Cilyrychen Quarry – Dewatering Abstraction Licence Application

Final Report

December 2021

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This report describes work commissioned by Dafydd Jones, on behalf of TRJ Ltd, by an e-mail dated 23 August 2021. Eleanor Williams and Joseph Cherry of JBA Consulting carried out this work.

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Purpose

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1 Introduction

1.1 Executive summary

This report provides supporting information for the NRW abstraction licence application. In addition, it provides a hydrogeological impact assessment, which evaluates any potential effect of the proposed activity on other water users and the local environment. In summary:

- The hydrogeological function of the Cilyrychen quarry has been conceptualised from a review of high-level information. The assessment for the proposed abstraction to dewatering Cilyrychen quarry is for no adverse impacts to surrounding water features or other local water users;
- In particular, the potential impacts to the turlough close to the quarry have been evaluated. However, there is no evidence for a hydraulic connection between the turlough and the quarry, and it is determined that it would not therefore be affected by a dewatering abstraction operating within the quarry void;
- It is noted that after the initial dewatering of the existing water within the void, abstraction would be infrequent and at a lower flow rate, due to the slow refilling of the void observed previously. This would permit the planned site activities to take place, which is the re-use and processing of quarried limestone within the void, within the dewatered area; and
- The applicant would nonetheless undertake monitoring of the turlough and quarry water levels prior to and during the initial abstraction period, to provide confirmation of the lack of connectivity.

1.2 Background and aims

T Richard Jones (Betws) Ltd (TRJ) has recently acquired the quarry site of Cilyrychen at Llandybie, Carmarthenshire, and proposes to carry out the construction and operation of an inert waste recycling facility, waste processing (processing and recycling of existing limestone stockpiles previously discarded), and associated works to include the construction of a screening bund.

It is proposed that, following the commencement of the works in the eastern part of the site, the works will eventually be primarily located within the former quarry void area in the west. This void is partially currently flooded, following the cessation of dewatering by the previous site owners, in 1999. TRJ has acquired the valid discharge consent for the site (under the name Dolawen Cyf). However, National Resources Wales (NRW) has advised TRJ that the dewatering abstraction is no longer exempt from licensing, and TRJ is now required to regularise the operation and obtain an abstraction licence for the dewatering before it can continue to operate the dewatering activities via the discharge consent.

1.3 Report structure

The report first outlines a summary of the licensing requirements for the proposed abstraction from the Cilyrychen quarry void, in Section 2, and provides supplementary information to the online licence application forms.

In order to support a hydrogeological impact assessment, Section 3 then outlines the baseline data available for the site from a range of online and site-specific data sources. This information is used to identify the conceptual understanding of the hydrogeological functioning of the site and the local area, in Section 4.

In Section 5, the hydrogeological impact assessment adopts the NRW-recommended approach to determine the suitability of the proposed abstraction to be granted an abstraction licence.

2 Licence application

2.1 Introduction

This section sets out the licensing requirements to which this NRW licence application should adhere, before addressing specific aspects of the forms submitted online and where further details are needed.

NRW sets out the licensing requirements on its web page, at:

- https://naturalresources.wales/permits-and-permissions/water-abstraction-and-impoundment/find-out-if-you-need-a-water-abstraction-or-impoundment-licence/?lang=en

At Cilyrychen quarry, a new full abstraction licence is needed, in order to abstract water for a period of time longer than 28 days, and given that the abstraction would be greater than 20 m^3/d.

There are a number of steps which should be checked prior to submitting a formal licence application[1], and for which details are then provided within the online application form. These are:

1 Check whether water is available;
2 Confirm right of access to the abstraction point;
3 Determine whether the proposed abstraction is likely to affect a designated conservation site;
4 Determine whether the proposed abstraction is likely to affect other local water features and users; and
5 Determine whether the proposed abstraction is likely to affect sites of historic value.

An evaluation of the list of numbered items given above is set out in the following sections. In addition, further information pertaining to particular NRW form sections is included, namely in relation to:

6 WRA – proposal summary;
7 WRA – hydrogeological impact assessment; and
8 WRD – planning application details

It is noted that NRW will carry out a Water Framework Directive (WFD) assessment based on this proposal, and may require further information in due course and which may affect the determination period.

It is understood that the Canal and Rivers Trust does not own or manage any part of the catchment from which this abstraction is proposed[2].

For groundwater licence applications, a groundwater investigation consent may be needed. This applies notably when a new borehole or well is needed. Data from such an investigation is used to support a hydrogeological impact assessment for groundwater

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[1] https://naturalresources.wales/permits-and-permissions/water-abstraction-and-impoundment/what-to-do-before-applying-for-a-water-abstraction-or-impoundment-licence/?lang=en

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/458647/MSN_1837_May_2015_addition_Ardrossan_Harbour_and_Loch_Harport_FINAL.pdf

abstractions[3]. However, there is different guidance relevant to abstraction in the form of dewatering groundwater from a void, and this has been used here to inform the impact assessment[4]. As such a groundwater investigation consent is not needed.

The sections below address the numbered items. In some cases, further information is provided in the hydrogeological baseline (Section 3) and conceptualisation sections (Section 4.

2.2 Proposal summary

In line with NRW's form WRA for abstraction licence applications, a proposal summary is required. The following sections provide the information required by NRW regarding the proposal outline:

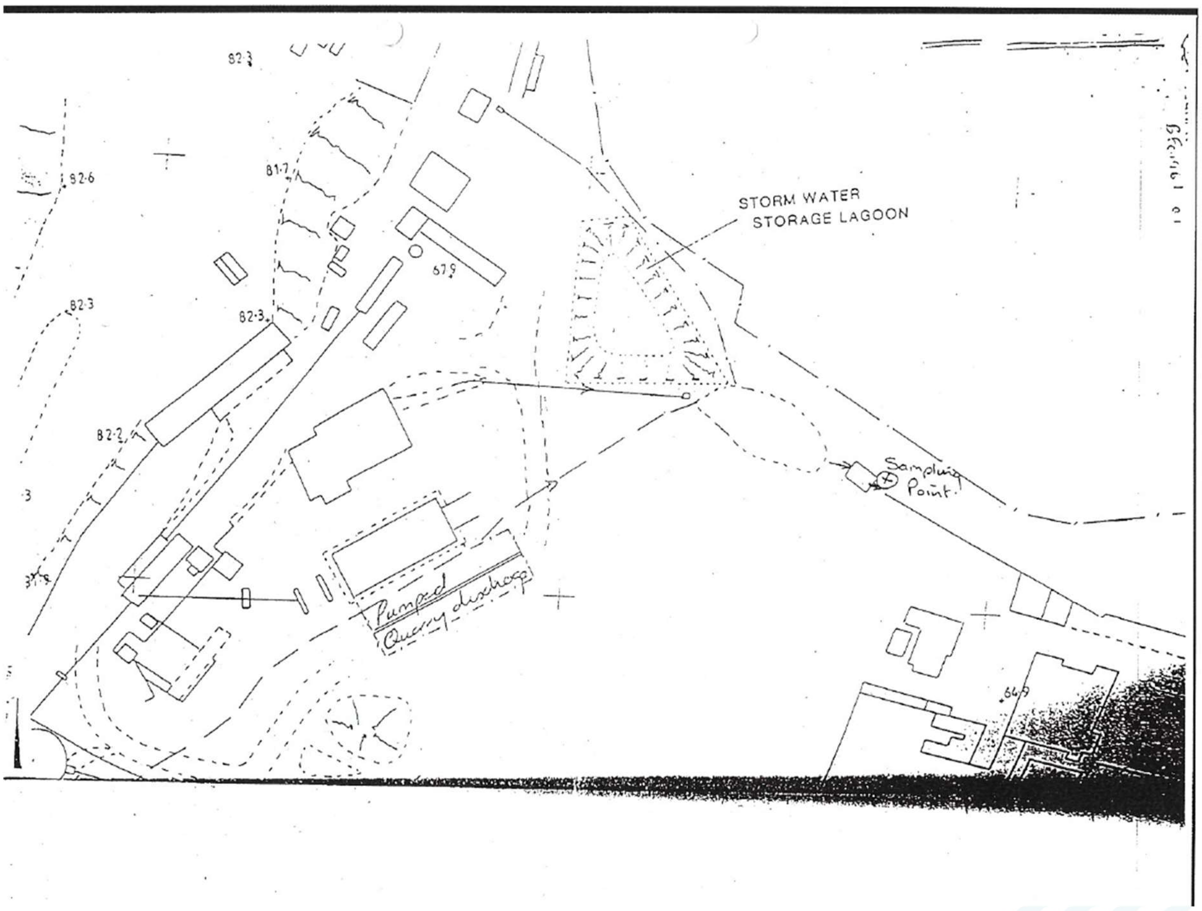
- Description of the activities which will take place at the site: Water will be pumped out of the water-filled void at Cilyrychen quarry in order to dewater the void. The void area will be used for processing and re-use of the limestone stockpiles. Once pumped out the void area, the water will discharge by gravity flow via a 10" open channel spillway to a series of settlement lagoons before discharging to a tributary of the Afon Marlas (River Marlais);
- The means of abstraction proposed: Abstraction is proposed via a pump with sufficient delivery head to abstract the water to the edge of the quarry void. The pump specification is provided in Appendix A; and
- The other related permit for this site is discharge permit BF0196101 relating to previous operations via which the dewatered void water is proposed to be discharged. The discharge arrangements are given in the layout in Figure 2-1, as given within the permit documentation. The discharge location also receives water from Tarmac Llandybie Concrete Plant, although details of discharge volumes are not known.

The total volume of water to be removed from the void is estimated to be ~570,000 m^3, based on the deepest part of the void being understood to be ~30 m deep and a known surface area of 38,000 m^2. It is noted that there are no proposals to extend the size of the existing quarry void. Dewatering is required in order to be able to make use of the working area that the void provides. As such, it would be expected to take ~30 days of pumping to initially dewater the void. Although this is a crude estimate, it gives an indication of the scale of the duration of pumping as being in the order of magnitude of a few months. Once the initial dewatering has taken place, pumping from the void would be anticipated to be much more infrequent and at a lower flow rate. This is discussed further in Section 3.6.2.

3 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291083/scho0407bmah-e-e.pdf

4 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291080/scho0407bmae-e-e.pdf

Figure 2-1 - Site abstraction and discharge arrangements



2.3 Planning application

There is a current planning application for the site under review. Details can be found online[5][6]. The planning layout is also available[7].

