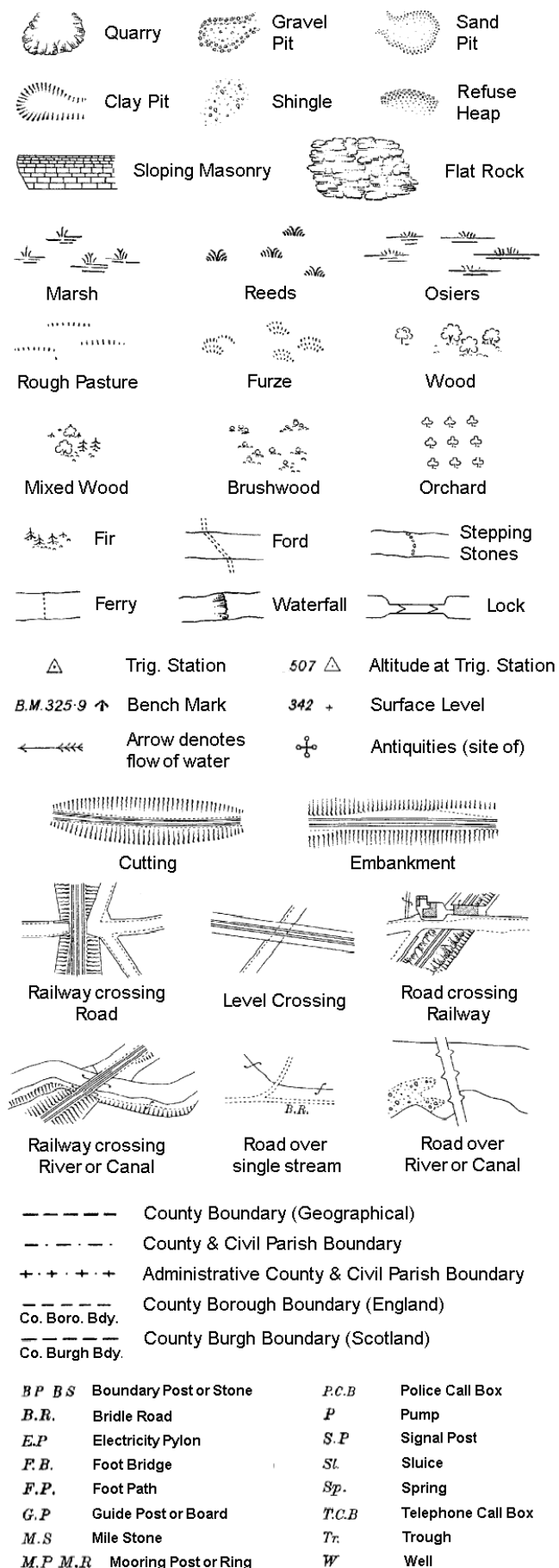
Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541 Junction, AFONWEN, CH7 5AD

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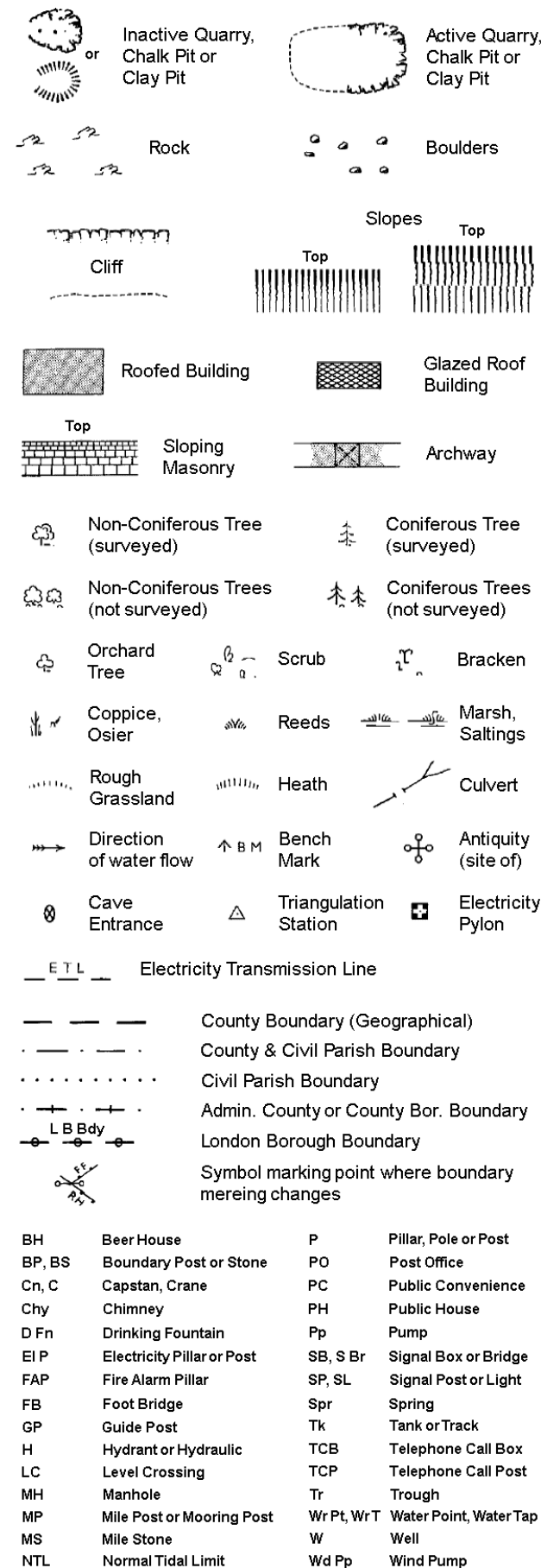
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Historical Mapping Legends

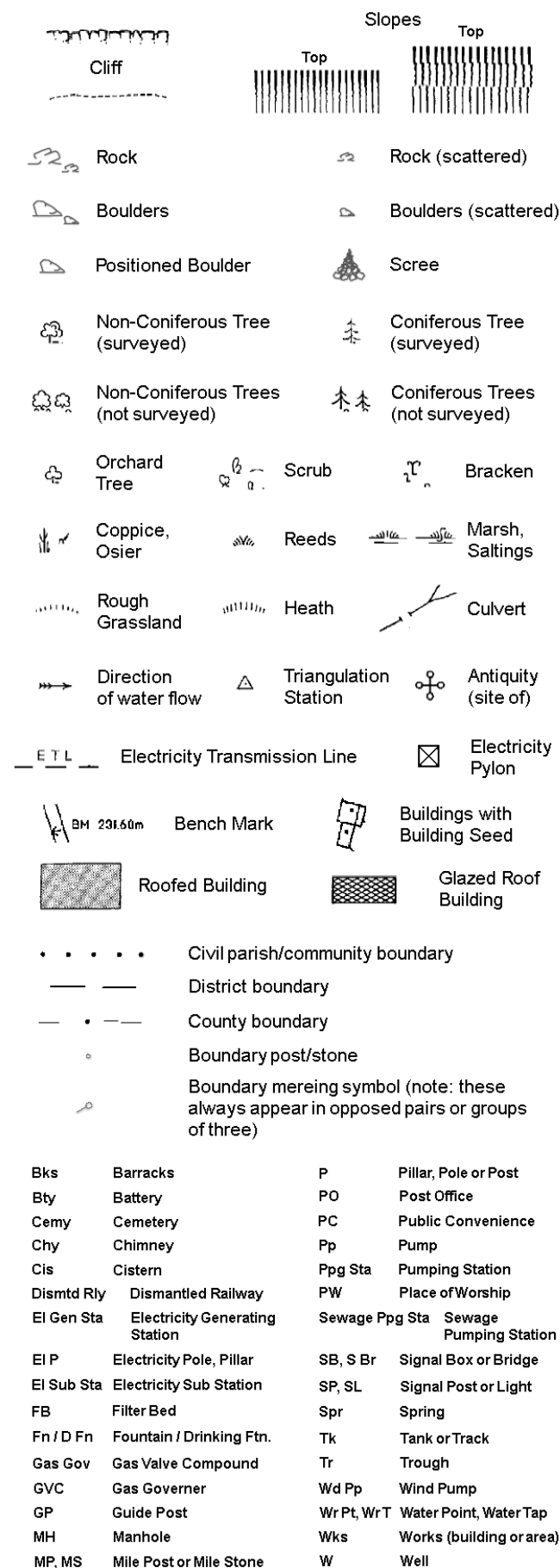
Ordnance Survey County Series and Ordnance Survey Plan 1:2,500



Ordnance Survey Plan, Additional SIMs and Supply of Unpublished Survey Information 1:2,500 and 1:1,250



Large-Scale National Grid Data 1:2,500 and 1:1,250



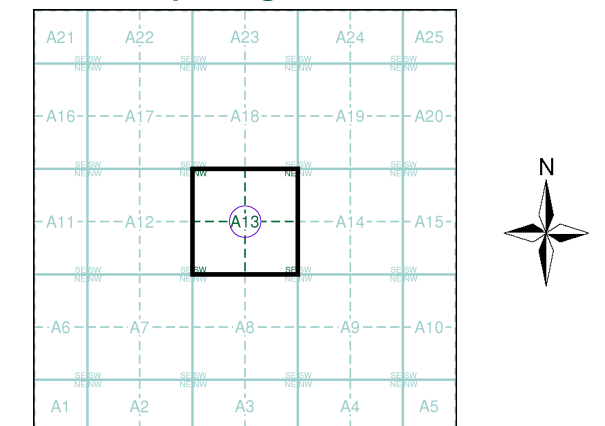
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Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Flintshire	1:2,500	1871	2
Denbighshire	1:2,500	1874 - 1875	3
Flintshire	1:2,500	1899	4
Denbighshire	1:2,500	1912 - 1913	5
Ordnance Survey Plan	1:2,500	1965	6
Additional SIMs	1:2,500	1987 - 1991	7
Additional SIMs	1:2,500	1991 - 1992	8
Large-Scale National Grid Data	1:2,500	1994	9
Historical Aerial Photography	1:2,500	2000	10

Historical Map - Segment A13



Order Details

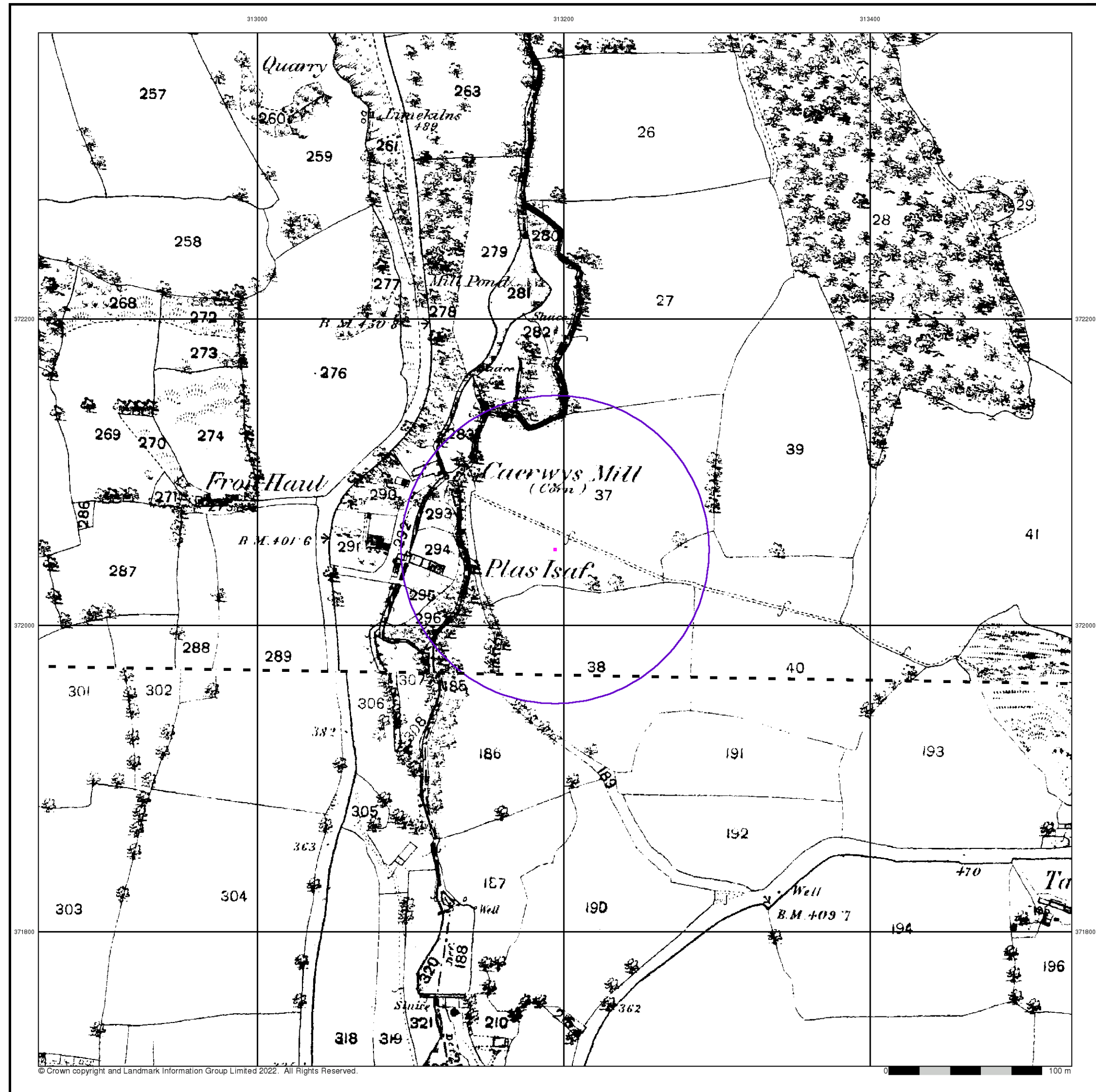
Order Number: 301428802_1_1
Customer Ref: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 100

