Working with Designation Constraints at Cwmystwyth

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Abstract

The Cwmystwyth mine remediation project aims to significantly reduce metal loading inputs into the Afon Ystwyth by addressing point source and diffuse pollution using interventions including active treatment and surface water management measures to prevent leaching and erosion of mine spoil. The Cwmystwyth mines have considerable ecological, heritage and landscape value, recognised by numerous statutory designations. Undertaking recent ground investigation works to inform the initial remediation project design required extensive environmental surveying, assessment and consenting to proceed under ecological and archaeological watching briefs. Further detailed environmental assessment work is ongoing to navigate the site's complex constraints moving towards project delivery.

Keywords: Heritage, calaminarian habitat, landscape, environmental assessment, intervention

The Cwmystwyth Metal Mine Remediation Project

This project is being delivered within the joint Metal (Non-Coal) Mine Programme between Natural Resources Wales (NRW) and the Coal Authority (CA). The programme supports the Western Wales River Basin Management Plan 2021–2027 that has a statutory function relating to the Water Framework Directive (WFD) required under The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.

Project motivation is WFD failure of the Afon Ystwyth downstream of the Cwmystwyth mines, which fails to meet the WFD chemical criteria for good water quality. The Afon Ystwyth is derogated by numerous metal mines for most of its length. The river headwaters typically contain little to no metal contamination, but metal concentrations subsequently increase to levels above recognised Environmental Quality Standards (EQS) due to diffuse pollution and point source inputs from the Cwmystwyth mines that adds major metal loading causing Zn, Cd, Pb and Cu EQS failures. There are further downstream contaminated inputs from Frongoch, Grogwynion, Gwaith Goch, Wemyss and Graiggoch mines, Frongoch Adit via Nant Magwr and the Level Fawr adit serving Logaulas, Glogfach and Glogfawr mines, which all result in EQS failure.

Some 24 tonnes of metals per year are discharged from Cwmystwyth into the Afon Ystwyth, eight tonnes from the permanent Pugh's Adit discharge in the far west. Two other adits contribute additional metal loadings, but are both blocked, buried and discharges are not directly visible. The post mineralisation Ystwyth fault cuts across all the adits and is considered an additional pollutant conduit. Visual observation of ochreous staining, sedimentation, efflorescence on stream cobbles and thermal imagery support the conceptual model of active pollutant linkages. In addition to these point source discharges, four tributary streams (Nant y Gwaith, Nant y Graig, Nant y Watcyn and Nant yr Onnen) cascade down the mountain to the north of the Afon Ystwyth, cutting through extensive

mine spoil and floodplain deposits, eroding sediments and leaching diffuse metals under typically highly variable flow conditions, all of which are additional contamination sources.

Design at Cwmystwyth aims to reduce the concentrations of dissolved Pb and Zn in the Afon Ystwyth by up to 50% in downstream sections, along with a major reduction in the amount of fine grained, metal rich sediment entering the river through erosion of exposed spoil and in-channel deposits. The proposed remediation works are located in an area of considerable ecological, heritage and landscape value, recognised by numerous statutory designations. This paper discusses the complexities posed by these statutory designations and describes the necessary consenting and environmental assessment requirements that forms an integral part of the project design and delivery.

Introduction to the Cwmystwyth Mine Site

The Cwmystwyth mines are situated 23km east south east of Aberystwyth, Ceredigion, in the steep sided valley of the upper Afon Ystwyth. Mining at Cwmystwyth began in the Bronze Age and continued during construction of the Cistercian Abbey at Strata Florida before 1200AD. Cwmystwyth is believed to be the source of lead for the abbey church roof. Mining ceased and the site was abandoned without any restoration or remediation in 1932. The site is owned by a dedicated mine preservation group, the Cambrian Mines Trust.