Advice has been sought on the planning application. However, the planning application is still being determined by the Local Planning Authority (LPA). As such, the planning authorities' response is not yet available.

2.4 Water availability

Water availability for the relevant groundwater body is of Good quantitative status. Further information is available in Section 3.6.3.

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[5] https://carmarthenshire-pr.force.com/en/s/planning-application/a0b5J000000d8DY/pl02167

[6] https://planning-carmarthenshire.msappproxy.net/PublicAccess_LIVE/SearchResult/RunThirdPartySearch?FileSystemId=PS&FOLDER1_REF=PL/02167

[7] https://planning-carmarthenshire.msappproxy.net/PublicAccess_LIVE/Document/ViewDocument?id=7DD7F25DE94A11EB826AC0B6F9AE5BCC

Water availability for the area is outlined in the Carmarthen Bay Abstraction Licensing Strategy[8]. Elsewhere in the area, the River Loughor at Tir y Dail gauging station in Ammanford indicates Limited Water Resource Availability at Q95 flows. Nonetheless, given the abstracted groundwater would be returned to surface water within the same catchment, the abstraction would not contribute to any surface water availability concerns.

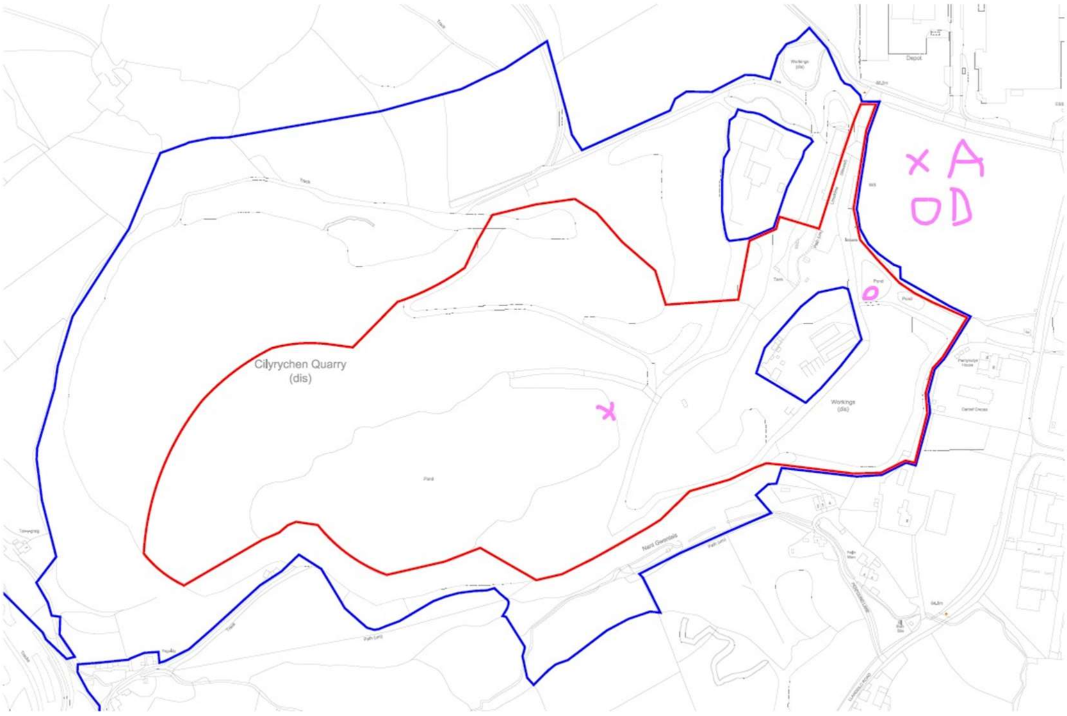
2.5 Rights of access

The rights of access to the abstraction point are confirmed in the sketch below (Figure 2-2), where:

- X marks the abstraction point, from within the quarry void; and
- O marks the discharge point, at the settlement lagoons.

Both locations like within the blue land ownership boundary. The red line boundary relates to the current planning application.

Figure 2-2 – Rights of access



2.6 Designated conservation sites

The nearest designated conservation site is Pant-y-Llyn turlough. Further details are given in Section 3.6.5. Whether the proposed abstraction is likely to affect the turlough is discussed in Section 4.

2.7 Local water users

The Ammanford and District Angling Club has fishing rights downgradient of the site on the River Loughor[9]. The upgradient extent of the fishing areas is at Brynmarlais

[8] https://cdn.cyfoethnaturiol.cymru/media/681625/carmarthen-bay_strategy_english.pdf?mode=pad&rnd=131596369480000000

[9] https://www.ammanfordangling.co.uk/river-maps

(approximately NGR 62200 14000), which is some ~2.6 km south-southeast of Cilyrychen quarry. As discussed with respect to water availability, above, fishing interests are unlikely to be affected by any reduced flows within the river, given the abstracted water would be returned to the catchment close by.

Private water supplies in the area are discussed in Section 3.6.4, below. It is concluded that they would be unlikely to be affected by the proposed abstraction.

There are no known canoe clubs in the vicinity (google maps search).

2.8 Historic environment

Online data resources were evaluated to determine the existence of any sites of historic values, and their level of sensitivity in relation to the water environment:

- Designated heritage assets: https://cadw.gov.wales/advice-support/cof-cymru/search-cadw-records
- Non-designated heritage assets: https://archwilio.org.uk/arch/
- National Monuments of Wales (NMW): https://coflein.gov.uk/en/map/

The Cadw site identifies listed buildings in the vicinity of Cilyrychen quarry. However, no Scheduled Monuments, World Heritage Sites, Registered Historic Landscapes nor Protected Wrecks are present.

The Archwilio website does not identify any features of interest within the vicinity of Cilyrychen quarry. Only listed buildings are noted within the area, as above.

The NMW identifies several sites of note in the vicinity of Cilyrychen quarry. However, they are all buildings or lime works, none of which are dependent on maintaining the current groundwater level to preserve their integrity.

3 Site baseline

3.1 Introduction

This section outlines the understanding of the baseline environment at and surrounding the site, to provide some context as to the likely groundwater behaviour in and close to the site. The baseline is collated from a combination of readily available online and site-specific information sources. These data are used to inform the conceptual understanding of groundwater flow at the site.

3.2 Data sources

The data used in the desk study were obtained from the following sources:

- Topography and general mapping:
  - OS Open Data, Terrain 50 DTM,
  - Aerial photography (Google Earth and Bing Maps),
  - National Library of Scotland Historical Maps[10]
- Geology and Soils:
  - BGS 1:50,000 Geology Mapping,
  - BGS digital geology mapping,
  - BGS online borehole database (BGS website),
  - BGS online Lexicon (BGS website),
  - Soilscapes (landis.org.uk)
- Hydrology and hydrogeology:
  - NRW National Cycle 2 Rivers and waterbodies[11]
  - DEFRA Magic Map (https://magic.defra.gov.uk/MagicMap.aspx)
- Previous reports:
  - BGS, 2012. https://core.ac.uk/reader/16748016
- Anecdotal site history

3.3 Site location, topography and land use

The site is located in Carmarthenshire, South Wales, approximately 1 km north of Llandybie (Figure 3-1). The red line boundary indicated is that planning used for the planning application for the site. Along the eastern boundary is Llandeilo Road (A483) and to the north-east is the Breedon Aggregates compound and Cilrychen Industrial Estate. To the north, west and south of the site, land use is predominantly agricultural with significant areas of woodland.

The quarry is sited within the Afon Marlas (or River Marlais) valley, where the topography generally slopes eastwards towards the southerly flowing Afon Marlas river. The topographical elevation across the site ranges from 64 to 143 metres above ordnance datum (mAOD) (Figure 3-2). The highest elevations are seen in the north and west of the site and while the lowest elevations are in the east. Lidar (2020) identified the water level within the quarry as 78.4 mAOD, which is at a higher elevation than the ground surface at

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[10] https://maps.nls.uk/geo/explore/#zoom=12&lat=51.83081&lon=-4.00653&layers=1&b=1

[11] https://nrw.maps.arcgis.com/apps/webappviewer/index.html?id=2176397a06d64731af8b21fd69a143f6

the eastern extent of the site boundary. The water level in the turlough lake was established from Lidar survey as 160.5 mAOD. Therefore, there is an 82.2 m elevation difference over a distance of ~500 m, which equates to a gradient of 16 % between the two water bodies.

