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# Carmarthenshire County Council: Mine Water Heat Opportunities

July 2024



Making a **better future** for people  
and the environment **in mining areas**

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## Executive summary

Coal mining has taken place in the Carmarthenshire County Council (CC) area since at least the 16th Century with the last mine to close being Cwmgwili in 1986. The Sothern extent of the borough is underlain by coal mine workings, with multiple seams being worked in many localities. The presence of mine workings combined with knowledge (where available) of recovered mine water levels are used to provide a very high level assessment of the potential for exploring the development of open loop mine water heat projects in the borough. In addition to borehole opportunities and gravity-fed discharges have also been assessed for heat potential. Some discharges do not have sufficient data for assessment, hence are not included in this report.

The workings vary in depth, being relatively shallow close to the outcrop along the B4319 road to greater depths of ~500m near Ammanford. The strata and associated coal seams and workings dip to the south east with the deepest seam workings in the Ammanford locality. The presence of numerous 'gravity fed discharges' in the Carmarthenshire CC administrative area together with the long period since the mines closed suggests that mine water has recovered.

The methodology for identifying the mine water heat opportunity areas is described in the overarching report. Mine water heat opportunities are based on mine workings information, with several 'good' and 'possible' opportunities the Carmarthenshire County Council (CC) area. This reports also includes surface details to provide opportunities to be progressed, these are also shown in the table below.

There are several gravity-fed discharges and two Coal Authority owned and operated mine water treatment schemes where mine water is emitting at surface. This mine water may offer potential for mine water heat without the cost and risk of drilling and pumping. A selection of the larger discharges having a heat potential of up to 2MWth is listed in table below.

It is recommended that the opportunities listed are considered against surface heat demands to highlight those which may be served by mine water heat technologies. A subsequent, more detailed study of the mining and hydrogeology would add further information to firm up the case to take a number of mine water heat projects forward.

**Summary of selected mine heat opportunity locations**

No./ Area	Opportunity name	Opportunity type	Opportunity Category	Estimated Heat Potential MW <sub>th</sub>
1	Morlais	MWTS	Good	2 to 4
2	Lanelli	Borehole	Good	Subject to further testing
3	Lindsay	MWTS	Good	0.2 to 0.5
4	Pontyberem	Discharge	Good	0.5 to 1
5	Pontyberem	Discharge	Good	0.5 to 1
6	Cross Hands	Borehole	Good	Subject to further testing
7	Gors-goch	Borehole	Good	Subject to further testing
8	Morfe	Borehole	Good	Subject to further testing

# 1 Introduction

The area covered in this section is the whole of the Carmarthenshire County Council administrative boundary within which the presence of mine workings combined with knowledge (where available) of recovered mine water levels are used to provide a very high level assessment of the potential for exploring the development of open loop mine water heat projects in the borough.

## 1.1 Geographic area

Carmarthenshire covers an area of approximately 2440 km<sup>2</sup>, and slightly elongated on a northeast-southwest trend. Much of the district is rural and is also not within the South Wales Coalfield. Main urban areas with coal mine workings include Llanelli, Ammanford, and Burry Port. Mine workings within Carmarthenshire are effectively to the south / southeast of the Gwendraeth Fawr.

# 2 Geological Summary

The solid and superficial geology, along with seam information has been ascertained by consultation of the available British Geological Survey records including:

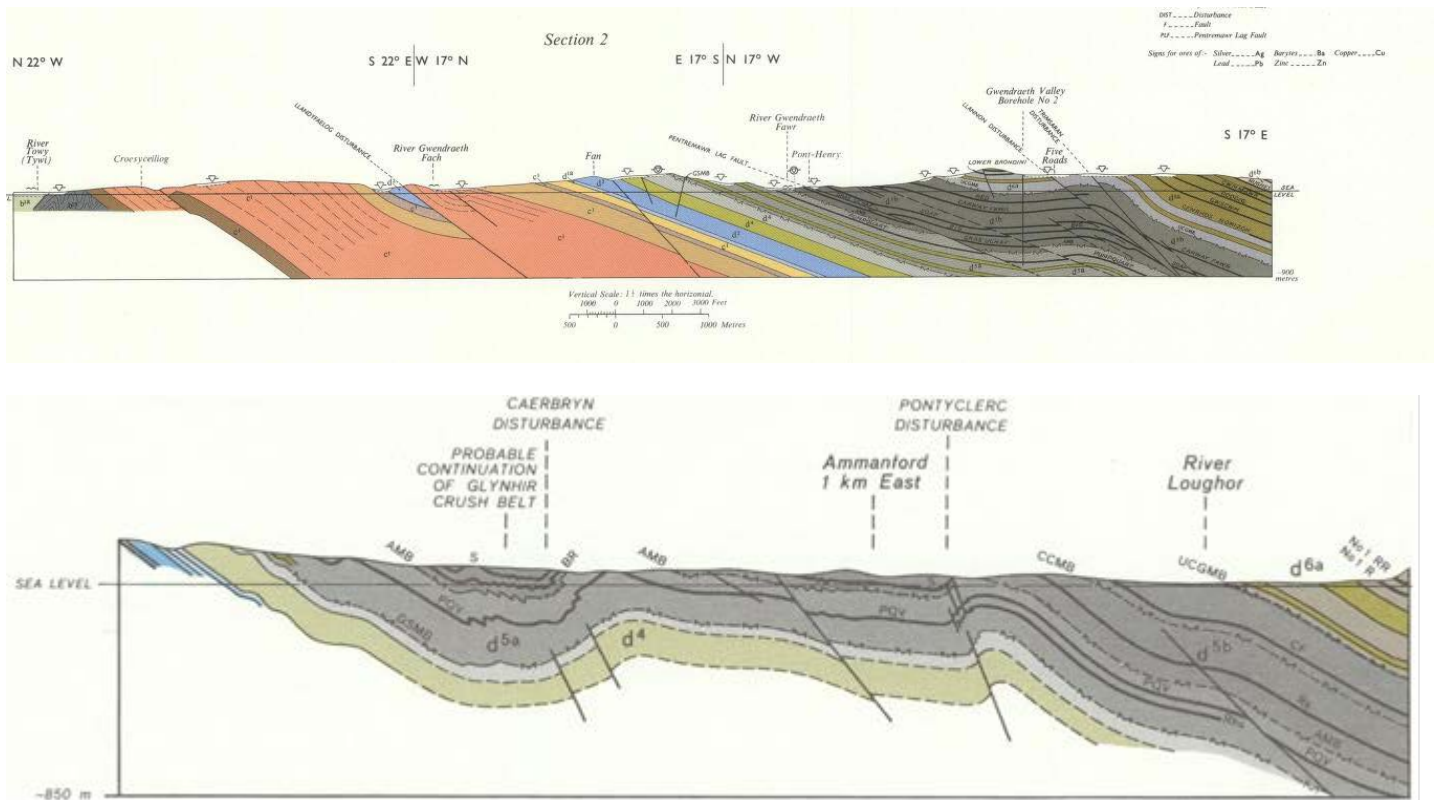
- Online GeoIndex viewer;
- Online geological memoirs;
- Online geology maps (Sheet 247 and Sheet 230 for Carmarthenshire area); and
- Borehole and mine shaft scans across the area of interest.

