The Coal Authority

# Bridgend County Borough Council: Mine Water Heat Opportunities

July 2024

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

# Disclaimer

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# Contents

# List of Figures



# List of Tables

# Executive summary

Underground (deep) coal mining took place in the borough between at least the 1800s and the 1980s, working coal seams within the Upper, Middle and Lower South Wales Coal Measures. Mine workings depths range from near surface to in excess of 600m below surface.

The methodology for identifying the mine water heat opportunity areas is described in the overarching report. There are a range of borehole mine water heat opportunities, ranging from good to challenging across the region, alongside gravity discharge point sources and a single mine water treatment scheme.

There are several gravity-fed discharges, 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 over 0.5MWth 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 ($MW_{th}$) |
|---|---|---|---|---|
| 1 | Pontycymer | Borehole scheme | Good | Subject to further testing |
| 2 | Price Town | Borehole scheme | Good | Subject to further testing |
| 3 | Caerau & Nantyffyllon | Borehole scheme | Possible | Subject to further testing |
| 4 | Craig-y-Aber | Mine Water Treatment Scheme | Possible | 0.6 |
| 5 | Nantyffyllon | Gravity discharge | Possible | 0.5 |
| 6 | Dinas Rhondda | Gravity discharge | Challenging | 2.4 |

# 1 Introduction

The area covered in this section is the whole of the Bridgend 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

Bridgend covers an area of approximately 255 $km^2$, and runs roughly north-south, from approximately south of the A4107 to south of Bridgend. Urban areas within Bridgend include: Bridgend, Porthcawl, Pyle, and Maesteg, along with conurbations along the Llynfi, Garw, Ogwr Fawr / Ogmore valleys. Coal Measures and associated mine workings are present roughly north of the line of the M4. Elevation in Bridgend CBC area ranges from sea level (about 0 mAOD) in the southwest parts to >550 m in the north.

# 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 (Austin and Evans, 1964);
- Online geology maps (Sheet 248 and Sheet 261/262 for Bridgend area); and
- Borehole and mine shaft scans across the area of interest.

## 2.1 Solid geology

The geology of the Bridgend area comprises geology from the Devonian through to the Jurassic. The Carboniferous includes South Wales Coal Measures.

The Coal Measures sequence covers much of northern portion of the local authority, up to the northern boundary of Bridgend town, where a change in topography exposes the Coal Measures sequence. The Coal Measures includes the Pennant Sandstone Formation (also known as the Upper Coal Measures), the South Wales Coal Measures sequences (Middle and Lower) (**Figure 2.2**). This includes cyclical sequences of hard sandstones, grey mudstones and siltstones and coal seams. The Pennant Sandstone formation is host to a number of notably hard quartz sandstones, alongside the shallowest productive coal seams, in the Rhondda Member and Brithdir Member. Middle and Lower Coal Measures are typically a sequence of siltstones, minor sandstones, seatearths and coal seams (many of which were mined). The coal measures geology extends to a maximum depth of over 600 m below ground level in the north of the district (>200 m below sea level) (BGS Sheet 248).

Regional solid geology and selected structural geology is shown in **Figure 2.2**. The stratigraphic sequence, approximate depths and thicknesses are shown in **Figure 2.3**. To the south of the M4, and across much of Bridgend, the geology consists of Permo-Triassic Mercia Mudstone, and the Jurassic Blue Lias formation.

## 2.2 Structural geology

The geology is folded, around Maesteg, exposing older Middle and Lower Measures at the surface. There are two significant east-west trending fault zones, with one just north of Bridgend town, and one running from Maesteg to Glynowgr. The faults divide the workings up into northern (north of Maesteg) and southern groups (between Maesteg and Bridgend). In addition to these east-west faults, there is a set north-northwest – south-southeast faults, which are most dense in the northern group of workings.

## 2.3 Superficial drift deposits

Superficial deposits consist of Alluvium, fluvioglacial sands and gravels and clay-bearing Till across the district.

