CROESOR HYDRO ELECTRIC SCHEME

ARCHAEOLOGICAL ASSESSMENT

Report No. 266

Ymddiriedolaeth Archaeolegol Gwynedd

Gwynedd Archaeological Trust

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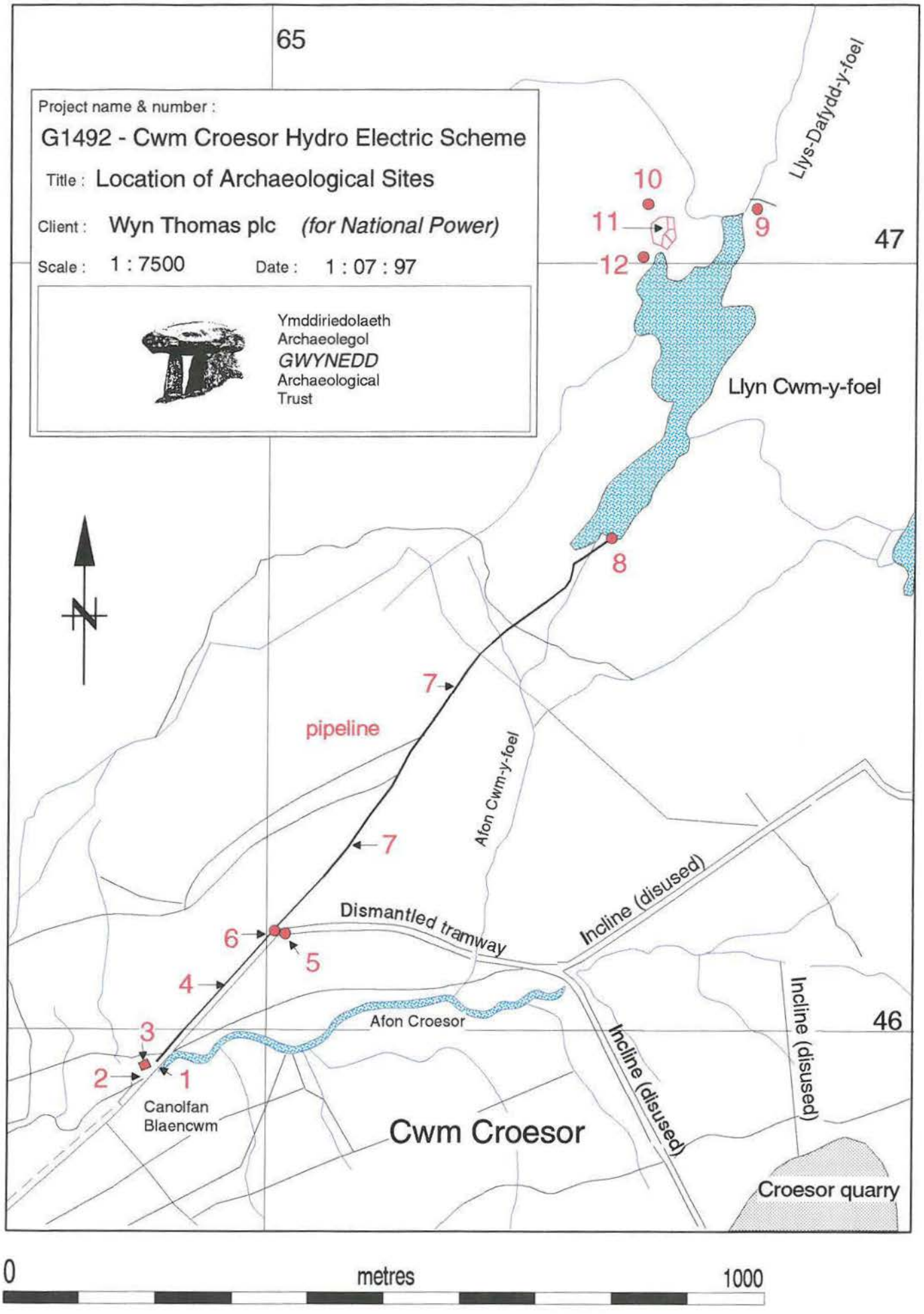
ARCHAEOLOGICAL ASSESSMENT (G1492)