## 2.1 Solid geology

The Carmarthenshire administrative area is underlain by a mixture of bedrock geology including Ordovician, Silurian, Devonian, and Carboniferous periods (**Figure 2.1** and **Figure 2.2**). The focus of this study is within the Carboniferous South Wales Coal Measures.

The Coal Measures strata comprises cyclic sequences of interbedded mudstones, siltstones, sandstones interspersed with coal seams, a generalised section of which is illustrated in **Figure 2.3**. The base of the South Wales Coal Measures is an unconformity tending northeast-southwest, and roughly follows the Gwendraeth Fawr Valley. Here the Coal Measures strata sequence dips to the south southeast reaching depths of around 500m.

The South Wales Upper Coal Measures (Pennant Measures) comprises predominantly sandstones with many coals seams, some of which have been mined. The South Wales Middle and Lower Coal Measures contains interbedded sequences of mudstone, siltstone, sandstone and coal seams, some of which have been mined.



**Figure 2.1: Regional geological cross sections top is approximately north-south through Pontyberem; bottom is approximately north-south through Ammanford**

Contains British Geological Survey materials © UKRI 2024.

[Source: British Geological Sheet 230 Ammanford](#)

[Source: British Geological Sheet 247 Swansea](#)

Regional solid geology and selected structural geology is shown in **Figure 2.2**

The stratigraphic sequence, approximate depths and noted shaft sections are shown in **Figure 2.3**.

## 2.2 Structural geology

The geology in the area is heavily faulted by normal and thrust faults. The faulting in the southern part of Carmarthenshire typically includes two sets. A south-west trend of thrust faults and disturbance, and a north-northwest / south-southeast trend of normal faults. More regionally the Coal Measures form a west-east trending syncline / basin.