The land at the Cwmystwyth mines is predominantly a mosaic of grassland, exposed spoil and rock with some areas of gorse scrub. The central parts of the mine site on the northern side of the Afon Ystwyth contain extensive ruins of a complex of mine buildings, associated working areas and spoil tips. The ruins and associated spoil heaps make a notable contribution to the landscape character of the valley.

Cwmystwyth Feasibility Study and Proposed Remediation Interventions

NRW and CA completed a feasibility study at Cwmystwyth in 2021 which identified potential intervention options to achieve remediation at the site as follows: The

- capture and transfer of pollution point sources (adits) into an active mine water treatment scheme.
- diversion of selected diffuse pollution sources emanating from spoil run-off and seepages into the active treatment scheme via interceptor drains.
- removal or relocation of slime heaps from the functional Afon Ystwyth floodplain preventing erosion.
- provision of interception drainage to prevent clean surface water infiltrating mine spoil.
- implementation of various engineering works on the four tributaries to reduce diffuse pollution and prevent clean surface water infiltrating mine spoil; including reinstatement of their former channels, protection of stream banks and lining of the stream channels across spoil and floodplain sediments.

Cwmystwyth Site Designations and Legislative Requirements

The long abandoned ancient mines and surrounding areas have developed features of considerable ecological value which are recognised by several ecological designations; the site also has designations for its heritage and landscape importance, which are summarised below along with their legislative context.

Elenydd SAC (Special Area of Conservation) and Elenydd SSSI (Site of Special Scientific Interest).

Covering an area of 8,600 hectares, Elenydd is one of the most important areas of Welsh hill land and is of outstanding nature conservation interest for its vegetation. The Elenydd SAC and SSSI are designated for several upland vegetation communities, including blanket bog and heathland habitats. Calaminarian grasslands of Violetalia calaminariae are also a primary reason for selection of the Elenydd SAC and are considered one of the UK's best examples of this habitat type. Calaminarian grasslands include a range of semi-natural and anthropogenic sparsely vegetated habitats on substrates characterised

by high metal toxicity and are associated with natural outcrops of serpentine rocks, river gravels rich in metals, as well as metal mine workings and spoil heaps. The calaminarian grassland comprises only 26 hectares of the entire Elenydd SAC habitats with the Cwmystwyth site containing the majority of the SACs calaminarian grassland resource. Areas of rock outcrop, scree, spoil-heaps, abandoned shafts, adits and buildings are colonised by specialist metal-tolerant lichens and bryophytes (metallophytes) including several scarce species, which are of individual conservation value.

Mapping of the calaminarian grassland at Cwmystwyth (Forster Brown 2017) has shown the site comprises a mix of calaminarian communities (Simkin 2014); the site is clearly of importance for the patchy but widespread extent of its calaminarian habitats. The mapping highlighted that calaminarian communities at Cwmystwyth vary in their distribution depending on the degree of contamination. The most contaminated areas are devoid of vegetation even after cessation of mining decades ago. Factors influencing bryophyte and metallophyte distribution include, substrate moisture, slope aspect, the spoil geochemical composition, the degree of spoil compaction and slope stability. Many spoil areas are very species-poor and lack the presence of metallophytes; other spoil tips are much more species-rich and these are often isolated from other spoil tips that support a similarly rich assemblage of metallophyte species.

Elenydd-Mallaen SPA (Special Protection Area).

Elenydd is also one of the most important areas of hill land in Wales for its outstanding range of breeding birds. The Elenydd-Mallaen SPA is notified for the breeding raptors Red Kite Milvus Milvus, Merlin Falco Columbaris and Peregrine Falcon Falco Peregrinus.

Mwyngloddfa Cwmystwyth SSSI.

