Reprinted from: Gloucestershire Society for Industrial Archaeology Journal for 1991 pages 17-27

SWALLOW HOLES AND MINE DRAINAGE IN THE FOREST OF DEAN

C.R. BOWEN

Introduction

Mining in the Forest of Dean for iron and coal has always been hampered by the excessive amounts of water encountered underground, trapped and held up by the basin shaped strata, and topped up by a fairly high rainfall typical of an upland, of between 40 to 60 inches per year. This surface rainwater drains into the basin by general percolation through the strata, and more directly by watercourses which drain into the many naturally occurring sinks and swallow holes. The depth of early mining was limited by the high water table in the basin.

To reach and work the deep deposits of iron and coal, vast amounts of water were pumped out of the basin to the surface. It was therefore of great economic importance wherever possible to prevent surface water from penetrating underground. General percolation of rain water could not be prevented, but wherever sinks and swallow holes were likely to occur, the beds of streams and brooks were waterproofed with conduits, troughs, and channels. These artificial drainage features occur at some point or other on almost every watercourse within the mining area. This paper records the major features, and very briefly describes the conditions that have made them necessary.

Geology and Hydrology

The rocks of the Forest of Dean have been folded to form an irregular shaped basin. The central area is covered by the coalfield, comprising clays, shales, sandstone and coal seams. Underlying the coal measures is the Carboniferous limestone series of sandstone, limestone-containing iron ore deposits, and shale. These rocks are only seen on the surface where they outcrop in a band around most of the perimeter of the coal measures. (See Figure 1) Surrounding the limestone is a large tract of Old Red Sandstone. (1)

One of the most exciting characteristics of Carboniferous limestone is its solubility in rainwater, this is well exhibited in the Forest by the number of sinks and swallow holes seen on the surface and their associated drainage systems below the surface. Any stream flowing across the outcrop of the limestone is almost certain to lose some or all of its water onto these sinks and thus easily find its way into the extensive mine workings for iron ore, and in one case thought to enter, via a fault, into a coal mine.

Natural sinks and swallow holes do not occur in the coal measure rocks, however surface water can sink into coal mine workings through fissures, joints ,and faults in the sandstone beds where exposed on the surface, or where the strata has been disturbed by subsidence.