Site Details

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Flintshire

Published 1871

Source map scale - 1:2,500

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Map Name(s) and Date(s)

008_03	1871	1:2,500
008_07	1871	1:2,500

Historical Map - Segment A13

N

Order Details

Order Number:	301428802_1_1
Customer Ref:	CDS-Plas Isaf -22
National Grid Reference:	313190, 372050
Slice:	A
Site Area (Ha):	0.01
Search Buffer (m):	100

Site Details

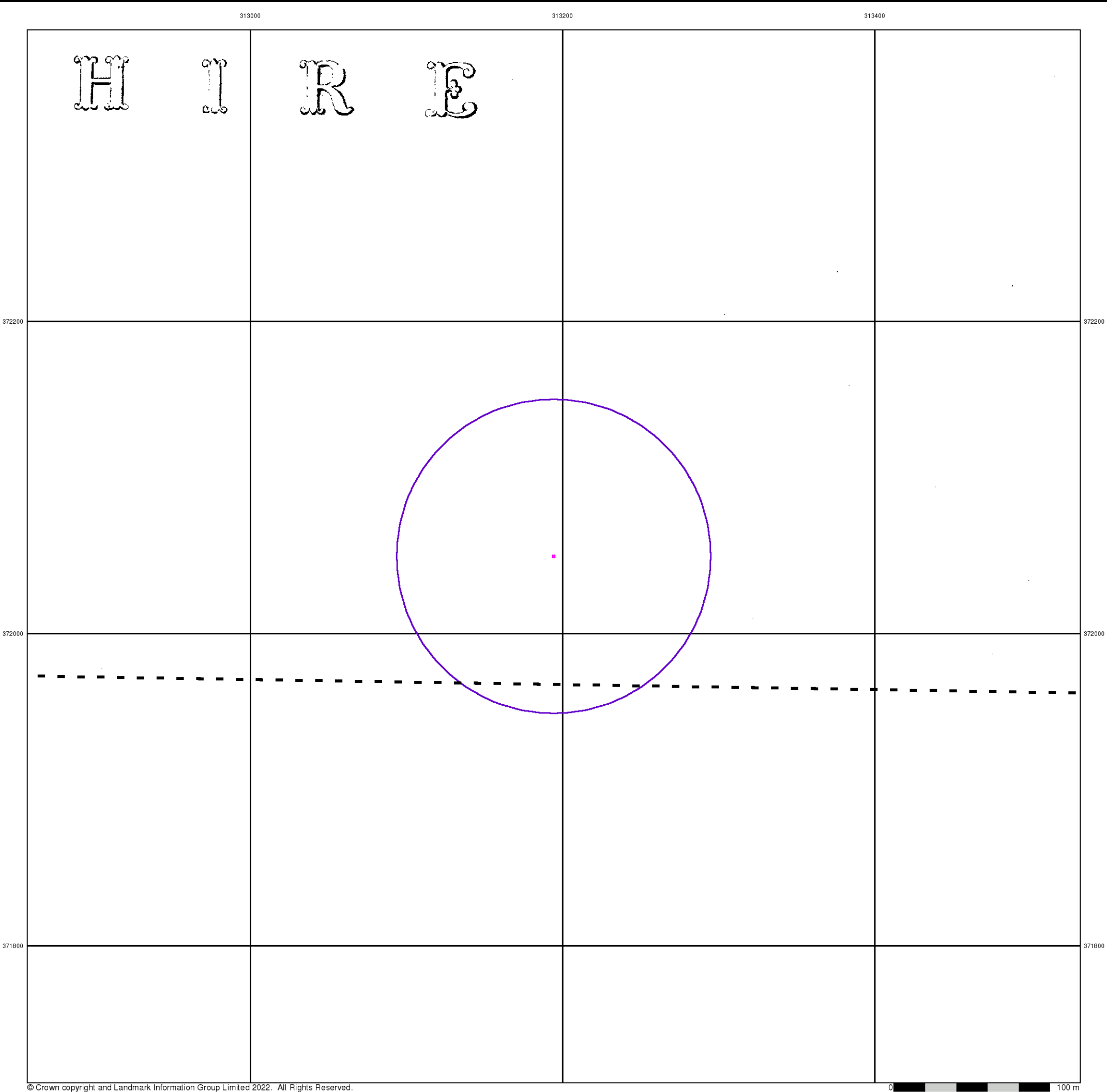
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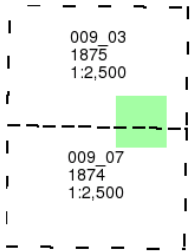
A Landmark Information Group Service v50.0 20-Sep-2022 Page 2 of 10



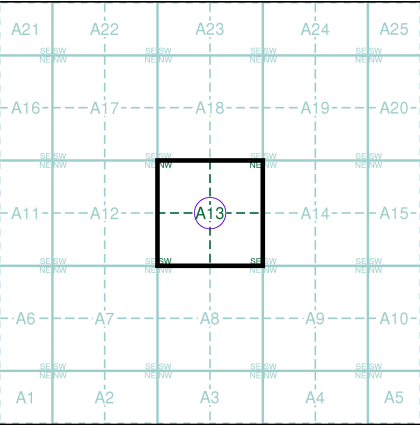
Denbighshire
Published 1874 - 1875
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13

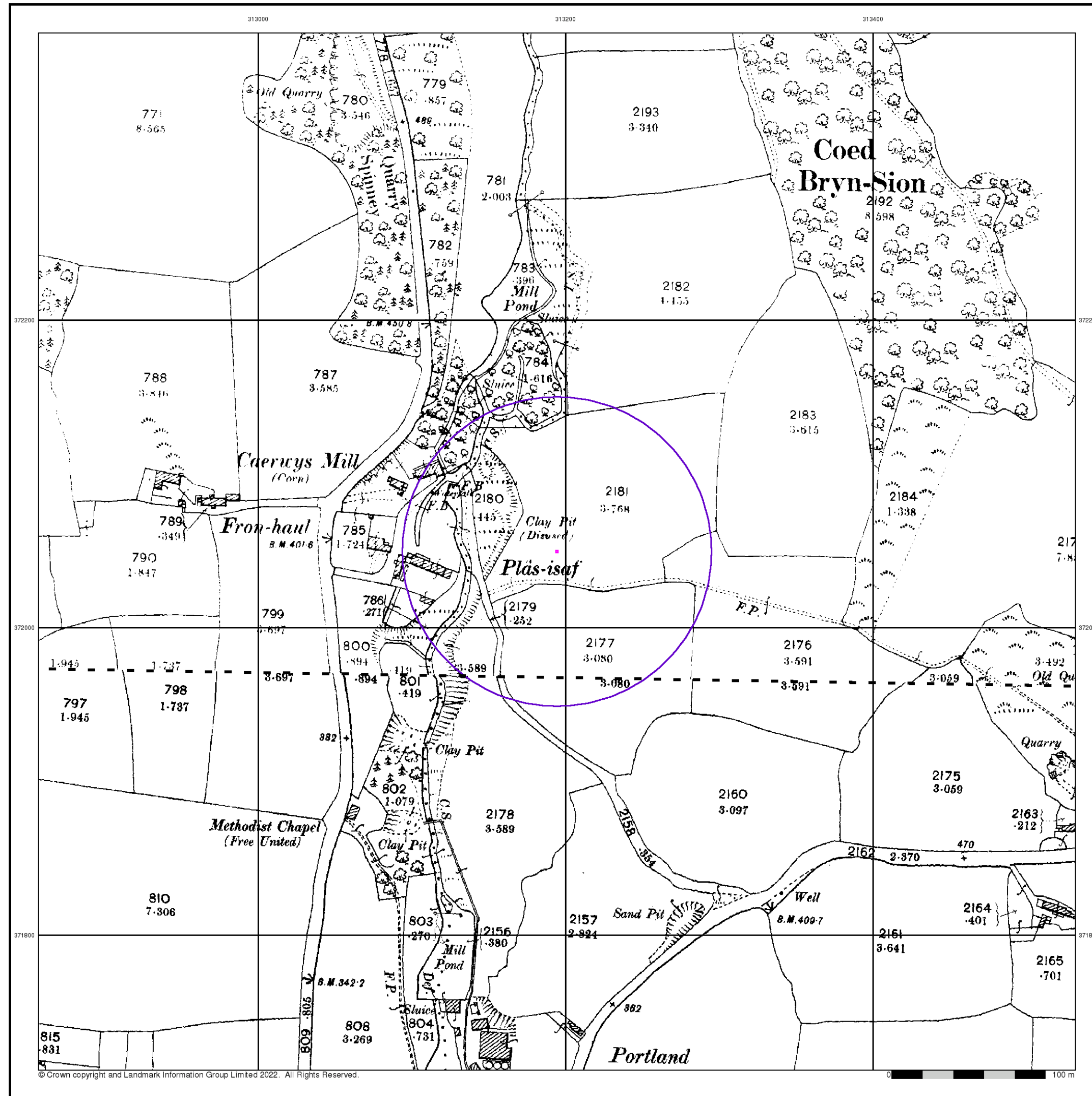


Order Details

Order Number: 301428802_1_1
Customer Ref: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 100

Site Details

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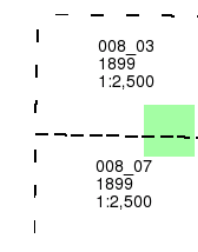
Flintshire

Published 1899

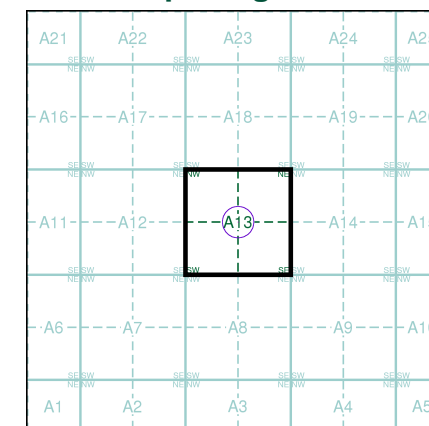
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

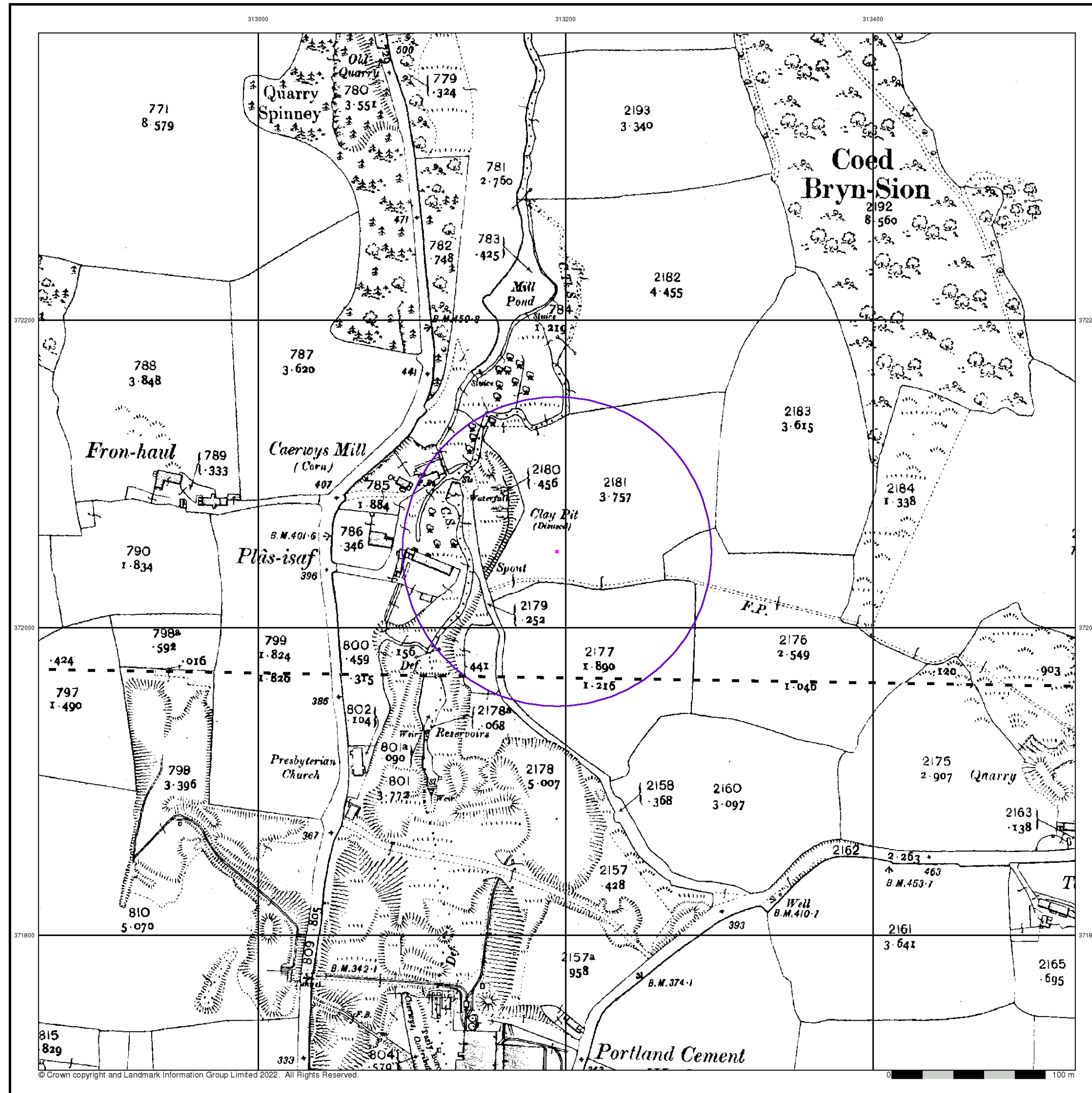
Order Number: 301428802_1_1
Customer Ref: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 100