Figure 3-1 - Site location

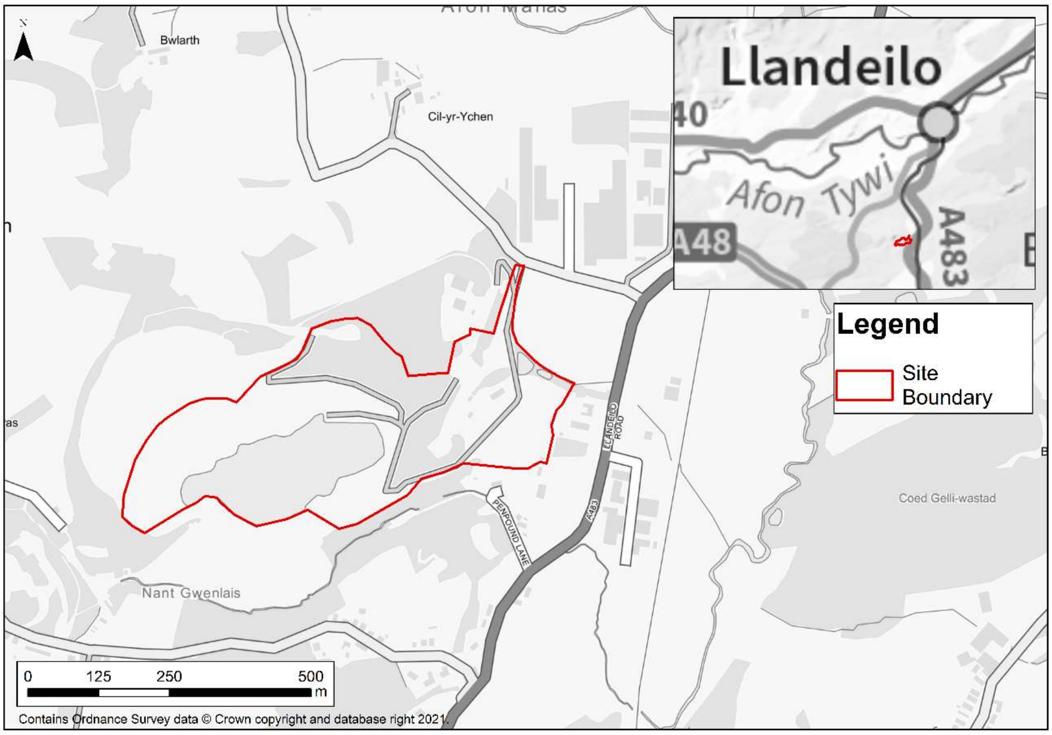
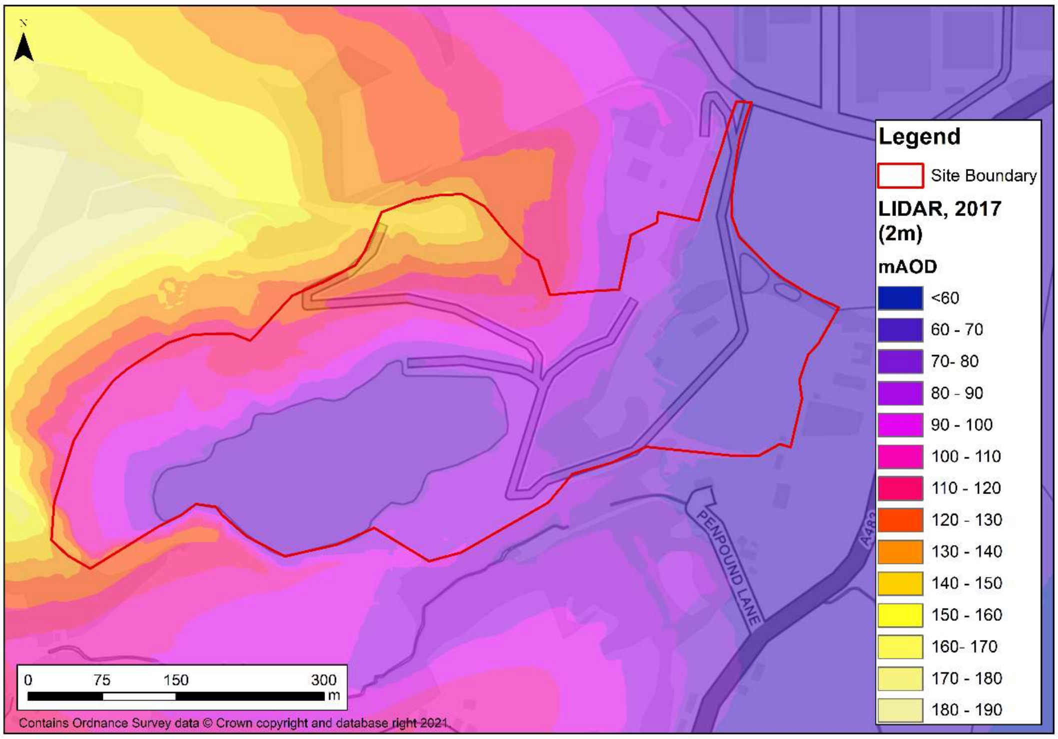


Figure 3-2 – Topography



In order to establish whether any previous uses of the site or activities in the surrounding area may have impacted on the hydrogeological functioning of the site, historical and contemporary OS maps of the area have been consulted. The main developments include:

- In the earliest extract from 1878, Cilyrychen Quarry consisted of four smaller pits, all located north-east of the present-day quarry. Woodland surrounded these smaller quarries and the wider area to the south and west. A network of small tramways connected the quarries to the "Lime Works", which was positioned to the east, adjacent to Llandeilo Road;
- In the extract from 1906, one of the quarry pits was excavated further to the south-west, although was still located north-east of the present-day pit. Areas of woodland were removed and more roads/tramway infrastructure have been built;
- In the extract from 1953, the excavated quarry area was expanded to the west and consisted of two main quarry pits (western and eastern pits). Additional tramways were constructed. The area of the quarry in 1953 comprised approximately the northern half of the present-day quarry footprint. The OS map also marked the occurrence of two groundwater springs, located just south-west of the quarry;
- In the extract from 1973, there is evidence of a small, but not significant expansion to the quarry area. Some tramways have been dismantled, while new tramways have been built in different areas across the site; and
- The quarry area was expanded southwards into the area it now occupies, at some point between 1973 and 2021 (no historical maps available during this period).

In summary there are no known underground site workings that might influence groundwater flow. Local historic quarrying elsewhere may have affected recharge rates to groundwater.

3.4 Site catchment and local hydrological features

3.4.1 Water features survey

Whilst no groundwater investigation consent for the proposed abstraction is needed, given no new borehole is proposed, this report section constitutes a Water Features Survey (WFS) for the site. Since the proposed abstraction is greater than 5,000 m^3/d, a radius of 4,000 m has been considered. The features closest to the site have been described below. The remaining features are digitised on the WFS map (Appendix B).

3.4.2 Watercourses and flows

The Afon Marlas constitutes the main river in the vicinity of the Cilyrychen quarry. The watercourse flows from its source, 2.5 km north-west of the site, towards the south-east and then south to where it joins the River Lougher on the northwestern edge of Ammaford. The total length of the Afon Marlas is approximately 9 km. The NRW online viewer provides information on the Afon Marlas catchment area down to its confluence with the Afon Llwchwr. With an area of 25.28 km^2, the overall quality status of the catchment is designated as "moderate" with "good" chemical classification but "moderate" ecological status.

Approximately 1 km west of the site, a spring forms the source of the Nant Gwenlais tributary stream, which flows east and passes the southern boundary of the site before meeting the Afon Marlas, approximately 500 m south-west of the site (Figure 3). The total length of the Nant Gwenlais is approximately 2.4 km, and its catchment areas is 2 km^2.

Other tributaries of the Afon Marlas, within 4 km of the site, include Afon Lash, Nant Cenfi and Gwyddfan. Approximately 1.4 km north of the site, the Afon Cennan flows south-west towards the site, before changing direction and flowing towards the north-east. Afon Cennan has an approximate length of 6 km^2.

River flows are gauged on the River Loughor at Tir-y-Dail (Ammanford)[12], where the Q95 flow is 0.336 m^3/s (1,210 m^3/h) and Q5 is 7.25 m^3/s (26,100 m^3/h).

3.4.3 Springs and issues

There are two issues (groundwater emergence points) within the eastern half of site boundary (Appendix B). The easternmost of these flows into two small settlement lagoons within the site.

In addition to the spring at the source of Nant Gwenlais stream (1 km west of the site), there is a spring mapped 0.3 km west of the site, occurring just north of the Nant Gwenlais stream. It occurs at an elevation of 155 mAOD, which is significantly higher than the water level in Cilyrychen quarry (78 mAOD) and, hence, unlikely to be hydraulically connected.

A further two springs lie ~300 m to the south of the site.

Within a 4 km radius from the site, there are 37 springs and 181 issues in total.

3.4.4 Open water features

The most notable feature within the vicinity of the site is the Pant-y-Llyn turlough, which lies 480 m west of the water-filled void within the site. It is discussed in more detail in Section 3.6.5.

OS mapping indicates two small ponds at the eastern extent of the site (Appendix B). These ponds are settlement lagoons which receive permitted discharge (NRW permit number BF0196101). A small drain flows eastward from the lagoons for approximately 0.4 km before meeting the Afon Marlas.

3.5 Geology

3.5.1 Introduction

Information on the soils and geology of the site and surrounding area has been derived from 1:50,000 BGS mapping, BGS online borehole archive and available ground investigation data.

3.5.2 Soils and made ground

The Soilscapes online mapping[13] indicates that the site lies in an area of freely draining, slightly acidic but base-rich soils. There are no nearby borehole records which give a description of the local nature of the soils.

3.5.3 Superficial deposits

Superficial deposits across the site are of limited lateral extent, with just one thin band of Devensian till covering part of the eastern site area (Figure 3-3). The bedrock is exposed at the ground surface across most the site area. South of the site, deposits of till overly the bedrock along the course of the Nant Gwenlais tributary stream. Devensian till is documented by the BGS as comprising clay, silt, sand and gravel.

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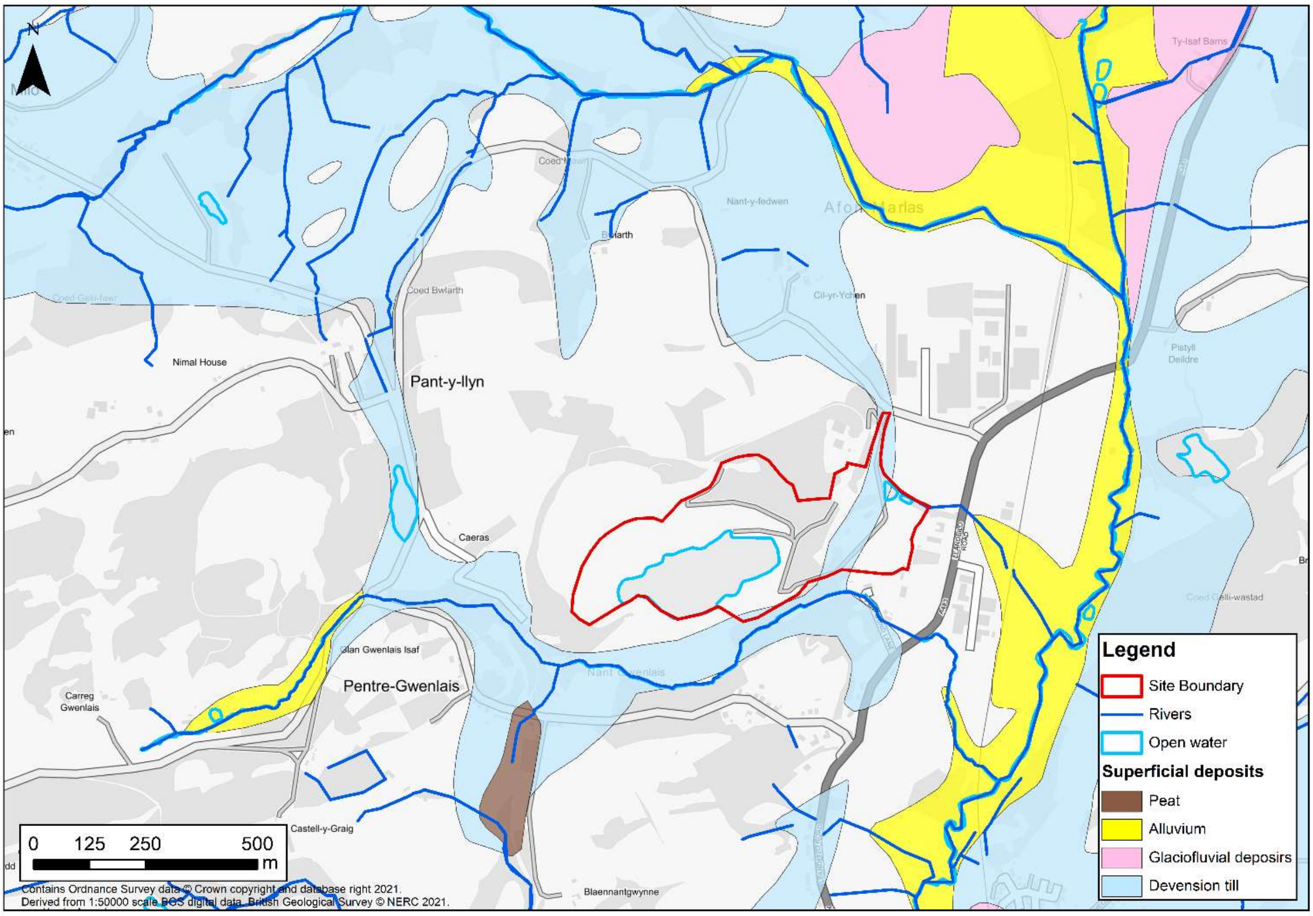
[12] https://nrfa.ceh.ac.uk/data/station/meanflow/59002