Mwyngloddfa Cwmystwyth SSSI is of special interest for its calaminarian plant communities and metallophyte lichens, including several rare species. The SSSI is also of special interest for its primary and significant secondary mineralisation associated with the spoil tips and the underground workings adjacent to the road and on the lower slopes of Graig-Fawr and Copper Hill (Bryn Copa). Complex sets of hushes and leats cross the heavily mined landscape (Bevins *et al*. 2010). The underground mine workings are also important for hibernating bats, and the site is the best known location in Ceredigion for hibernating bats. Long-term monitoring has shown that Myotis species and Brown long-eared bats Plecotus auritus are regularly present during the winter.

Grogwynion SAC

Grogwynion SAC covers 42 hectares located in the Ystwyth floodplain 9 km downstream of the Cwmystwyth mines. It is designated for its' shingle heath which comprises of calaminarian grassland and heathland habitats, which both contain a rich metallophyte lichen species assemblage. These habitats cover four hectares within the overall SAC. Cwmystwyth is hydrologically connected to the Grogwynion SAC via the Afon Ystwyth. The shingle heath feature and its notable metallophytes depend on the presence of metalliferous coarse and fine-grained substrates for colonisation and the fluvial processes and river realignment that expose or deposit new areas of fresh shingle and silts. Metalliferous substrate is present at Grogwynion due to historical metal mining in the catchment, and the input of metalliferous material at the site is likely dominated by the localised contribution from the former Grogwynion and Gwaith Goch Pb mines. Metal mining wastes have intermingled with natural river gravels to create the foundations of an extensive area of shingle heath on the Afon Ystwyth floodplain. The dynamic river processes at Grogwynion regularly rework gravels creating a series of river shoals, with fresh material being deposited when the river overflows. Additionally, a range of seral successional stages of bare shingle substrate, calaminarian grassland, heathland and scrub communities are found. Metallophyte lichens are locally dominant in the calaminarian grassland and heath, with a number of rare species present.

In flood events the supply of contaminated material at Grogwynion is refreshed by deposition of metal-rich silts that have been eroded from upstream metal mine sites such as Cwmystwyth, although the current inputs are significantly less compared to when the mines were active. A further source of metalliferous material to the Grogwynion SAC are sediments already stored in the Afon Ystwyth's bed and banks, which are subsequently eroded and transported downstream by fluvial processes. These sediments derive from a combination of the historical mining sediments within the river and new metalliferous sediment eroded from mine spoil via surface runoff. The Afon Ystwyth hydrologically connects the Cwmystwyth mines to the Grogwynion SAC and it is considered that the proposed remedial intervention measures may represent a potential impact pathway to the Grogwynion SAC by reducing downstream sediments.

Biodiversity Legislation and Policy in Wales Relating to the Sites.

The Conservation of Habitats and Species Regulations 2017 provides the legislative framework for the designation and protection of SACs and SPAs. This requires that statutory bodies such as NRW and Local Planning Authorities, referred to as Competent Authorities, must follow the strict Habitats Regulations Assessment (HRA) process set out in legislation to test if a proposal could significantly harm any designated features of a SAC/SPA. The HRA process has three sequential steps in considering any project's effects. Firstly, a project screening for any "likely significant effects" is undertaken, which checks for pathways of effect between the project and the protected site. If there are no connections the project is then screened out and no further assessment is required, otherwise the project proceeds to the next step. Secondly, a project must be assessed in detail, via Appropriate Assessment, to determine its effects on the protected ecological features for which the site is designated and identify ways to avoid or minimise any effects. If any effects can be avoided or mitigated these are then implemented and the process is complete, otherwise the process proceeds to the final step. Finally, if it is considered a proposal that would have an adverse effect on a SAC/SPA, then the process requires an examination of whether the project would qualify for various derogations. In order to qualify, the project must meet three criteria; there must be no alternative to the project, it must have Imperative Reasons of Overriding Public Interest (IROPI), and lastly that compensatory measures can be put in place to ensure no negative effects occur on the national network of SAC and SPA sites as a whole.

The Wildlife and Countryside Act 1981 (as amended) (WCA) is the primary legislation which protects animals, plants and habitats in the UK. The WCA covers the protection and designation of protected areas including SSSIs. When carrying out works that may affect a SSSI it is a requirement to notify NRW and obtain SSSI assent under section 28H of the WCA.