prepared for Wyn Thomas Plc

July 1997

Gwynedd Archaeological Trust Report No. 266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Project name & number :
G1492 - Cwm Croesor Hydro Electric Scheme
Title : Location of Archaeological Sites
Client : Wyn Thomas plc (for National Power)
Scale : 1 : 7500
Date : 1 : 07 : 97
Ymddiriedolaeth
Archaeolegol
GWYNEDD
Archaeological
Trust
Llys-Dafydd-y-foel
10
11
12
9
47
Llyn Cwm-y-foel
8
7
pipeline
Afon Cwm-y-foel
7
Dismantled tramway
Incline (disused)
6
5
4
Afon Croesor
46
3
2
1
Canolfan
Blaencwm
Cwm Croesor
Incline (disused)
Incline (disused)
Croesor quarry
0
metres
1000

CWM CROESOR HYDRO SCHEME (G1492)

Archaeological Assessment

1. INTRODUCTION

Gwynedd Archaeological Trust (Contracts Section) has been asked by Wyn Thomas plc, on behalf of National Power, to prepare an archaeological assessment of a site at Cwm Croesor in advance of a proposed hydro-electrcity scheme.

2. ASSESSMENT BRIEF

The basic requirement was for a desk-top survey and field visit to the proposed area to assess the impact of any future development on the archaeological and heritage features within the area concerned. The importance and condition of known archaeological remains were to be assessed and areas of archaeological potential identified.

Gwynedd Archaeological Trust's proposals for fulfilling these requirements were, briefly, as follows:

a) to identify and record the cultural heritage of the area to be affected by the proposals

b) to evaluate the importance of what was identified

c) to recommend ways in which damage to the cultural heritage can be avoided or minimised.

3. METHODS AND TECHNIQUES

Desk-top work was carried out in the Dolgellau Record Office of the Gwynedd Archive Services. The standard work on the railways of the area, James Boyd's *Narrow Gauge Railways in South Caernarvonshire Volume 1* was consulted, as was the file of information on Cwm Croesor amassed by the Launceston Steam Railway Quarries Research Group. In addition, photocopies of Moses Kellow's autbiography in private posession were consulted.

Fieldwork was carried out on 30 June 1997, when the whole area of the proposed development was walked by two members of the Trust staff. Visibility was good and fieldwork conditions were favourable. Features were identified on a current 1:10,000 OS map and each was described and assessed. Detailed notes, sketch plans and photographs were made of the more important features.

3.3 Report

All available information was collated and the sites were then assessed and allocated to the categories listed below. These are intended to give an idea of the importance of the site and the level of response likely to be required; descriptions of the sites and specific recommendations for further assessment or mitigatory measures, as appropriate, are given in the relevant sections of the report. The criteria used for allocating sites to categories are those used by the Secretary of State when considering ancient monuments for scheduling; these are set out in Welsh Office Circular 60/96 Planning and Historic Environment: Archaeology.

3.4 Categories

The following categories were used to define the importance of the archaeological resource.

Category A - Sites of national importance.
Scheduled Ancient Monuments, Listed Buildings and sites of schedulable or listable quality, *i.e.* those which would meet the requirements for scheduling (ancient monuments) or listing (buildings) or both.

Sites which are scheduled or listed have legal protection, and it is recommended that all Category A sites remain preserved and protected *in situ*.

Category B - Sites of regional or county importance.
Sites which would not fulfil the criteria for scheduling or listing, but which are nevertheless of particular importance within the region.

Preservation *in situ* is the preferred option for Category B sites, but if damage or destruction cannot be avoided, appropriate detailed recording might be an acceptable alternative.

Category C - Sites of district or local importance.
Sites which are not of sufficient importance to justify a recommendation for preservation if threatened.

Category C sites nevertheless merit adequate recording in advance of damage or destruction.

Category D - Minor and damaged sites.
Sites which are of minor importance or so badly damaged that too little remains to justify their inclusion in a higher category.