[13] http://www.landis.org.uk/soilscapes/

A BGS borehole record (BGS Ref: SN61NW11[14] (Figure 3-4)), located 0.5 km southwest of the site, described the till deposits as comprising a layer, at least 5 m thick, of peat underlain by fine silts and clays, with clay content increasing with depth. Organic remains are reportedly interbedded with the clays and silts.

Located within the nearby Pant-y-Llyn turlough lake, a BGS borehole record (BGS Ref: SN61NW12[15]) documents the till deposit as comprising a 3.6 m thick layer of peat followed by a layer of fine silty clay with organic remains, which is at least 1.4 m in thickness (borehole record finished at 5 mbgl).

Figure 3-3 - Superficial deposits



3.5.4 Bedrock geology

The bedrock underlying the site (Figure 3-4) and throughout the local area comprises a largely conformable succession of Devonian and Carboniferous mudstone, sandstones and limestones, with units becoming younger towards the south. The strata dip steeply towards the south-east, with angles 30-40 degrees. The local area was subjected to extensional (west-east) deformation, resulting in numerous north-south trending normal faults.

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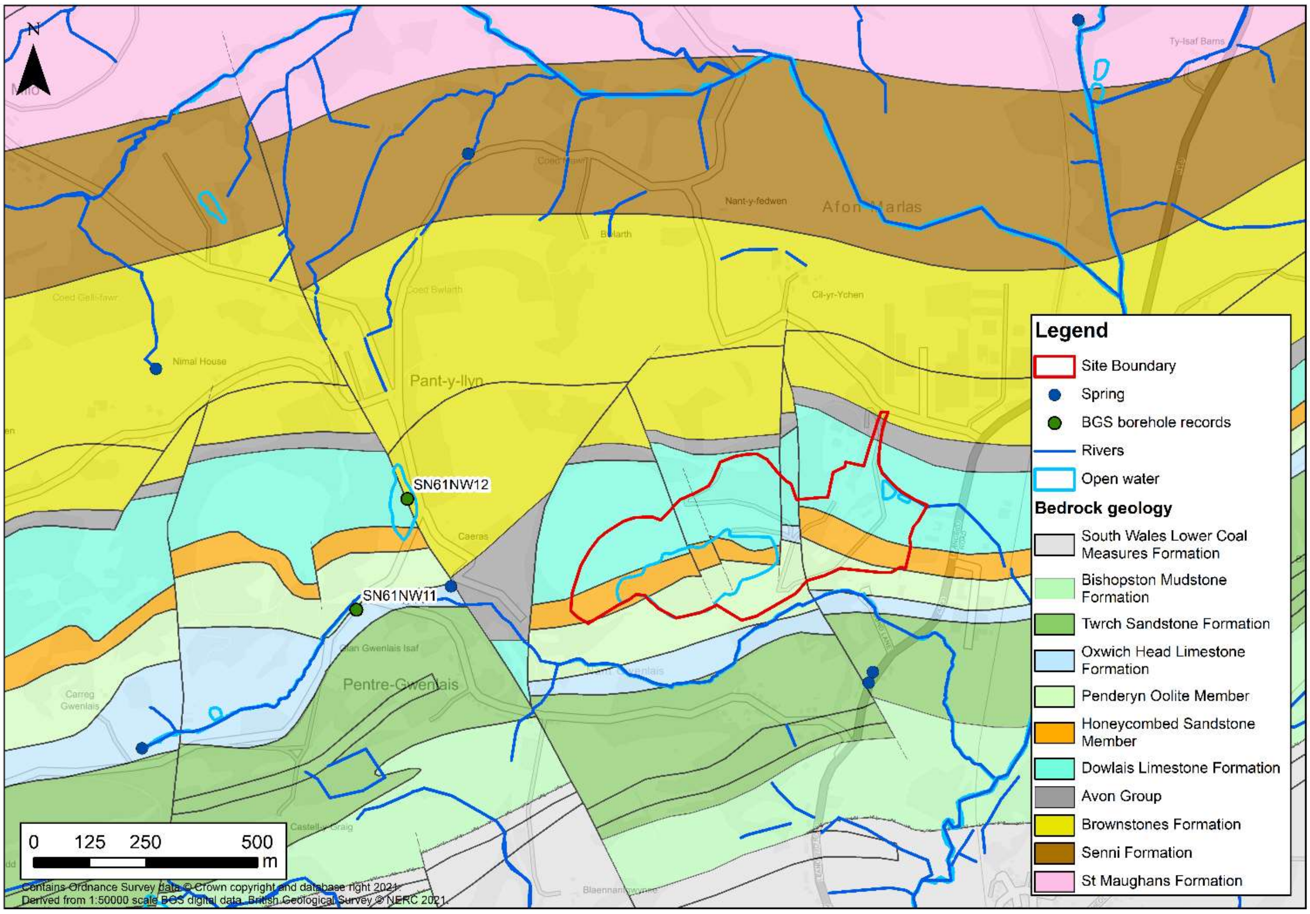
[14] http://scans.bgs.ac.uk/sobi_scans/boreholes/256327/images/14422305.html

[15] http://scans.bgs.ac.uk/sobi_scans/boreholes/19592640/images/19592647.html

Within the site boundary, the oldest outcropping bedrock is the Dowlais Limestone Formation, located in the northern half of the site area. Overlying the limestone, and outcropping under the pond within the quarry, is the sandstone unit of the Honeycombe Member (part of Oxwich Head Limestone Formation). The youngest unit is the Penderyn Oolite Formation, also part of the Oxwich Head Limestone Formation, which is exposed over southern part of the site area.

Immediately to the west of the site, a north-south trending normal fault has exposed the Avon Group and the underlying Brownstones Formation to the west of the fault. East of the fault, these units underly the younger Dowlais Formation. The Avon Group comprises interbedded grey mudstones and thin to medium bedded limestones with one to several thick units of ooidal and skeletal grainstones. Thin units of calcite mudstone and mudstone are locally present. Brownstones Formation, which is part of the Lower Old Red Sandstone and Brecon Subgroup, comprises interbedded sandstones and conglomerates with subordinate mudstone interbeds.

Figure 3-4 – Bedrock geology



A BGS borehole record (BGS Ref: SN61NW11, Figure 3-4), located ~0.6km west of the site, describes the Oxwich Head Limestone Formation as comprising a succession of grey fractured, medium grey and black limestone units with observable quartz.

Approximately 1.4 km south-west of the site, a BGS borehole record (BGS Ref: SN51NE1), situated on the Twrch Sandstone Formation, described the upper 5 m as dark silty shales and grey siltstone underlain by 15 m of fine-medium grained white quartzite. Below this, the formation comprises interbedded fine-grained sandstone, hard grey siltstones and black shales down to a depth of 110 m below ground level (bgl), with a 10 m thick unit of quartzite occurring at a depth of 70 mbgl.

Borehole records (BGS Refs: SN51NW5, SN51NW8) located on the exposed Brownstones Formation, approximately 7 km west of the site, have documented the unit as a weathered, red/brown, medium-coarse grained thin to medium bedded, moderately strong, slightly silty sandstone. Subordinate layers of laminated, slightly silty mudstone with occasional iron staining occur throughout. One record (SN51NW7) noted the occurrence of conglomeratic sandstone layers at a depth of 10 mbgl, in addition to weathered subvertical quartzite veins.

Within the site, there are four extensional, sub-vertical, north-west to south-west trending normal faults, where the downthrown strata are to the east. The magnitude of offset is not known.

West of the site, a fault block comprising two normal faults has downthrown strata to the west and east, thus exposing the older Avon Group and Brownstones Formation, which underly the Dowlais Formation across much of the site further to the east.

A summary of the superficial and bedrock geology is given in Table 3-1.