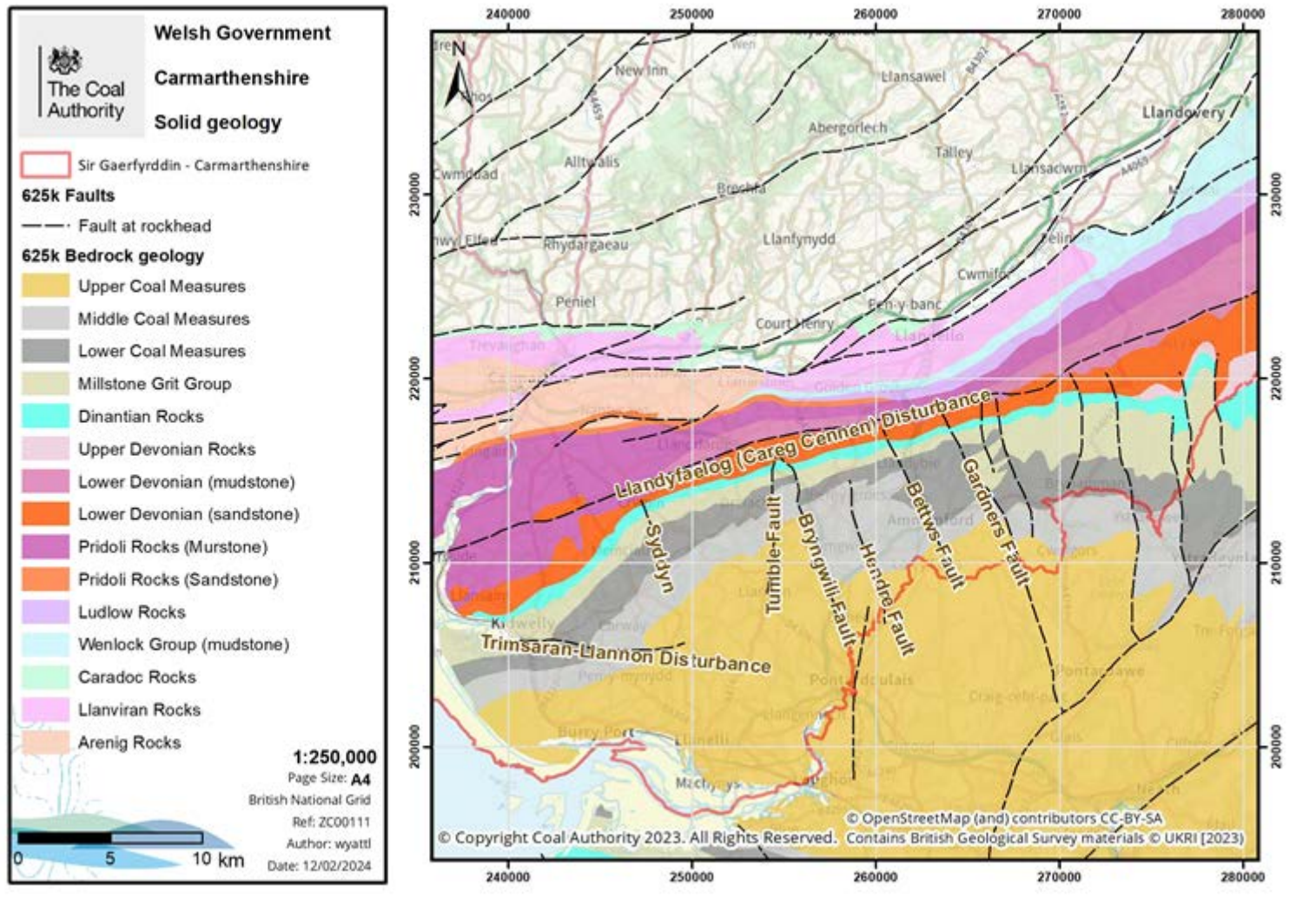
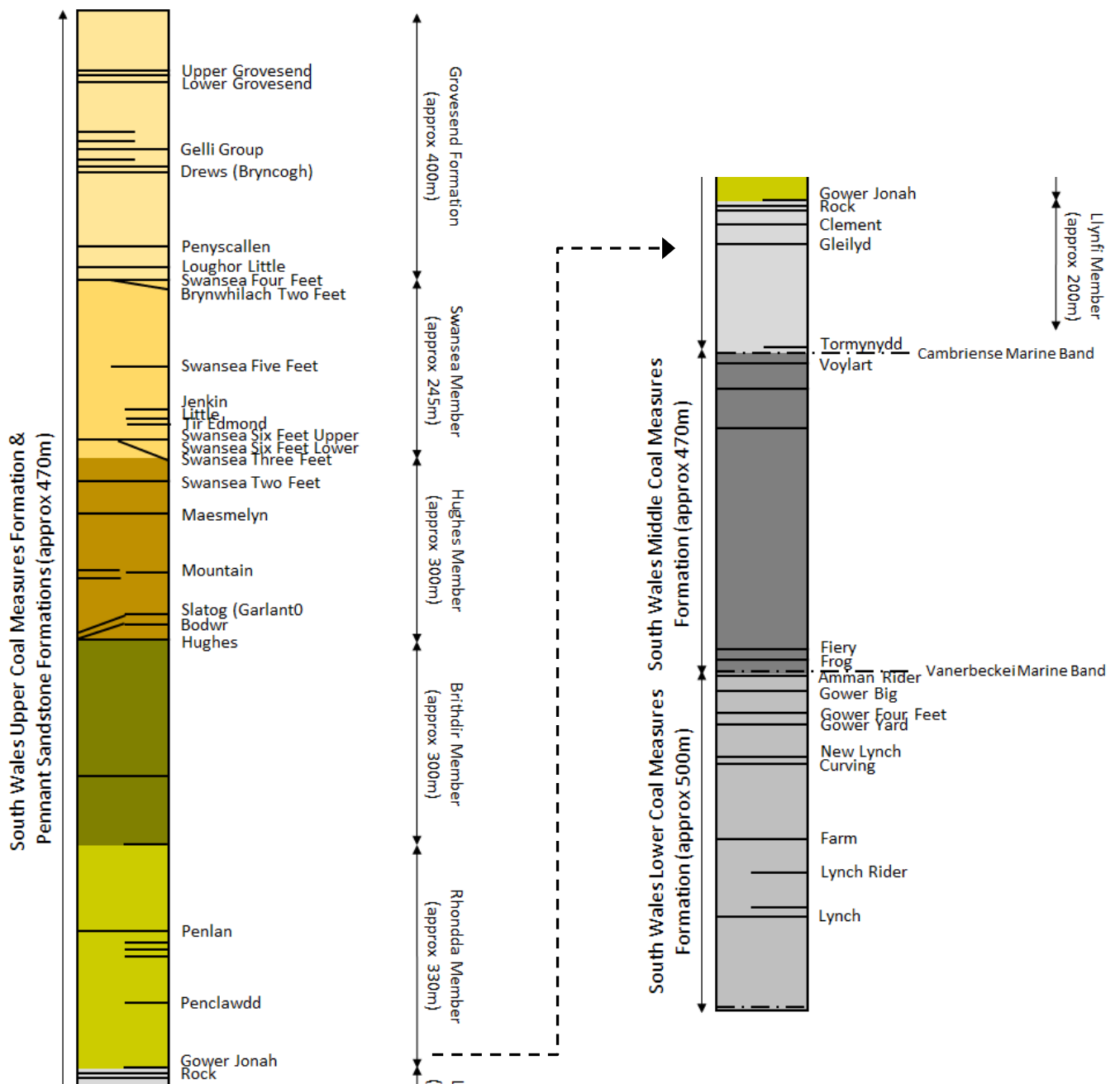


Figure 2.2: Bedrock geology in the south part of Carmarthenshire



**Figure 2.3: Summary Coal Measures stratigraphy and geological sequence for the study area, based on BGS Sheet 247**

### 3 Mining situation

Coal mining has taken place in South Wales for several centuries with shallow seams being worked near to outcrop by means of roadways driven from the surface. These workings were often gravity drained by means of water levels or soughs.

From at least the mid 1800's, the industrial revolution and concomitant increase in demand for coal led to the sinking of many collieries into the deeper seams. The mine workings in the South Wales Upper Coal Measures / Pennant Formations and those in the South Wales Middle and Lower Coal Measures were often not connected during mining.

Camarthenshire was an area where a number of large scale collieries were developed across much of the borough to feed the demand for coal which continued for many years through the 1900's. In the 1970's and 1980's collieries were often connected together underground to form 'complexes' to improve efficiency by making use of common surface facilities such as coal preparation. These underground mining connections have a great bearing on the underground mine water regime by interconnecting considerable areas of mine workings.

Following colliery closures and end of mines in the 1980/90s, several mines were lost due to flooding. The final collieries to close, some of which had merged to become complexes, are set out in **Table 3.1** below. Following these closures pumping ceased and the mines started to fill with mine water.