Site Details

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Denbighshire

Published 1912 - 1913
Source map scale - 1:2,500

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Map Name(s) and Date(s)

009_03
1913
1:2,500

009_07
1912
1:2,500

Historical Map - Segment A13

Order Details

Order Number: 301428802_1_1
Customer Ref: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 100

Site Details

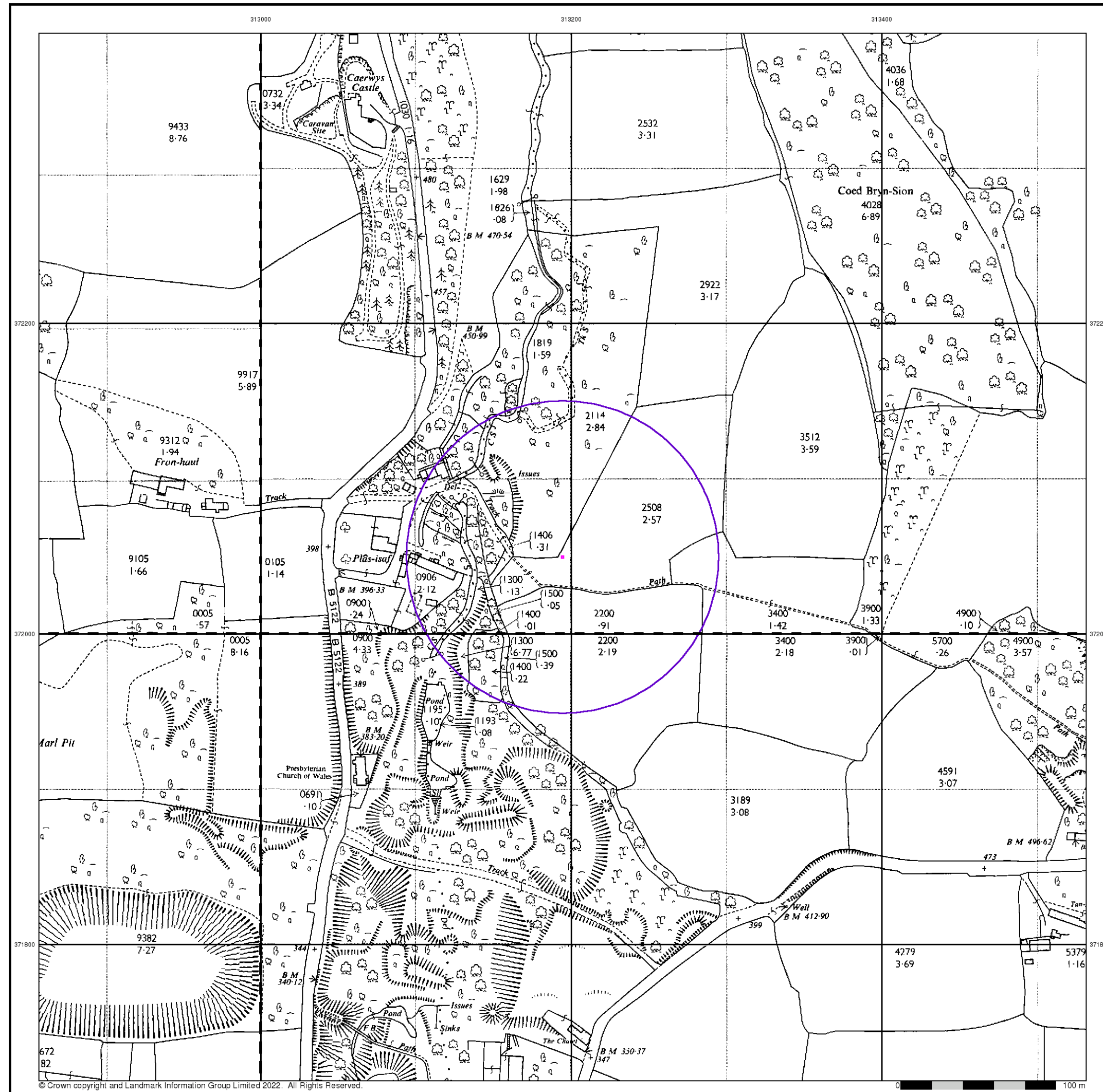
Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541 Junction, AFONWEN, CH7 5AD

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Ordnance Survey Plan

Published 1965

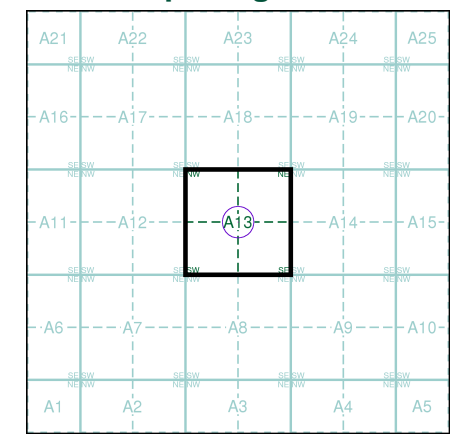
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The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)

SJ1272	SJ1372
1965	1965
12,500	12,500
SJ1271	SJ1371
1965	1965
12,500	12,500

Historical Map - Segment A13

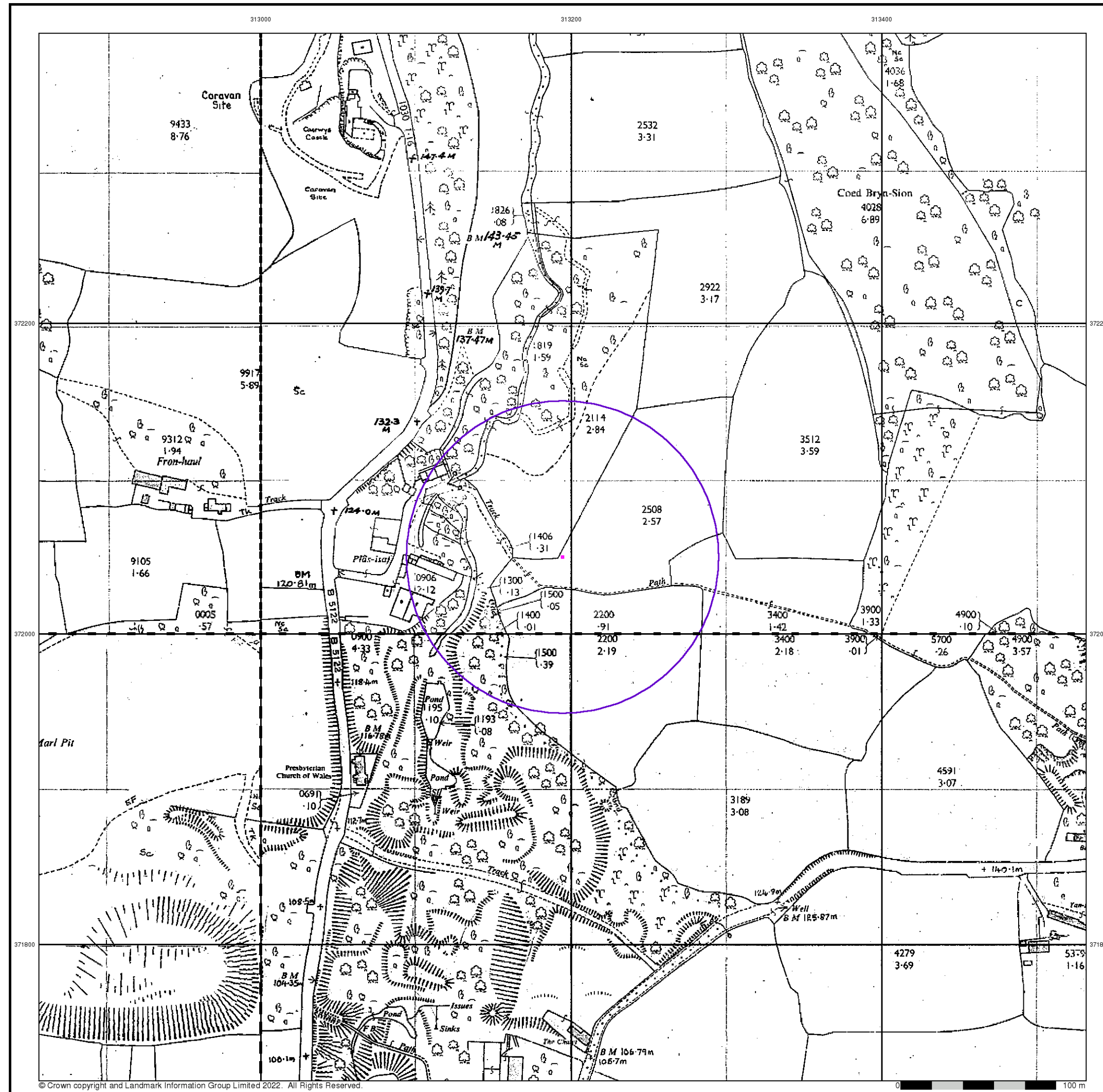


Order Details

Order Number: 301428802_1_1
Customer Ref: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
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Site Area (Ha): 0.01
Search Buffer (m): 100

Site Details

Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541 Junction, AFONWEN, CH7 5AD



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Additional SIMs

Published 1987 - 1991

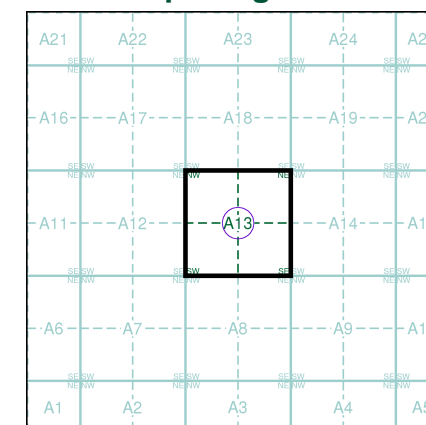
Source map scale - 1:2,500

The SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SJ1272 1987 12,500	SJ1372 1991 12,500
SJ1271 1991 12,500	SJ1371 1990 12,500

Historical Map - Segment A13



Order Details

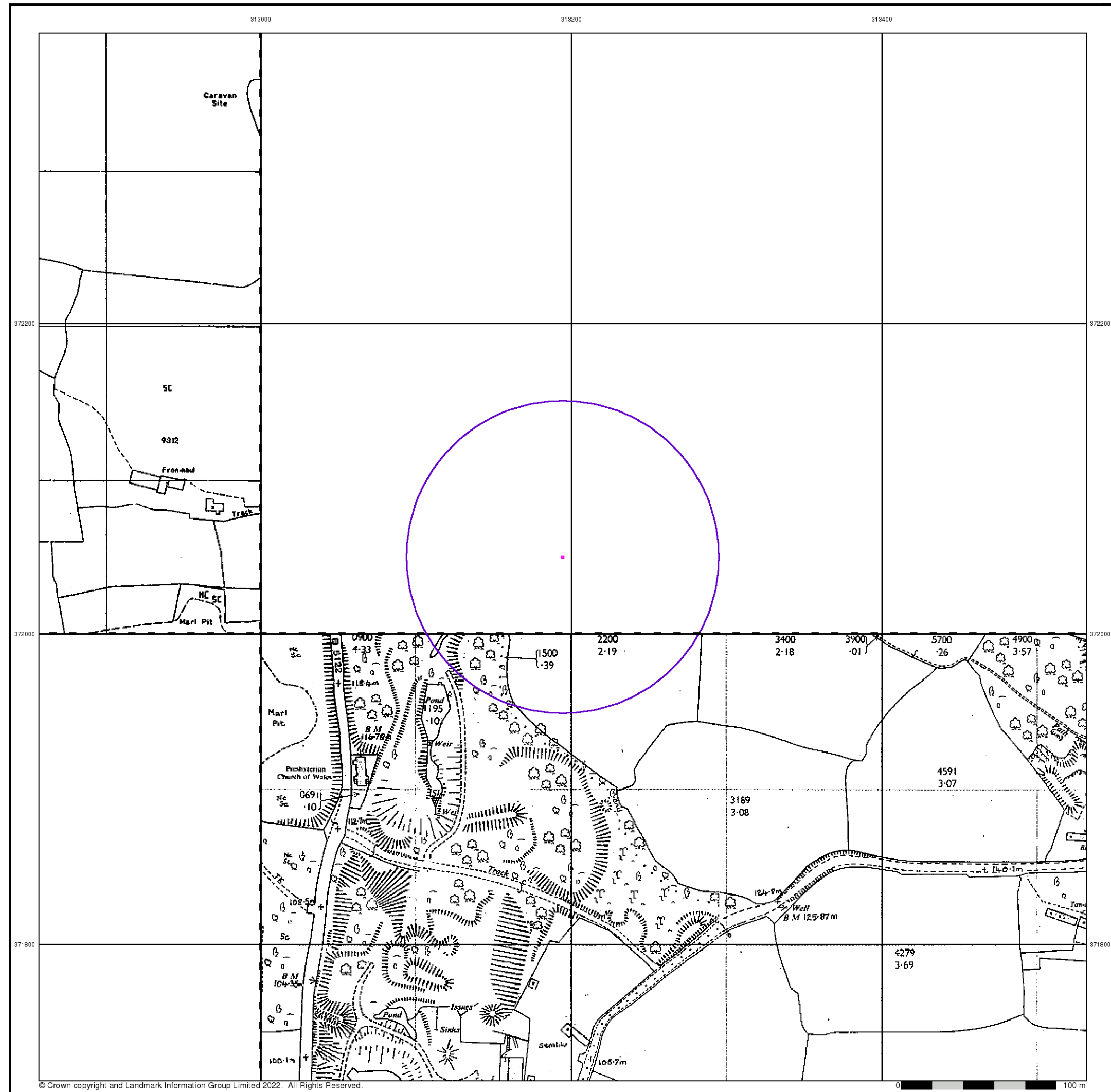
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Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 100

