

## 5. Dam Busters: the Breaching of Greenock Reservoirs No.1 & 2

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### Introduction

This short paper describes the results of an archaeological watching brief during breaching work at Greenock Reservoirs Nos. 1 and 2 that had to be undertaken in the interests of safety. The work, commissioned by West of Scotland Water, was undertaken in 1998, when I was working for Centre for Field Archaeology, University of Edinburgh. These reservoirs form part of an extensive system of water works constructed in the early 19<sup>th</sup> century by Robert Thom for supplying water to Greenock (Fig. 1). This system of water works is recognised as being of National Importance to our Industrial Heritage and is a Scheduled Ancient Monument. Historic Scotland therefore required that an archaeologist should monitor the breaching work.

The need for improving the water supply to Greenock was first investigated in the late 18<sup>th</sup> century when increased population growth and poor sanitation led to an increased demand on the water supply. In 1790 James Watt and George Robinson surveyed the hills behind Greenock to look for ways to increase the water supply; this resulted in the construction of two dams but proved inadequate to meet demands. Robert Thom, who had built a water system to supply his factory on the adjacent island of Bute, was persuaded to construct a similar system above Greenock (Fig. 1A). This involved the construction of a large reservoir, now called Loch Thom, which dammed the upper end of the Shaws Water. In order to allow the Shaws Water to continue to flow down to Inverkip a smaller compensation reservoir was also built. The water from the reservoir was transported around the west and north side of the hills to behind Greenock by means of an aqueduct or cut c.7 miles long. This consisted of a stone lined cut 3-4m wide and up to 1.5m deep. The scheme was accepted and construction started in 1825 taking two and a half years to complete, finally being opened on 16<sup>th</sup> April 1827. At the eastern end the water was collected into the Overton Reservoir where a series of 19 falls was used in a range of different industrial processes including powering flour mills, a flax mill, a woollen mill, sugar refineries, an iron foundry, a paper works and a chemical works. Drinking water was piped through a number of filtering tanks down to the town. A series of eight smaller reservoirs were constructed around 1829 on the hills above Greenock in order to capture more water and feed it into the aqueduct system (Fig.1B 1-8). The south-western two of this series of dams are Greenock Reservoirs 1 and 2. The water works continued in use until 1971 when it was replaced by a tunnel, one and a quarter miles long, under the hills which transported water from Loch Thom to a new filter station at Overton.

Prior to this project both Greenock Reservoirs Nos.1 and 2 have had to be kept empty by West of Scotland Water as a safety precaution since there had been an unacceptable amount of leakage on the face of the dams. The cost to upgrade these dams and the effect on their character and traditional appearance was prohibitive to any repair works. Following talks with Historic Scotland it was agreed that the dams should be breached along the line of the original water courses but that care should be taken to preserve as much as possible of the original structures.