**Table 3.1: List of most recent colliery closures**

Colliery	Closure date	Connected underground to
Cwmgwili	1996	
Betws	1993	
Carway Fawr Drift	1993	
Cynheidre	1989	
Morlais	1985	
Note: a detailed assessment of underground mining connections is required to confirm the mining hydrogeological conceptual model(s)		

## 4 Mine water regime

### 4.1 Description of mine water blocks

Parts of the South Wales mine water blocks 1, 2, 3 and 3A are present within the Carmarthenshire CC boundary as illustrated in **Figure 4.1**. Mine water recovery in these blocks is uncertain, but based on gravity-fed discharges and limited water level monitoring, it is considered recovered

### 4.2 Monitoring data

#### 4.2.1 Mine water levels

Mine water level monitoring data are available at only 2 points for the Carmarthenshire area with information shown at **Table 4.1**. Though limited, the monitoring data suggests mine water is largely recovered at those locations. The volumes of water pumped during mining, and the time elapsed (>20 years) since colliery closures suggests mine water levels should be recovered in the different mine water blocks. The presence of numerous gravity discharges along with limited water level monitoring also suggest mine water recovery is complete. The degree of hydraulic connectivity between workings in the South Wales Upper Coal Measures / Pennant Formations, and those in the Middle / Lower Coal Measures seams is unclear and will require further more detailed site specific study.

**Table 4.1:** Mine water level monitoring points

Monitoring point name	Mine Water Block	Typical Water level (mAOD)
Cross Hands Big Seam Borehole	2	96 to 98
Morfa Big Seam Borehole	2	96 to 102

#### 4.2.2 Mine water temperature

A study into mine water temperatures at various depths around the UK coalfields was published in 2020 ([Farr et al, 2020](#)). This study used historic underground water and strata temperatures along with data from mine water pumping where available.

Temperature typically increases with depth and data published in the study suggests the following may be anticipated for the Carmarthenshire area:

**Table 4.2: Anticipated underground mine water temperatures around of Llanelli**

Depth (m BGL)	Mean(°C)
100	11.3
200	13.6
300	15.8
400	17.9
500	20.4
600	22.5

**Table 4.3: Anticipated underground mine water temperatures around Cross Hands**

Depth (m BGL)	Mean (°C)	Max. (°C)	Min. (°C)
100	11.6	11.7	11.5
200	14.3	14.3	14.2
300	16.9	17	16.9
400	19.6	19.7	19.6
500	22.3	22.4	22.3

### 4.2.3 Mine water chemistry

Mine water chemistry can be highly variable depending on specific location and would not normally form part of any initial high level opportunity scoping considerations guided by this study.