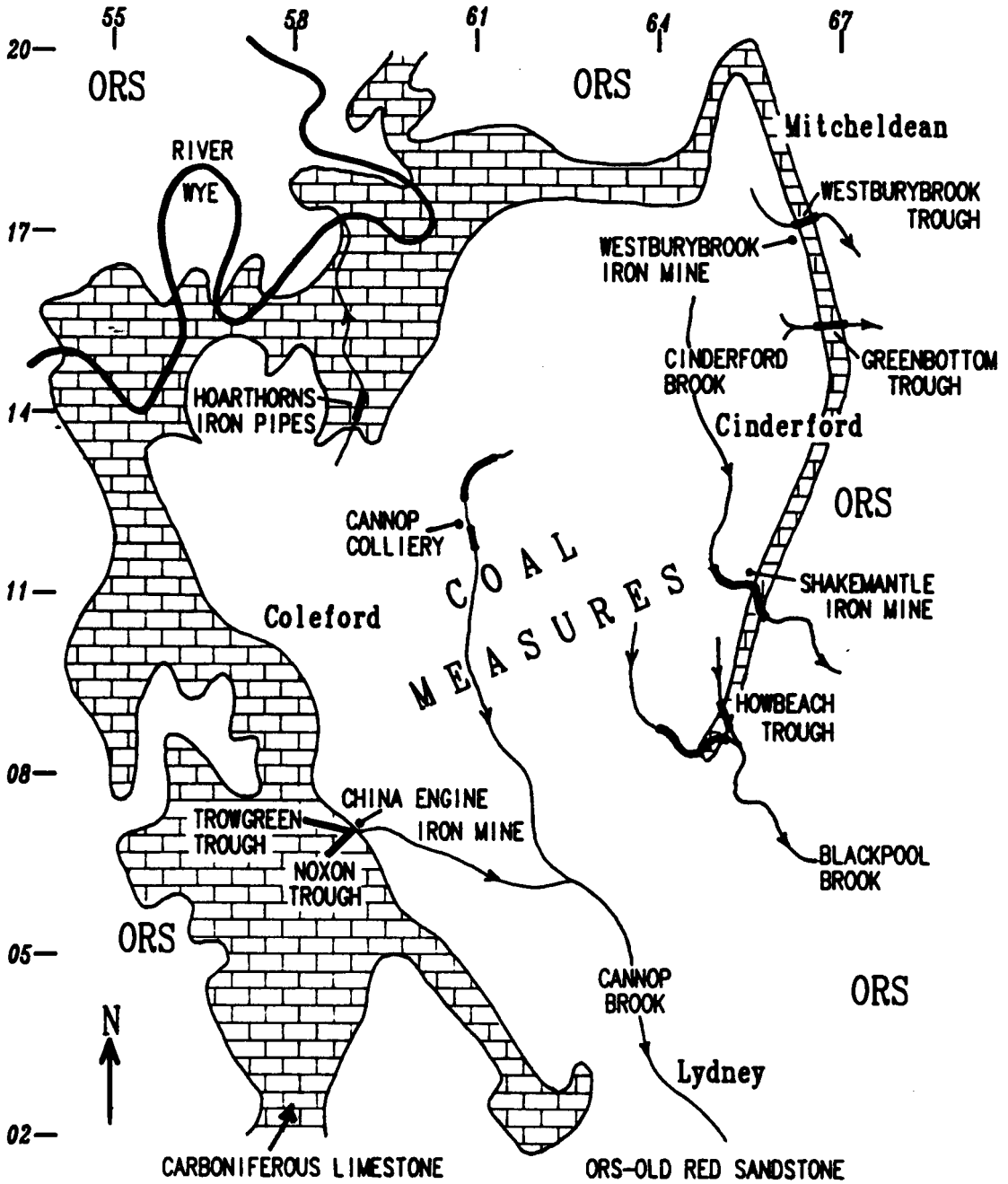

FIG.1 Sketch Map of the FOREST OF DEAN showing GEOLOGY and HYDROLOGY

Main surface drainage of the basin is by three streams: the Cannop brook, Cinderford brook, and the Blackpool brook. All three cut through the basin rim in deep valleys and eventually discharge into the River Severn. For much of their length within the basin the streams run over impervious clay superficial 'head ' deposits, but where the valleys cut through the rim of the basin, coal measures sandstone and carboniferous limestone is exposed allowing the streams to penetrate underground. Around the fringe of the basin smaller streams, draining local areas of either coal measures of Old Red Sandstone, sink almost immediately on reaching the limestone.

The Cinderford Brook (See Figure 2)