Site Details

Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541 Junction, AFONWEN, CH7 5AD

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Additional SIMs

Published 1991 - 1992

Source map scale - 1:2,500

The SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SJ1272 1992 12,500	
	SJ1371 1991 12,500

Historical Map - Segment A13

A21	A22	A23	A24	A25
A16	A17	A18	A19	A20
A11	A12	A13	A14	A15
A6	A7	A8	A9	A10
A1	A2	A3	A4	A5

Order Details

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Customer Ref:	CDS-Plas Isaf -22
National Grid Reference:	313190, 372050
Slice:	A
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Search Buffer (m):	100

Site Details

Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541 Junction, AFONWEN, CH7 5AD

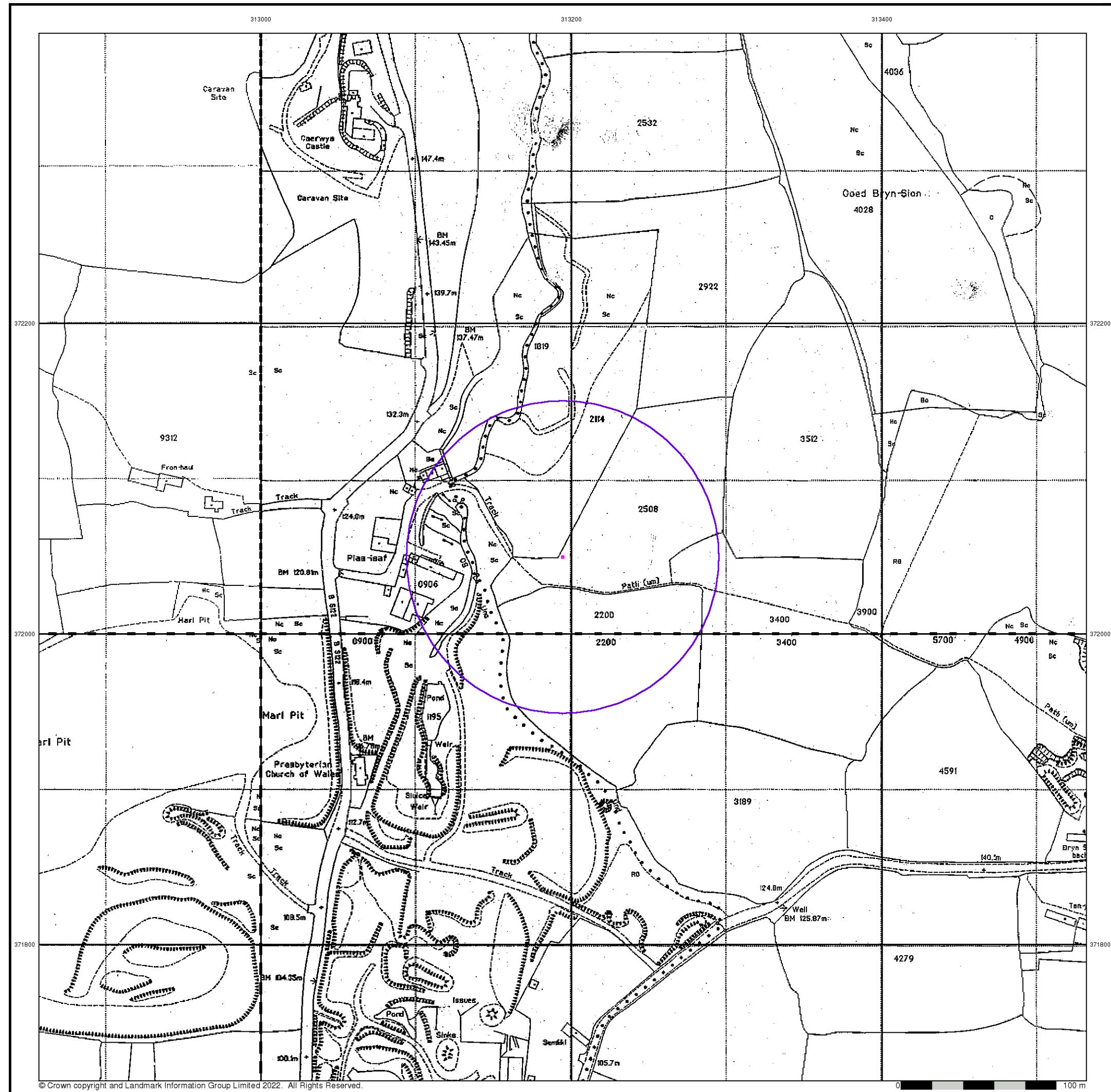
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Large-Scale National Grid Data

Published 1994

Source map scale - 1:2,500

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SJ1272 1994 12,500	SJ1372 1994 12,500
SJ1271 1994 12,500	SJ1371 1994 12,500

Historical Map - Segment A13

Order Details

Order Number: 301428802_1_1
Customer Ref: CDS-Plas Isaf -22
National Grid Reference: 313190, 372050
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 100

Site Details

Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541 Junction, AFONWEN, CH7 5AD

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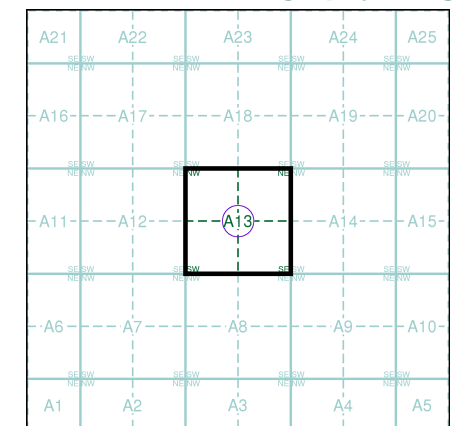


Historical Aerial Photography

Published 2000

This aerial photography was produced by Getmapping, these vertical aerial photographs provide a seamless, full colour survey of the whole of Great Britain

Historical Aerial Photography - Segment A13



Order Details

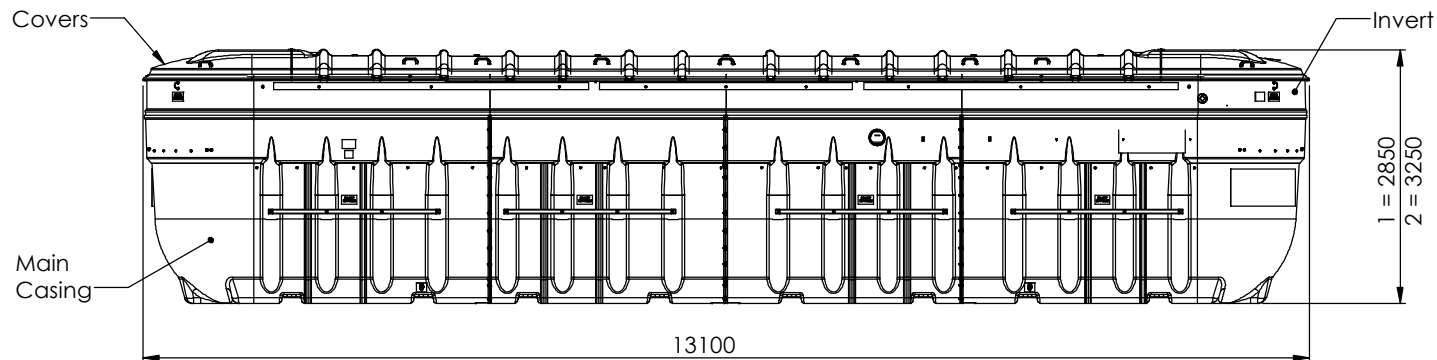
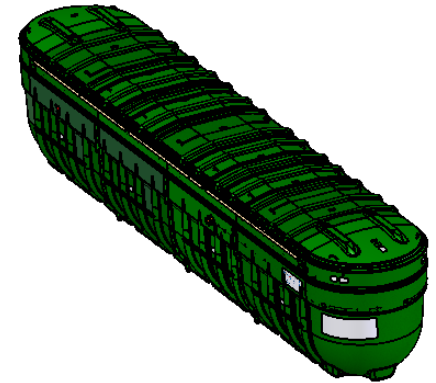
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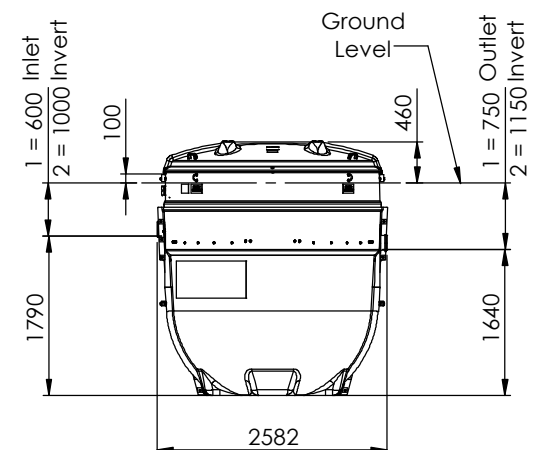
Plas Isaf Holiday and Lodge Park, B5122 Trigfa to A541
Junction, AFONWEN, CH7 5AD