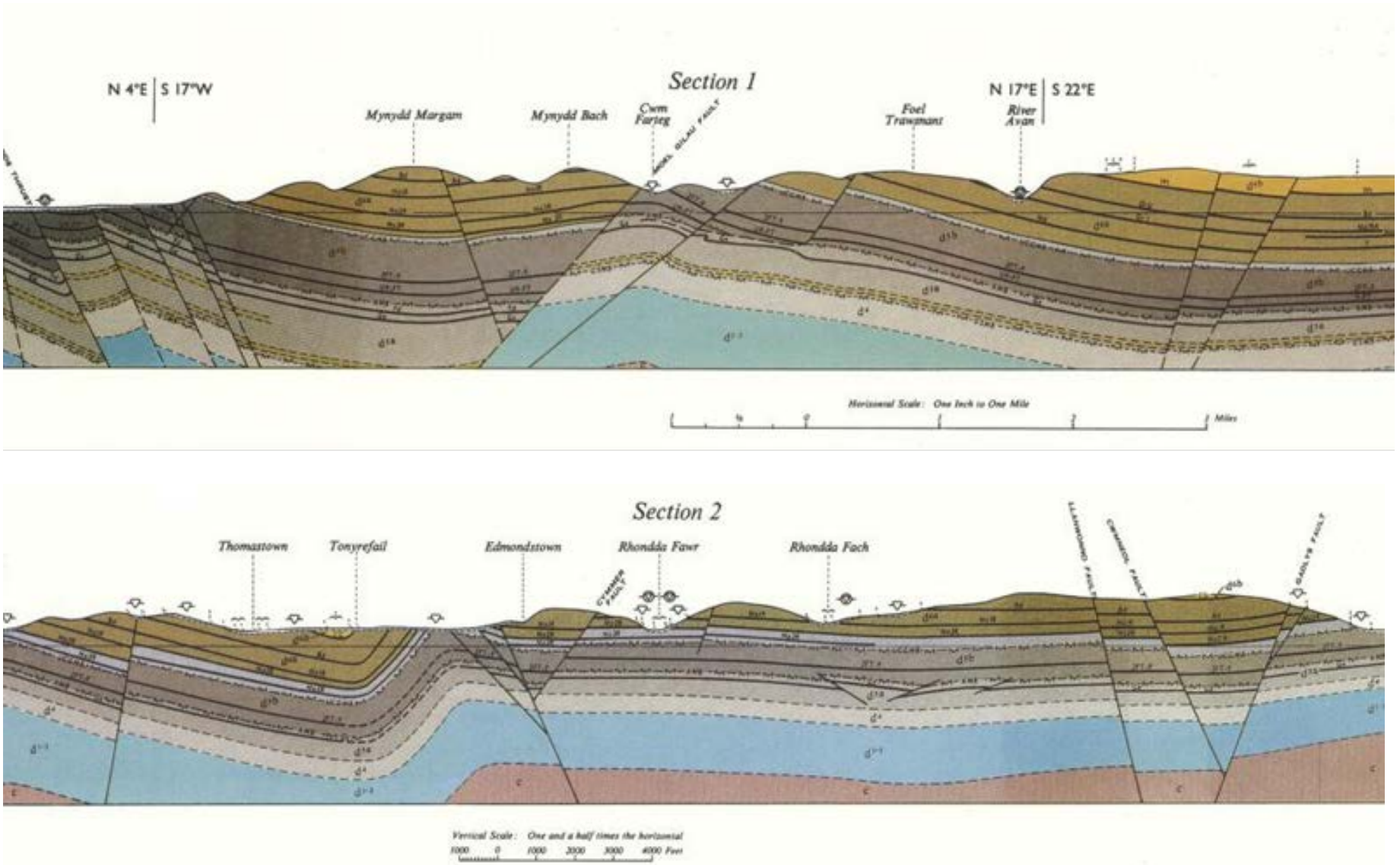



**Figure 2.1: Geological cross sections approximately north-south for Bridgend [Source: British Geological Sheet 248 Pontypridd]**

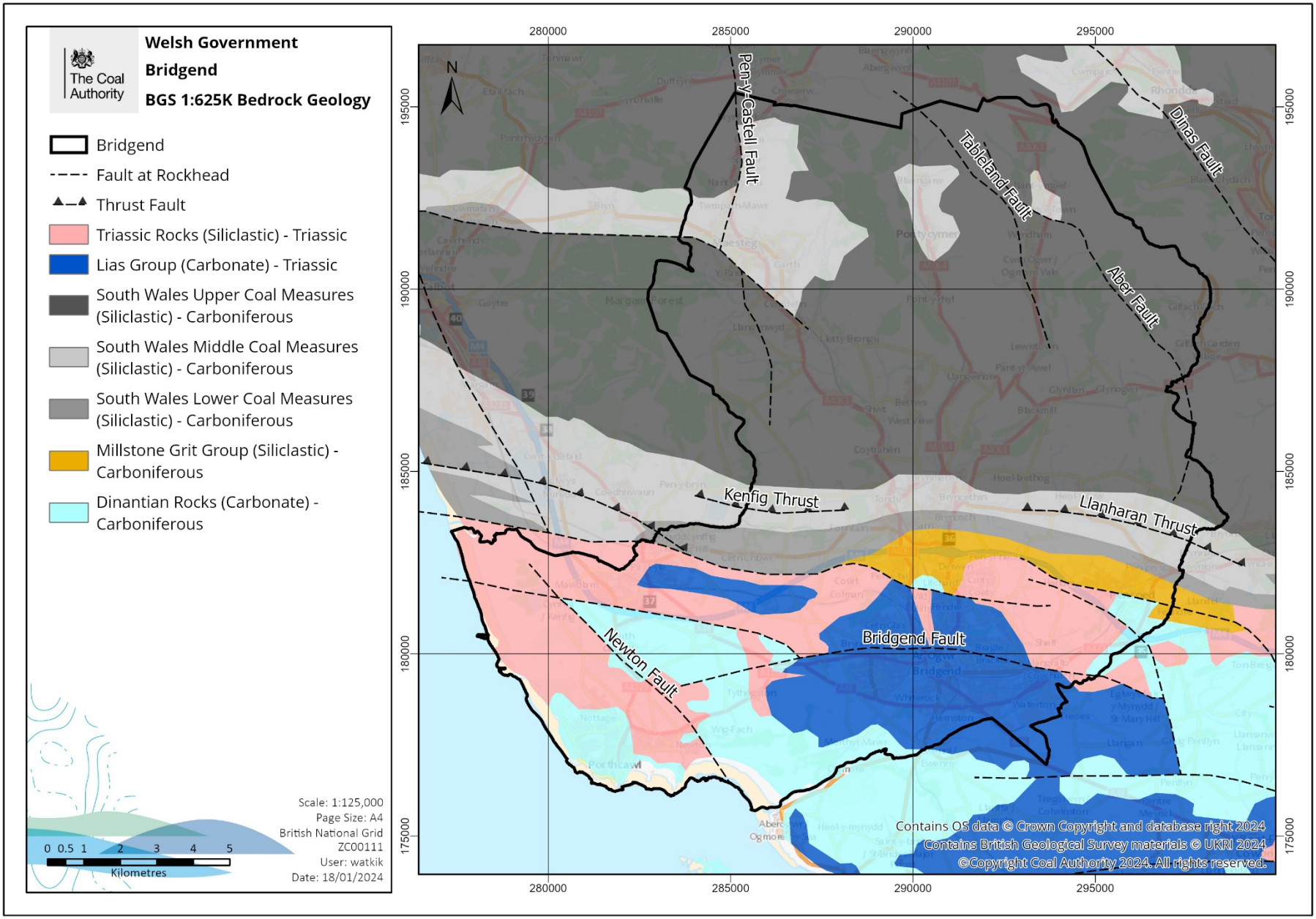
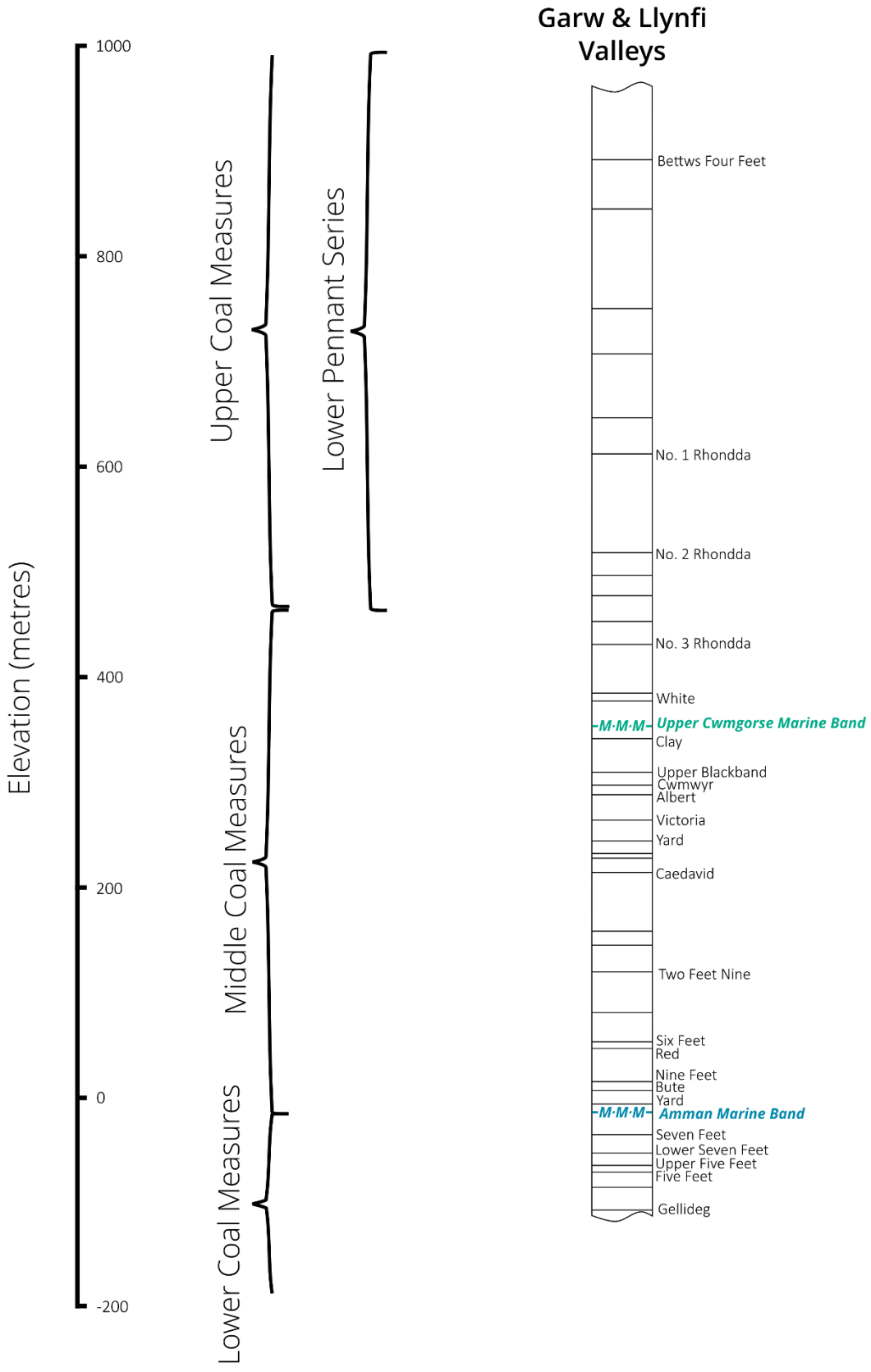