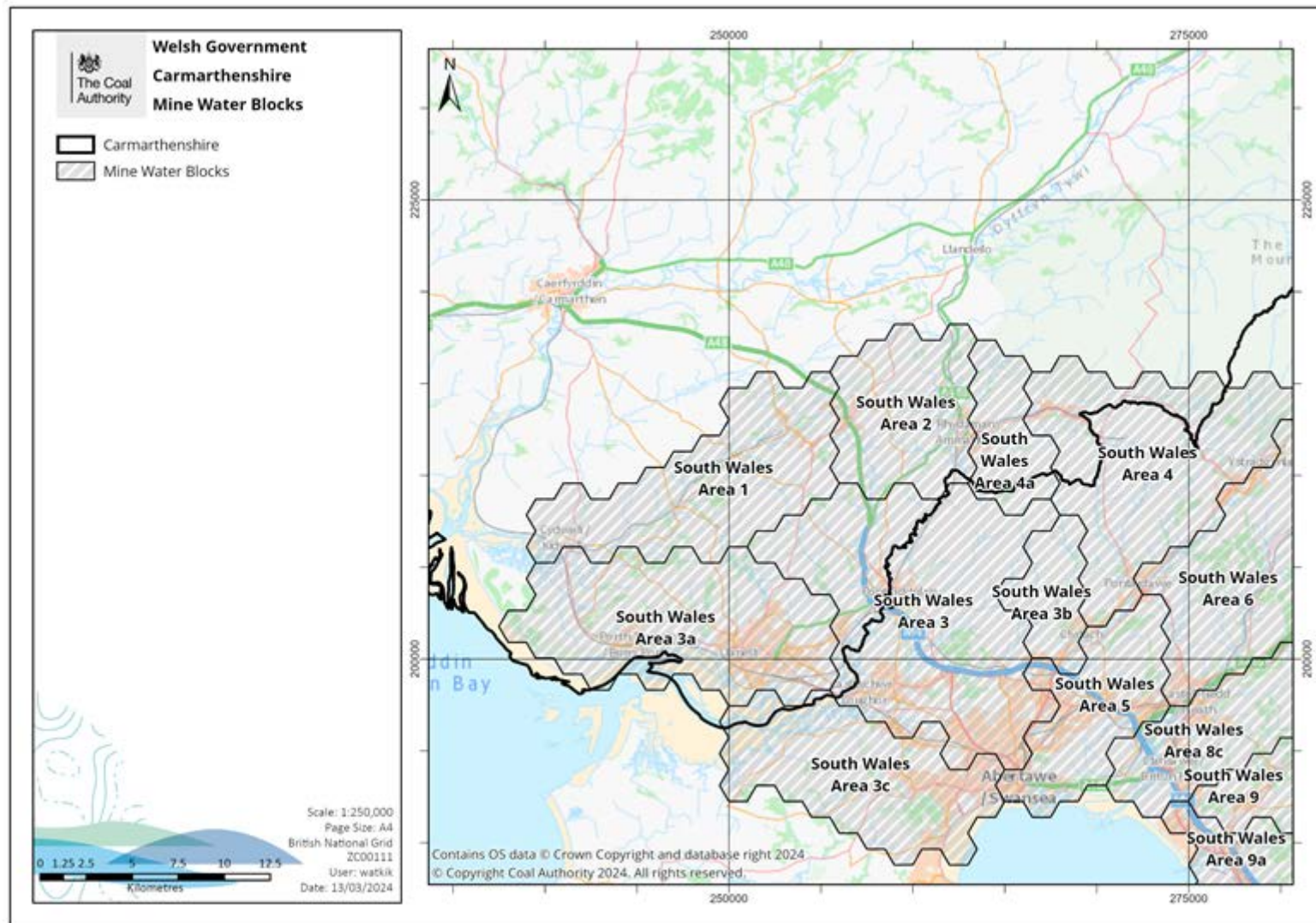


Figure 4.1: Mine water bocks in Carmarthenshire

# 5 Mine water heat opportunities

## 5.1 Borehole schemes

The prospects for progressing a mine water heat scheme based on drilling boreholes to abstract the mine water are assessed on a 'tier' basis, and re-inject to the same mine system, or discharge to surface watercourse. Three tiers have been adopted for the purposes of this study, the methodology and assessment criteria being set out in the overarching report.

The classification of borehole based opportunities are:

**Good opportunities** – shown coloured dark orange

**Possible opportunities** – shown coloured medium orange

**Challenging opportunities** – shown coloured light orange

The opportunity areas within Carmarthenshire boundary are outlined below and are illustrated on the maps at **Figure 5.1** and **Figure 5.6**.

Any areas where no opportunity exists, mainly due to absence of mine work are shown uncoloured/un-hatched.

### 5.1.1 Good borehole opportunities

In broad terms, good opportunities are expected to exist in the southern part of the borough concentrated around the built up areas of Llanelli, Llangennech and to a lesser extent Cross Hands.

In the south of the borough good opportunities exist at **Lanelli**. The town is underlain by multiple seams of coal workings, at depths ranging from shallow to 190m. This area includes a number of significant commercial/industrial buildings on the **Trostre Industrial Estate**, there is also a large retail park in close proximity. **The Ysbyty Tywysog Phillip Prince Phillip Hospital** also sits beneath this prospective area.

**Further north, Cross Hands, Gors-goch and Morfa** area are also considered to be in good opportunity areas with a significant amount of industrial and retail units. workings here are in multiple seams at depth of 0-300m.

East of **Cross Hands**, a small area around **Tycroes** represents a good opportunity area with workings present in more than one seam at depths from c.25m to c.130m.

### 5.1.2 Possible borehole opportunities

A 1.5Km wide band offering possible opportunities exists following the B4317 road from Heol-Ddu to Cwm-Mawr. These workings follow the line multiple coal outcrops where they appear at the surface and trend in a NE-SW orientation and dip to the south east at an average angle of 15-20°. Here the shallow workings in conjunction with deeper workings mark this area out as an area of possible opportunities.

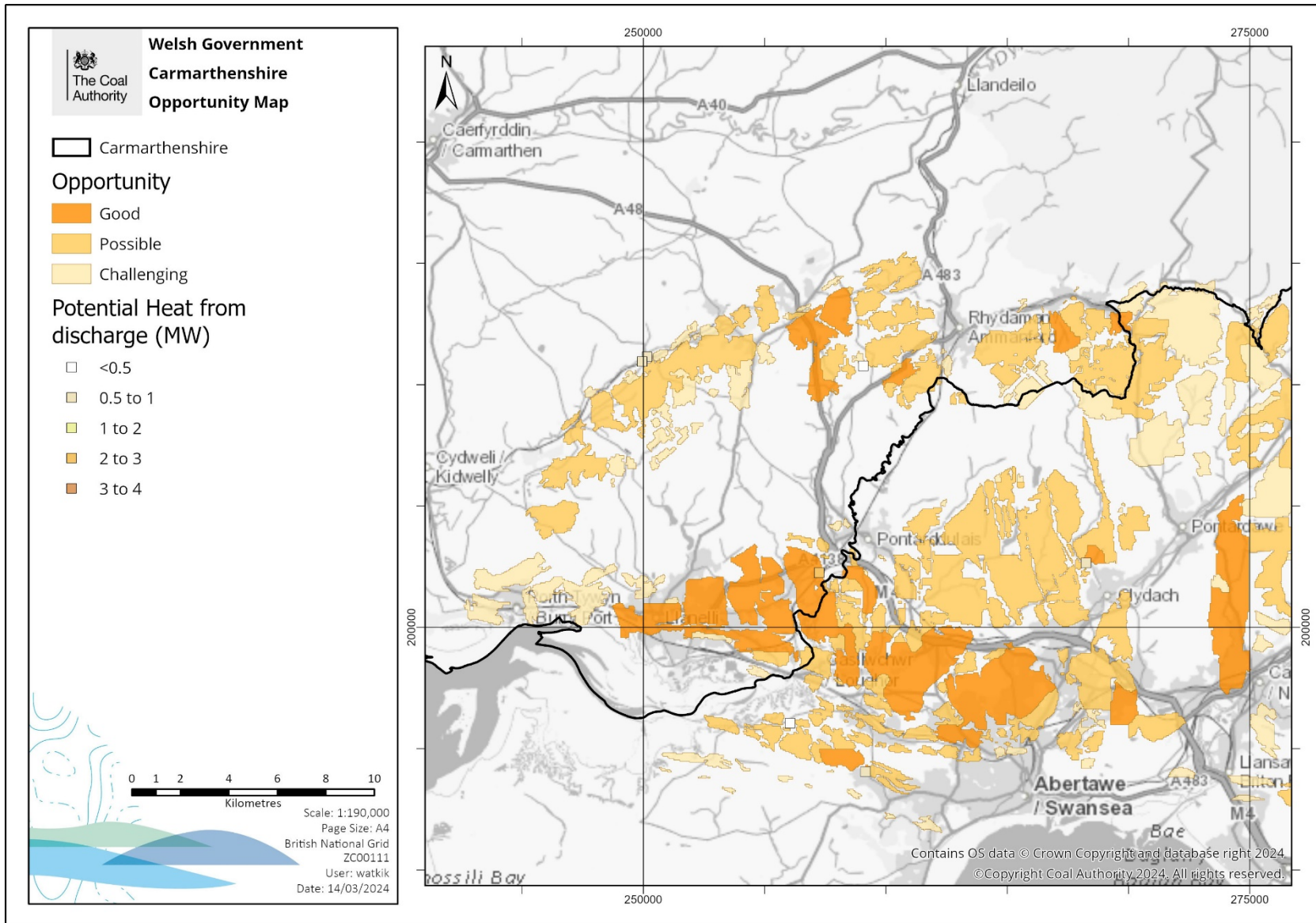
There are multiple primary schools in the area who have been awarded funding to install both air and ground source heat pumps. Of these, only Ysgol Llechyfedach School near Cross Hands is located on any coal workings, a small project may possible if workings can be accessed from the schools grounds.