The ecological value of metal mine lichen assemblages across Wales are recognised by their inclusion on the Section 7 list of species and habitats of principal importance for conservation of biological diversity in Wales under the Environment (Wales) Act (2016). There is also a Section 6 duty under this legislation for public bodies to maintain and enhance Section 7 habitats and species.

Heritage Designations

Extensive parts of the Cwmystwyth mine site and the buildings are designated for their heritage interest as the Copa Hill/ Cwmystwyth Lead, Copper and Zinc Mines Scheduled Monument. The Scheduled Monument comprises the remains of the lead mining complex, which also produced Cu and Zn. Work at the Cwmystwyth mines has been dated back as far as the Early Bronze Age with radio carbon dating of deer antler implements and charcoal (Timberlake 1988). Mining continued intermittently over many centuries until all activity finally ceased in the 1930s. The visible features within the scheduled area include numerous shaft and adit entrances, areas of opencast working, water-management and transport systems, extraction and dressing processes with their power systems, as well as remains of office and residential buildings, garden plots and even an early 20th-century tennis court for

the mine captain's daughter. The monument is of national importance for its potential to enhance and illustrate the knowledge and understanding of mining technologies from a variety of periods.

Any works within a Scheduled Monument (SM) requires SM consent (SMC) under the Ancient Monuments and Archaeological Areas Act 1979 as amended by The Historic Environment (Wales) Act 2016. An application is considered in accordance with Conservation Principles for the Sustainable Management of the Historic Environment in Wales (Welsh Government 2011) and Annex A of Technical Advice Note 24: The Historic Environment (Welsh Government 2017). The main purpose of scheduling is to ensure the preservation of ancient monuments and, when considering an application for SMC, there is a presumption against proposals which would involve significant alteration or cause damage or which would have a significant impact on the setting of remains. Projects are expected to demonstrate that no practicable alternative location that would avoid the scheduled area exists and that the need to undertake works outweighs the presumption in favour of the protection of the SM.

Landscape Designations

The Cwmystwyth mines are located wholly within the Northern Uplands Special Landscape Area (SLA). SLAs are noted in Ceredigion County Council's Local Development Plan which states: 'Proposals for development within SLAs will be assessed in relation to scale and nature of development and their ability to be accommodated without significant damage to, and where possible the enhancement of, the valued visual, historic, geological, ecological and cultural characteristics of the SLA.' The Cwmystwyth mines are also located within the Upper Ceredigion registered historic landscape. Landscapes of outstanding or special historic interest are non-statutory designations compiled by Cadw (Welsh Government's historic environment service), NRW and the International Council on Monuments and Sites. Landscapes are registered to recognise their historic landscape value and raise awareness of their importance.

Practical Delivery of Recent Ground Investigation Works

A ground investigation (GI) to inform the design of pollution alleviation measures was completed in early 2023 comprising geotechnical and geo-environmental investigations using a combination of machine and hand dug trial pits. The aim was to provide information on ground conditions to help design proposed channels and drainage interventions, outline spoil heap composition to inform future relocation or stabilisation options and to accurately establish the blocked adit locations for future water capture structures.

The GI works were subject to HRA and required SSSI assent in relation to the SAC, SPA and SSSI designations. HRA screening ruled out any significant effects to Grogwynion SAC as a result of the GI. Significant impacts on the Mwyngloddfa Cwmystwyth SSSI spoil tip mineralisation processes was also ruled out as all disturbed spoil was reinstated post works. Impacts on the Elenydd-Mallaen SPA raptor features were avoided by being undertaken in early 2023 outside the breeding season. The GI works were assessed for any effects on the calaminarian grassland SAC and SSSI communities within the Cwmystwyth mines site through the HRA, and the Mwyngloddfa Cwmystwyth SSSI hibernating bat features were addressed via the SSSI assenting process.