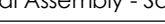
APPENDIX D

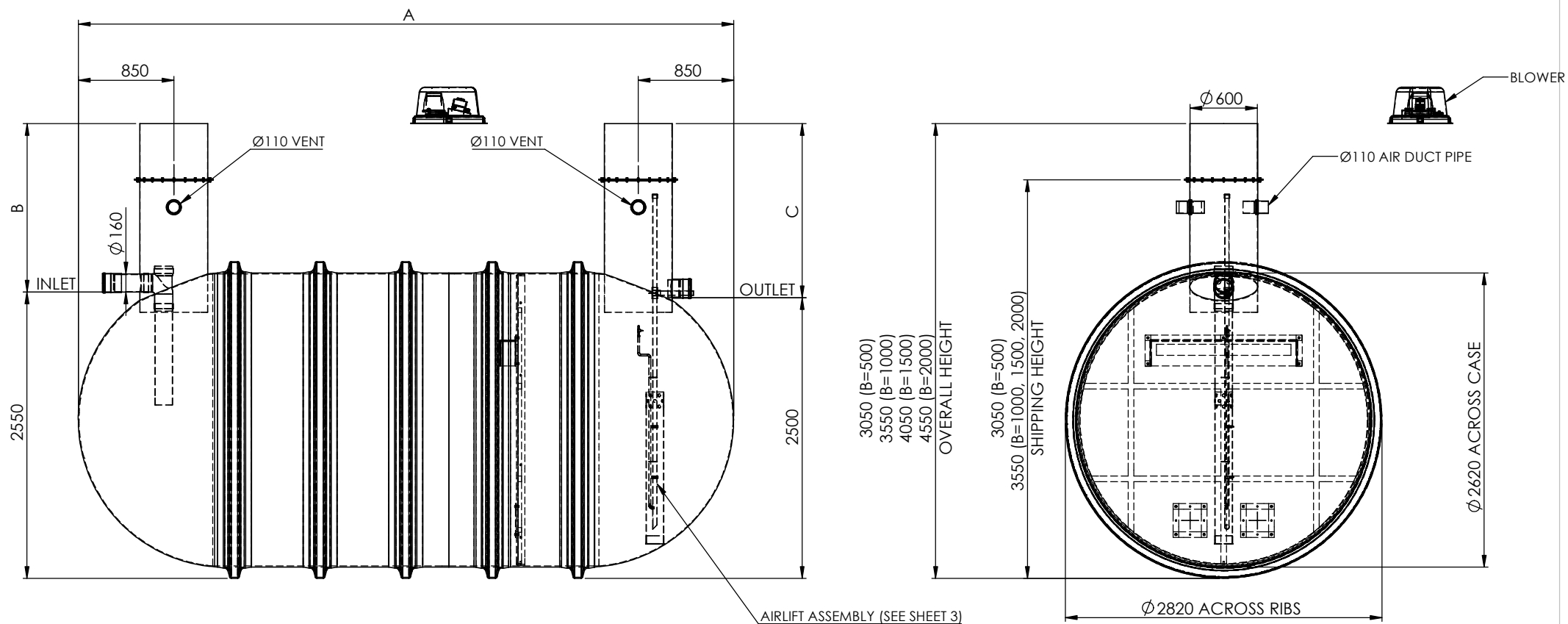
FOUL TREATMENT PLANT DETAILS



1. Inlet And Outlet Pipework To Be 6" PVCu
2. Unit Must Be Slung In Positions Shown.





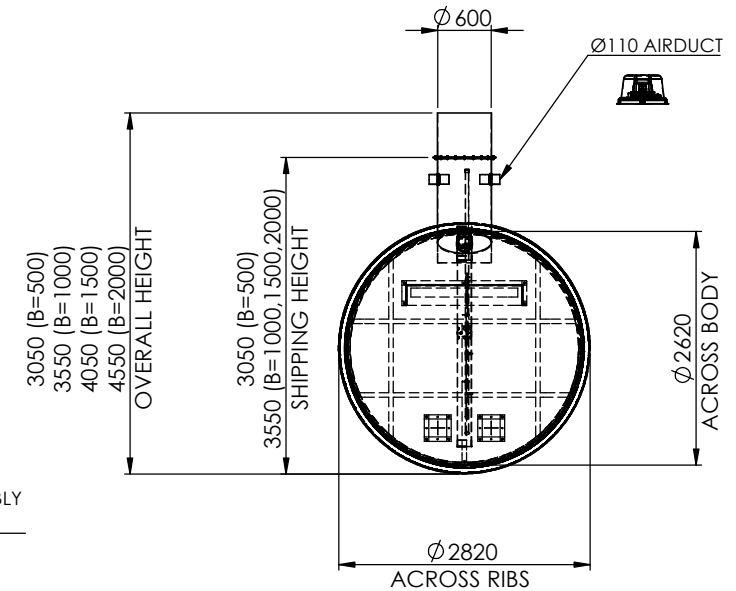
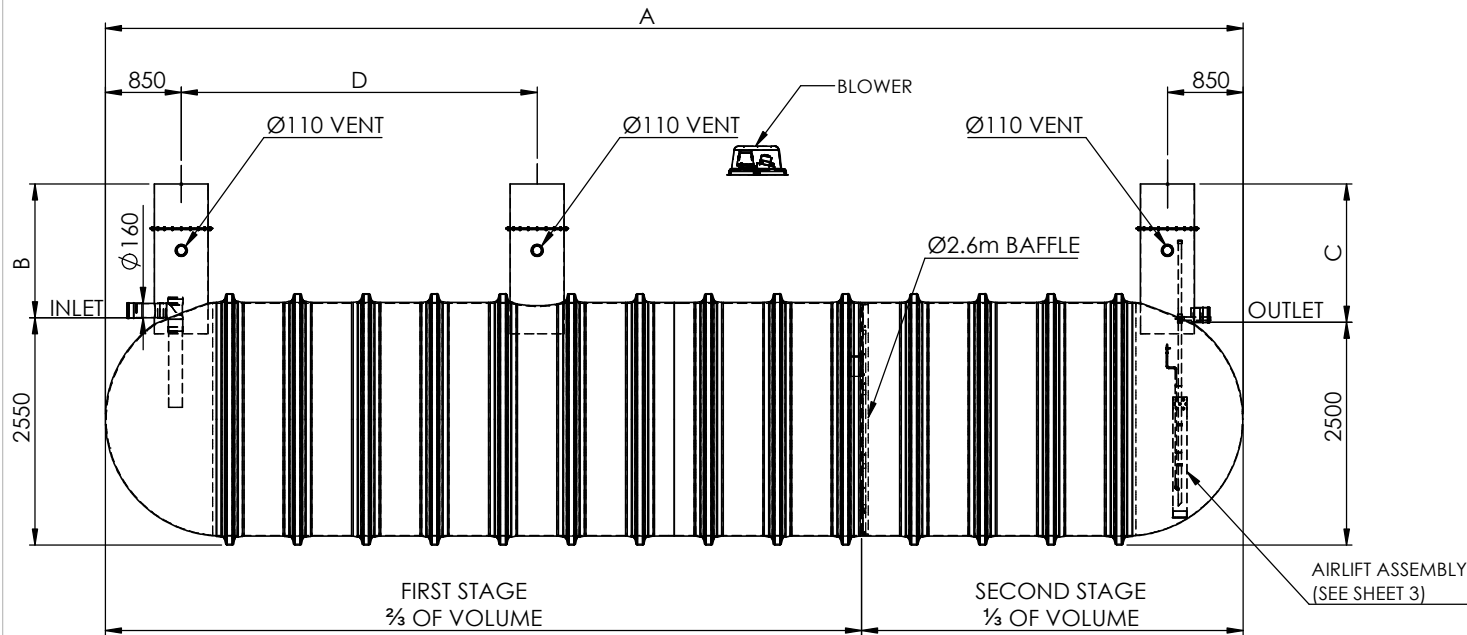
Please Check with Kingspan Environmental For The Latest Issue Of This Drawing					Material : Various	Tolerance (unless stated) :	Drawing : DS1334	Page 1 of 1
Issue	Date	Drawn by	Approved by	Description	Finish :	Thickness : n/a		
01	21.08.17	T.Kelly		CC1392 - Initial Issue	Weight : 5750 kg	Surface Area : m²	BN BioDisc General Assembly - Sales Drawing	
					Modelled By : T.Kelly			
All Dimensions In mm		Scale: Do Not Scale		 Third Angle Projection	Kingspan Environmental reserve the right to alter the details of this drawing without prior notice. This drawing is copyright and may not be reproduced or used without the written permission of Kingspan Environmental			
R:\Engineering Projects\957A BioDisc BN\Two End Motor Gearboxes\DS1334								



NOTES:-

- STANDARD INLET/ OUTLET PIPES ARE $\phi 160$ PVCu UNDERGROUND DRAINAGE.
- THIS DRAWING IS PROVIDED TO SUPPLY DIMENSIONAL INFORMATION ONLY.
- THE UNIT MUST BE INSTALLED WITH A CONCRETE SURROUND. PLEASE SEE THE DETAILED INSTALLATION PROCEDURE, SUPPLIED WITH EACH UNIT
- THE UNIT IS SUPPLIED WITH LOOSE, BOLT ON EXTENSION NECKS TO SUIT EITHER A 1.5 OR 2.0 METER INVERT (SPECIFY WITH ORDER). THEY MUST BE FITTED ON SITE AS PART OF THE INSTALLATION AND CAN BE TRIMMED TO SUIT EXACT SIZE OF INVERT.
- UNITS SHOULD NOT BE INSTALLED DEEPER THAN NECESSARY, NOR DEEPER THAN THE INVERT SPECIFIED FOR THE UNIT SUPPLIED. GROUND IS SELDOM SUITABLE AT GREAT DEPTH FOR INFILTRATION.
- PEDESTRIAN DUTY COVER AND FRAMES, TO FIT 600mm DIAMETER NECKS, ARE AVAILABLE FOR PURCHASE.
- THE WEIGHTS GIVEN ARE FOR HANDLING PURPOSES ONLY AND EXCLUDE BOLT ON SHAFTS.
- VARIOUS INLET / OUTLET PIPEWORK CONFIGURATIONS ARE AVAILABLE. CONSULT TECH SALES SUPPORT FOR OPTIONS.


Please Check with Kingspan Environmental For The Latest Issue Of This Drawing					Material : Various	Tolerance (unless stated) :	Drawing : DS0637P	Page 1 of 3
Issue	Date	Drawn by	Approved by	Description	Finish :	Thickness :		
2	16.05.19	Viaasan K		CC1487 - Redrawn on Solidworks	Weight :	Surface Area : m²	Balance Tank Assembly 18m³ - 79m³	
1	13.06.08	JC		Initial Issue	Modelled By :			
All Dimensions In mm		Scale: Do Not Scale		 Third Angle Projection	Kingspan Environmental reserve the right to alter the details of this drawing without prior notice. This drawing is copyright and may not be reproduced or used without the written permission of Kingspan Environmental			
Z:\Drawing Data\02 - Sales Drawings\DS\DS - 06\DS0637P - BALANCE TANKS 18000L To 79000L								



NOTES:-

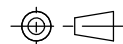
- STANDARD INLET/ OUTLET PIPES ARE Ø160 PVCu UNDERGROUND DRAINAGE.
- THIS DRAWING IS PROVIDED TO SUPPLY DIMENSIONAL INFORMATION ONLY.
- THE UNIT MUST BE INSTALLED WITH A CONCRETE SURROUND. PLEASE SEE THE DETAILED INSTALLATION PROCEDURE, SUPPLIED WITH EACH UNIT
- THE UNIT IS SUPPLIED WITH LOOSE, BOLT ON EXTENSION NECKS TO SUIT EITHER A 1.5 OR 2.0 METER INVERT (SPECIFY WITH ORDER). THEY MUST BE FITTED ON SITE AS PART OF THE INSTALLATION AND CAN BE TRIMMED TO SUIT EXACT SIZE OF INVERT.
- UNITS SHOULD NOT BE INSTALLED DEEPER THAN NECESSARY, NOR DEEPER THAN THE INVERT SPECIFIED FOR THE UNIT SUPPLIED. GROUND IS SELDOM SUITABLE AT GREAT DEPTH FOR INFILTRATION.
- PEDESTRIAN DUTY COVER AND FRAMES, TO FIT 600mm DIAMETER NECKS, ARE AVAILABLE FOR PURCHASE.
- THE WEIGHTS GIVEN ARE FOR HANDLING PURPOSES ONLY AND EXCLUDE BOLT ON SHAFTS.
- VARIOUS INLET / OUTLET PIPEWORK CONFIGURATIONS ARE AVAILABLE. CONSULT TECH SALES SUPPORT FOR OPTIONS.

Nominal Volume (Litres)	Weight (kg)	Overall Length A	Inlet Invert B (B=0.5m, 1.0m, 1.5m, 2.0m)	Outlet Invert C (B=0.5m, 1.0m, 1.5m, 2.0m)	Dimension Between Necks (D)
46,000	2,050	9,684	500,1000,1500,2000	550,1050,1550,2050	3222
54,000	2400	11,222	500,1000,1500,2000	550,1050,1550,2050	3227
59,000	2500	11,991	500,1000,1500,2000	550,1050,1550,2050	3995
63,000	2700	12,960	500,1000,1500,2000	550,1050,1550,2050	3993
71,000	3150	14,295	500,1000,1500,2000	550,1050,1550,2050	5530
79,000	3650	15,833	500,1000,1500,2000	550,1050,1550,2050	6302

Material : Various	Tolerance (unless stated) :	Drawing : DS0637P	Page 2 of 3
Finish :	Thickness :		
Weight :	Surface Area : m²		
Modelled By :			
Kingspan Environmental reserve the right to alter the details of this drawing without prior notice. This drawing is copyright and may not be reproduced or used without the written permission of Kingspan Environmental		Balance Tank Assembly - 18m³ - 79m³	
			

All Dimensions In mm

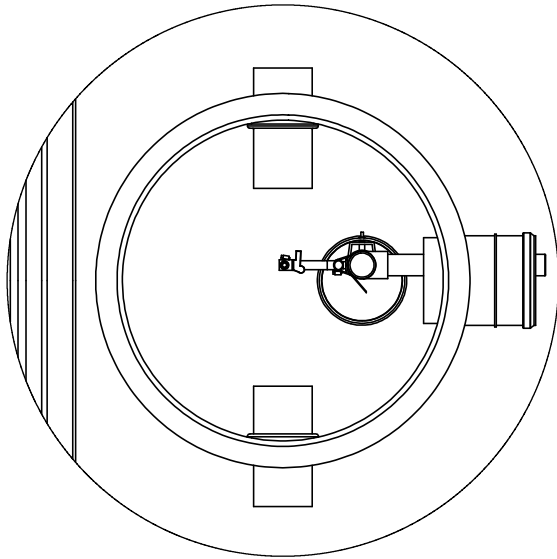
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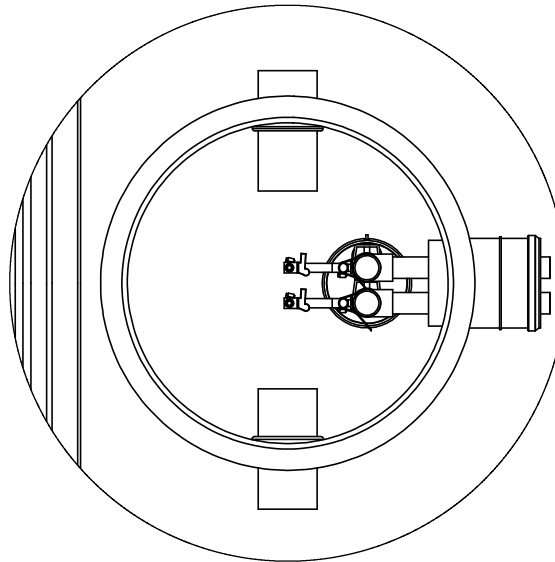
Third Angle Projection