### 5.1.3 Challenging Opportunities

Workings exist under parts of **Burry Port** in a single seam at a depths of over 0-300m. While a mine water heat scheme(s) may be technically possible it is unlikely to be viable at the present time due to workings in a single seam.

Challenging opportunities exist at the site of the former **Cynheidre Colliery**. These workings are deep 500m but if a suitable development can be developed in close proximity to these workings then a scheme may be viable.





**Figure 5.1: Mine water heat opportunities – borehole schemes**

## 5.2 Mine water treatment schemes

Existing Coal Authority mine water treatment schemes where mine water is already either pumped or flowing may in some circumstances potentially offer a lower risk approach to developing mine water heat projects as new drilling and testing of boreholes would not be required.

There are three mine water treatment schemes in the Carmarthenshire County Council area located at: Morlais, Lindsay and Mountain Gate Mine water treatment schemes in Carmarthenshire are from gravity-fed discharges, albeit pumping is required to deliver the water to the treatment scheme. Lindsay and Morlais are discussed below in **Section 5.3**.

Mountain Gate: this is located approximately 1km east of Capel Hendre and approximately 250m west of Fferws Hill, and discharges in to Nant Farw. Flow rate varies with rainfall and ranges between approximately <5 and 30 L/s, with an average flow of about 10 L/s. Mine heat potential based on average flow rate is approximately 0.2 to 0.3MW. Potential heat users and feasibility will need further investigation.

## 5.3 Gravity-fed discharge schemes

Numerous gravity mine water discharges exist in the Carmarthenshire area. Many are not monitored for flow rate, water quality or temperature, some of these may offer heat potential not presented in this report. Gravity-fed discharges generally occur when mine workings connect with the surface, typically via mine entries and boreholes.

The nature of gravity-fed discharges (flow, temperature and quality) will be dependent upon a number of factors including mining type and geometry, the hydrogeological system of the mine workings and rainfall.

Some discharges are likely to be more variable in flow rate and temperature than others but as many of the discharges are not currently monitored for flow rate, water quality or temperature and it is difficult to evaluate with any degree of confidence.

Those discharges that do have some monitoring data (albeit in some cases relatively limited) and are likely to have a heat potential of >0.5MW<sub>th</sub> are described in the sections below supported by data in **Table 5.1** and illustrated on the plans in **Figure 5.6**.

Should a potential heat demand be identified close to one of these discharges (shown in **Table 5.1**) or any other discharge in the area, then a more detailed study would be required. Additional investigation and data gathering will likely be required to establish its potential

**Table 5.1: Summary of selected gravity-fed discharges for mine water heat potential**

Name	Flow average L/s	Flow range L/s	Typical temp. °C	Potential heat MW <sub>th</sub>
Lindsay (treatment scheme)	21	10 to 30	15.1	0.2 to 0.5
Morlais (treatment scheme)	135	100 to >150	14.3	2 to 4
Pontyberem Bridge	28	10 to 45	10 to 11	0.5 to 1
Pontyberem Old Level	30	Spot reading	10 to 11	0.5 to 1

Note: Potential heat is based on spot readings and / or average flow rate. Potential heat will vary with flow rate, which varies with rainfall. Potential heat at a site may be above or below the estimated value at different stages of the year

### 5.3.1 Lindsay (treatment scheme)

Lindsay is an existing Coal Authority mine water treatment scheme to the south of **Capel Hendre**, and just to the south of Capel Hendre industrial estate. Mine water discharges in to a sump, from where it is pumped to the top of the treatment scheme. Mine water is then treated by ponds and wetlands before discharging in to Fferrws Brook. Potential users will need to be identified and feasibility study to be undertaken.

An initial estimate suggests a heat potential of around 0.2 to 0.5MW<sub>th</sub> (based on average flow rate). Flow rates vary with rainfall, thus heat potential could be in excess of 0.5MW<sub>th</sub> in / after wetter periods and <0.2MW<sub>th</sub> in drier periods. Assessment of flow rate, flow rate variability and temperature ranges will be required to confirm feasibility for a heat scheme(s).

### 5.3.2 Morlais (treatment scheme)

Morlais is an existing Coal Authority mine water treatment scheme approximately 1km to the northeast of Llangennech. Mine water upwells from a former Morlais Colliery mine shaft, it then flow through a series of ponds and wetlands before discharging in to the River Morlais. In addition to the shaft discharge, there is also a smaller second discharge in to the wetlands. Potential users will need to be identified, and feasibility study to be undertaken.

Flow rate data is variable and may need some assessment to confirm range of flow rates. Based on average flow rate of approximately 125 L/s (range of about 50 to >20 L/s), heat potential is around 2.1 to 3.85MW<sub>th</sub>. Heat potential will vary with variable discharge flow rates, thus be above and below this range.

### 5.3.3 Pontyberem discharges

There are two or possibly three discharges at Pontyberem. There is data available for two discharges:

**Pontyberem Bridge discharge:** discharges in to the Gwendraeth Fawr at Pontyberem Park. Potential users will need to be determined, but could include nearby Pontyberem Primary School. Flow rates data is limited to spot estimates. Temperature data and additional flow rate data and assessment will be required to confirm heat potential. Based on an

approximate flow rate of 34 L/s, heat potential is approximately 0.7 to 1MW<sub>th</sub>. Heat potential will vary with rainfall and flow rate, thus can be above and below this range at times.