**Figure 2.2: Bedrock geology in the Bridgend area Contains British Geological Survey materials © UKRI [2024]**




Adapted from Figure 2 in "Overview of the South Wales Coalfield" report reference A031899-2 by White Young Green 2007

**Figure 2.3: Summary stratigraphy and geological sequence for the study area**

# 3 Mining situation

Coal mining took place in the Bridgend district from the 1800s, up until the 1980s. Mining took place in the north around Maesteg, Pontycymer and Ogmore Vale, and in the south of the district around Coytrahen and Glynogwr, with limited workings in the central part of the district. There are no workings beneath Bridgend town. A number of notable collieries were in operation across the district, including Caerau, Maesteg Deep, Coegnant, Wyndham and Coed Cae.

Coal was extracted from the Upper South Wales Coal Measures across the north and south of the district. Deeper workings targeted the Middle and Lower South Wales Coal Measures, primarily found in the north of the district, with an area to the northwest of Bridgend town. Workings in the northern half of the borough cross over into Rhondda Cynon Taf and Neath Porth Talbot. Following colliery closures and end of mines in the 1980/90s, several mines were lost due to flooding. The final collieries (some of which had merged to become complexes) to close are set out in **Table 3.1** below.

**Table 3.1: List of most recent colliery closures (from NMRS, 2023)**

| Colliery | Closure date | Connected underground to |
|---|---|---|
| Coegnant | 1981 | St John's, Caerau, Maesteg Deep |
| Garw / Ffladau | 1985 | Wyndham / Western, International, St John's (with stopping), Avon |
| St John's | 1985 | Coegnant, Garw (with stopping) |
| Wyndham / Western | 1984 | Garw / Ffaldau |
| Note: a detailed assessment of underground mining connections is required to confirm the mining hydrogeological conceptual model(s) | | |

Following these closures all mine water pumping ceased and the mines started to refill.

There are up to 34 named worked seams across the Bridgend CBC district, across the Upper, Middle and Lower Coal Measures. The full sequence outcrops to the north of Bridgend town, and then only the Upper and Middle measures in the hills and valleys heading north.

The uppermost seams worked in the district are in the the Pennant Sandstone/Upper Coal Measures, including the No.1 and No.2 Rhondda Seams. The deeper workings in the Middle and Lower Coal Measures are constrained to the area between Maesteg and Ogmore Vale. The Five Feet and Gellideg are the deepest seams in the area.

# 4 Mine water regime

## 4.1 Description of mine water blocks

The Bridgend district intersects the Area 9, Area 9a and Area 10a South Wales mine water blocks. These blocks extend away out of the district into adjacent local authorities, to the east and west, covering the top 15 km of the district outside of Bridgend town. The blocks cover extents of workings in the Upper Measures, and the Middle and Lower Measures, which are often hydraulically isolated from each other. Further detailed studies are required to confirm the boundaries of the mine water blocks, and hydraulic connections internally within the blocks and externally between blocks.

The southern half of the region is covered by blocks 9a, 10 and 10a, whilst the northern half is covered by block 9.

- Block 9 covers Coegnant, Caerau, and Wyndham collieries and is undergoing rising mine water / mine water recovery. Connections between the shallow and deep mine systems needs to be confirmed
- Block 9a covers Aberbaiden (Craig-y-Aber discharge and treatment scheme) and is considered to be recovery
- Block 10 is present in the northeast extents of Bridgend and includes a mixture of recovering and rising mine water situations, and may also include shallow system and deep system
- Block 10a includes Coed Cae and is likely to be recovered.

Sources of discharges in Block 9 are not well understood, whilst Blocks 9a and 10a represent isolated areas of workings with a clearer understanding on sources. Block 9a is host to isolated deeper workings in the Upper and Middle/Lower measures, similar to Block 10a where there are isolated blocks of workings in both the Upper and Middle/Lower measures.

The mine water blocks in this locality are shown in **Figure 4.1**.

## 4.2 Water level monitoring data

There are only two water level monitoring points in the Bridgend borough recording measurements, at Wyndham (Ogmore Vale) and a newly completed borehole near Caerau, with information included in **Table 4.1**. The two boreholes are at opposite ends of the No.9 mine water block. There are a number of other monitoring points and unmonitored discharges where information could be obtained from by in-person inspection.