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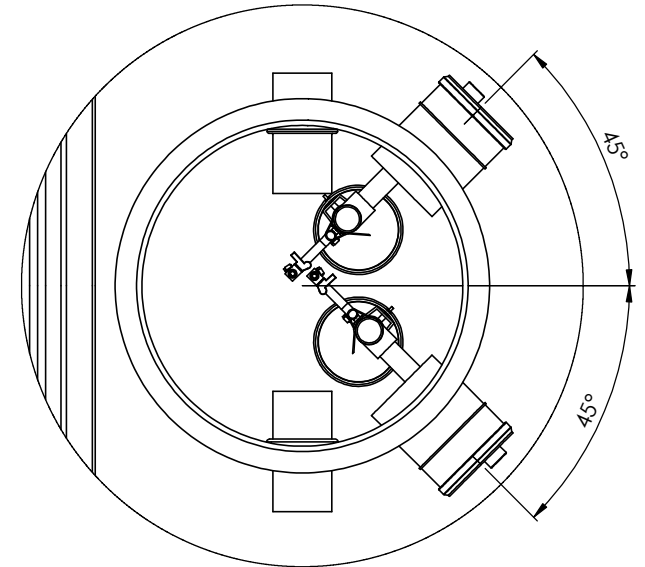
v = AIRLIFT ASSEMBLY OPTIONS




v = A
Single Airlift with Single Outlet



v = B
Twin Airlift with Single Outlet



v = C
Twin Airlift with Twin Outlet

Material : Various	Tolerance (unless stated) :	Drawing : DS0637P	Page 3 of 3
Finish :	Thickness :		
Weight :	Surface Area : m²		
Modelled By :			
Kingspan Environmental reserve the right to alter the details of this drawing without prior notice. This drawing is copyright and may not be reproduced or used without the written permission of Kingspan Environmental		Balance Tank Airlift Assembly 18m³ - 79m³	
			

APPENDIX E

Hydrogeological Risk Assessment

Hydrogeological Risk Assessment for Plas Isaf Lodge Park Drainage

Introduction

This letter report has been completed by LMB Geosolutions Ltd (LMB), on behalf of CDS Group (the Client) in relation to the proposed drainage field for treated effluent discharge for the proposed development at Plas Isaf Lodge Park, Caerwys Hill, Mold, Caerwys, CH7 5AD.

This document provides a Hydrogeological Risk Assessment of the potential pollutant impact on groundwater of the proposed drainage system based on site specific and literature information and a number of reasonable assumptions.

Background

National Resource Wales Correspondence

The following correspondence was received from Natural Resources Wales in relation to the proposed drainage system:

We need more information about your application

Application reference: PAN-018353

Operator: Darwin (Plas Isaf) Ltd

Facility: Package treatment plant and infiltration system serving Plas Isaf Lodge Park

We need to ask you for some more information before we can do any more work on it. Please would you

- *Provide a Groundwater risk assessment*

The Groundwater risk assessment needs to demonstrate that there are no unacceptable inputs of hazardous substances or non-hazardous pollutants to controlled waters. Further information is required in accordance with Infiltration systems: groundwater risk assessments - GOV.UK (www.gov.uk) to adequately assess the risk to groundwater posed by the discharge.

Discharges of treated sewage effluent greater than 15 m³ in volume, require extended or comprehensive information to support the assessment; refer to infiltration system; groundwater risk assessment guidance for the level of information required to see detail of the level of information required to carry out an appropriate level tiered risk assessment for this site. Extended information includes, but is not limited to, the following:

Extended information: what you must include

- *Geological information of the site, including solid and drift deposits, soil or subsoil characteristics to 3m below base of drainage field and borehole logs and trial pits*
- *groundwater flow mechanism – fissure or intergranular flow*
- *direction of groundwater flow – groundwater monitoring boreholes*
- *hydraulic gradient – groundwater monitoring boreholes that let you measure the groundwater level (boreholes that can be dipped) you can use them to calculate the hydraulic gradient*
- *effective porosity of the aquifer – you can use literature values*
- *mixing depth – from borehole logs, groundwater quality sampling or theoretical calculations*
- *site specific data to determine the hydraulic conductivity of the aquifer*
- *details of operation and maintenance – monitoring of discharge rates, effluent quality, liquid levels in distribution chamber*

If you're carrying out groundwater risk assessments, you should be an industry professional with an appropriate accreditation, or working under the supervision of one, towards an accreditation such as a chartered geologist, Chartered

Institution of Water and Environmental Management (CIWEM) or chartered engineer. You must make sure that only a competent person (such as an experienced hydrogeologist) creates any models you use. These models must be based on a strong conceptual model using hydrogeological expertise.

Existing Report

The following report has been produced in relation to the proposed development and associated drainage system:

- CDS Group (September 2022). Groundwater Risk Assessment on behalf of Darwin (Plas Isaf) Ltd. Plas Isaf Lodge Park, Caerwys Hill, Mold, Caerwys CH7 5AD.

The above referenced report includes information within a drainage design report for the development completed by RA Dalton.

Summary of Drainage Design Information

Information provided within the CDS report in relation to the proposed drainage requirements and drainage field are summarised below:

- The development comprises 57 holiday lodges for which a new foul water drainage system is required. Planning consent was given for the use of an onsite package treatment plant.
- The discharging effluent is classified as domestic effluent, as it comprises sewage waste only from the 57 lodges.
- Treatment stages – Primary and Secondary treatment provided by the Kingspan BN Biodisc and additional 34m³ settlement tank,
- Tertiary treatment provided by a drainage field.
- Calculated peak daily flow, assuming a maximum of 4 people per lodge is 34200 litres (34.2m³).
- Pumping rate from the discharge point from the package treatment plant to the drainage field is 2l/s, reducing down to 1l/s in the demarcation/break chamber.
- The frequency and duration of discharge is proposed to be intermittent, with the aim of the system to provide little and frequent volumes rather than larger volumes.
- Calculated population equivalent (PE) for organic, hydraulic and ammonia is 228.

Environmental Setting

Elevation and Topography

Information provided by the Client along with reference to publicly available mapping suggests that in the site slopes from approximately 150m AOD in the east to approximately 115m AOD in the west. The land continues to slope to the west from the site to the River Wheeler at an elevation of approximately 85m AOD.

Summary of Ground & Groundwater Conditions

Geology

Reference to the BGS information provided within the CDS report along with publicly available geological mapping, indicates that the majority of the site comprises Alluvial soils (ALV) and Tufa (TUFA), progressing into Glaciofluvial Ice Contact Deposits (GFICD) and Glacial Till (TILLD) in the eastern area of the site. Beneath the drift deposit the bedrock geology is mapped as the Llarmon Limestone (LNML) in the northern site area progressing into the Foel Formation (FOF) in the southern area of the site.

A fault is also mapped near the eastern site boundary, running approximately north-south and following the approximate course of the River Wheeler.

Two phases of ground investigation were completed by CDS in two adjacent fields that were potential locations for the proposed drainage field.

In the most easterly field 6no. trial pits were completed with a variable succession of soils encountered but commonly comprising topsoil and calcareous Silt overlying Peat which in turn overlies silty Sand and gravelly Sand. The soils encountered are considered to be representative of the ALV and TUFA detailed on the published geology.

In the most westerly field 11no. dynamic (windowless) sampler boreholes were completed with ground conditions typically comprising topsoil overlying a sequence of gravelly Clay and clayey, gravelly Sand which is interpreted to be representative of the GFICD and TILLD. In the majority of locations both clay and sand units are present, however in locations WLS110 and WLS111 the soils were primarily Sand and in locations WLS101 and WLS109 the soils were primarily Clays.

Hydrogeology

The site is not located within a designated groundwater Source Protection Zone (SPZ) with the nearest located approximately 2km north of the site.

Reference to the BGS information provided within the CDS report indicates that the ALV, TUFA and GFICD are designated a Secondary (A) Aquifer and the TILLD is designated a Secondary (B) Aquifer. The LNML is designated a Principal Aquifer.

During the trial pit investigation groundwater was observed at depths of between approximately 1.2m and 2.6m bgl with the Peat soils fully saturated. In the window sampler investigation groundwater seepages were observed in six of the eleven locations at depths of approximately 1.90m and 5.0m bgl (approximately 131.30mAOD to 128.9mAOD). Five of the window sampler boreholes were completed with monitoring well installations (101, 104, 105, 107 and 108) and during return monitoring all were found to be dry apart from WLS108 which is located in the lower field where the trial pit investigation was completed.

The groundwater observations during the ground investigation works and return monitoring suggest that in the upper (most easterly) field groundwater is present in discrete granular units that have limited lateral extent. This is considered to be typical of groundwater within GFICD and TILLD.

In the lower (most westerly) field shallow groundwater is present within the Peat layer and within the underlying soils and is considered to be representative of the Secondary (A) Aquifer of the ALV.

It is not known if there is any hydraulic connection between groundwater observed in the GFICD and TILLD and groundwater observed in the ALV. The elevation of the upper field (most easterly) varies between approximately 145m and 130m AOD and in the lower field varies between approximately 130m AOD and 120m AOD. Groundwater seepages were observed in two of the WLS locations along the boundary of the two fields at 3.10m and 3.50m bgl (approx. 128m and 128.8m AOD). In location WLS108 installed in the lower field a groundwater seepage was observed at 1.2m (approximately 121.5m AOD) and during return monitoring groundwater was recorded at 0.64m bgl (approximately 122.06m AOD)

The water seepage and monitored elevations in the upper field are notably higher than those in the lower field suggesting that any direct hydraulic connection between the observed groundwater units is very localised.

Hydrogeological Conceptual Site Model

Introduction

The information within the referenced reports along with literature information presented in the following sections of this report has been used to construct a Hydrogeological Conceptual Site Model (HCSM) that has been used as the basis for the subsequent Hydrogeological Risk Assessment presented in the next section. A HCSM Schematic is appended.

Local Hydrology & Hydrometric Data

As outlined the River Wheeler runs in an approximately north-south orientation along the western site boundary. Reference to information on the NRW interactive map for Cycle 3 (2021) Rivers and Water Bodies Map indicates that the site is located within the catchment of the lower Wheeler which has been assigned an overall moderate quality.

Information within the UK Hydrometric Register for the River Wheeler (Bofari gauging station) indicates that the mean annual average rainfall is 877mm (377mm run off and 500mm losses). The baseflow index for the gauging station (similar geology) is 0.82 suggesting that groundwater provides a significant proportion of river flow.

Infiltration & Recharge

Based on the current understanding of the on-site conditions, recharge across the site will vary according to the ground cover and unsaturated zone geology. At present the ground surface cover across the site is entirely soft surface cover and following installation of the treatment facility this is not anticipated to alter significantly.

In the areas of soft ground cover, rainfall infiltration will be controlled by the Soil Moisture Deficit and rates of evapotranspiration. In areas of hard cover rates of run-off will be relatively high and rainfall infiltration will be limited to localised cracks in hard standing and inputs from artificial mechanisms such as leaking drains, which is likely to be low given it is a new development.

It is considered likely that direct rainfall recharge of groundwater beneath the site will only be significant in the winter months. In addition, there is potential for recharge of the groundwater beneath the site via off-site areas as there is a significant proportion of soft ground cover in the vicinity of the site. However, this would be limited by the extent (outcrop), geological heterogeneities and possibly hydraulic continuity of the superficial deposits.

However, within the HCSM and subsequent risk assessment the results of the site specific testing completed as part of the RA Dalton assessment have utilised i.e. a percolation rate of 32s/mm and an infiltration rate of 0.024m/d over the drainage field area.

Unsaturated Zone

Information presented within the CDS report indicates that groundwater within the Principal Aquifer of the LNML is anticipated to be approximately 30-40m bgl which provides a significant unsaturated zone thickness. However, groundwater observations during the site investigation works suggest that groundwater is present within the ALV and TUFA and also within the GFICD and TILLD.

The CDS report suggests that due to the presence of peat and shallow groundwater within the lower field it will not be considered for the location of the proposed drainage field. Within the upper field no groundwater was recorded during return monitoring but as outlined groundwater seepages were recorded at depths of between 1.90m and 5.0m bgl (approximately 131.30mAOD to 128.9mAOD) and in the two of the WLS locations along the boundary of the two fields at 3.10m and 3.50m bgl (approx. 128m and 128.8m AOD).

On this basis within the HCSM a conservative approach has been taken and an UZ thickness of between 3.0m has been applied in the assessment.

Aquifer Properties

The Environment Agency (EA) document *The Physical Properties of Minor Aquifers in England and Wales (Allen, DJ et al 1997)* provides a limited amount of information relating to the hydrogeology of the LNML and suggests that groundwater movement and storage is controlled by solution enlarged fractures with very low primary porosity and permeability, resulting in highly variable aquifer properties. Given the predicted depth to groundwater in this formation and the presence of overlying drift deposits the groundwater in the LNML has not been considered within this assessment.

For the aquifer properties of the drift deposits at the site general literature information present within Fetter et al and the ConSim helpfile has been referenced. Matrix flow in the observed sand units within the GFICD and TILLD in the upper field have been considered and a porosity of 25% and a conservative hydraulic conductivity of 5.00m/d applied within the assessment.

Groundwater Flow

It has been assumed that any groundwater flow within the drift deposits is down topographical gradient to the west in the general direction of the River Wheeler. Within the HCSM an hydraulic gradient of 0.005 has been applied and is considered to be a reasonable approximation.