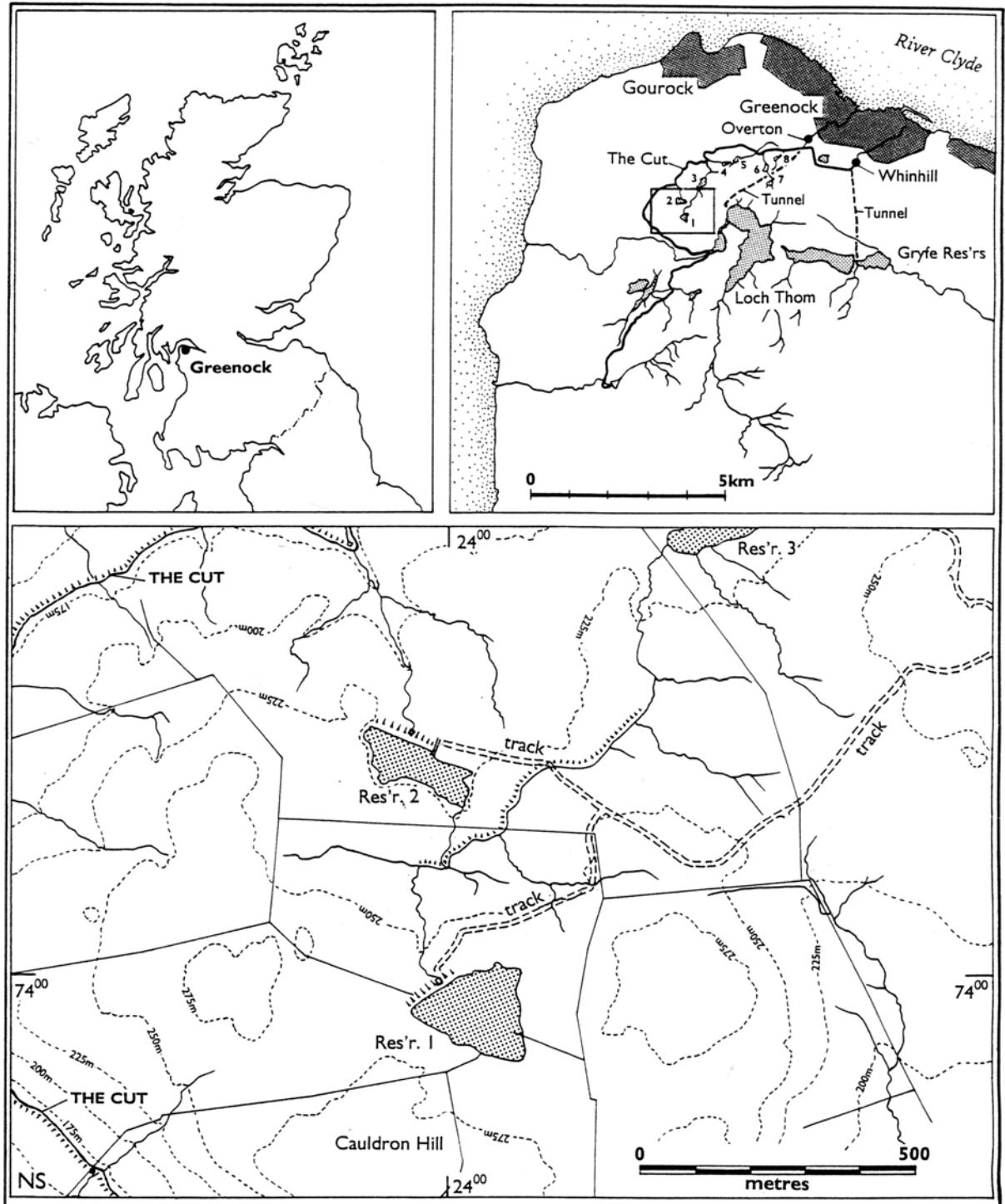


Fig. 1 - Location map

Breaching work was carried out in two stages. The first stage was to remove the top three metres of the embankments with one side at a slope of 1 to 3 and the other side 1 to 2. This then was to be left for a period of around 21 days after which an engineer confirmed that the material within the embankments would be stable enough if left at a slope of 1 to 2. This was necessary because the steeper the slope that could be achieved on either side of the breach the less of the dam would have to be removed. Once this decision was taken both the dams were breached down to their original bases and the sluice pipe removed.

Consultation with Historic Scotland confirmed that they required an archaeologist to examine the dam sections in order to record their fills and methods of construction. In particular, the aim was to record the materials with which the dams were constructed because in an early article on the subject Thom (1843, 1991-92) specifically mentions the use of peat. In addition, any other associated features that were to be removed, such as sluices, were recorded.

In his article of 1843, Thom described at length his model for reservoir embankment construction. This included the suggestion that the slope, especially on the inner face, should not be less than three to one and that the foundation should be excavated to such depth as to prevent the passage of water. The core of the embankment itself, he suggested, should be made of alternate layers of puddled peat or alluvial earth and gravel, beaten together until completely mixed. The slopes of the dam should be covered with a puddle made up of small stones or furnace cinders mixed with clay to prevent animal burrowing.