There is limited monitoring data available for the Bridgend region, but there may be historical data or information able to be obtained based on discharge elevations to complete the picture.

**Table 4.1: Mine water monitoring points**

| Monitoring point name | Monitoring | Mine water level (mAOD) | Comments |
|---|---|---|---|
| Wyndham (Ogmore Vale) BH | MCM/LCM | 87.8 | <75m BGL, recovering |
| Caerau Six Feet Seam BH | MCM/LCM | 100.8 | >100 mBGL, recovering |

### 4.2.1 Mine water levels

There is limited monitored mine water level data across the Bridgend CBC area, but with a number of unmonitored discharges, it can be considered that certain parts of the mine workings across the region are recovered and discharging. In the east, for Ogmore Vale, water levels are <75 mBGL, and recovering/rising. There is a newly completed Coal Authority monitoring point at Caerau, which has been monitoring water levels since May 2023.

There is methane vented from Coegnant Shafts, this suggests that there is at least one unflooded inset between the shaft and the mine workings. The highest known inset in Coegnant Shafts is in the Two Feet Nine Seam at approximately 100 mAOD, presence of methane suggests this inset if not fully flooded, but may be close to becoming flooded.

### 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 are shown in from Table **4.2** to **Table 4.5**.

**Table 4.2: Anticipated mine water temperatures block 9**

| Depth (m BGL) | Mean average(°C) | Maximum (°C) | Minimum (°C) |
|---|---|---|---|
| 100 | 11 | 11.3 | 10.7 |
| 200 | 13.1 | 13.7 | 12.5 |
| 300 | 15.1 | 16 | 14.2 |
| 400 | 17.1 | 18.3 | 16 |
| 500 | 19.1 | 20.6 | 17.7 |
| 600 | 21.2 | 23 | 19.4 |

**Table 4.3: Anticipated mine water temperatures block 9a**

| Depth (m BGL) | Mean average(°C) | Maximum (°C) | Minimum (°C) |
|---|---|---|---|
| 100 | 11 | 10.2 | 9.9 |
| 200 | 13.1 | 11.3 | 10.7 |
| 300 | 15.1 | 16 | 14.2 |
| 400 | 17.1 | 18.3 | 16 |
| 500 | 19.1 | 20.6 | 17.7 |

**Table 4.4: Anticipated mine water temperatures block 10**

| Depth (m BGL) | Mean average(°C) | Maximum (°C) | Minimum (°C) |
|---|---|---|---|
| 100 | 11.3 | 14.2 | 9.8 |
| 200 | 13.7 | 17.8 | 11.8 |
| 300 | 16.5 | 23.7 | 13.2 |
| 400 | 18.9 | 25.6 | 14.6 |
| 500 | 21.6 | 29.6 | 16 |
| 600 | 24.4 | 33.6 | 17.4 |

**Table 4.5: Anticipated mine water temperatures block 10a**

| Depth (m BGL) | Mean average(°C) | Maximum (°C) | Minimum (°C) |
|---|---|---|---|
| 100 | 10.9 | 10.9 | 10.9 |
| 200 | 12.8 | 12.9 | 12.7 |
| 300 | 14.7 | 14.8 | 14.6 |
| 400 | 16.6 | 16.8 | 16.5 |
| 500 | 18.5 | 18.7 | 18.4 |
| 600 | 20.4 | 20.6 | 20.4 |

### 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. The matter would be included in any more detailed, site specific, studies which may be commissioned in future.