Table 3-1: Summary of geology

Age	Group	Formation / Member	Description	Thickness
Quaternary	Superficial deposits	Topsoil	Freely draining, slightly acidic but base-rich soils.	Unknown
		Devensian Till	Clay, silt, sand and gravel	Unknown
	Marros Group	Twrch Sandstone Formation	The lower boundary, which is generally an unconformity, is placed at the base of the major development of quartz arenite and quartz pebble conglomerate. The Twrch Sandstone Formation rests with discordance on the underlying limestones of the Pembroke Limestone Group. In the south of the type area it rests unconformably on rocks of the Oystermouth Formation, in the north on rocks of the Oxwich Head Limestone Formation.	To 190 m Approximately 4 Ma unconformity at base
	Oxwich head Limestone Formation	Penderyn Oolite Member	Pale grey, massive ooidal limestone, lenticular sandstone, rubbly limestone and shelly mudstone, locally with coal streaks and seatearth, at top.	13 m – 33 m. Approximately 4 Ma unconformity at upper boundary
		Honeycombed Sandstone Member	Calcareous, locally conglomeratic, sandstone, with distinctive honeycomb weathering, locally in two tongues, separated by pale grey oolitic grainstone. Deposited as a transgressive shoreface sand/ooidal limestone.	4-12 m

Carboniferous	Pembroke Limestone Group	Dowlais Limestone Formation	Tabular, thick-bedded, mid- to dark grey, fetid, bituminous, fossiliferous, peloidal grainstone, packstone and wackestone limestones with dark grey shale interbeds; minor dark grey, micritic limestones and pale grey ooidal limestones and some local basal sandstones.	To 120 m
	Carboniferous Limestone Supergroup	Avon Group	Interbedded grey mudstones and thin- to medium-bedded skeletal packstones with one to several thick units of ooidal and skeletal grainstones. Thin units of calcite mudstone and mudstone locally present. Sparse thin ironstones. Represents mid to inner shelf/ramp deposits with coeval barrier, back barrier and coastal plain sediments.	To 150 m (though likely around 10 m close to the site)
Devonian	Brecon Subgroup	Brownstones Formation	Red, brown and purple fluvial sandstones and conglomerates with red mudstone interbeds.	To 1200 m
Source: BGS Lexicon of Named Rock Units				

3.6 Hydrogeology

3.6.1 Aquifer designation

The geological strata have been assessed for their hydrogeological properties. The superficial till deposits are classified as Secondary Undifferentiated aquifers – meaning it has not been possible to attribute either category A or B. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

The youngest outcropping bedrock lithology, the Twrch Sandstone Formation, and the two oldest units, the Avon Group and Brownstones Formation, are all classified as Secondary A aquifers. These contain 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.

The Dowlais Limestone and Oxwich Head Limestone Formations comprise a Principal aquifer, comprising layers of rock or drift deposits that have high intergranular and/or fracture permeability and provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. A summary of aquifer designations for superficial and bedrock geological units is given in Table 3-2.

Table 3-2: Aquifer designations

Geology type	Formation	Classification
Superficial	Topsoil	N/A
	Devensian Till	Secondary (Undifferentiated)
Bedrock	Twrch Sandstone Formation	Secondary A Aquifer
	Penderyn Oolite Member (Oxwich Head Formation)	Principal Aquifer
	Honeycombed Sandstone Member (Oxwich Head Formation)	Principal Aquifer
	Dowlais Limestone Formation	Principal Aquifer
	Avon Group	Secondary A Aquifer
	Brownstones Formation	Secondary A Aquifer

3.6.2 Groundwater flow and water levels

The general groundwater gradient can be expected to reflect the local topography. Therefore, groundwater flow is likely to be east and south-east towards the centre of the Afon Marlas valley. Through the Principal, predominantly limestone aquifers (Dowlais and Oxwich Formations), groundwater flow is predominantly through fractures and discontinuities. Within the Secondary A aquifers (Avon group, and Twrch and Brownstones Formations), which exhibit interbedded sandstones, conglomerates, siltstones and shales, groundwater flow is likely to be primarily intergranular through the silts and sandstone layers. These are separated by low permeability mudstone and shale aquitards, which may have fracture permeability in some areas.

There are no known groundwater level borehole data for the site or the surrounding area. It is possible that there are groundwater monitoring data collected by previous owners/operators of Cilyrychen quarry. However, it has not been possible to obtain any, despite efforts made. It is also possible that there are no previous groundwater monitoring or abstraction flow rate data because dewatering abstraction from this site was previously exempt until relatively recently.

Within Cilyrychen quarry, water was pumped from early April to early July, 2021, prior to this application process commencing. Pumping took place 24 hours a day with around ten days of no pumping within this period for maintenance of the pump infrastructure. It was pumped using the pump proposed for this abstraction application. The pumping rate was therefore in the region of the pump capacity, of 735 m^3/h.

By the time of the cessation of pumping, the water level in the void had fallen an estimated 10 m (as illustrated by the 'tide line' in Figure 3-5. By late November 2021, the water level had only risen back ~1 m, demonstrating a slow response to recharge, runoff and/or infiltration. On this basis, it is considered that once the quarry void has been initially dewatered, it would not require ongoing pumping at such sustained levels thereafter in order to maintain a dry working area for the quarry activities.

A further observation is that the location of the mapped springs aligns with the location of fault lines (Figure 3-4). Therefore, the springs are deemed to be fault-controlled i.e. the fault constitutes a flow barrier and groundwater emergence occurs.

Figure 3-5: Quarry level Nov 2021

3.6.3 Groundwater quality

The till deposits are marked as having high vulnerability, meaning pollution is easily transmitted groundwater. High vulnerability aquifers are characterised by high leaching soils and the absence of low permeability superficial deposits.

All of the bedrock lithologies are described as having medium-high vulnerability, in which there is groundwater protection in some areas, but they are exposed to potential contaminants in other areas. Due to the lack of superficial cover within the site, the bedrock units are likely to be highly vulnerable.

There are no known groundwater source protection zones (SPZs).

The WFD groundwater body is the Carmarthen Carboniferous Coal Measures (ID GB41002G200600). It has an Overall status of Poor, with a Quantitative status of Good, and a Chemical status of Poor.

Groundwater quality data are not available for the site. However, visual inspection of the water-filled void indicated relatively low turbidity and a clear blue colour, as might be expected for a groundwater-fed water body.

3.6.4 Groundwater abstractions

The BGS borehole record SN61NW11 is cited as being a water well, and is 79.5 m deep, constructed in 2000. No further details are available as to whether it is currently in use.

A FoI request to Carmarthenshire County Council was made to obtain information on local groundwater abstractions in the form of private water supplies (PWSs). The locations of two PWSs were noted at:

- Castell Y Graig, which is located 930 m south-west of the site at an elevation of 172 mAOD, and is likely to abstract from the Twrch Sandstone Formation; and

- Tireinon, which is located 2 km south-west of the site at an elevation of 106 mAOD, and is likely to abstract from the Pennine Lower Coal Measures.

However, details were not provided as to whether the abstractions are from surface water or groundwater, or from which source (spring, borehole, well etc.). Also, the locations provided may relate to the properties rather than the abstraction point itself and it is unknown if they are current or historical. The locations of these PWSs and borehole are noted on the WFS (Appendix B).

In the event that the Castell Y Graig PWS is from a deep borehole, it is not expected to be impacted by the proposed abstraction. The ground surface at Castell Y Graig is 94 m above the water level in Cilyrychen quarry, which translates to a gradient of 10%. It is anticipated that the water table is close to the ground surface at this location due to groundwater emergence points located 130 m north-east and groundwater fed ponds 300 m to the south-west. Therefore, it is not expected that the groundwater is hydraulically connected due to the steep gradient and geological faulting present between the bedrock units.

The Tireinon PWS is situated at a similar elevation to the quarry pond. However, it is unlikely to be hydraulically connected to the quarry due to the lateral distance, in addition to the numerous geological faults which are likely to form a hydraulic barrier, as discussed above.

3.6.5 Designated groundwater-dependent receptors

The Pant-y-Llyn turlough[16][17][18] is the only designated groundwater-dependent site within the vicinity of Cilyrychen quarry.

Turloughs are seasonally flooded lakes in karstic limestone areas, that are principally filled by subterranean waters via ephemeral springs or estavelles, and drain back into the groundwater table via swallets or estavelles. They have no natural surface outlet. Due to the groundwater supply within limestone, the water is calcium-rich and, because they receive negligible surface water inputs, they are less prone to siltation, and can therefore be larger than most seasonal ponds. More extensive in Ireland, in the UK they are limited to two sites: a group of three in Northern Ireland, and at Cernydd Carmel in south Wales.

Details of the Pant-y-Llyn turlough are available on the JNCC webpage[19]. The turlough constitutes an Annex I habitat and is the primary reason for the selection of this site. It states:

Pant-y-Llyn turlough occupies a small depression on the northern perimeter of the South Wales Coalfield at Cernydd Carmel. This depression represents a glacial channel formed along the Betws Fault where displacement has brought Carboniferous limestone into contact with older Devonian rock. The hydrological regime of the waterbody is linked to local groundwater behaviour within the limestone. The basin fills to a depth of about 3 m during late autumn and remains full until the following summer when it empties completely, thus reflecting the characteristic behaviour of turloughs. There are no surface drainage channels, and a swallow hole is located at the northern end of the basin. The basin floor is covered by bryophytes (mainly Fontinalis antipyretica and Drepanocladus aduncus) and

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16 https://naturalresources.wales/media/671239/Cernydd%20Carmel%20SAC%20Management%20Plan.pdf

17 https://cdn.cyfoethnaturiol.cymru/media/683621/nrw-carmel-nnr.pdf?mode=pad&rnd=131994443840000000

18 https://www.welshwildlife.org/wp-content/uploads/2013/12/Carmel-handbook-sheet.pdf

19 https://sac.jncc.gov.uk/site/UK0030070

herbaceous swamp (water horsetail Equisetum fluviatile and bladder-sedge Carex vesicaria) communities and is surrounded by W3 Salix cinerea – Galium palustre woodland. Within the willow Salix carr, there is a further zonation among the epiphytic bryophytes, with a well-defined Fontinalis community on the lower parts of the trees, which are subject to immersion. The invertebrate fauna is characteristic of seasonal standing waters with aquatic beetles Coleoptera acting as the most diverse group of predators on a microinvertebrate community dominated by relatively large Cladocera and Copepoda.

It is usually empty by June–July and fills again from October to December.

The geology underlying the turlough comprises the Dowlais Limestone Formation and the Honeycombed sandstone Member in the western half, with Brownstones Formation outcropping in the east. Through the centre of the turlough is a north-south trending normal fault, which has downthrown the Dowlais and Honeycombed sandstone Formation to the west and exposed the older Brownstones Formation to the east. In addition, a band of till deposits underlies the turlough lake to the west. The geology is illustrated in a hydrogeological conceptual cross section shown in Section 4.1.

Lidar (2020) data illustrates the water level elevation within the turlough is 160.5 mAOD, some 82.1 m higher than that observed within Cilyrychen quarry (water level 78.4 mAOD). Water levels were also recorded (and also modelled) for a two-year period by BGS (2012) and indicate highs of ~160.5 mAOD from typically November to April. The base of the turlough when empty is at ~157.5 mAOD and revealed a discrete estavelle in the bed which both fills and empties the feature.

Freedom of information (FoI) requests to the Wildlife Trust of South and West Wales (WTSWT) and to NRW regarding any historic monitoring of water levels at the site were made. No routine monitoring data are known to be available since 2012.