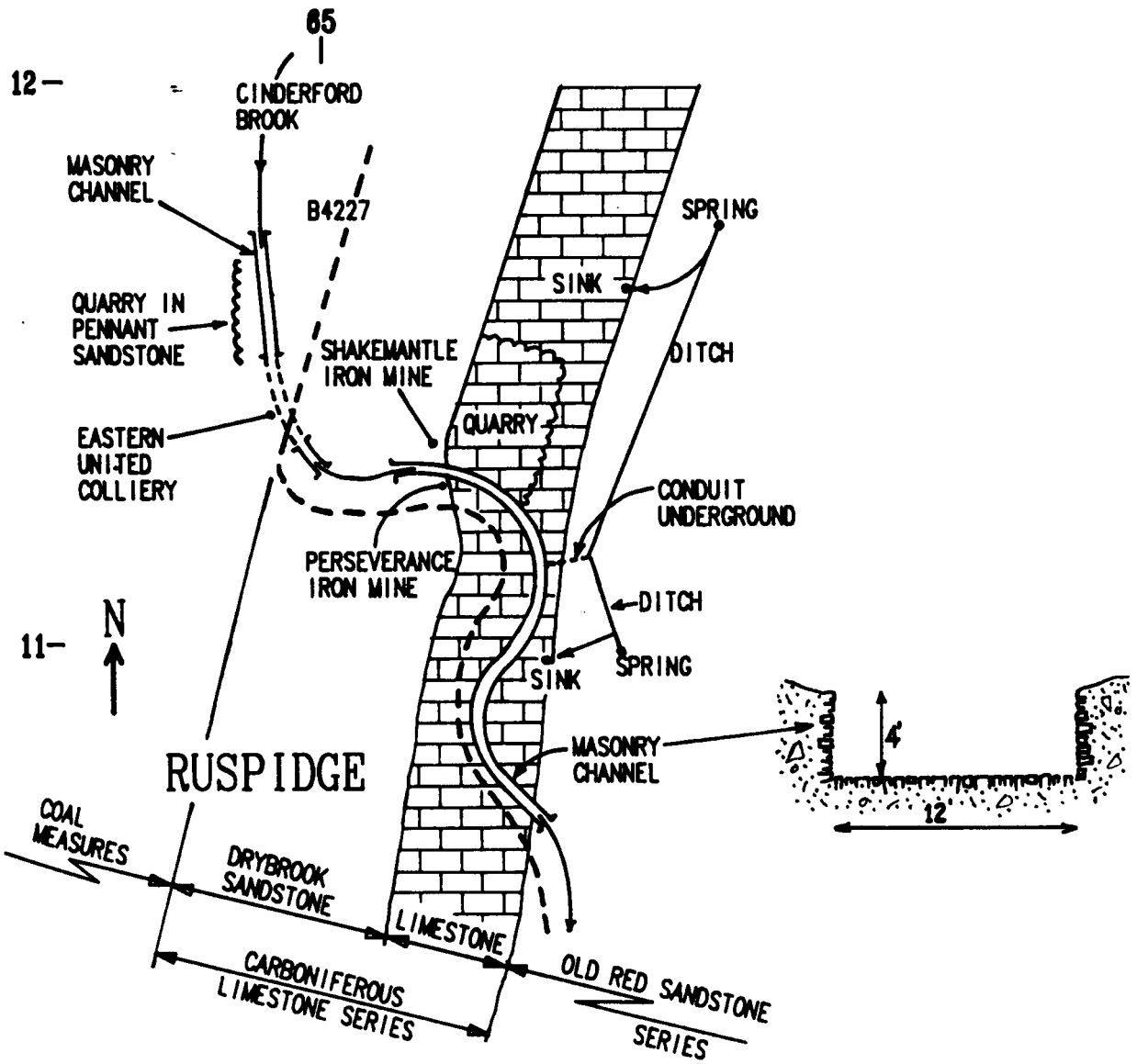

FIG.2 - CINDERFORD BROOK

In the Ruspidge valley the Cinderford brook passes under the B4227. Upstream and down stream of this crossing (Grid Ref 649113) the brook flows in masonry channels for a total of ¾ mile. The upstream section, 300 yards long, was part of the adjacent Eastern United Colliery which started about 1909. The channel bed, repaired in places with concrete, carries the brook over coal measures sandstone.

Downstream, after a short section of un-lined streamway, a meandering masonry channel carries the brook over the outcrop of the pervious limestone, passing on its way close to the site of the Shakemantle iron mine, now obliterated by quarrying. Above on the hillside the issue from several small springs was directed away from their natural route across the limestone outcrop by two ditches which discharges into the main channel via a two foot diameter stone lined conduit. Today both ditches are breached and water from the springs drains probably into their original sinks in the limestone, creating abnormally short streamlets, about 50 yards from source to sink.

These artificial drainage features are all that remains on the surface of the Shakemantle iron mine, started in 1829 and once the most productive and deepest iron mine in the Forest, whose huge pumping engine was able to pump 2000 gallons of water per hour from workings far below in the limestone up to the surface.

The abandoned track of the mineral railway is now a footpath and follows the downstream course of the brook from the B4227.

The Blackpool Brook (See Figure 3)

Leakage from the Blackpool brook was prevented by the construction of ¾ mile of masonry channels and iron conduit in the valley between Mallard's Pike and Blackpool bridge. Channeling commences at the roadside (B4431) east of Mallard's Pike (Grid Ref 638089). Downstream at Morse's level, an old coal mine, the channel is covered, then for a short distance the brook is un-lined until it disappears under an embankment. Beyond this the brook runs inside 5 feet diameter iron tubes with flanged joints laid in a shallow curve for 55 yards. (2)

The next section of channel has suffered by subsidence of coal workings below. Repairs have been made using red bricks and a portion has been replaced with a concrete channel of which the last 18 yards have been virtually obliterated by further subsidence.

The channeling and conduit up to this point is over coal measures and was probably constructed by the nineteenth century Wallsend Colliery. Many other remains of coalmining can be seen here of various ages up to present day prospecting and small scale mining.

The final section of channel carries the brook over limestone and past the undeveloped Howbeech iron mine, it is unlikely to have been constructed for the Howbeech mine as their mineral rights were in the hillside above the brook only. (3) It is more likely that this channel was built for the Perseverance iron mine, an extensive mine between Howbeech and Shakemantle and drained by the Shakemantle mine pumps. Although the end of the Perseverance workings was ½ mile away from the Blackpool brook, their depth at 285 feet below the brook, would encourage leakage through the pervious limestone.