The recording work was carried out as a watching brief. An initial visit was made to the site before breaching work commenced and then again after the stage1 breaching of the dams down to 3m. Once the monitoring period was finished two more visits were made to record the sections down the full depth of the breaches. Recording of the make up of the dams was done by photography and by cleaning and drawing representative sections of one of the faces of each breach.

## **ARCHAEOLOGICAL RESULTS**

### **Dam 1**

Greenock Reservoir No. 1 (NS 240 730) was constructed in 1829 and stands 5.9m high (Fig. 2). Its maximum capacity was 59,700 cubic metres. The dam is c.115m long across its top and is built at the northern end of a shallow natural depression.

Breaching of this dam immediately confirmed Thom's use of peat in dam construction. The inside face of the dam was protected by a layer of stone pitching c. 0.4 – 0.5m thick set within a medium brown silty loam which spread right across the dam. This silty loam was thickest on the dam summit where it underlay a rubble trackway. It also spread down the exterior face underneath the turf covering. Below this the majority of the dam was formed of dark brown/black peat sometimes mixed with stone and clay. This clay clearly contained fragments of branches, which mainly appeared to be birch. It is unclear whether these branches were already incorporated within the peat prior to its use in the construction of the dam or if it

simply reflects a number of small trees that were cleared in the immediate vicinity during dam construction in 1829. However, from the quantity of wood material and the recent recovery of bands of birch material from peat bogs elsewhere in the Renfrewshire uplands, most notably in Muirshiel Country Park, it is most likely that this wood was within the peat and could be thousands of years old. Thom specifically mentions the spreading of alternate layers of puddled peat or alluvial earth (clay) and gravel, beating them together with wooden dumpers until completely mixed. Layers of boulder clay and fragmented rock were recovered throughout the profile of the dam but these were always very thin layers or lenses.

## **Dam 2**

Greenock Reservoir No. 2 (NS 239 734) was constructed in 1829 and stands 6.7m high (Figs. 3). Its maximum capacity was 27,100 cubic metres. The dam is c.110m long across its top and links two natural hillocks on either side of a small stream.

Breaching of Dam 2 revealed a remarkably different make up to Dam 1. The superficial covering of the dam was the same with stone pitching on the interior, turf on the exterior, and a track along the summit. In addition the associated features such as the spindle, sluice gate and manhole were similar to those recorded on Dam 1. However, the fill of the dam itself was completely different being constructed mainly of bands of clay rather than peat. Peat was noticeably absent apart from a couple of narrow bands towards the base. The majority of the dam was made of layers of grey and orange boulder clay although there was a noticeably looser band of fragmented rock and clay, c. 1 - 1.5m thick, in the middle. There were also more stones in the lower portion of the dam.

## **CONCLUSIONS**

The watching brief results suggest that both dams were most likely constructed of materials available within the immediate vicinity; the material quarried to deepen the area of the reservoirs was used in the construction of the dams. No old ground surface survived below the embankments and it is likely that the foundations of the dams were levelled and cut down into the underlying subsoil to prevent any leakage. The difference in the make up between Dam 1 and 2, simply appears to reflect the concentration of peat in the basin to the south of Dam 1 while there was less peat to the south of Dam 2. Quarries into the bedrock are visible around the edges of both dams and this stone was probably used mainly for the pitching on the inside face, although the fragmented bedrock was also used in the construction of the core of Dam 2. This fragmented bedrock was included in a matrix of silty clay in order to prevent seepage.

The watching brief undertaken at Greenock Reservoirs Nos. 1 and 2 allowed the methods of construction of both dams to be recorded. Dam 1 clearly confirmed Thom's documented use of peat in construction but was contrasted by Dam 2 that was built mostly of clay. It appears that the material used in their construction was quarried in the immediate vicinity and it is interesting to speculate how many of the other dams in this nationally important set of water works also incorporated peat.