Potential Pollutant Linkages

Within the HCSM it has been assumed that treated effluent from the treatment plant would be discharged via the drainage field and leach and migrate via the unsaturated zone and then into a hypothetical thin groundwater bearing sand unit (0.50m) within the GFICD and TILLD that is in hydraulic continuity with groundwater within the ALV and the River Wheeler.

Hydrogeological Risk Assessment

Assessment Approach

Best Practice Guidance

In completing the risk assessment, the following documents relating to current best practice, policy and regulation have been referenced:

- NRW guidance relating to Land Contamination (<https://naturalresources.wales/guidance-and-advice/business-sectors/planning-and-development/advice-for-developers/land-contamination/?lang=en>)
- Guidance on the gov.uk website relating to Infiltration systems: groundwater risk assessments (<https://www.gov.uk/guidance/infiltration-systems-groundwater-risk-assessments#risk-assessment-approach>)
- Groundwater Protection (previously covered in GP3, withdrawn on 14th March 2017) and associated guidance on the Gov.uk website relating to groundwater risk assessments;
- Guidance on the Assessment and Interrogation of Subsurface Analytical Contaminant Fate and Transport Models. National Groundwater & Contaminated Land Centre report NC/99/38/1 (2001).
- Environment Agency (2014). Groundwater Risk Assessment for Treated Effluent Discharges to Infiltration Systems. Annex J5: Infiltration Worksheet User Manual v2.0;
- Water Framework Directive (Directive 2000/60/EC) and associated UK Technical Advisory Group documents; and
- The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

In accordance with current best practice, the 'prevent and limit' approach has been adopted for the assessment of controlled waters, such that:

- *Where pollutants have not yet entered the groundwater, all necessary and reasonable measures must be taken to;*
 - *Prevent the input of hazardous substances into groundwater.*
 - *Minimize entry of other (non-hazardous) pollutants into groundwater so as to avoid pollution and deterioration of the status of groundwater bodies or sustained, upward trends in pollutant concentrations.*
- *Where hazardous substances or non-hazardous pollutants have already entered the groundwater, the priority is to;*
 - *Minimise further entry of hazardous substances and non-hazardous pollutants into groundwater.*
 - *Take necessary and reasonable measures to limit the pollution of groundwater or impact on the status of the groundwater body from the future expansion of a contaminant 'plume', if necessary by actively reducing its extent.*

Key Risk Drivers

In relation to discharge from the treatment plant the key risk driver is considered to be Ammoniacal Nitrogen.

Receptors & Compliance Point

The groundwater beneath the site is designated a Secondary (A) Aquifer but in this case is considered to be primarily a pathway to the River Wheeler which is considered to be the main receptor. The key risk driver is a non-hazardous pollutant and as such a compliance point of up to 250m could be considered. However, within this assessment a conservative approach has been adopted and an initial **compliance point of 50m** has been set in considering local surface water features as potential receptors.

Water Quality Standards

Based on the 'prevent and limit' approach of the Water Framework Directive (2000/60/EC) and the identified receptors, the following Water Quality Standards (WQS) have been applied:

- Drinking Water Quality Standards England & Wales, 2000 (Amended 2004, DWS).
- The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.
- World Health Organisation (WHO) Guidelines for Drinking Water Quality, Fourth Edition, Volume 1;

Based on the site setting and the importance of the Principal Aquifer, where available the DWS has been applied as the WQS. In the case of oils/hydrocarbons WHO guidance has been applied.

The River Wheeler is at an elevation of approximately 85m AOD and reference to the *Waterwise* water hardness of the British Isles suggests it would have an alkalinity of approximately 100-200mg/l CaCO₃. Reference to the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015 suggests that the River Wheeler should be designated a Type 6 river and assigned an EQS for Ammonia of 0.75mg/l.

Risk Assessment

Initial Contaminant Inputs

Information presented from the RA Dalton assessment in the CDS report indicates that the maximum concentration of Ammoniacal Nitrogen discharged to the drainage field will be 5mg/l and as such this has been applied as the initial contaminant concentration within the assessment.

Fate and Transport Model

The assessment of potential impacts associated with Ammoniacal Nitrogen on the underlying groundwater has been undertaken with the aid of the Environment Agency Groundwater risk assessment for treated effluent discharges to infiltration systems worksheet (InfWS) and associated user manual.

InfWS is a deterministic model that requires input of site specific parameters relating to the drainage field, unsaturated zone and aquifer specific parameters such as hydraulic conductivity as well as contaminant specific parameters such as half-life and partitioning which can be both soil/aquifer and contaminant specific.

InfWS enables modelling and prediction of contaminant fate and transport in drainage system, unsaturated zone and groundwater.

Summary of Results

50m Compliance Point

The results of the InfWS risk assessment model for a 50m compliance point are appended and summarised in the table below:

Key Risk Driver	Predicted Concentration (mg/l)		
Ammoniacal Nitrogen	Base of UZ	Groundwater below Drainage Field	Groundwater at 50m compliance
	4.94	4.87	0.855

The predicted concentration at the 50m compliance point is 0.855mg/l which is slightly above the relevant EQS of 0.75mg/l and would result in a provisional environmental permit limit of 4.39mg/l.

However, the upper field where the drainage field is proposed is approximately 135m east of the River Wheeler (from its western boundary).

60m Compliance Point

The results of the InfWS risk assessment model for a 60m compliance point are appended and summarised in the table below:

Key Risk Driver	Predicted Concentration (mg/l)		
	Base of UZ	Groundwater below Drainage Field	Groundwater at 50m compliance
Ammoniacal Nitrogen	4.94	4.87	0.701

The predicted concentration at the 60m compliance point is 0.701mg/l which is below the relevant EQS of 0.75mg/l and would result in a provisional environmental permit limit of 5.35mg/l.

Conclusions & Recommendations

The results of the assessment suggest that potential impacts from the proposed drainage system on groundwater within the Secondary (A) Aquifer would be minimal and that impacts to the River Wheeler would be negligible. On this basis the proposed discharge concentration of 5mg/l of Ammoniacal Nitrogen is considered to be appropriate.

Recommendations

It is recommended that a programme of monitoring, sampling and analysis is undertaken to appraise the actual concentrations entering and being discharged from drainage field to ensure that the assumption and results of the model and assessment are valid.

I trust the information provided is of use. However, if you have any queries then please feel free to contact me at your convenience.

Best regards,



Philip Lewis
Bsc (Hons), Msc, FGS, CGeol

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APPENDICES

Infiltration Worksheet

Infiltration System



This sheet allows user to enter effluent concentration and details of infiltration system

Substance	Ammonium	From introduction sheet
Compliance value or environmental standard	C _T 7.50E-01 mg/l	From introduction sheet

Input Parameters

Standard entry

Concentration of substance in discharge (entering infiltration system)	C _e	5.00E+00	mg/l	RA Dalton design information
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Type of treatment plant

Package treatment plant

Water use and percolation rate (for use only with septic tanks and package treatment plants)

Number of persons	p	2.28E+02		RA Dalton design information
Water use		1.50E+02	litres/person/day	RA Dalton design information
Percolation rate	Vp	3.20E+01	s/mm	RA Dalton design information

Specify discharge (Q1) or calculate based on use (Q2)

Calculated discharge Q2

Discharge rate	Q1		m ³ /d	
Calculated discharge	Q2	3.42E+01	m ³ /d	

Value calculated and not specified by user

Area of drainage field and hydraulic loading

Specify area of drainage field or calculate based on percolation rate

Calculate

Enter area of drainage field	A	0.09E+00	m ²	
Calculated area of drainage field	A	1.46E+03	m ²	
Calculated infiltration rate	Inf	2.34E-02	m/d	

Value calculated and not specified by user

Site being assessed:	Plas Isaf Lodge Park
Completed by:	PIL
Date:	27-Sep-22
Version:	x.xx

Infiltration Worksheet



Attenuation unsaturated zone

This sheet calculates attenuation factor for the unsaturated zone; concentration at base of unsaturated zone and discharge consent limit

Contaminant	Variable	Value	Unit	Source of parameter value
Ammonium				
Compliance value or environmental standard	C_T	7.50E-01	mg/l	From introduction sheet
Concentration of substance in substance in discharge (entering infiltration system)	C_e	5.00E+00	mg/l	From introduction sheet
Input Parameters				
Standard entry				
Infiltration rate	Inf	2.34E-02	ml/d	From infiltration sheet
Thickness of drainage layer	S_1	1.00E+00	m	Client supplied information
Water filled porosity	θ_1	2.00E-01	fraction	estimated from porosity calculator
Bulk density	ρ_1	1.80E+00	g/cm ³	estimated value
Calculated dispersivity	D_1	1.00E-01	m	calculated
Option to select degradation				
Half life for degradation of substance	$t_{1/2}$	1.10E+03	days	Buss et al mid value for sands & gravels
Calculated decay rate	λ_1	6.96E-05	days ⁻¹	calculated (very low value set if no degradation)
Enter method of defining partition co-efficient (using pull down list)				
Entry if specify partition coefficient (option)				
Soil water partition coefficient	K_d	9.00E-01	l/kg	Buss et al for clean sand & gravel
Entry for organic chemicals (option)				
Soil water partition coefficient used in assessment	K_d	9.00E-01	l/kg	Specified value
Retardation factor	R_{d1}	9.10E+00		
Unretarded travel time (no dispersion)	t_u	8.53E+00	d	
Unretarded travel time (with dispersion)	t_u	7.68E+00	d	
Retarded travel time (with dispersion)	t_r	6.96E+01	d	
Attenuation factor	AF_{u1}	1.01E+00		
Unsaturation Zone				
Thickness of unsaturated zone below drainage field	S_2	3.00E+00	m	site investigation & monitoring data
Water filled porosity	θ_2	1.50E-01	fraction	estimated from porosity calculator
Bulk density of unsaturated zone	ρ_2	1.80E+00	g/cm ³	estimated value
Calculated dispersivity	D_2	3.00E-01	m	calculated
Option to select degradation				
Half life for degradation of substance	$t_{1/2}$	2.19E+03	days	Buss et al highest for sands & gravels
Calculated decay rate	λ_2	3.86E-05	days ⁻¹	calculated (very low value set if no degradation)
Fraction of rapid flow through unsaturated zone	B	0.00E+00		
Enter method of defining partition co-efficient (using pull down list)				
Entry if specify partition coefficient (option)				
Soil water partition coefficient	K_d	6.00E-01	l/kg	Buss et al for clayey sand & gravel
Entry for organic chemicals (option)				
Soil water partition coefficient used in assessment	K_d	6.00E-01	l/kg	Specified value
Retardation factor	R_{d2}	8.20E+00		
Unretarded travel time (no dispersion)	t_u	1.92E+01	d	
Unretarded travel time (with dispersion)	t_u	1.73E+01	d	
Retarded travel time (with dispersion)	t_r	1.42E+02	d	
Attenuation factor	AF_{u2}	1.01E+00		
Total unretarded travel time	$t_u + t_u$	2.77E+01	d	
Total retarded travel time	$t_r + t_r$	2.36E+02	d	
Attenuation factor and discharge consent limit				
Drainage layer attenuation factor	AF_{u1}	1.01E+00		
Unsaturation zone attenuation factor	AF_{u2}	1.01E+00		
Concentration at base of drainage layer	C_{db}	4.97E+00	mg/l	
Concentration at base of unsaturated zone	C_{wt}	4.94E+00	mg/l	
		and		

Site being assessed: Plas Isaf Lodge Park
 Completed by: PIL
 Date: 27-Sep-22
 Version: xxx

Infiltration Worksheet



Dilution

Substance		Ammonium		
Compliance value or environmental standard	C _T	7.50E-01	mg/l	From introduction sheet
Source concentration	C _e	5.00E+00	mg/l	From introduction sheet
Concentration at base of drainage layer	C _{wt}	4.94E+00	mg/l	From infiltration sheet
				From atten_unsatzone sheet

This sheet calculates the dilution factor for groundwater dilution below the drainage field.
Substance concentration in groundwater and discharge consent limit

Input Parameters	Variable	Value	Unit	Source of parameter value
Infiltration	Inf	2.34E-02	m/d	From infiltration sheet
Area of drainage field	A	1.46E+03	m ²	From infiltration sheet

Entry for groundwater flow below site

Length of drainage field in direction of groundwater flow	L	3.82E+01	m	<div>Information within RA Dalton report</div> <div>Assumed thin gw bearing unit</div> <div>Fetter et al for sand & gravel</div> <div>conservative assumption</div> <div>Information within RA Dalton report</div>	
Saturated aquifer thickness	da	5.00E-01	m		
Hydraulic Conductivity of aquifer in which dilution occurs	K	5.00E+00	m/d		
Hydraulic gradient of water table	i	5.00E-03	fraction		
Width of drainage field perpendicular to groundwater flow	w	3.82E+01	m		
Background concentration of substance in groundwater up-gradient of site	Cu	0.00E+00	mg/l		
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate			
Enter mixing zone thickness	Mz	5.00E-01	m		Not valid - Value calculated
Calculated mixing zone thickness	Mz	5.00E-01	m		
Groundwater flow (mixing zone) below drainage field	Gw	0.48	m ³ /d		

w * L (1459.24) does not equal area (A) of drainage field (1459.2) - check parameters used (this may be OK if drainage field at angle to flow direction)

w * L (1459.24) does not equal area (A) of drainage field (1459.2) - check parameters used (this may be OK if drainage field at angle to flow direction)