The BGS (2012) study examined the flood duration response at the turlough because this has implications for the plant life expected at the site. From a hydrological functioning perspective, it is noted that this turlough is very small compared to its Irish counterparts and is also at a much higher elevation. It is also very shallow in comparison, where Irish turloughs typically range from 3-15.4 m deep. Overall, it is noted as having a slower response to rainfall.

No turlough water level data are available during or after the time of pumping at Cilyrychen quarry in the summer of 2021. Nonetheless, visual inspection of the turlough in late November 2021 showed the turlough to be full and indicative of winter water levels

). There was no evidence to suggest that the turlough's ability to achieve its winter water levels had been impaired as a result of the pumping at Cilyrychen quarry during the summer.

Figure 3-6 – Turlough water level, Nov 2021

4 Conceptual understanding

4.1 Introduction

A hydrogeological conceptual model is a description of how a hydrogeological system is believed to behave. It describes how water enters an aquifer system, flows through the aquifer system and leaves the aquifer system. This section describes the conceptual understanding of the hydrogeological functioning of Cilyrychen quarry and the surrounding area, gained from the baseline understanding presented in the section above.

Within the conceptualisation, the likelihood and mechanisms for any hydraulic connectivity between the turlough and Cilyrychen quarry are discussed.

4.2 Conceptual hydrogeological model

The hydrogeological conceptual model for the site is shown in Figure 4-1 and Figure 4-2, with line of cross section shown in the inset map for each figure. It has the following features:

- Topography:
  - The quarry is sited within the Afon Marlas valley, where the topography generally slopes eastwards towards the southerly flowing Afon Marlas river. The topographical elevation across the site area ranges from 64 to 143 mAOD. The highest elevations are seen in the north and west of the site and the lowest elevations are in the east.
  - The water level in the turlough lake was established from Lidar survey as 160.5 mAOD, whereas the level in Cilyrychwn quarry is 78.4 mAOD. Therefore, there is an 82.1 m elevation difference over a distance of ~500 m, which equates to a gradient of 16% between the two lakes.
- Geology
  - Superficial deposits across the site area are limited, with just one thin band of Devonian till covering part of the eastern site area. However, to the west of the site, at least 5 m of till underlies the Pant-y-Llyn turlough lake, comprising peat underlain by silty clay with organic remains.
  - The main bedrock strata underlying the site and turlough lake are, from oldest to youngest, the Brownstones Formation, Avon Group, Dowlais Formation and Oxwich Head Formation (including Honeycombed Sandstone and Penderyn Oolite Members).
  - The strata dip steeply towards the south-west, with angles 30-40 degrees. The local area was subjected to extensional (west-east) deformation, resulting in numerous north-south trending normal faults.
- Hydrogeology
  - The Dowlais and Oxwich Head Formations are high permeability Principal Aquifers whereas the Brownstones and Avon Group are designated as less permeable Secondary A aquifers, due to the presence of subordinate mudstone aquitard layers.
  - Groundwater flow generally follows the regional gradient and topography towards the south-east. However, the extensive array of faults and fault blocks has disrupted continuous flow through the higher permeability aquifers across the region.
  - In the hydrogeological cross section view, groundwater flows south-eastwards through the Dowlais limestone Formation and supplies water to the turlough lake (Figure 4-1). However, Gwenglais quarry, upgradient and to the west of

the turlough, is dry. As such, the general water table within the Dowlais Formation must be at an elevation below 155 mAOD in this area. The fault block to the east of the turlough has brought the older, less permeable Brownstones Formation adjacent to the Dowlais Formation, and is considered to constitute a hydraulic barrier, beyond which groundwater does not largely continue to flow eastwards. Therefore, it is anticipated that water within the turlough is provided by groundwater upwelling against the fault plane via the estavelle.

    - Groundwater within the Brownstones Formation is likely to flow within permeable sandstone layers, which are interbedded with mudstone aquitards with low fracture permeability. East of the fault block, groundwater within the Dowlais flows south-west and emerges within Cilyrychen quarry, filling the worked void.
    - Groundwater levels are unlikely to be hydraulically connected from west to east, across both outcrops of the Dowlais Formation, via the Brownstones Formation. This is because the topographic gradient, which controls the overall hydraulic gradient, is extremely steep between the turlough and Cilyrychen quarry. Such a groundwater gradient is unlikely to occur. If it did, hydraulic pressures would dictate that the gradient seek a steady state and, instead, groundwater seepages would be observed along the western cliff face of the quarry. This is not observed to be the case. In addition, the springs appear to be fault-controlled and suggests that the fault constitute a barrier to groundwater flow within the aquifers.
- Runoff, infiltration and recharge:
    - Runoff within the west and central parts of the site will drain towards the water-filled void within the centre, while rainfall falling on the eastern part is likely to drain east into the small drainage channel.
    - Within the site and local area, rainfall will both flow as runoff and infiltrate through the topsoil and all the permeable bedrock units of the area, forming the main source of recharge to the aquifers. Runoff is like to be the dominant process over the steepest slopes, while infiltration will be prevalent in areas of flatter topography.
    - Recharge to the groundwater body supplying Cilyrychen quarry is anticipated to occur along the fault line immediately west of the quarry void, with groundwater storage also occurring in the strata of the Oxwich Head Formation underlying the quarry (Figure 4-2). This conceptualisation is aligned with the observed water level response in the quarry following the cessation of pumping. Water levels have yet to approach anything like pre-pumping water levels.
    - The contrast between quarry water levels which have not recovered to pre-pumped levels, and winter water levels observed in the turlough, provides further evidence to support the hypothesis that the quarry and the turlough are not hydraulically connected.
- Abstractions:
    - Local enquiries revealed that there are two PWSs located within 4 km of the site. However, it is unknown as to whether these are from surface water or groundwater sources. If the abstractions are from groundwater boreholes, it is not expected that dewatering operations would affect the PWSs due to the lateral and elevation distances and the numerous geological faults, which significantly reduce the hydraulic connectivity.
- Groundwater surface interactions:

- The hydraulic connection between the turlough and Cilyrychen quarry has been discussed above.
- The two smaller ponds at the eastern extent of the site area are primarily fed by discharge inputs. There may be a component of groundwater input, although there are no data to confirm this.
- In addition, the Nant Gwenlais stream to the south is likely to be hydraulically connected to the local groundwater system. However, it is likely to be confined locally by the presence of glacial till which might be expected to limit the lowering of the groundwater table. Nonetheless, any reduction in flows in the Nant Gwenlais will not be expected to have a knock-on effect to flows in the Afon Marlas, because the dewatered water will be return to the surface water system upgradient of where the Nant Gwenlais has its confluence with the Afon Marlas.
- The proposed discharge of 735 m^3/d represents 2.8% of the flood (Q5) flow in the downgradient River Loughor at Tir-y-Dail. As such, discharge of the dewatering output to the Afon Marlas is unlikely to result in an increased flood risk.

* Predicted drawdown impacts from dewatering
  - Drawdown effects are anticipated to remain localised to the site due to the numerous locations of the nearby faults such that the quarry is sited within an isolated block/basin. This is supported by the slow recovery of water levels observed during the test pumping period.
  - The spring to the west of the quarry is at a significantly higher elevation than the water level in the void, and is not considered to be hydraulically connected to the quarry.

Figure 4-1 - Hydrogeological conceptual model cross section (west-east)