## **ACKNOWLEDGMENTS**

Thanks are due to thank Mr J. Rafferty and Mr N. Nathan of West of Scotland Water for their help and advice during the watching brief. Thanks are also due to Sam, the reservoir warden, for arranging access and for sharing his knowledge of Thom's water system. Kevin Hicks drew the illustrations.

## REFERENCES

Alexander, D 1998 *Greenock Reservoirs Nos 1 and 2: Archaeological Recording, Watching brief report, CFA Report No 408*. Commissioned by West of Scotland Water.

Historic Scotland 1993 *A List of Ancient Monuments in Scotland 1993*, Edinburgh

Thom, R 1829 *Brief Account of Shaws Water Scheme*, Columbian Press, Greenock

Thom, R 1844 'On the formation of embankments for reservoirs to retain water', *Proceedings of the Institute of Civil Engineers*, 1843, vol II, 191-92

Fig. 1 – Location map

Fig. 2 – Dam 1 plan and sections

Fig .3 – Dam 2 plan and sections

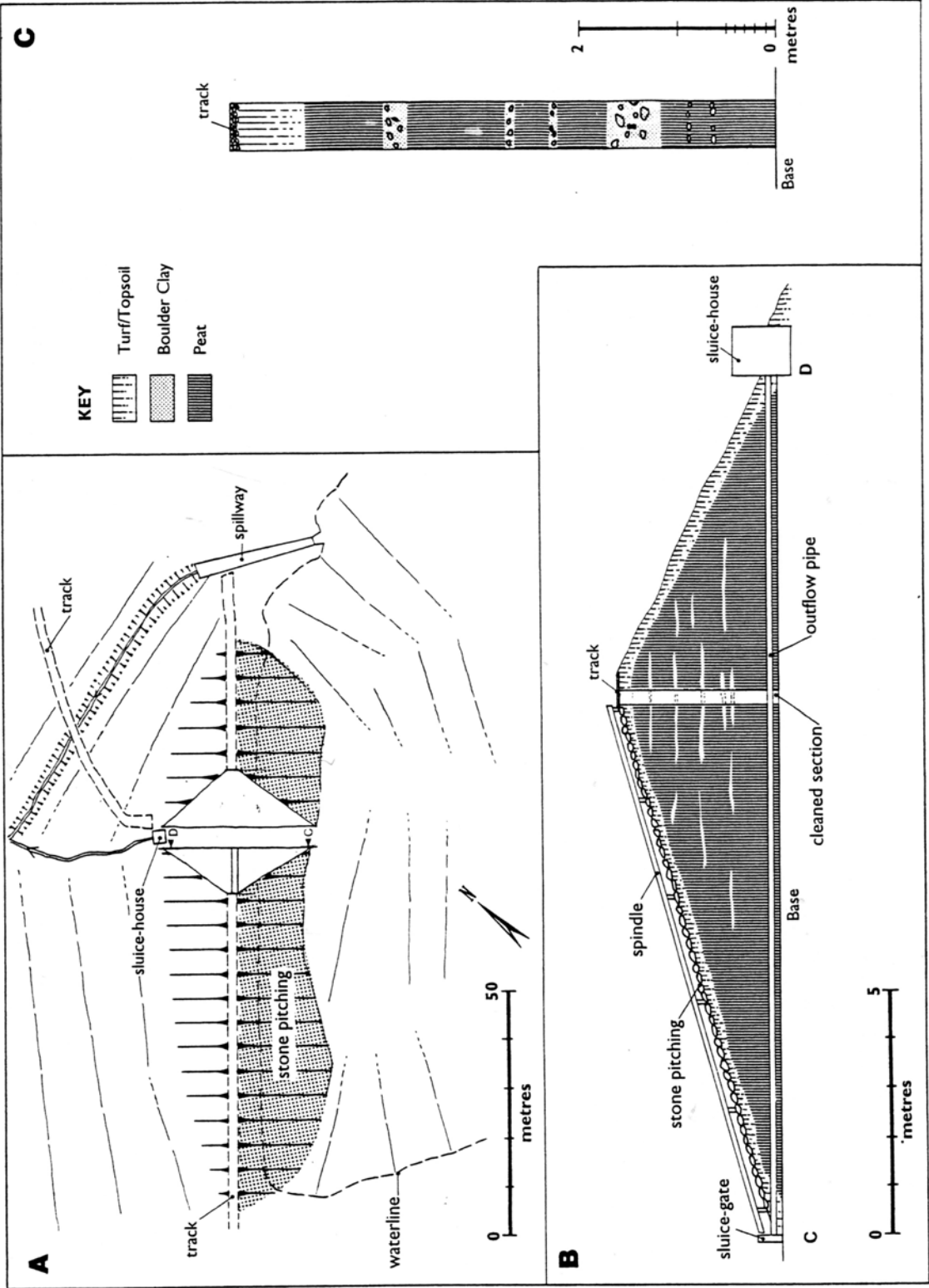


Fig. 2 - Dam 1 plan and sections

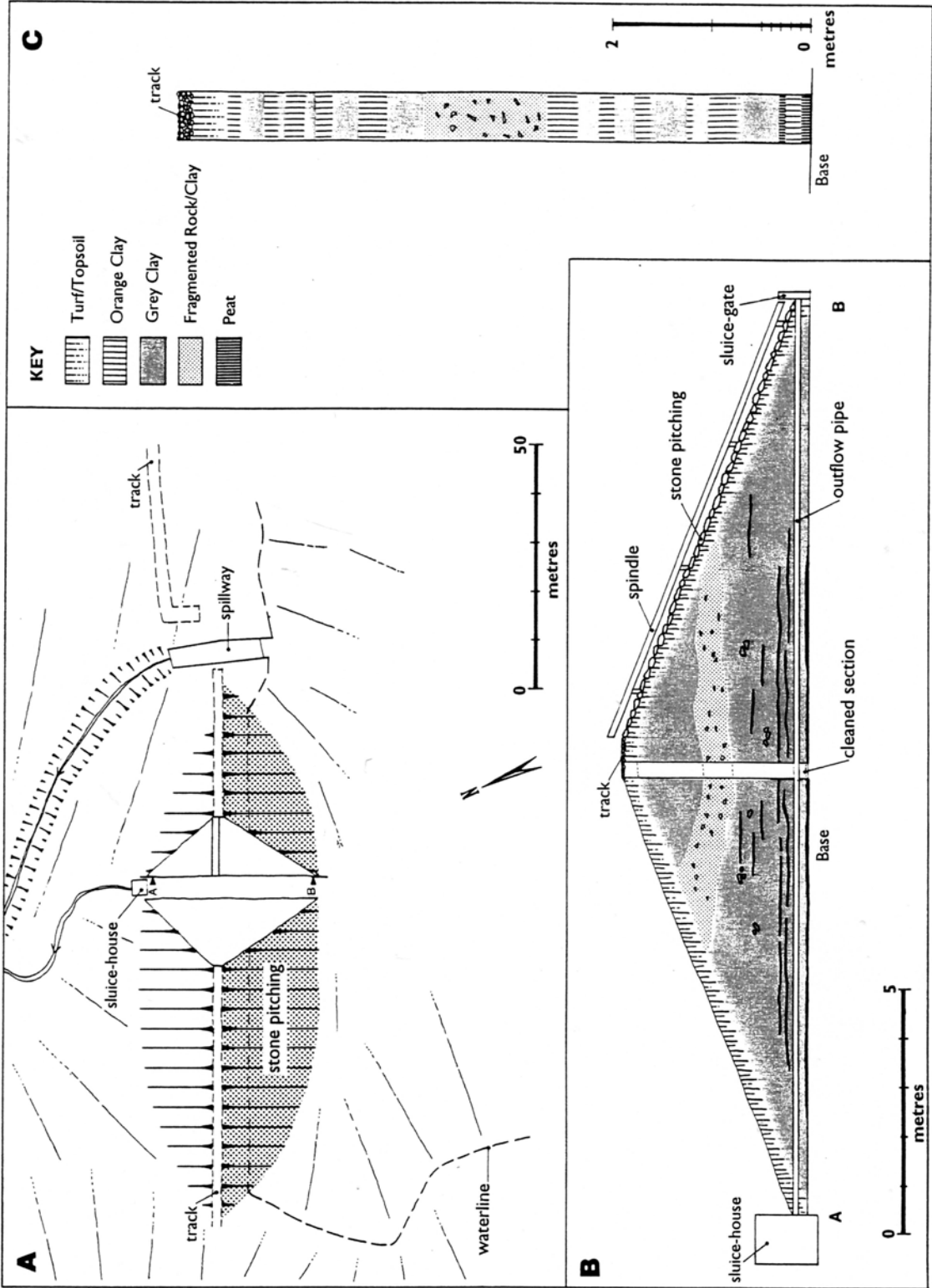


Fig. 3 - Dam 2 plan and sections

Further to 'Dam Busters' by Derek Alexander  
(Note published in 'Notes and Queries', RLHF Journal Vol 12)

The construction of the dams described in the article differs because they were built at different times by different engineers. The chain of Auxiliary Reservoirs was projected by Thom in his earliest drafts of the scheme as a source of drinking water, the Great Reservoir being kept for power and industrial water. They contained water which had been impounded immediately after its emergence from igneous rock, which did not dissolve readily.