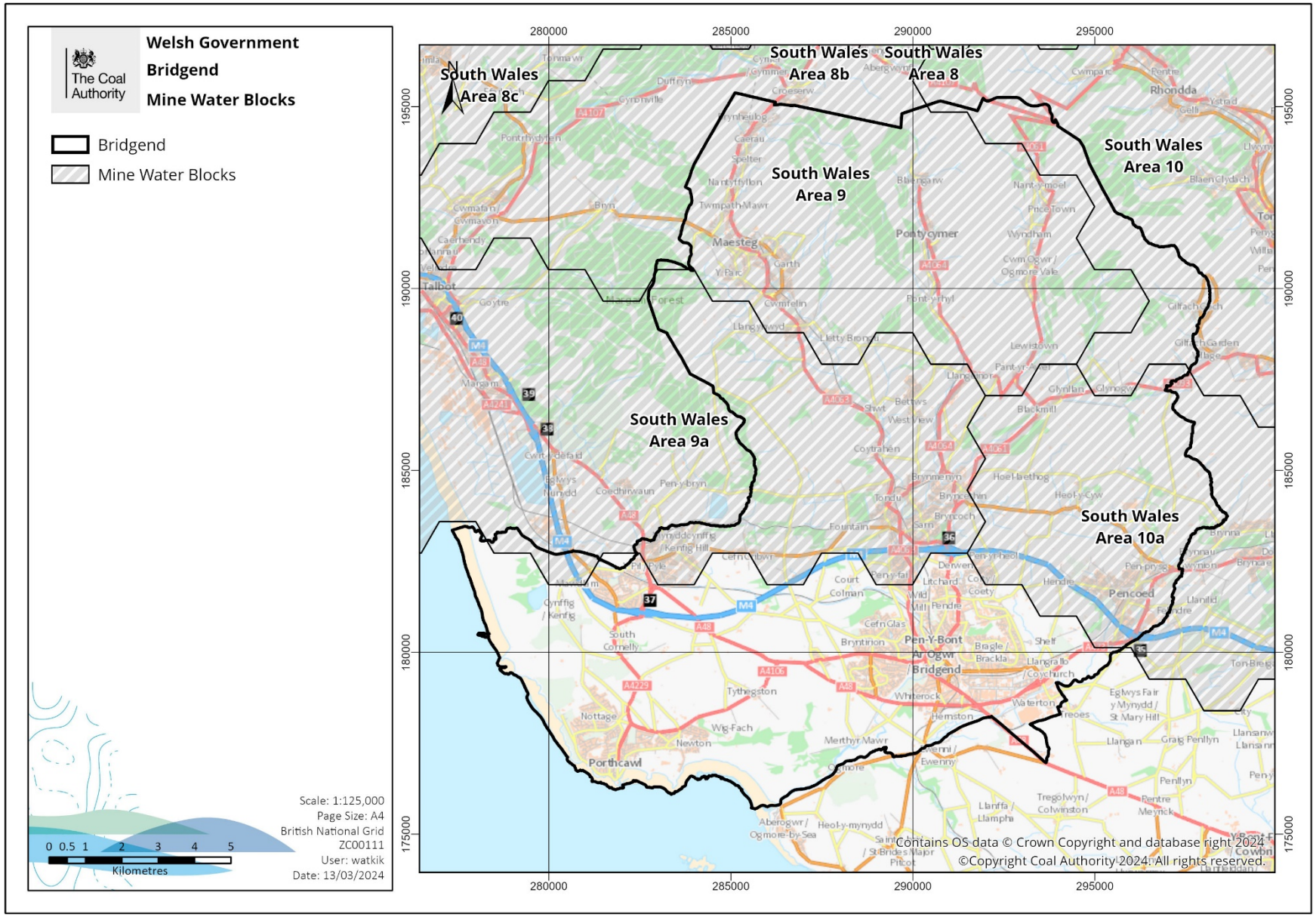



**Figure 4.1: Mine water blocks for Bridgend**

# 5 Mine water heat opportunities

## 5.1 Borehole schemes

The prospects for progressing a mine water heat scheme based on drilling boreholes to access and return the mine water are assessed on a 'tier' basis.

Three tiers have been adopted for the purposes of this study, the methodology and assessment criteria being set out in the over-arching report for Welsh Government.

The tiers are:

**Good opportunities** – shown coloured dark orange

**Possible opportunities** – shown coloured mid orange

**Challenging opportunities** – shown coloured light orange

Any areas where no opportunity exists, mainly due to absence of mine workings are shown uncoloured.

The opportunity areas within Bridgend CBC boundary are outlined below and are illustrated on the maps in **Figure 5.1.**

### 5.1.1 Good borehole opportunities

There are limited good opportunities for mine water heat schemes across Bridgend, with most being located in the North and Northeast sectors. Mine water levels are recovering in the northern area (and may be less than 75 mBGL), and many workings are less than 300 mBGL. There are other deeper targets underlying these as well. These opportunity areas are in and around:

- Pontycymer; and
- Price Town, near Ogmore Vale.

### 5.1.2 Possible borehole opportunities

Much of the north of the Bridgend region falls into the possible category, where mine water levels may not have fully recovered beyond 100 mBGL (although still rising), but there are range of mine working targets less than 500 mBGL. These areas are in the vicinity of:

- Caerau, to the North of Maesteg;
- around Pontycymer; and
- to the north of Ogmore Vale.

The Caerau monitoring points indicates water levels are deep, and with limited monitoring to identify if it will recover to shallower depths.

There are also possible opportunities around Coytrahen, where there is a single extensive seam, but this would require thorough investigation on the size of scheme and geometry of the workings in more detail.

### 5.1.3 Challenging borehole opportunities

The southern half of the county is predominantly challenging to no opportunities. This is either where workings are deep (500 mBGL or deeper), or a single seam of limited extent close to outcrop. There are possible opportunities to the southwest of Pont Rhyd-y-cyff, where workings are deep (>500 mBGL), and water levels may not have fully recovered yet.

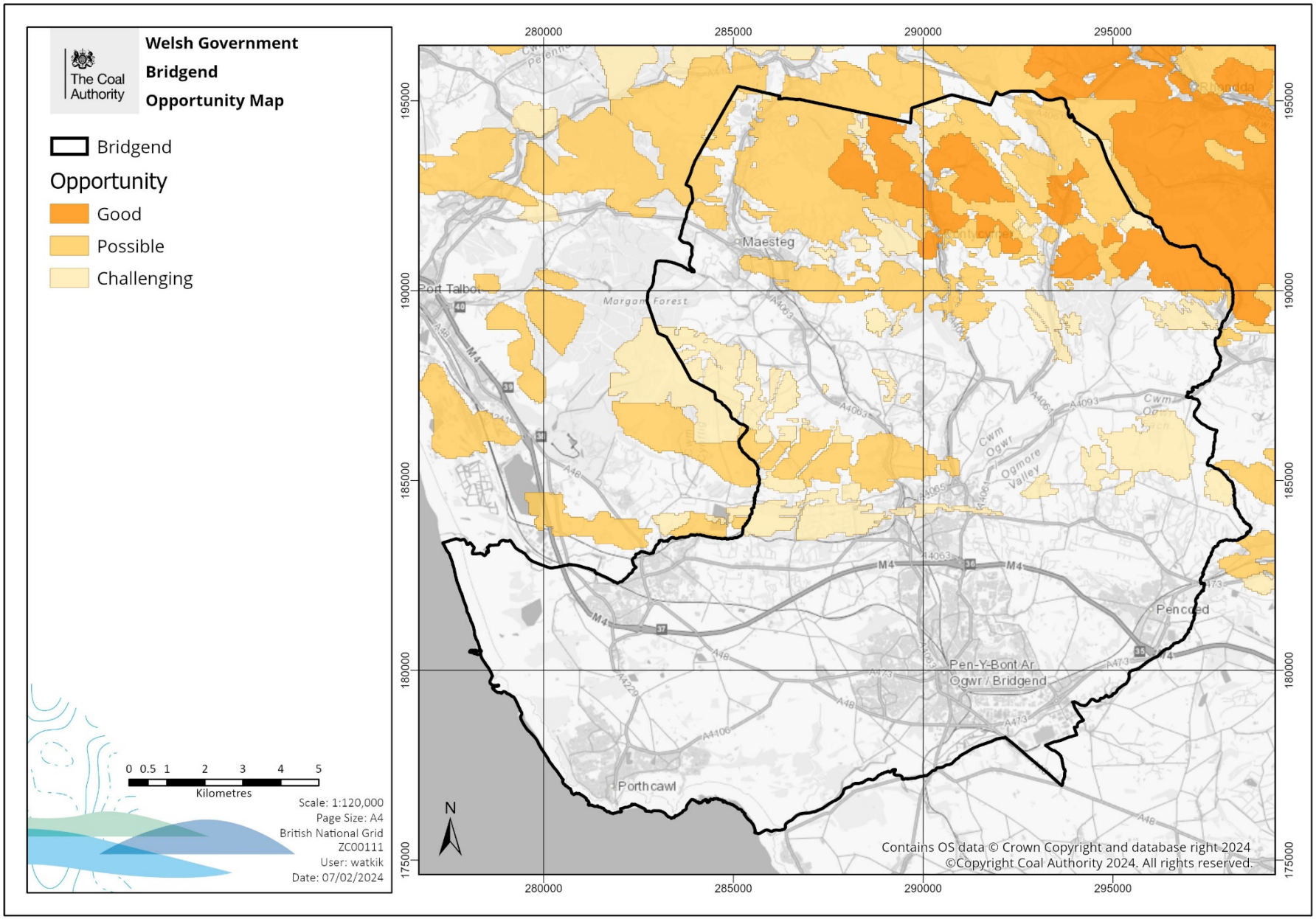



**Figure 5.1: Mine water heat opportunities – borehole schemes**

## 5.2 Mine water treatment schemes

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

Details of the mine water treatment schemes in the Bridgend area are shown in **Table 5.1** and their locations in **Figure 5.4**.