Initially, the GI was designed to avoid mapped areas of high value lower plant habitats. This approach was however, unable to completely remove the conflict as several trial holes were required within high value zones to gather information for further design stages. This was therefore followed by a detailed risk assessment to assess the calaminarian grassland and metallophyte lichen interest at the GI locations and access routes. Subsequently, a method statement to minimise effects to lower plants resulting from the works was implemented to secure mitigation to allow works to proceed. All works were progressed under an ecological watching brief by a lower plant specialist; micro-siting of GI locations was undertaken to avoid disturbance of high conservation value lower plants where possible. Translocation of rocks and spoil crusts that

supported nationally rare species that could not be avoided was undertaken; these were placed separately on tarpaulin in a safe location away from the working area and then reinstated carefully following completion of the excavations. A low impact tracked vehicle was used for the works to avoid or reduce disturbance. With the adoption of these mitigation measures the HRA appropriate assessment concluded that the Elenydd SACs site integrity would not be adversely affected by the works, furthermore SSSI assent was granted for the GI with conditions securing the mitigation measures.

A bat survey was completed to inform the project proposals and assess hibernating bat potential. Four features with bat hibernation potential were noted within the Mwyngloddfa Cwmystwyth SSSI. The survey recorded a single pipistrelle summer day roost. The timing of works in early 2023 avoided disturbance to the summer roost. The work period coincided with the bat hibernation period; however, it was concluded that the GI works would not significantly disturb the hibernating bat SSSI feature associated with underground workings, as these were not directly affected by the works. Further mitigating factors included, the short duration of GI at each location and also that the GI locations closest to bat features were to be hand dug and required no machinery access. In addition buffer zones were implemented between underground structures and GI locations ensuring minimal disturbance. Ecological Clerk of Works (ECoW) supervision was put in place to ensure there was no access into the buffer zones by personnel and equipment and no light spill occurred. The ECoW was also present to ensure if accidental access into an adit occurred this could be immediately assessed for bat risk. SSSI assent was granted as the mitigation measures would protect the SSSI bat interest.

SMC was secured for the GI and noted that some locations would specifically target historic features, whereas unknown archaeology may also be uncovered elsewhere. The SMC noted that the GI may potentially damage nationally important archaeological remains that would be contrary to the scheduling, which is to preserve features in situ. The SMC considered that the GI was justified in order to fully understand the site conditions and to allow the development of the remediation works. The SMC concluded that any localised damage because of the GI would be outweighed by obtaining an improved understanding of the SM and also by the project aims to address water pollution.

An archaeological watching brief undertaken by a suitably qualified archaeologist during the GI ensured that archaeological features were identified and recorded. The SMC required that if significant features were identified works must stop to enable Cadw to undertake an assessment and request trial pit relocation. The watching brief information, gathered improved knowledge and understanding of the SM and informed future remedial design. The watching brief recorded a subsurface buddle, which will now be avoided during design. The ground disturbance caused a temporary negative impact to the SM's aesthetic value, which ceased following reinstatement. The SMC included conditions ensuring Cadw officers access for the works duration; compliance with the consent documentation which included an Environmental Action Plan (EAP), Reinstatement Method Statement, the Archaeology Written Scheme of Investigation (WSI) and provision of post work reports to Cadw.

Ongoing Habitats Regulations Assessment (HRA) Process

One of the operational project aims is to significantly reduce the amount of metalliferous sediment entering the Afon Ystwyth from the Cwmystwyth mines. Due to the Grogwynion SAC shingle heath feature depending upon the supply of metalliferous substrate and its hydrological connection to the Cwmystwyth site, it was screened in at the first step of the project HRA. During the second step, the Appropriate Assessment, it has been challenging to predict the potential changes expected at Grogwynion that will result from the project. It is difficult to differentiate the sources of metalliferous fluvial sediment reserves present within the Afon Ystwyth, to determine which originate from other historical mining activities and from the Cwmystwyth mines. Due to these