Greenock already had a Town's Water system, as Derek observes, but the power system was the exciting new proposal on which Thom concentrated his attention. He was probably not aware that Sir Michael Shaw-Stewart's proposed arrangements for Town's Water had aroused fierce opposition. Instead of the elected Water Trust set up by Act of Parliament there was to be a Joint Stock Company with Sir Michael in the chair. This was in the Radical 1820s and Greenock had seen blood shed. The Town Council opposed the Shaws Water Bill and secured the excision of the clause allowing the Company to levy a water-rate on the inhabitants.

This caused a financial problem for the Company and works were cut back. Only one of the Auxiliary Reservoirs was completed, although they all appear on the map included in the book of 1829.

In 1830 the Company obtained the Whinhill Reservoir for its potable supply, but in 1835 that burst disastrously (it was not built on Thom's principles). The Company battled on (an appropriate description for its relations with the Council) while hiding a considerable debt to the Ardgowan Estate, until in 1845 it was able to obtain a second Shaws Water Act increasing its revenue, rebuilding and extending, but making no mention of the Auxiliary Reservoirs.

During the following years there was unpredictable weather: droughts and floods, sometimes in the same year, and mill stoppages. In 1852 the millowners agitated for an increased storage capacity. The Company refused to heighten Loch Thom but did agree to complete the chain of Auxiliary Reservoirs. Robert Thom was dead by that time, and I have not yet found out who the contractors were; but they evidently followed the time-honoured practice with dams: a "puddle trench" from which rose a "clay core", rising layer by layer, with an outer cladding of whatever strong material came to hand, and stone facing on the water side. It was usual to find material in the bottom of an existing reservoir; a traditional dam might be constructed over three years with the deposited clay of each rainy season being scraped out and placed on the slowly rising embankment.

When Loch Thom was at last raised, around 1900, the contractors confidently expected to mine out the masses of clay in the centre of the main embankment and re-use it. Robert Thom had left them an unwelcome surprise. His clay was packed with gravel throughout. So far as I know, no embankment built according to Thom's prescription ever failed.

**Additional Sources:**

Letter-books and other archival material on the Shaws Water Company is available on the top floor of the Mitchell Library; Greenock publications (including newspapers) in the Watt Library. The House of Lords Record Office has drafts and Books of Reference relating to the Acts of Parliament.

Dr. Sylvia Clark