Dilution factor and discharge consent limit

Dilution Factor	DF	1.013961988		From infiltration sheet
Headroom Factor	HF	1.013961988		
Unsaturated zone attenuation factor	AFu	1.01E+00		
Concentration in groundwater below drainage field	C _{gw}	4.87E+00	mg/l	
Environmental Permit limit value	EPL ₂	0.76924585	mg/l	

Site being assessed:	Plas Isaf Lodge Park
Completed by:	PIL
Date:	27-Sep-22
Version:	x.xx

Concentration immediately downgradient of drainage field exceeds target concentration

Infiltration Worksheet

Attenuation in saturated zone

Input Parameters	Variable	Value	Unit	Source
Substance		Ammonium		From introduction sheet
Compliance value or environmental standard	C _t	7.50E-01	mg/l	From introduction sheet
Source concentration	C _s	5.00E+00	mg/l	From infiltration sheet
Dilution Factor	DF	1.01E+00		from dilution sheet
Unsaturated zone attenuation factor	AF _u	1.01E+00		From atten_unsatzone sheet

Variable	Value	Unit	Source of parameter value
Concentration in groundwater below drainage field	C _{gw}	4.87E+00	mg/l from dilution sheet
Degradation occurs dissolved phase only			
Option to select degradation			
Half life for degradation of substance	t _{1/2}	2.19E+03	days Buss et al highest value
Calculated decay rate	λ	4.23E-05	days ⁻¹ calculated (very low value set if no degradation)
Width of drainage field	w	3.82E+01	m from dilution sheet
Mixing zone thickness	Mz	5.00E-01	m from dilution sheet
Bulk density of aquifer materials	ρ	1.92E+00	g/cm ³ estimated value
Effective porosity of aquifer	n	2.50E-01	fraction Fetter et al
Hydraulic gradient	i _{ozw}	3.63E-01	fraction from dilution sheet (adjusted)
Hydraulic conductivity of saturated aquifer	K	5.00E+00	m/d from dilution sheet
Distance to compliance point	x	5.00E+01	m
Option to select time			
Use steady state (recommended)			
Time since pollutant entered groundwater	t	1.00E+99	
Parameters values determined from options			
Partition coefficient	K _d	9.00E-01	l/kg see options
Longitudinal dispersivity	α _x	5.00E+00	m see options
Transverse dispersivity	α _z	5.00E-01	m see options
Vertical dispersivity	α _y	5.00E-02	m see options

Calculated Parameters	Variable	Value	Unit
Groundwater flow velocity	v	7.28E+00	m/d
Retardation factor	Rf	7.48E+00	fraction
Decay rate used	λ	4.23E-05	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i _{ozw}	3.63E-01	fraction
Rate of contaminant flow due to retardation	u	9.71E-01	m/d
Attenuation factor	AF _s	5.70E+00	fraction

Attenuation and Dilution factors and discharge consent limit

Dilution Factor	DF	1.01E+00
Unsaturated zone attenuation factor	AF _u	1.01E+00
Saturated zone attenuation factor	AF _s	5.70E+00
Concentration in groundwater at compliance point	C _{gw}	0.854725205 mg/l
Environmental Permit limit value	EPL ₃	4.39E+00 mg/l
Distance to compliance point		50 m

Concentration at compliance point exceeds target concentration

This sheet calculates attenuation factor for the saturated zone; substance concentration at downgradient compliance point and discharge consent limit



Enter method of defining partition co-efficient (using pull down list)

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient	K _d	9.00E-01	l/kg
Entry for organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}		fraction
Organic carbon partition coefficient	K _{oc}		l/kg
Soil water partition coefficient	K _d	9.00E-01	l/kg

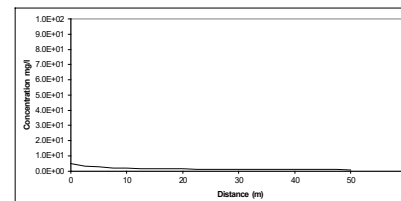
Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

	ax	ay	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity (m)	ax		1.00E-12	5.00E+00	2.98E-01
Transverse dispersivity (m)	az		1.00E-12	5.00E-01	2.98E-01
Vertical dispersivity (m)	ay		1.00E-12	5.00E-02	2.98E-02

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $\alpha_x = 0.83(\log_{10} x)^{0.414}$; $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed
For calculated value, assumes $\alpha_x = 0.1 \times x$, $\alpha_z = 0.01 \times x$, $\alpha_y = 0.001 \times x$



Calculated concentrations for distance-concentration graph

From calculation sheet

Distance m	Concentration mg/l
0	4.9E+00
2.5	3.33E+00
5.0	2.54E+00
7.5	2.13E+00
10.0	1.87E+00
12.5	1.68E+00
15.0	1.54E+00
17.5	1.43E+00
20.0	1.35E+00
22.5	1.27E+00
25.0	1.21E+00
27.5	1.15E+00
30.0	1.11E+00
32.5	1.06E+00
35.0	1.02E+00
37.5	9.90E-01
40.0	9.58E-01
42.5	9.29E-01
45.0	9.03E-01
47.5	8.78E-01
50.0	8.55E-01

Site being assessed: Plas Isaf Lodge Park
Completed by: 0
Date: 00-Jan-00
Version: 0

Infiltration Worksheet

Summary of calculations for concentration of substance in groundwater

No input required, values taken from previous worksheets

Summary of compliance data, attenuation and dilution factors

Substance		Ammonium
Effluent concentration	C_e	5.00E+00 mg/l
Compliance value or environmental standard	C_T	0.75 mg/l
Distance to compliance point		50.00 m
Attenuation factor - unsat zone	AFu	1.01E+00
Dilution Factor	DF	1.01E+00
Attenuation factor- sat zone	AFs	5.70E+00

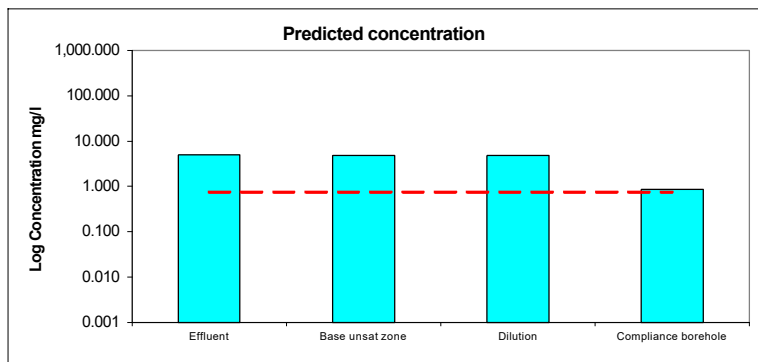
Predicted concentrations at compliance point based on proposed effluent concentration

Concentration at base of unsaturated zone	C_{wt}	4.94E+00 mg/l	Attenuation in unsaturated zone only
Concentration in groundwater below drainage field	C_{gw}	4.87E+00 mg/l	Dilution taken into account
Concentration in groundwater at compliance point	C_{dcp}	8.55E-01 mg/l	Attenuation in saturated zone taken into account

Lower effluent concentration may be required - see below

Provisional Environmental Permit limit values

Based on attenuation in unsaturated zone	EPL ₁	7.59E-01 mg/l
Based on attenuation in unsaturated zone and dilution	EPL ₂	7.69E-01 mg/l
Based on dilution and attenuation in unsaturated and saturated zone	EPL ₃	4.39E+00 mg/l



Infiltration Worksheet

Attenuation in saturated zone

Input Parameters	Variable	Value	Unit	Source
Substance		Ammonium		From introduction sheet
Compliance value or environmental standard	C _t	7.50E-01	mg/l	From introduction sheet
Source concentration	C _s	5.00E+00	mg/l	From infiltration sheet
Dilution Factor	DF	1.01E+00		from dilution sheet
Unsaturated zone attenuation factor	AF _u	1.01E+00		From atten_unsatzone sheet

Variable	Value	Unit	Source of parameter value
Concentration in groundwater below drainage field	C _{gw}	4.87E+00	mg/l from dilution sheet
Option to select degradation			
Degradation occurs dissolved phase only			
Half life for degradation of substance	t _{1/2}	2.19E+03	days Buss et al highest value
Calculated decay rate	λ	4.23E-05	days ⁻¹ calculated (very low value set if no degradation)
Width of drainage field	w	3.82E+01	m from dilution sheet
Mixing zone thickness	Mz	5.00E-01	m from dilution sheet
Bulk density of aquifer materials	ρ	1.90E+00	g/cm ³ estimated value
Effective porosity of aquifer	n	2.50E-01	fraction Fetter et al
Hydraulic gradient	i _{corr}	3.63E-01	fraction from dilution sheet (adjusted)
Hydraulic conductivity of saturated aquifer	K	5.00E+00	m/d from dilution sheet
Distance to compliance point	x	6.00E+01	m
Option to select time			
Use steady state (recommended)			
Time since pollutant entered groundwater	t	1.00E+99	days
Parameters values determined from options			
Partition coefficient	K _d	9.00E-01	l/kg see options
Longitudinal dispersivity	ax	6.00E+00	m see options
Transverse dispersivity	az	6.00E-01	m see options
Vertical dispersivity	ay	6.00E-02	m see options

Calculated Parameters	Variable	Value	Unit
Groundwater flow velocity	v	7.28E+00	m/d
Retardation factor	Rf	7.49E+00	fraction
Decay rate used	λ	4.23E-05	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i _{corr}	3.63E-01	fraction
Rate of contaminant flow due to retardation	u	9.71E-01	m/d
Attenuation factor	AF _s	6.95E+00	fraction

Attenuation and Dilution factors and discharge consent limit

Dilution Factor	DF	1.01E+00
Unsaturated zone attenuation factor	AF _u	1.01E+00
Saturated zone attenuation factor	AF _s	6.95E+00
Concentration in groundwater at compliance point	C _{gw}	0.701203563 mg/l
Environmental Permit limit value	EPL ₃	5.35E+00 mg/l
Distance to compliance point		60 m

below compliance value

Discharge limit for discussion with Environment Agency

Concentration at compliance point below target concentration

This sheet calculates attenuation factor for the saturated zone; substance concentration at downgradient compliance point and discharge consent limit



Enter method of defining partition co-efficient (using pull down list)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	K _d	9.00E-01	l/kg
Entry for organic chemicals (option)			
Fraction of organic carbon in aquifer	f _{oc}		fraction
Organic carbon partition coefficient	K _{oc}		l/kg
Soil water partition coefficient	K _d	9.00E-01	l/kg

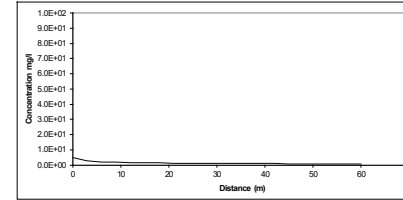
Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity (m)			
ax	Enter value	Calc value	Xu & Eckstein
ax	1.00E-12	6.00E+00	3.33E-01
Transverse dispersivity (m)			
az	1.00E-12	6.00E-01	3.33E-01
Vertical dispersivity (m)			
ay	1.00E-12	6.00E-02	3.33E-02

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log₁₀ x)^{0.414}; az = ax/10, ay = ax/100 are assumed
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x



Calculated concentrations for distance-concentration graph

Distance m	Concentration mg/l
0	4.9E+00
3.0	2.90E+00
6.0	2.17E+00
9.0	1.80E+00
12.0	1.57E+00
15.0	1.42E+00
18.0	1.30E+00
21.0	1.20E+00
24.0	1.13E+00
27.0	1.06E+00
30.0	1.01E+00
33.0	9.63E-01
36.0	9.22E-01
39.0	8.85E-01
42.0	8.51E-01
45.0	8.21E-01
48.0	7.93E-01
51.0	7.68E-01
54.0	7.44E-01
57.0	7.22E-01
60.0	7.01E-01

Site being assessed:	Plas Isaf Lodge Park
Completed by:	0
Date:	00-Jan-00
Version:	0

Infiltration Worksheet

Summary of calculations for concentration of substance in groundwater

No input required, values taken from previous worksheets

Summary of compliance data, attenuation and dilution factors

Substance		Ammonium
Effluent concentration	C_e	5.00E+00 mg/l
Compliance value or environmental standard	C_T	0.75 mg/l
Distance to compliance point		60.00 m
Attenuation factor - unsat zone	AF _u	1.01E+00
Dilution Factor	DF	1.01E+00
Attenuation factor- sat zone	AF _s	6.95E+00

Predicted concentrations at compliance point based on proposed effluent concentration

Concentration at base of unsaturated zone	C_{wt}	4.94E+00 mg/l	Attenuation in unsaturated zone only
Concentration in groundwater below drainage field	C_{gw}	4.87E+00 mg/l	Dilution taken into account
Concentration in groundwater at compliance point	C_{dcp}	7.01E-01 mg/l	Attenuation in saturated zone taken into account

Provisional Environmental Permit limit values

Based on attenuation in unsaturated zone	EPL ₁	7.59E-01 mg/l	
Based on attenuation in unsaturated zone and dilution	EPL ₂	7.69E-01 mg/l	
Based on dilution and attenuation in unsaturated and saturated zone	EPL ₃	5.35E+00 mg/l	Discharge limit for discussion with Environment Agency