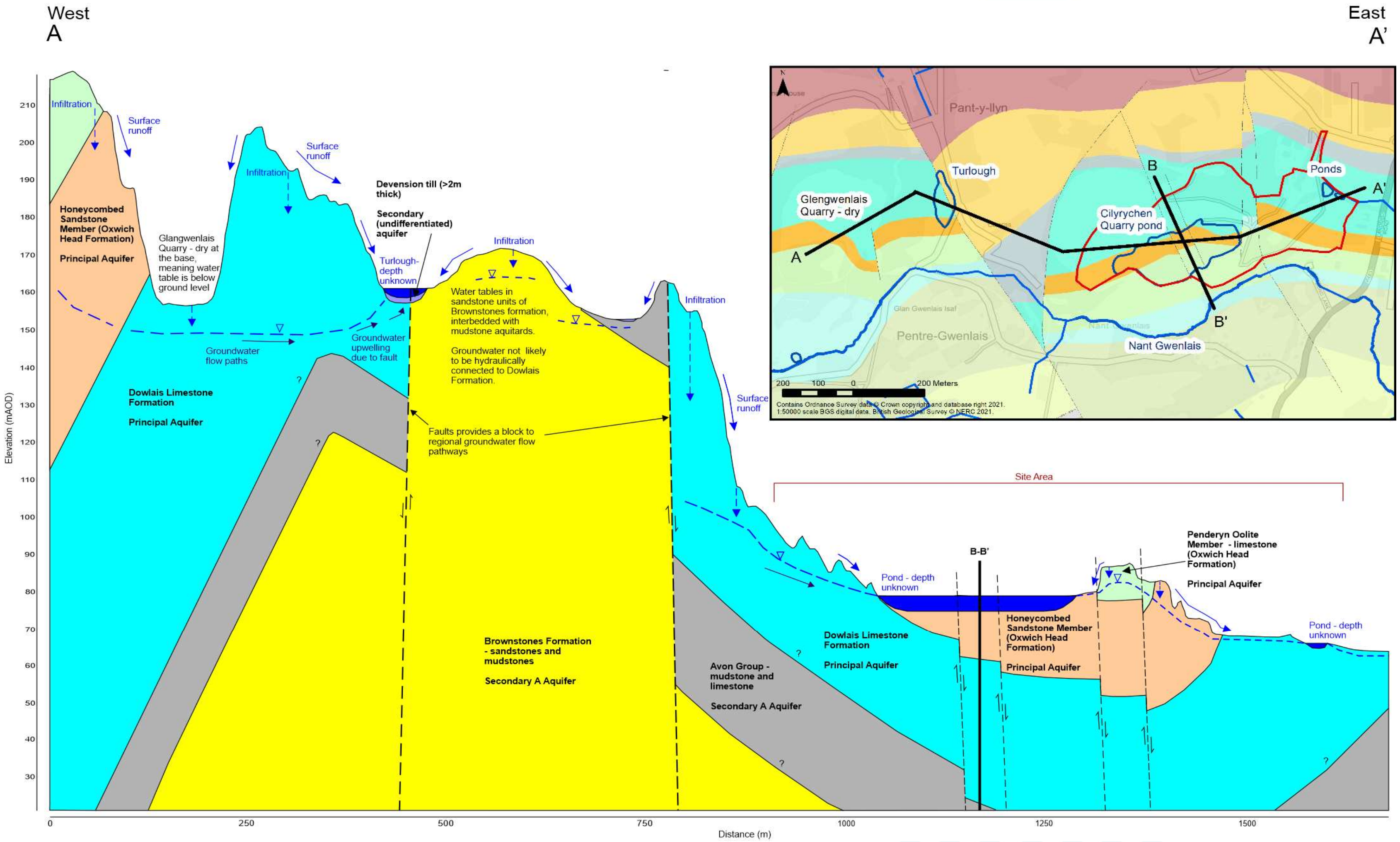
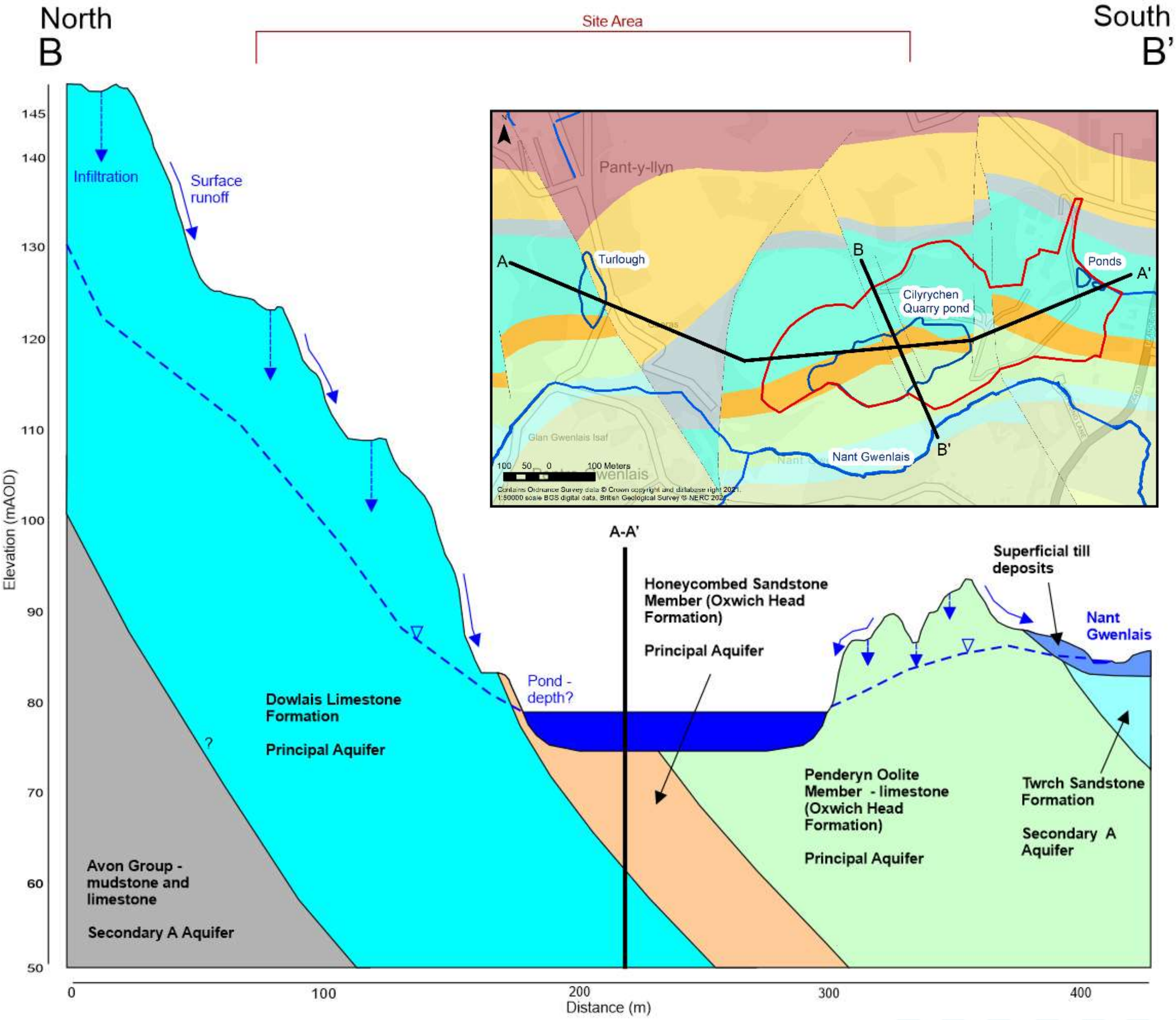


Figure 4-2 - Hydrogeological conceptual model cross section (north-south)



5 Hydrogeological impact appraisal

5.1 Introduction

For dewatering abstractions, NRW advises that the Environment Agency's *Hydrogeological impact appraisal for dewatering abstractions*[20] should be followed, in order to provide an assessment of the effect the proposed abstraction will have on other water users and the local environment. It is noted that the steps are not intended to be prescriptive, with the level of effort expended on each step to be matched to the situation. It is recognised that a conceptual model is an iterative process and, in turn, could be refined to align with a tiered or hierarchical approach to assessing potential for impacts from the abstraction. The assessment provided below constitutes a Tier 1 assessment.

5.2 Step 1 – Regional water resource status

As discussed in Section 2.4, it is considered that there is sufficient water resource availability especially given the non-consumptive nature of the proposed dewatering abstraction with the water returned to the nearby watercourse.

5.3 Step 2 – Conceptual model

The conceptual model for the site has been presented in Section 4.2. The main issues relating to the dewatering of Cilyrychen quarry appear to be:

- Confirmation of the total volume of water in the void to be removed in the first instance; and
- Potential impacts on flows in the Nant Gwenlais, albeit it without implications for the flow in the Afon Marlas.

5.4 Step 3 – Water features susceptible to flow impacts

From the conceptual model, it is considered that the water feature susceptible to flow impacts from the dewatering activities at Cilyrychen quarry is the stream Nant Gwenlais.

5.5 Step 4 – Apportion the flow impacts

The abstraction of groundwater via dewatering of the current quarry void could be manifested as a reduction in natural discharge from the groundwater system, or a reduction in flows to the Nant Gwenlais. Nonetheless, the Nant Gwenlais is a minor water course with no particular designation or WFD classification.

5.6 Step 5 – Mitigation of flow impacts

Flow impacts to surface water bodies from the dewatering of the groundwater within the quarry void are mitigated by the return of the non-consumptive usage to the unnamed Afon Marlas tributary upgradient of the confluence of the Nant Gwenlais with the Afon Marlas.

5.7 Step 6 – Significance of net flow impacts

In terms of flows to surface watercourses, it is likely that flows are actually enhanced as a result of dewatering operations. The River Loughor at Tir-y-Dail shows Limited Water Resource Availability at Q95 flows. Hence, direct transfer of water our of Cilrychen quarry could be viewed as a positive benefit.

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20 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291080/scho0407bmae-e-e.pdf

5.8 Step 7 – Search area for drawdown impacts

The search area for drawdown impacts is assumed to be the western side of the Afon Marlas valley. However, the uncertainty attached to the hydrogeological effects of the extensive faulting in the area means that a realistic estimate of these drawdown impacts is difficult within a Tier 1 assessment.

5.9 Step 8 - Water features susceptible to drawdown impacts

There are no groundwater source protection zones within this search area, so it is assumed that there are no major groundwater abstractions. Local enquiries did not identify any pre-existing groundwater abstractions with hydraulic connectivity to the area of proposed dewatering.

A groundwater-fed turlough lies upgradient of the site. However, it is considered that it is not hydraulically connected to the quarry void to be dewatered. Consideration of the relative water levels of the turlough and the quarry sump and their horizontal separation reveals an extremely steep apparent hydraulic gradient of 0.16 between the two. This suggests either that the rocks separating the two have an extremely low permeability (unlikely given the aquifer classifications of the strata), or that the turlough is hydraulically separated from the quarry by low permeability faults which form a barrier to flow. In either case, this would suggest that drawdown impacts for dewatering abstractions on the turlough are probably minimal. This is corroborated by the observations that ongoing depressed water levels in the quarry from a test dewatering period in the summer of 2021 has not prevented the turlough from regaining its usual winter water levels. Furthermore, there has been no anecdotal evidence that when the quarry was dewatered historically (in the 1990s) water levels in the turlough were adversely affected.

A couple of springs issue from the hillside to the west of the quarry. However, these are all well above the level of the quarry and will not be affected by dewatering.

5.10 Step 9 - Predict maximum drawdown impacts

Not applicable.

5.11 Step 10 - Mitigation of drawdown impacts

Not applicable.

5.12 Step 11 - Significance of drawdown impacts

Not applicable.

5.13 Step 12 - Water quality impacts

Water is pumped from the main quarry void into a tributary of the Afon Marlas, after passing through treatment/settlement lagoons. The discharge from Cilyrychen quarry is therefore likely to be broadly similar when it reaches the Afon Marlas than if it had discharged to surface water via natural groundwater flow pathways.

5.14 Step 13 - Redesign mitigation measures

Not applicable.

5.15 Step 14 - Monitoring and reporting plan

Water levels and pumping rates should be measured for the duration of the dewatering operations, and daily visual inspections made at the settlement lagoon overflow points to ensure that no problems develop with silt mobilisation.

In addition, water level monitoring at the turlough would be recommended to validate the hypothesis that the quarry void water is not hydraulically connected to the turlough. It would be ideal if dewatering commenced prior to the natural seasonal drying out of the turlough, so that the Depending on the time of year that dewatering is carried out, some thresholds should be set for the rate of water level changes in the turlough, based upon previous observed rates of drying out of the turlough during the summer months. This is in order to verify whether any drying out of the turlough is part of its natural cycle, or whether it could be being affected by the dewatering. Ideally, dewatering would take place in the winter, prior to the usual season for which the turlough is observed to dry out.

Finally, visual checks on flows in the Nant Gwenlais should be carried out during the dewatering to observe whether flows are deemed to be being affected by the abstraction.

5.16 After Tier 1

Although the abstraction application is for a long term, rather than temporary, licence, no further tiers of investigation necessary, given the temporary nature of the abstraction. This is because the water level is not observed to rise readily after cessation of dewatering. As such, once the void is dewatered, ongoing abstraction is likely to be only occasional and short-lived.