complexities, it has not been possible during the appropriate assessment phase to rule out that the project will not adversely affect the Grogwynion SAC. The legislation requires that a precautionary approach must be adopted. It has therefore been concluded that there may be possible degradation of the physical, chemical or biological processes that support the Grogwynion SAC shingle heath feature. Any such degradation of these processes may result in potential changes to the extent or the vegetation composition of the shingle heath. It has therefore not been possible to determine beyond reasonable scientific doubt the scale to which the SAC feature would be affected by remedial interventions at Cwmystwyth, therefore, an adverse effect on site integrity during the operational phase cannot be ruled out.

Further detailed HRA is required for the Elenydd SAC and the Elenydd-Mallaen SPA designations to demonstrate compliance with the Conservation of Habitats and Species Regulations 2017 (as amended). This will be completed following further scaling and refinement of ongoing remedial designs. Bespoke environmental mitigation and compensation will need to be integrated into the project. Whilst alternatives have been considered, there are no feasible ones that will allow metal sediment loadings from Cwmystwyth to continue feeding the shingle heath habitat at Grogwynion SAC via the Afon Ystwyth, given that it is contradictory to the project objectives and WFD. It is therefore necessary to demonstrate IROPI, devising suitable compensation measures to fulfil legislative requirements. The case for the intervention measures is due to environmental benefit and WFD; the project therefore meets the criteria of being imperative and in the public interest.

Further Considerations for the Future Project

A Cultural Heritage and Archaeology Appraisal was undertaken in 2019 to provide preliminary information on the sites cultural heritage and archaeology, to identify potential archaeological issues and heritage constraints, along with wider landscape constraints that must be considered during project design and planning. Given that the Cwmystwyth mines and all the features and structures within the site are high value heritage assets, the protection and preservation of surface and sub-surface remains must be a principal consideration in our remediation design proposals to avoid adverse effects. As the site is positioned entirely within a SM, remediation design proposals will be accompanied by a SMC application, to include detailed plans and full desk-based assessment following consultation with Cadw. The full desk-based assessment will form part of the required statutory Environmental Impact Assessment (EIA) once the remediation design is finalised. As part of this study, an Assessment of Significance of Impact of Development on Historic Landscape (ASIDOHL2) may be needed to assess the potential impact on the Uplands Ceredigion registered historic landscape.

A preliminary landscape appraisal following the Guidelines for Landscape and Visual Assessment (LVIA), (Landscape Institute 2013) has been compiled to inform the project; this comprised a desktop review and site visit. The report compiled baseline landscape information for the site and identified design considerations, opportunities and constraints, such as visual screening, maintenance of the sites open character, using sensitive materials and colour palettes, stabilising and preserving the existing ruined mining buildings and structures, and promoting walking and cycle routes. Given the project will be located in an SLA, a full LVIA with reference to the aforementioned guidelines will be produced, along with a landscape mitigation plan as part of the EIA.

The treatment of mine waters at Cwmystwyth may be considered to be continuing the mining landscape narrative. An approach which seeks concealment of treatment works may represent a missed opportunity in allowing the public to appreciate the ongoing mining story within the landscape. Nonetheless, given the landscape character and the landscape designations that apply to the Cwmystwyth site, a design approach which is sympathetic to the local landscape character, visual

amenity, heritage and ecology is required. The extremely rich history and prehistoric origins of the Cwmystwyth mines provide a substantial opportunity as part of the remedial interventions to promote regional and local distinctiveness, and a sense of place by utilising the mines remains as an educational, economic and social asset in conjunction with relevant stakeholders.

Conclusions

The Cwmystwyth mines have a rich tapestry of statutory ecology, heritage and landscape designations and various environmental assessment and consenting procedures have been undertaken or are required to navigate the sites complex constraints and move the pollution remediation project towards delivery.

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