**Table 5.1: Mine water treatment schemes**

| Name | Flow average L/s | Flow range L/s | Typical temperature °C | Estimated potential heat MWth |
|---|---|---|---|---|
| Craig-yr-Aber | 25 | <5 to >50 | 12.2 | 0.4 to 0.7 |

The discharges at Craig-yr-Aber are collected by a sump, from where it is pumped to the treatment schemes. The discharges were to the Nant Craigyraber, which at the site is the border with Neath Port Talbot, the treatment scheme itself is within Bridgend area. There is minimal potential heat users at the site.

## 5.3 Gravity-fed discharge opportunities

Numerous gravity mine water discharges exist in the Bridgend 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 >0.5$MW_{th}$ are described in the sections below supported by data in **Table 5.2** and illustrated on the plans in **Figure 5.4.**

**Table 5.2: Summary of selected gravity-fed discharges for mine water heat potential**

| Name | Flow average L/s | Flow range L/s | Typical temperature °C | Estimated potential heat MWth |
|---|---|---|---|---|
| Dinas Rhondda | 115 (further testing required) | 1 spot reading | 9.4 (further testing required) | 2.4 (est) |
| Nantyffyllon | 21 (further testing required) | 1 spot reading | 10.1 | 0.5 (est) |
| 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 | | | | |

Should a potential heat demand be identified close to one of these discharges (shown in **Table 5.2 /Figure 5.4**) 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.

### 5.3.1 Dinas Rhondda Discharges

There are two discharges to the Ogwr Fach (form the boundary with Rhondda Cynon Taf at the site) approximately 800m upstream of Evanstown, with parts of Gilfach Goch extending to <300m from the discharges. One of the discharge is within Rhondda Cynon Taf boundary and the other is within Bridgend boundary. Further investigations would need to be undertaken to confirm flow rate, temperature, chemistry. Potential heat users and feasibility of transferring the water will also need to be confirmed by a future study.

**Figure 5.2: Photo of one of the Dinas Rhondda Discharges**

### 5.3.2 Nantyffyllon

The discharge is in to Nant y Ffyllon to the west of Garnwen Road in Nantyffyllon. The discharge is highly ochreous (based on photos of the discharge), within an overgrown and difficult to access part of the stream. There is potentially a second, unknown mine water discharge upstream. Capturing the flow from the discharge could be difficult. Further investigations would need to be undertaken to confirm flow rate, temperature, chemistry. Potential heat users and feasibility of transferring the water will also need to be confirmed by a future study.

**Figure 5.3: Photograph of Nantyffyllon Discharge**

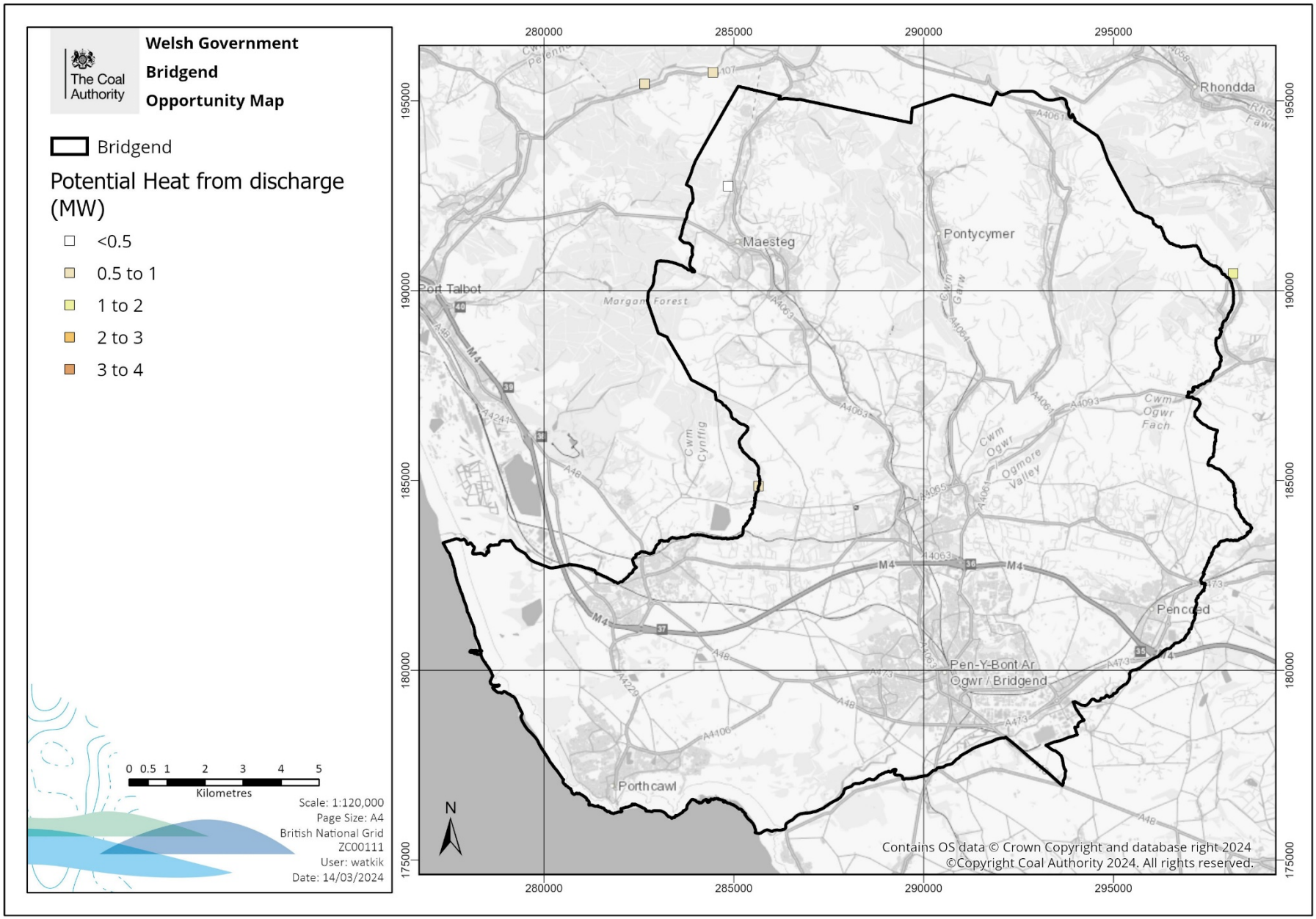



**Figure 5.4: Mine water heat opportunities – treatment schemes and gravity discharges**

# 6 Summary Bridgend CBC area

The Bridgend Council region had active deep coal mines between the 1800s until the 1980s, with coal worked across the Upper, Middle and Lower Coal Measures. Notable collieries included Caerau, Maesteg Deep, Coegnant, and Wyndham. Mine water levels vary across the region, with deep (>100 mBGL) and possibly recovering mine water levels in the northwest, and shallower water levels (<75 mBGL), which are also recovering. Mine water levels in the southern parts of the Coal Measures are thought to be recovered. Mine water temperatures are estimated to be between 11°C and >20°C.