**Pontyberem Old Level discharge:** discharges in to the Gwendraeth Fawr below Railway Terrace, west Pontyberem. Potential users will need confirming, within the immediate area, users are limited to residential houses on Railway Terrace. Feasibility studies and additional data will be required to confirm potential users. Flow rates are variable between approximately 10 to 45 L/s, with an average of about 20 to 30 L/s. Temperature data and additional flow rate data and assessment will be required to confirm heat potential. Based on average flow rate of 26 L/s, heat potential is approximately 0.5 to 0.7MW<sub>th</sub>. Heat potential will vary with rainfall and flow rate, thus can be above and below this range at times



**Figure 5.2: Lindsay treated discharge**



**Figure 5.3: Morlais treatment scheme - ponds and wetlands**



**Figure 5.4: Pontyberem Bridge discharge to river**



**Figure 5.5: Pontyberem Old Level discharge**

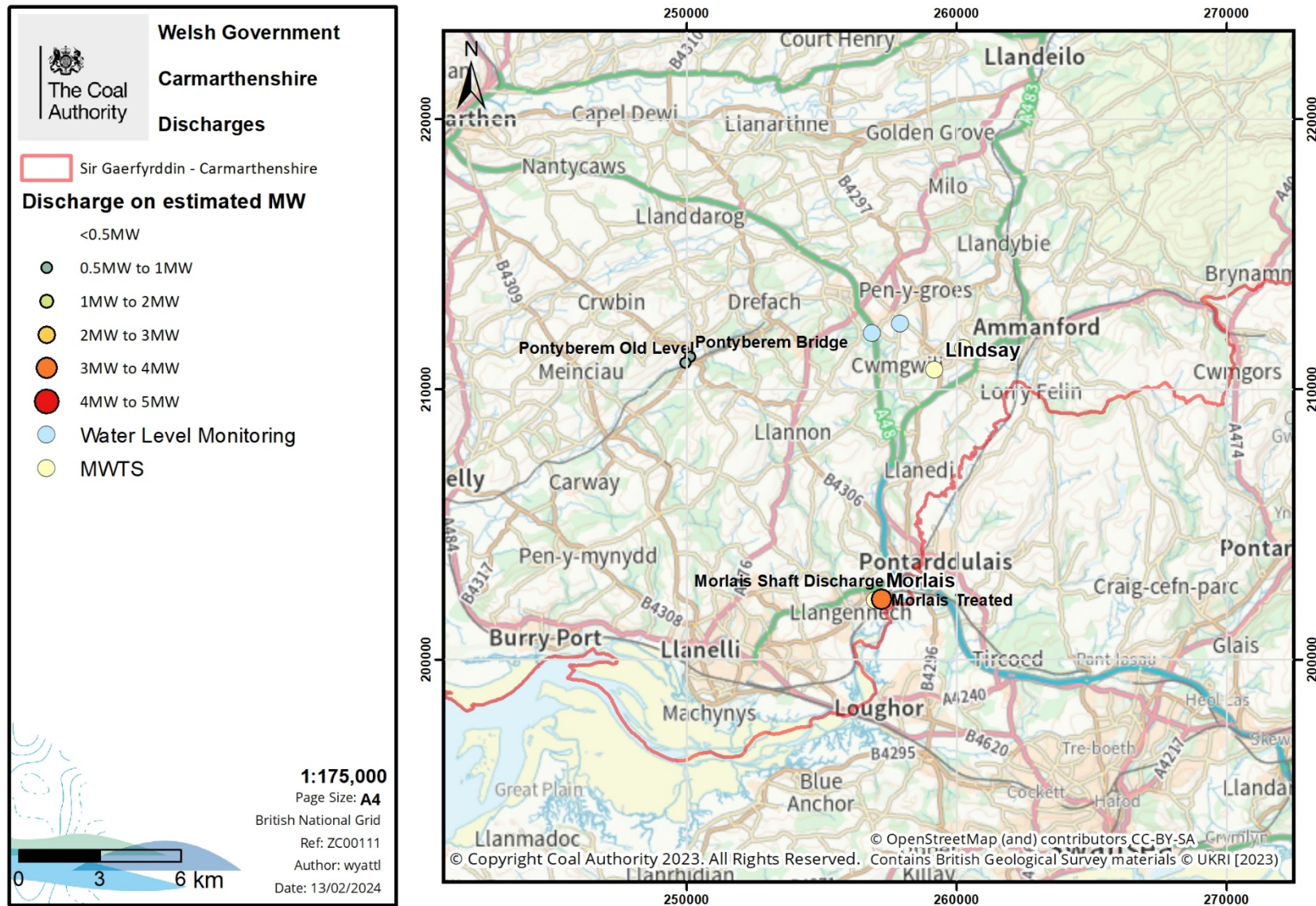


Figure 5.6: Mine water heat opportunities – treatment schemes and gravity discharges

## 6 Summary

The above sections of the report consider the mining and mine water parameters across the whole borough to rank areas by reference to a tier system which sets out quality of opportunities on an area basis.

This section overlays the tiers on populated conurbations to provide a steer on localities where mining aspects and surface development may present the most likely places to further investigate mine water heat. The places are illustrated in **Figure 6.1**.

### 6.1 Borehole schemes

A proportion of the southern part of the Carmarthenshire CC administrative area is underlain by abandoned coal mine workings at a depth and with a mine water recovery status offering varying degrees of potential for delivery of a borehole based mine water heat scheme.

#### 6.1.1 Good opportunities

The main area of good opportunities for boreholes in Carmarthenshire is the area around Llanelli. Here there is an ideal mix of off-takers including residential, industrial and public sector buildings that could be integrated into a heat networks including the Trostre Industrial Estate, a large retail park and The Ysbyty Tywysog Phillip Prince Phillip Hospital.