For Category D sites, rapid recording, either in advance or during destruction, should be sufficient.

Category E - Sites needing further investigation.
Sites whose importance is as yet undetermined and which will require further work before they can be allocated to categories A - D are temporarily placed in this category, with specific recommendations for further evaluation. By the end of the assessment there should be no sites remaining in this category.

4. ARCHAEOLOGICAL FINDINGS

4.1 Historical background

4.1.1 Cwm Croesor and its industries

Cwm Croesor is situated in the community (formerly parish) of Llanfrothen in the former county of Merioneth. Until the nineteenth century the economy of this area was entirely pastoral. Geologically, it lies on the periphery of the Blaenau Ffestiniog slate quarrying area, and the veins of ordovician slate which were exploited at Blaenau itself from the mid-eighteenth century were also worked on a small scale on the ridge between Ffestiniog and the Croesor valley, at Moelwyn from 1825, Rhosydd from the 1830s and Pant Mawr from the 1840s. Croesor Quarry was first exploited from 1858, though there had been small-scale exploration from *c.* 1833, and was extensively capitalised from 1860s onwards.

The position of these sites meant that several of them had the choice of exporting their output either through Ffestiniog or through Cwm Croesor. Many of them made use of the Ffestiniog Railway, operational from 1836, but by 1863 Hugh Beaver Roberts, the owner of the Croesor estate and a major shareholder in the Croesor company, was setting about the construction of a separate railway access down the Croesor valley to the quays at Porthmadog. This was operational by 1 August 1864, and extended as far as the site of the later Blaen y Cwm power station. From here a further length of railway involving two counter-balanced inclines and a short level section in between, built at the cost of the Croesor Company to give access to their quarry. This made a junction with a further incline, an extraordinary "Jacob's Ladder" system, which served Rhosydd quarry. Croesor Quarry began to use the lower railway in February 1864, and their own inclines were completed in August of that year. The first traffic from Rhosydd down the new railway is also recorded in that month.

Rhosydd, Croesor and the other smaller quarries which the railway system served, functioned either continuously or intermittently until the trade depression of 1929-1930 killed off the local slate industry.

The railway saw some very limited use into the 1960s, hauling manure for the farmers, but the rails began to disappear shortly afterwards (Boyd 1988, Lewis and Denton 1974, Richards 1991).

The quarries were short-lived ventures, even by local standards, yet they nourished a vibrant community - the bards Tegfelyn and Ioan Brothen were both quarrymen, and alongside Moses Kellow, the most remarkable character associated with Croesor Quarry was Bob Owen, the clerk who was also a compulsive bibliophile, awarded the degree of M.A. by the University of Wales *honoris causa* while on the dole after the quarry shut.

4.1.2 Hydro-electricity in North-west Wales

The use of water power in the industries of North-west Wales was very extensive in the 19th century, but in general it was a technology in which local industries were content to follow rather than lead. Where North-west Wales was instrumental in evolving a new technology was in the use of water-power to generate electricity. Direct current stations were established in some of the Blaenau quarries at the beginning of the century - Llechwedd's Pant yr Afon site and Maenofferen's hydro-system were operational from 1904. Much more ambitious, however, was the North Wales Power and Traction Company's system, which from its inception in 1906 supplied electricity to the Pen yr Orsedd and Oakeley slate quarries from a hydro-station at Cwm Dyli, the most extensive alternating current distribution system yet conceived (Gwyn 1989). It has been plausibly suggested that the figure instrumental in encouraging the North wales Power and Traction Company to adopt alternating current was Moses Kellow (Weaver 1986).

4.1.3 Moses Kellow

Moses Kellow was a native of the West Country but a Welshman by adoption. He was born on 5 June 1862, the son of William Kellow, a foreman at Delabole slate quarry near Tintagel, the largest of the Cornish slate quarries, and of Charity, his wife. The family moved to Tremadoc in 1865, and immersed themselves in the life of the area they had made their home, worshipping at Peniel chapel as well as at the parish church. Moses was educated at Porthmadog Grammar School, by a private tutor and by his father, and barely into his twenties was appointed manager of the Parc quarry near the village of Croesor. In January 1892 he married Nell, daughter of Thomas Williams, manager of Croesor Quarry, two miles higher up the valley, and on his father-in-law's death a few years later stepped into his shoes and assumed the responsibility for Croesor as well as for Parc (Roberts 1982, Croesor file).