A summary of notable mine water heat opportunities are presented below:

**Table 6.1: Mine water heat opportunities within Bridgend Council area**

| No./ Area | Opportunity name | Opportunity type | Opportunity Category | Estimated Heat Potential $MW_{th}$ |
|---|---|---|---|---|
| 1 | Pontycymer | Borehole scheme | Good | Subject to further testing |
| 2 | Price Town | Borehole scheme | Good | Subject to further testing |
| 3 | Caerau & Nantyffyllon | Borehole scheme | Possible | Subject to further testing |
| 4 | Craig-yr-Aber | Mine Water Treatment Scheme | Challenging | 0.6 |
| 5 | Nantyffyllon | Gravity discharge | Possible | 0.5 |
| 6 | Dinas Rhondda | Gravity discharge | Challenging | 2.4 |

## 6.1 Borehole Schemes

### 6.1.1 Good Opportunities

There are two areas considered as “Good” opportunities for mine water heat schemes in Bridgend County Borough Council, which are shown on as **Area 1** and **Area 2**.

- **Area 1**, covering Pontycymer, consisting predominantly of residential properties, light industrial units, a leisure centre, and sports grounds;
- **Area 2**, covering Price Town, near Ogmore Valley, comprising residential properties and a school.

### 6.1.2 Possible Opportunities

“Possible” opportunity areas in Bridgend for borehole mine water heat schemes include Caerau and Nantyffyllon (**Area 3** on **Figure 6.2**), and extents of Ogmore Valley, and Coytrahen. Coytrahen is marked as “Possible” as an extensive single-seam opportunity, but is not recommended to be investigated further at this stage whilst there are other prominent opportunities across the region.

## 6.2 Mine water treatment schemes

**Location 4** is the Craig-yr-Aber mine water treatment scheme, which is situated on the western border of the district, next to Neath-Port-Talbot. It is considered a "Challenging" discharge opportunity because of its remote location and lack of nearby end users. It is recommended that a review is carried out to identify potential end-users or planned developments for the area.

## 6.3 Mine water discharges

A number of gravity mine water discharges are known to exist in the Bridgend county borough, but only two are considered to have sufficient data to indicate a potential heat output over 0.5 $MW_{th}$. Ratings have been applied to discharges according to the following criteria:

- Good means heat potential over 0.5MW uncomplicated capture and uncomplicated heat transfer.
- Possible means heat potential over 0.5MW complicated capture or complicated heat transfer.
- Challenging heat potential over 0.5MW complicated capture and complicated heat transfer

The two gravity discharges are:

- **Location 5**, Nantyffyllon, which has a "Possible" rating due to the low thermal output (just over 0.5 $MW_{th}$) but with some nearby residential end-users which may warrant further investigation;
- **Location 6**, Dinas Rhondda discharges, situated at the border between Rhondda Cynon Taf and Bridgend, which are considered "Challenging" due to the limited end-users located nearby and complicated means of capturing and transporting heat.

## 6.4 Next steps

There are a number of potential mine water heat scheme opportunities across the region. While some of the areas are relatively undeveloped, the opportunity areas have been considered against the major developed areas in the borough to seek to identify places where good or possible heat supply opportunities may coincide with significant heat demand. It is suggested that the opportunities covered in this section and listed in **Table 6.1** and shown in **Figure 6.2** are further considered for more detailed study.

For borehole based mine water heat schemes, there are limited "Good" opportunities in the north of the region in the Upper and Middle/Lower Coal Measures. Some areas have been ranked "Possible" on the basis of opencast workings at surface, potentially deep mine water levels (>100 mBGL but recovering) and on depth alone (300 - 500 mBGL, or close to shallow

workings/outcrop). The heat potential of the borehole schemes cannot be estimated to any degree of certainty until more detailed and localised study is undertaken.

Point source opportunities across the region include Craig-y-Aber mine water treatment scheme (potentially up to 0.7 $MW_{th}$), Nantyffyllon, and the Dinas Rhondda discharges.

It is suggested that a survey of the main heat loads, particularly potential large 'anchor' loads such as hospitals or larger public buildings is undertaken in the opportunity areas in **Table 6.1** to establish synergies between potential heat supply and heat demand. Once areas are identified, it is recommended that more focused Phase 1 studies take place at a number of these locations to review the nature of the workings in detail, site specific water levels, potential mine water chemistry, and offer suggestions on possible targets suitable for a mine water heat scheme.