#### 6.1.2 Possible opportunities

The main are of possible opportunities follow the B4317 road but these are currently mainly rural areas. If there any future plans for development here then a scheme may be viable. It would be advisable to approach The Coal Authority in this instance to see what may be possible in terms of the workings beneath the site.

#### 6.1.3 Poor opportunities

Seeming poor opportunities exist in areas such as Burry Port and the site of the former Cynheidre Colliery. But these may be able to be developed if either single seam projects or deeper drilling become economically viable. A discussion with The Coal Authority prior to development would be advised in both circumstances

### 6.2 Mine water treatment schemes

There are two Coal Authority mine water treatment schemes within the Carmarthenshire CC area - Morlais and Lindsay. These represent excellent opportunities if development can occur in close proximity to keep the pipework cost to a minimum.

### 6.3 Mine water discharges

Many mine water discharges are known to exist in the area, currently 8 of these have been considered as offering potential for a mine water heat scheme although many of these do present some challenges in collecting the mine water and so are ranked as 'possible' opportunities although the heat potential is good. Individually they offer heat potential of  $0.2\text{MW}_{\text{th}}$  to  $2\text{MW}_{\text{th}}$  without the need for boreholes and associated deep pumping.

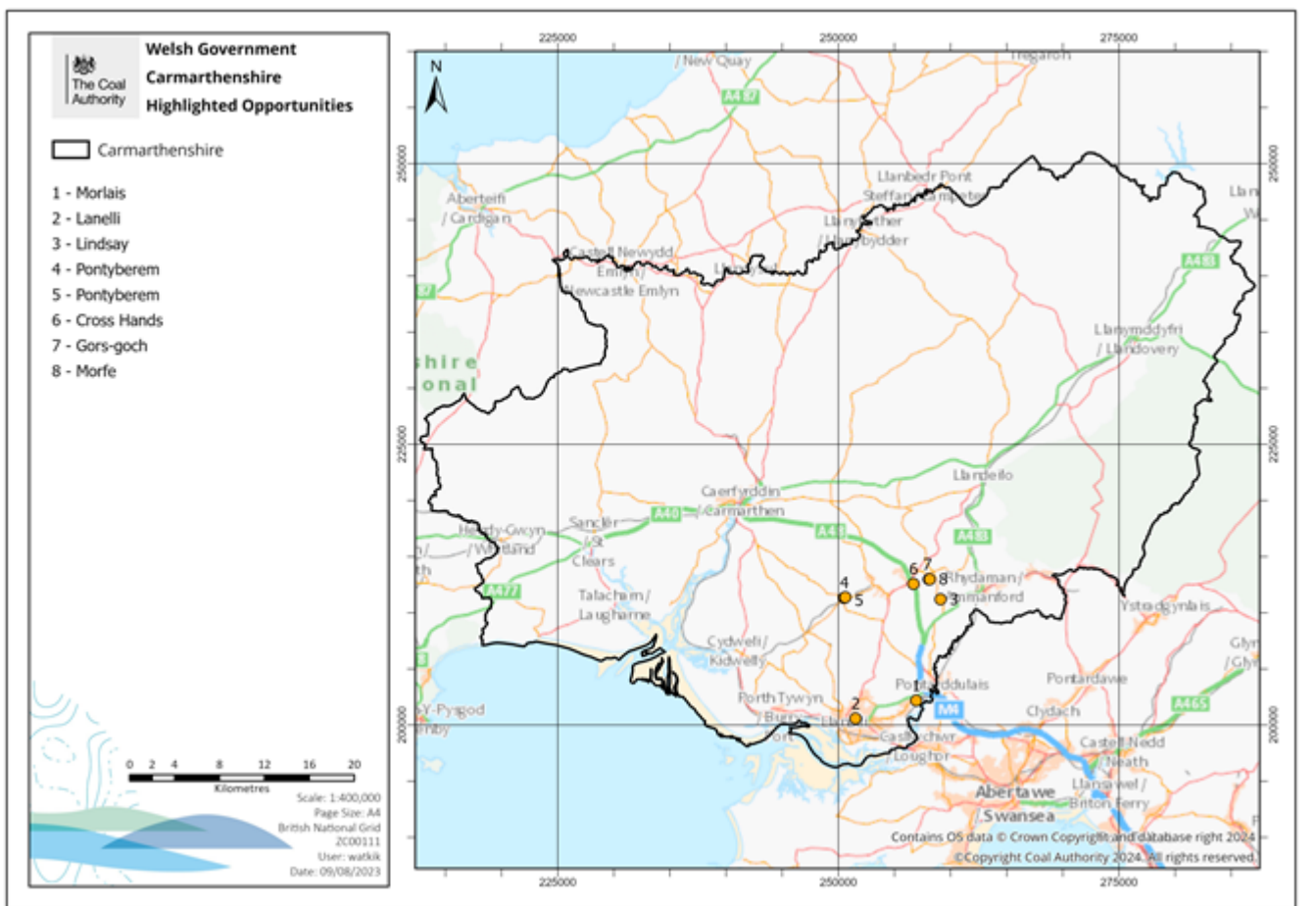


## 6.4 Summary and next steps

While the opportunity tiers are set out earlier in this report, much of the Carmarthenshire CC area. It is suggested that the places covered in this section are further considered for more detailed study.

**Table 6.1: Mine water heat opportunities within Carmarthenshire**

No./ Area	Opportunity name	Opportunity type	Category
1	Morlais	MWTS	Good
2	Lanelli	Borehole	Good
3	Lindsay	MWTS	Good
4	Pontyberem	Discharge	Good
5	Pontyberem	Discharge	Good
6	Cross Hands	Borehole	Good
7	Gors-goch	Borehole	Good
8	Morfe	Borehole	Good



**Figure 6.1: Highlighted good opportunities**

## 7 References

Farr, G., Busby, J., Wyatt, L., Crooks, J., Schofield, D.I., Holden, A. 2020. The temperature of Britain's coalfields. *Quarterly Journal of Engineering Geology and Hydrogeology* (2021); **54**(3). pp.1-14. <http://dx.doi.org/10.1144/qjegh2020-109>