Parc had enjoyed mixed fortunes since its development in the 1860s, and Croesor had proved a fiasco; Kellow realised that they could only pay their way if they were substantially modernised. Both were dependent on hydraulic power, making use of waterwheels to operate the mill machinery, and of water-balances and a pressure-engine to raise blocks on underground inclines. The power-source that Kellow chose to develop was electricity, to be generated from the quarries' already extensive catchment systems.

Unfortunately, nothing is known of Kellow's early training in electrical power; Warren Roberts, the engineer of Llechwedd Quarry in Blaenau Ffestiniog, who was developing electrical supply systems at around the same time, is known to have had a wealthy father who sent him abroad for his training, none other than Hugh Beaver Roberts, owner of the Croesor estate, but there is no record of who formed Kellow's contacts at this time.

4.1.4 The Blaen y Cwm power station and its associated features

Kellow himself wrote an account of his work with hydro-electricity from a paper which he read to the Institute of Civil Engineers in 1907, and published further details from his autobiography, serialised in *The Quarry Manager's Journal* in the 1940s. The following details are taken from these sources and from the Croesor File in the Dolgellau Record Office. Kellow's memory was not in every respect infallible, and he had no embarrassment about blowing his own trumpet, but some of the details can be confirmed from other sources.

Kellow decided to set about electrifying the Croesor Quarry in 1901. The first stage involved constructing a dam at Llyn Cwm y Foel, on the highlands above Cwm Croesor. This is enclosed on three sides by steep slopes, and a dam 263' long across its outlet was sufficient to raise the water-level for the requirements of the power station he proposed on the valley floor. 233' of this dam was constructed on solid rock, and the remainder on impervious clay. It was 8' wide at the top and rectangular in section to a depth of approximately 4', with a batter of 2' in 5' on the outside wall. The dam was 24' high and 16' wide at the sluices, and its inner face, for a thickness of 2' 6", was constructed of syenite bedded in Portland cement. The remaining part of the dame was constructed of slate rubble masonry bedded in hydraulic lime mortar. Sluices and three outlet pipes were fitted.

The head was 860', the highest then used anywhere in the world for hydro-electricity generation, generating a pressure of 373lbs per square inch. Kellow devised a special form of pipe incorporating male-female joints, and chambers in which air was admitted to minimise pressure variations, the air itself being compressed by the pressure of the water. Eight relief valves were installed at the lower end of the pipeline to prevent dangerous rises in pressure. The lower part of the pipeline ran alongside the course of the 1864 incline built by Croesor Quarry to make an end-on junction with Hugh Beaver Roberts' railway near the site of the power station.

The power station itself housed two impulse pelton wheels, one of 375 BHP, and one of 25 BHP. The principle of the impulse wheel is that the water issues from one or more jets at the velocity due to its head, and gives up its energy, losing absolute velocity as it passes over the vanes of the wheel. These had been developed in America by Abner Doble and Lester Pelton for the use of the Californian gold-fields, and had been available in Britain for a number of years (Wilson 1957-9).

The power station was constructed from the stone of a row of cottages which formerly stood nearby, built in 1878 to house quarrymen.

By far the most innovative feature of Kellow's design lay in the electricity generating equipment. The more powerful impulse wheel was coupled to a 250 kilowatt 3-phase alternator of the revolving field stationary armature type, running at 600 rpm. Its smaller counterpart drove exciters. Automatic governors gave practically constant speed, notwithstanding severe fluctuations of load.

Most electricity supply system in Britain were at that time direct current at 550 volts, which was undesirable for use below ground in mines and which also involved unacceptably high, from Kellow's point of view, power loss when transmitting from more than a mile away. The 3-phase alternating current system meant that high voltages could be used for transmission and stopped down by stationary transformers to any low and convenient voltage. This meant going against the prevailing wisdom of the British electrical supply industry, which was at that time wedded to the idea of a.c. supply, but continental practice was much more amenable to the new system, and it was to Kolben of Prague that Kellow went for his equipment.

