

Abandoned Mine Case Study: Cwmystwyth Lead Mine



Cwmystwyth Mine is approximately 6km northeast of the village of Pont-rhyd-y-groes, Ceredigion. The mine covers around 250ha on the steep northern slopes of the Ystwyth Valley, with some minor workings on the southern slopes. Cwmystwyth exploited three mineral lodes over the course of its operation, namely Comet, Kingside and Mitchell. The earliest mining at Cwmystwyth has been dated to the Early Bronze Age, when copper was extracted from the Comet lode in an opencast on Copa Hill. The mine was worked intermittently from this time, at varying profitability, until finally being abandoned in 1950. The remains at Cwmystwyth are extensive and include vast waste dumps, a large opencast, ruinous buildings, shafts, adits and leats.

Cwmystwyth Mine lies within the Elenydd Special Area of Conservation (SAC) & Site of Special Scientific Interest (SSSI), and the Elenydd-Mallaen Special Protection Area (SPA). Much of the site itself has been designated as a Scheduled Ancient Monument (SAM), with 14ha designated as a SSSI (Mwyngloddfa Cwmystwyth).

Cwmystwyth is a hydrologically complex site, with mining activity having had a significant impact on the natural regime. The River Ystwyth receives all surface and sub-surface drainage from the mine, causing it to fail European Water Framework Directive (WFD) standards for zinc, lead and cadmium. The subsurface workings are drained via Pugh's, Gill's Lower and Kingside adits. Pugh's Adit is the largest point source of metals from the site, whilst Gill's Lower and Kingside are collapsed and emerge as small upwellings. There are also numerous other minor upwellings of contaminated groundwater. A number of streams draining the plateau high above Cwmystwyth flow down through the site, eroding and mobilising heavy metals from the extensive waste tips. These include the Nant y Gwaith, Nant y Graig, Nant Watcyn and Nant yr Onnen. These watercourses are often lost to ground as they pass through the site, making flow monitoring and determination of metal loads challenging. Mine drainage is also influenced by the large Ystwyth Fault which runs in an east-northeast to west-southwest trend, bisecting the River Ystwyth. It is thought that contaminated groundwater from the sub-surface workings discharges directly into the river through the fault zone.

In 2006 we commissioned Parsons Brinkerhoff Ltd to carry out a feasibility study into remedial design at Cwmystwyth. This study identified potential options for remediation, and recommended further monitoring to improve understanding of the hydraulic system. In 2007 Atkins Ltd carried out a programme of detailed monitoring on our behalf. This report recommended producing an updated feasibility report focusing on the point sources from Pugh's & Gill's Lower adits, and the diffuse pollution from the waste tips along the Nant y Gwaith, Nant y Graig, Nant Watcyn and Nant yr Onnen. It also recommended continued monitoring to validate previous data and to ensure that any treatment design works are suitable. We carried out further water quality and flow monitoring between 2009 and 2012, including an MSc water quality modelling project on the Ystwyth catchment in 2012. This identified Pugh's Adit as the second biggest discharge of zinc in the Ystwyth catchment after the Frongoch Adit.



Impact on receiving watercourses

Length impacted:	33km
WFD water body ecological status:	
• Upper Ystwyth	Moderate
• Lower Ystwyth	Moderate



In 2013 the Cambrian Mines Trust obtained ownership of Cwmystwyth Mine from the Crown Estate with the aim of securing the preservation, restoration and improvement of the site for public benefit. We are discussing ways in which we can work together to reduce pollution from the mine whilst preserving its heritage value for future generations. This includes reducing erosion of the waste tips along the Nant y Gwaith and the treatment of the adit discharges using passive technologies. We have calculated the size of a Vertical Flow Pond (VFP) passive treatment system required to treat the combined discharges from Pugh's and Gill's Lower adits, and in 2014 commissioned CH2M Hill Ltd to assess the availability of land to construct such a treatment system.

In 2015 C-Cure Solutions undertook site investigations, including spoil analysis and detailed aerial imagery with an Unmanned Aerial Vehicle (UAV). The images were used to create an erosion model, which estimated an average erosion rate across the site of approximately 20 tonnes ha⁻¹yr⁻¹, and in areas of very high erosion this increased to 125 tonnes ha⁻¹yr⁻¹. Laboratory trials were also carried out to assess the effect of amending mine spoil with C-Cure biochar. This was successful in reducing metal leaching from the spoil, in some cases by up to 100%, and resulted in good plant establishment of rye grass with biomass increasing by up to 40%.

In 2016 the Coal Authority will review all available information on a number of the most polluting metal mines across Wales, including Cwmystwyth, to identify preferred sites for one or more remediation schemes in the near future, subject to securing funding.

Monitoring data

	Pugh's Adit	Gill's Lower Adit	Ystwyth upstream mine	Ystwyth downstream mine
Flow (L/sec)	9.6	3.2	980	2,029
pH	6.5	6.4	6.4	6.4
Zinc (µg/L)	23,085	4,244	9.1	330
Lead (µg/L)	585	383	1.4	48
Cadmium (µg/L)	26.7	8.4	<0.1	0.64
Zinc (kg/yr)	6,070	384	12	21,217
Lead (kg/yr)	156	46	1.8	3,068
Cadmium (kg/yr)	7.6	0.9	0.06	41

Benefits of remediation

- Over 20 tonnes of harmful metals could be prevented from entering the River Ystwyth and subsequently the Cardigan Bay Special Area of Conservation each year.
- The receiving and downstream water body will be more likely to achieve Good Ecological Status, although there are other mining pressures on these water bodies that will also need to be addressed.
- Reduced contaminated sediment load to the River Ystwyth.
- Potential to develop partnerships with important stakeholders, including the Cambrian Mines Trust.
- Potential to develop an educational resource at the site, demonstrating passive treatment technologies.

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