Appendices

A Proposed Abstraction: Pump Specification

CD225M Dri-Prime® Hush-Pac

The Godwin Dri-Prime CD225M pump is an extremely powerful yet compact pump with flow capabilities to 735 m^3/hr and discharge heads to 49 metres.

The CD225M features the unique Godwin high pressure oil bath mechanical seal design. This allows for dry running for prolonged periods while automatically priming and repriming. Able to perform in the toughest conditions, the CD225M can handle solids up to 75 mm in diameter. This makes it an extremely effective pump, suitable for both slurry and clean water applications. The powerful CD225M has proven itself a pump of choice for mines, quarries and many other high capacity applications.

Features and Benefits

- Fully automatic priming from dry to 8.5 metres suction lift.
- Godwin Dri-Prime is a continuously operated Venturi air ejector priming device which requires no periodic adjustment or control.
- Extensive application flexibility. It will handle sewage, slurries and liquids with solids up to 75 mm in diameter.
- Dry-running high pressure liquid bath mechanical seal, with high abrasion resistant silicon carbide faces.
- A Close-coupled centrifugal pump with Godwin Dri-Prime system mounted to a diesel engine or electric drive.
- All cast iron construction (stainless steel construction option available) with cast steel impeller.
- Also available as a openset or as a bareshaft pumpend.
- Standard build engines; Perkins 1106D-E66TA (129), Perkins 1104D-E44TA. Other engine options are available.

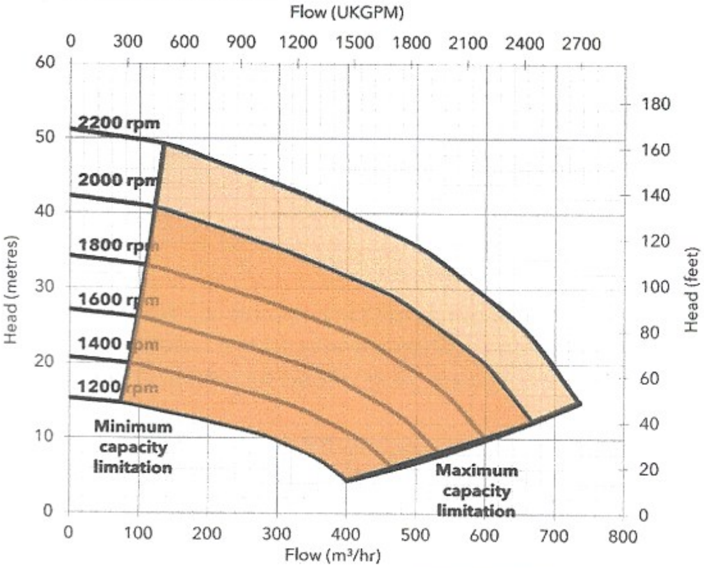
Specifications

Suction connection	200 mm (8" BS10 Table 'D')
Delivery connection	200 mm (8" BS10 Table 'D')
Max capacity	735 m^3/hr
Max Solids handling	75 mm
Max Impeller diameter	290 mm
Max operating temperature	80 °C *
Max pressure	5.0 bar
Max suction pressure	5.0 bar
Max casing pressure	7.5 bar
Max operating speed	2200 rpm

* Please contact our office for applications in excess of 80°C.

godwin
a xylem brand

Performance Curve



Materials

Pump casing & suction cover	Cast iron BS EN 1561 - 1997
Wearplates	High Chromium Cast Iron HC403:1977
Pump Shaft	Carbon steel BS 970 - 1991 817M40T
Impeller	Cast Steel BS3100 A5 Hardness to 200 HB Brinell
Non-return Valve body	Cast iron BS EN 1561 - 1997
Mechanical Seal Faces	Silicon carbide vs silicon carbide

Engine option 1

Price list ref - CD225M-01-DBH-003

Perkins, 1106D-E66TA (129), 103.5 kW @ 2200 rpm

Impeller diameter 290 mm

Pump Speed 2200 rpm

Suction Lift Table

Total Suction Head (metres)	Total Delivery Head (metres)				
	13	21	31	37	42
	Output (m³/hr)				
3.0	715	660	528	-	-
4.6	660	578	468	385	-
6.1	385	385	385	330	-
7.6	275	275	275	220	88

Fuel capacity (Full) 324 litres, (Usable) 262 litres

Fuel consumption @ 2000 rpm 26.7 litres/hour

Weight: (Dry) 2,940 kg, (Wet) 3,230 kg

Dimensions: (L) 3,350 x (W) 1,300 x (H) 1,887 mm

Performance data provided in tables is based on water tests at sea level and 20°C ambient. All information is approximate and for general guidance only. Please contact the factory or office for further details.

Av Sound Pressure Rating (dbA)

Running Speed (rpm)	Distance		
	1m	3m	7m
1400	73	67	66
2000	77	71	68
2200	79	78	76

Engine option 2

Price list ref - CD225M-01-DBH-002

Perkins, 1104D-E44TA, 74.1 kW @ 2000 rpm

Impeller diameter 290 mm

Pump Speed 2000 rpm

Suction Lift Table

Total Suction Head (metres)	Total Delivery Head (metres)				
	10	17	25	30	34
	Output (m³/hr)				
3.0	650	600	480	-	-
4.6	600	525	425	350	-
6.1	350	350	350	300	-
7.6	250	250	250	200	80

Fuel capacity (Full) 340 litres, (Usable) 275 litres

Fuel consumption @ 2000 rpm 18.5 litres/hour

Weight: (Dry) 2,100 kg, (Wet) 2,350 kg

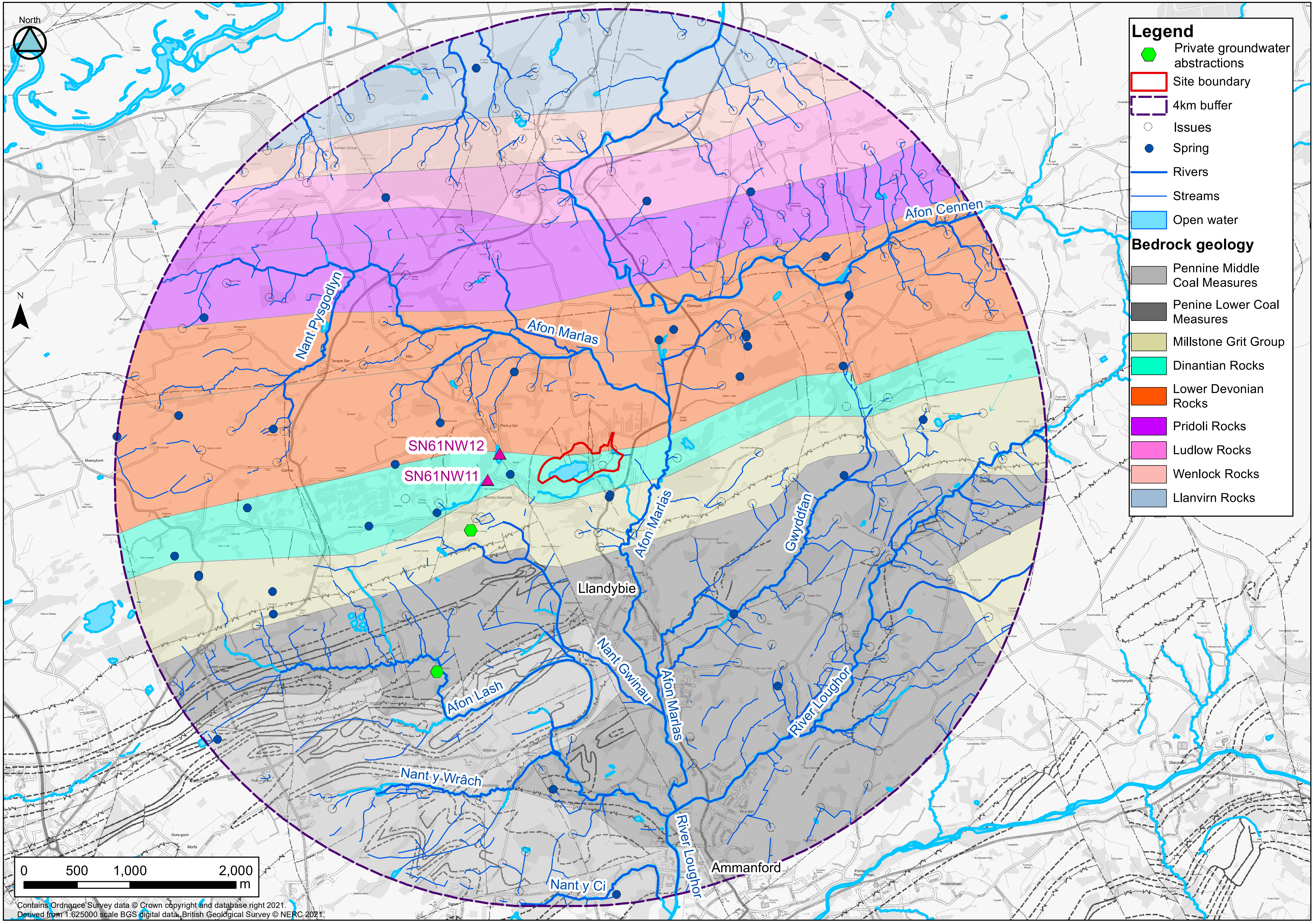
Dimensions: (L) 2,890 x (W) 1,300 x (H) 1,800 mm

Performance data provided in tables is based on water tests at sea level and 20°C ambient. All information is approximate and for general guidance only. Please contact the factory or office for further details.

Av Sound Pressure Rating (dbA)

Running Speed (rpm)	Distance		
	1m	3m	7m
1400	72	65	65
1800	76	69	66

B Water Features Survey Map



North
Legend
Private groundwater abstractions
Site boundary
4km buffer
Issues
Spring
Rivers
Streams
Open water
Bedrock geology
Pennine Middle Coal Measures
Penine Lower Coal Measures
Millstone Grit Group
Dinantian Rocks
Lower Devonian Rocks
Pridoli Rocks
Ludlow Rocks
Wenlock Rocks
Llanvirn Rocks
Afon Cennen
Afon Marlas
Nant Pysgodlyn
SN61NW12
SN61NW11
Llandybie
Gwyddfan
Afon Lash
Nant Gwinau
River Loughor
Nant y Wrâch
Nant y Ci
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Dublin
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