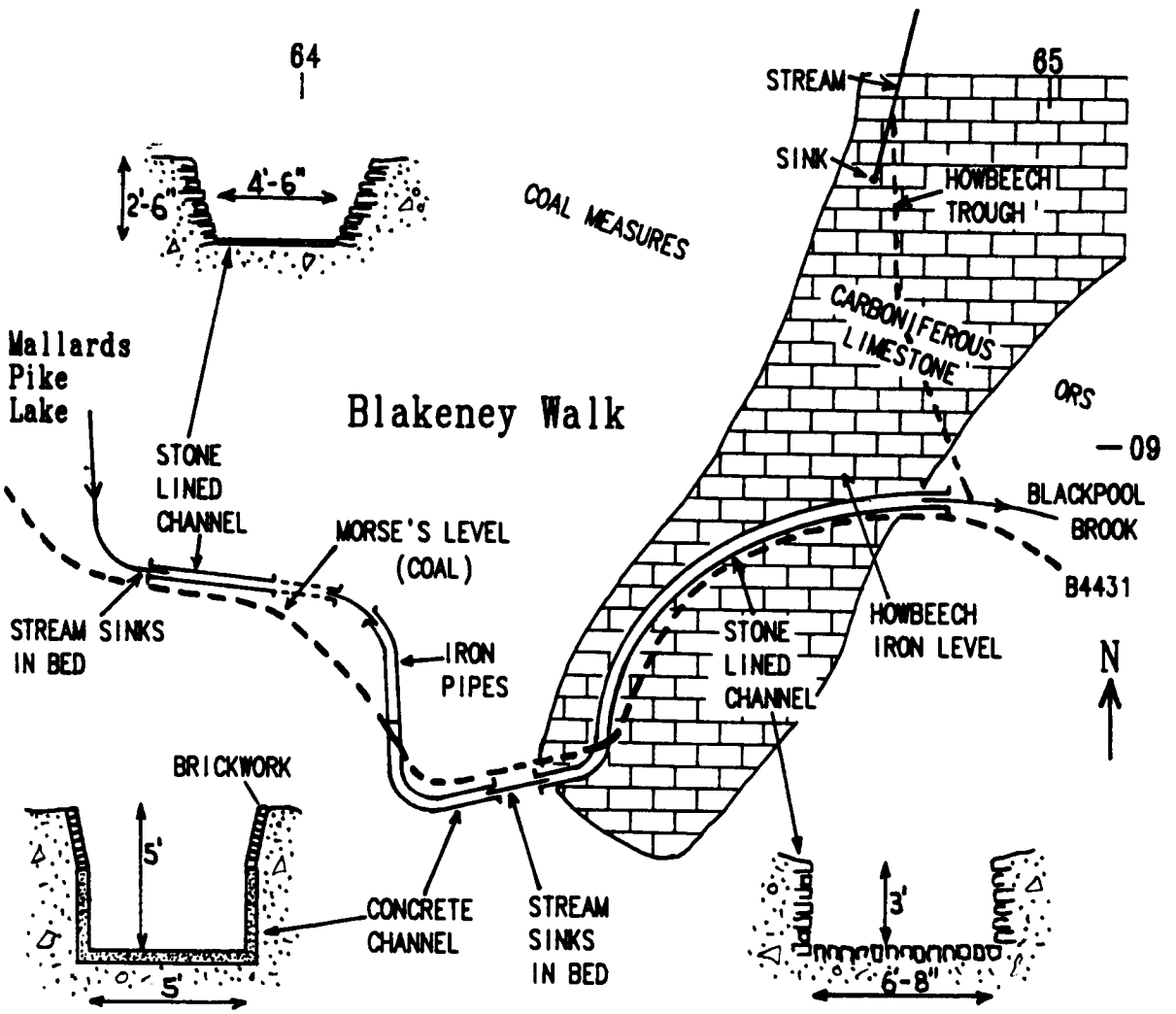

FIG.3 - BLACKPOOL BROOK

Towards the downstream end of the channel, in the north bank, is the partly obscured portal to the Howbeech iron level, abandoned after driving only 30 yards. Today leaks in the bed of the brook occur in two places caused by subsidence. In very dry periods all the water may be lost underground leaving the stream bed dry almost down to Blackpool bridge where it is replenished by small springs.

The Cannop Brook

The course of the Cannop brook within the Forest follows a strip of highly faulted strata. This is a zone of fractures 5 miles long made up of 25 small faults and known as the Cannop fault belt. (4)

Leakage however from the brook into this disturbed ground and into the workings of Cannop Colliery is naturally prevented by a thick covering of impervious clay head deposits which covers most of the valley floor. The only artificial channeling is at the head of the valley where the 'head' covering may have been removed by stream erosion and re-deposited downstream perhaps to form the Cannop ponds.

About 600 yards of channeling was built by the Cannop Colliery, consisting of seven separate lengths made of cast concrete and two masonry conduits. Inscribed in the concrete is the date "Sept. 1913". The channeling is in the vicinity of the old Cannop Colliery site, now a county council depot, and east of the B4234 between Grid Refs. 610123 and 615131.