From the power station he installed an overhead power-line 3,200' long, which then divided, one continuing as an overhead power-line to the Croesor Quarry mill, the other going underground to oil-cooled 3-phase transformers. Amongst the items of machinery it powered was a locomotive which Kellow claimed, incorrectly, was "the first electric mining locomotive that had been used in this country."

Croesor Quarry continued to operate until 1930, when it closed as a result of the trade depression, but the power station remained open to operate the pumps. On 15 July 1942 the quarry was requisitioned by the Ministry of Supply as an explosives store, and the power station itself was requisitioned on 5 August of the same year. Captain Matthews, the then owner of the Croesor estate, retained responsibility for the power station, employing Morris Rowlands of Croesor as engineer, who installed a twin-cylinder Lister diesel winch and a welding generator at the top of the incline to repair the pipeline.

Croesor quarry remained in use as an explosives store after the war, from 1949 by Cooke's of Penrhyndeudraeth, but with the construction of an overhead line up the valley in 1961 it became possible to dispense with Blaen y Cwm power station. The machinery was by this time in very poor

condition, and blocks of frozen water which had leaked from the pipeline were visible from as far away as Porthmadog. In 1961 the machinery was scrapped by W.O. Williams of Harlech ("Wil Scraps") and his assistant Dafydd Price, who blew out the windows in the process. The empty building was later bought by Showell Styles of Croesor who sold it to Urdd Gobaith Cymru for use as a bunkhouse.

4.2 Archaeological description

The area of proposed development forms part of the community of Llanfrothen and is situated in the upper end of a hanging valley. The lower part of the pipeline lies alongside the Blaen-y-cwm incline, which fed the traffic from Croesor and Rhosydd quarries onto the Croesor Tramway. The upper part traverses open country to the south end of Llyn Cwm-y-foel. In addition to the proposed pipeline, the perimiter of the lake was also examined for sites which may be affected by a rise in water level.

(The numbers refer to the map (fig. 1)

1. Tramway bridge SH64854594
Category B
A four-arch "clapper" bridge, 11m long, forming part of the Croesor Tramway. It was constructed for a double line of 2' gauge railway, and is built of slate slabs supported on low stone pillars. The height to rail level from the surface of the water is approximately 1.5m.

2 Yard SH64844594
Category D
A grassed-over yard, formerly the site of sidings serving the power station. The river bank side of the yard, in which the power-station tail-race emerges, is revetted with country rock, topped with substantial slate slabs.

3. Power station SH64844595
Category B
A rectangular building with slate pitched roof orientated south-west to north-east, built of country-rock, and externally rendered. There is a chimney in each gable. A single window in the north-east gable looks out over the pipline; a large rounded-arch doorway in the south-west gable is now blocked, but formerly gave rail access. The north-west longitudinal wall is blank; in the south-east longitudinal wall three tall rectangular windows rise to dormers, the middle one being higher than the other two. The building measures 11m X 14m in plan.

A 1' diameter pipe of riveted steel enters the building from the north-east.

There is no apparent trace of the cottages that formerly stood on this site, believed to have been demolished to provide stonework for 3.

4. Incline/pipeline SH64854596 to SH65024613
Category B
A constant pitch counterbalance incline running from SE to NE (summit), which lay at the extreme north end of the Croesor Tramway, and linked that tramway to Croesor and Rhosydd quarries. It is double track, some wooden sleepers survive, one cast iron chair was noted *in situ*, which was intended to carry T-section wrought-iron rails.

Along the upslope (north-west) side of the incline is a revetted wall of schist, 1m high in places, above which is a shelf on which the pipeline was formerly carried. The shelf is approximately 1m broad, and there is a further revetted wall behind, up to 1m+ high, built mainly out of sawn slate slabs. The difference in build suggests the upper revetment wall may date from the construction of the pipeline, whereas the lower revetment wall forms part of the incline. There is a trace of an alcove in the lower revetted wall at one point, possibly a safety recess pre-dating the pipeline. The trace of a wooden cradle, possibly to support the pipeline, was noted at one point on the shelf.