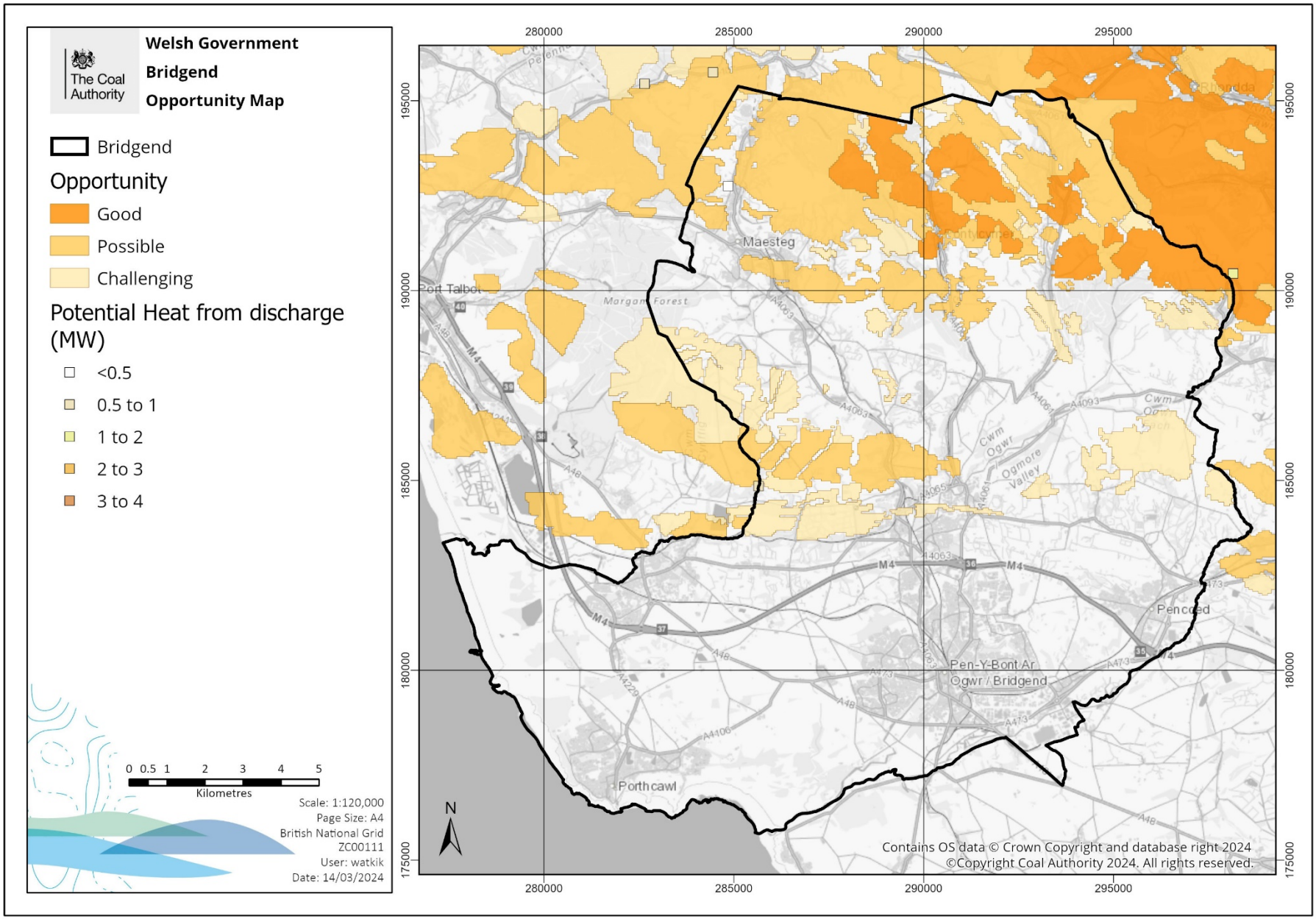



**Figure 6.1: Combined mine water heat opportunities map**

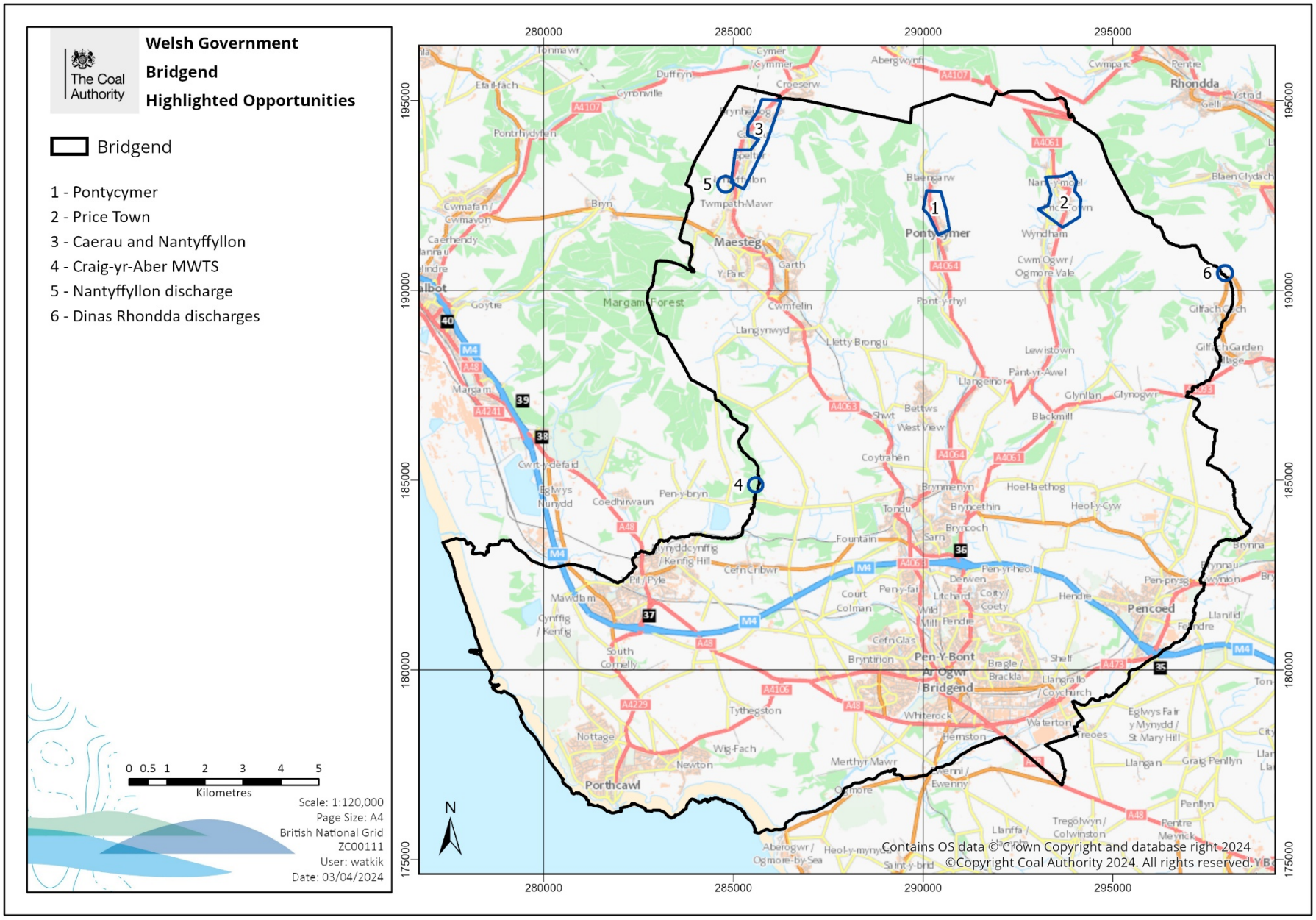



**Figure 6.2: Highlighted good opportunities for Bridgend**

# 7 References

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