5. Drumhouse SH65024613

Category B

A substantial drumhouse for the incline, of the "remote" type (one in which the rails do not pass underneath the drum), with traces of an unusual monopitch roof (the majority of drum houses were double pitched). An angled slab on an incline crimp still has a bearing bolted into it, probably to sustain the angle of the rope as it wound off and on the drum. The drum and other ironwork has been removed but the position of the drum is clear from timber supports and from apertures in the walls to give access for oiling.

6. Caban SH65034612

Category B

A monopitch slab-built and slab-roofed *caban* (shelter) for the incline operators.

7. Pipeline SH65024613 to SH65434664

Category B

The upper section of pipeline continues independently of the Rhosydd tramway; some sections remain *in situ*, some of which appear to be replacements for the original. Some also show evidence of welded repairs. In one place the iron pipe has been replaced by one of concrete manufacture. Two A-frame hand-winches survive near the course of the pipeline. A number of stone square pillars remain which formerly supported the pipe.

8. Dam SH65434664

Category B

A substantial stone-built and mortared dam, of an unusual design and shape. It is substantially as described by Kellow himself in 1907 (see *4.1.iv*). It is built of mortared stone, and rendered on the inside face and top. It is approximately 2.5m wide, and slightly battered on the outer face. The dam does not cut straight across the end of the lake, but follows the edge of the rock in four joined lengths, running (from the east side) slightly north of west, then a right-angled turn to slightly west of south, then a slightly angled turn so it runs south-west, and finally another turn back to the original alignment of slightly north of west. The piped outlet is in the middle of the eastern section: the pipes are visible emerging from the base of the dam on the exterior, whilst on the interior are the remains of a stone structure protruding from the inner face of the dam, presumably to protect the outlet. Between the second and third stretches of dam is the site of a sluice gate, now missing, and this gap is the current outlet point for the water from the lake.

The rock sides of the southern end of the lake appear to have been partly blasted away to form the present steep sides.

9. Rectangular stone structure SH65644706

Category C

A small rectangular structure some 6m by 4m at the head of the lake on low lying ground beside a stream. It is aligned roughly north-south, with a door in the west longitudinal wall. The walls remain to a height of just under 1m. It was probably a shelter for shepherds: the lack of traces of clearance or cultivation around it suggests it was not a permanent settlement. The date is not known but probably post-medieval and pre-1800.

10. Rectangular stone structure SH65504755

Category C

The remains of another structure similar to site 9, although slightly more fragmentary. It is close to a large sheep fold (site 10), and was probably also used by shepherds, or perhaps was a field barn for use with the fold.

11. Sheepfold SH67514704

Category C

A large sheepfold built of dry stone between rock outcrops. The walls still stand to just over a metre high. The interior consists of one large enclosure and four interlinking small enclosures on the east side.

12. Possible trial adit SH67494700

Category D

Two parallel stone walls aligned roughly east-west merge into the slope on the east side of the lake just above the mark of high water. At the lower end of the walls is a platform of waste stone, and it is probable that the parallel walls mark the former opening to a trial adit, although no opening is visible.

5. RECOMMENDATIONS

5.1 Introduction

The proposed scheme is to use Kellow's generating station to house the new generators. The new pipe will run up the incline, buried between the two retaining walls on the west side, then part buried, part covered along the rest of the route to the dam. The dam will be repaired and will operate with a new spillway, and new pipes and valves.

5.2 Slate transport system

Sites 1, 2, 4, 5, and 6 which constitute the Blaen-y-cwm incline, bridge, drum house and caban will only be slightly affected. It is recommended that care is taken when passing the drum house to avoid damage to the structure, and that the work on the incline is carried out in a minimalist way to avoid greater disturbance than is necessary. The two retaining walls are built of different rock types, and it would be preferable to retain that difference when re-building. A basic photographic survey of all the structures should be carried out before work starts.

5.3 Hydro-electricity generating scheme

Sites 3, 7 and 8 which constitute the power house, pipeline and dam of the former hydro generating scheme will also not be substatially affected. However, the historic importance of the scheme, as outlined in 4.1 above, means the remains are of particular importance. It is therefore recommended that changes to the generating house are carried out sympathetically, and that where possible, the earlier remains of the pipeline and associated superstructure are left *in situ*. The dam, if it is to be significantly rebuilt, should be recorded in detail. A basic photographic survey should be carried out of each of the features, and particularly of those features which are to be be altered or removed, for example the point at which the existing pipe enters the generating house.

5.4 Other sites

Sites 9, 10, 11 and 12 are situated around the northern edge of the lake. It is not known if these will be affected by the necessary rise in water level. It is understood that a survey is to be carried out which will indicate the limits of the new water level. If they are likely to be affected, it is recommended that the surface remains are recorded in detail. Although excavation is not necessary because the structures are not to be directly disturbed, their condition should, ideally, be monitored to ensure rising water levels do not erode archaeological deposits. If erosion does become significant, then further recording would be necessary.

5.5 Other areas

There is very little potential for the discovery of additional archaeological remains along the route of the proposed pipeline: the rock is very close to the surface, and remains would be visible as upstanding features. No such features were observed, and so a watching brief during the construction of the pipeline is not recommended.

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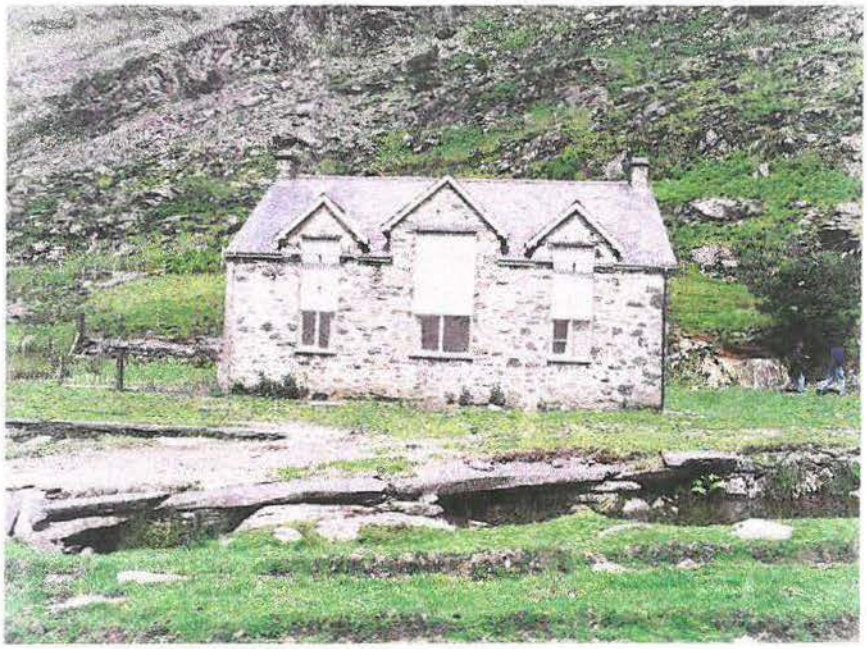
7. NON-TECHNICAL SUMMARY

This project has assessed the archaeological and archival evidence for the area of a proposed hydro-electricity installation at Cwm Croesor. It has identified twelve features, three of them dating from the late Medieval or early Modern period, and nine from the nineteenth or early twentieth centuries. These latter remains are part of either the exit tramways from Rhosydd and Croesor slate quarries, or part of the pioneering alternating current installation of 1901-1902, engineered by Moses Kellow. This latter represents a major landmark in the development of electrical technology in Britain, and so is of particular historic importance. It is recommended that earlier industrial remains are left *in situ* where possible. Also a photographic survey is recommended, with additional recording for features that are to be disturbed.



Site 3: Power station with bridge in foreground

Site 8: Dam

Site 7: Pipeline route with winch in foreground

Site 7: Pillar supports for former pipeline

Site 9: Rectangular stone structure

Site 10: Rectangular stone structure