Southwards where the brook leaves the mineral field no channeling is necessary as here the limestone is not exposed on the surface.

Besides the waterproofing works carried out to the three main brooks waterproofing has also been carried out to several minor variable flow streams where they cross the limestone outcrop, to protect the iron mines below. These are stone-lined channels of a different style, known locally as "trows". (5) The usual shape is half round, like a trough or gutter, so designed that when operating under minimum flow conditions the stream is contained in a narrow band thus maintaining a good velocity and self cleansing affect.

Green Bottom Trough Grid Ref667152

This fine masonry trough is situated near the top of the hillside west of Green Bottom pumping station. On Sopwiths map 1835 (6) it is called "Trow Ditch", also shown at the foot of the hillside is the "Trow Ditch Iron Mine Level" which was driven into the hillside to the iron ore workings below the trough. Both were constructed sometime between 1829 and 1835.

The trough carries a small intermittent stream from off higher coal measures across the outcrop of the limestone, it is constructed of random size squared limestone and sandstone blocks, with the faces of large blocks dressed to the curve of the trough. The blocks are set in mortar with thin good fitting joints. See Figure 4 for section, it is about 200 yards long.

Driving the"Trow ditch level" cross measures into the saturated lower basin, as might be expected, had its problems. "When about 100 yards of the heading had been driven, the work men had to cut through for a considerable distance a bed of conglomerate or what is locally known as pudding-stone. This rock yielded water so rapidly that to use the words of the workmen, it flew out as though shot from a riddle and the work of driving the heading had to be abandoned for a time. This work was subsequently taken in hand and completed." (7) The average flow from the heading was 100,000 gallons per day of good quality water. In 1870 a waterworks company was formed for local supply and still operates today.

Westbury Brook Trough Grid Ref 661170

Very similar to the Green Bottom trough, it is located just below the small tips and concrete capped shaft of the Westbury brook iron mine, and close to the roadside (A4136) near the top of Plump hill. The lower half is in a private garden.

The trough was probably constructed shortly before 1843 when the Westbury brook mine became productive. It may have replaced an earlier attempt at sealing the limestone as it is known that extensive mining took place here before the Westbury brook mine commenced, "the first level driven out north and south from the Westbury brook shaft, to explore the limestone for iron ore deposits, found that extensive ore bodies, which originally lay between the level and the surface had already been worked out. As a result of this the level was not continued". (8)

In 1913 a large collapse occurred, causing the surface to run into the mine workings, taking with it two cottages (9) and 50 feet of the trough which apparently was never re-built. Today the missing stonework is replaced with wooden boards lined with corrugated iron sheets.

Howbeech Trough Grid Ref 648093

See sketch map Figure 3 for location. A small streamlet only flowing in very wet condition runs off coal measures and onto the limestone where it soon disappears into the ground. A trough was constructed by early nineteenth century iron ore prospectors to by-pass the sink, today the trough is filled with silt and mud, allowing the occasional stream to overflow and follow its original course to the sink. Both sink and

trough were previously unknown and only recently came to light through fieldwork.

A small excavation near the sink revealed the trough to be not the usual masonry half round style, but more of a ditch with the bottom sealed with two feet square sandstone slabs, laid over laping similar to roof tiling. The extent of this is not known but the line of the ditch can be followed down the hillside until it meets the Blackpool brook.

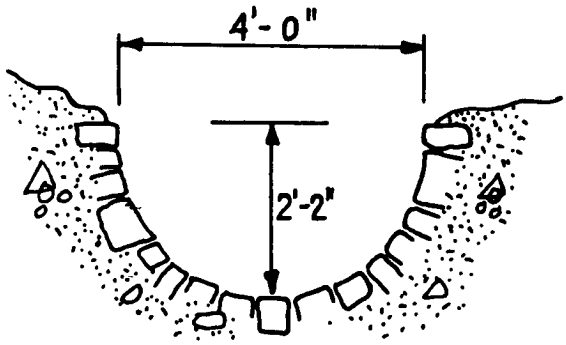

FIG. 4
GREENBOTTOM TROUGH
&
WESTBURYBROOK TROUGH

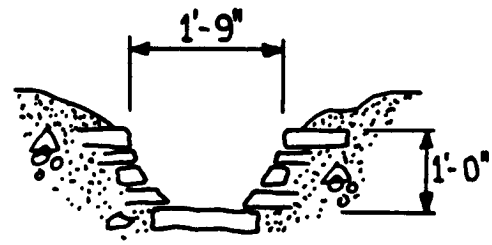

FIG. 5
TROWGREEN TROUGH

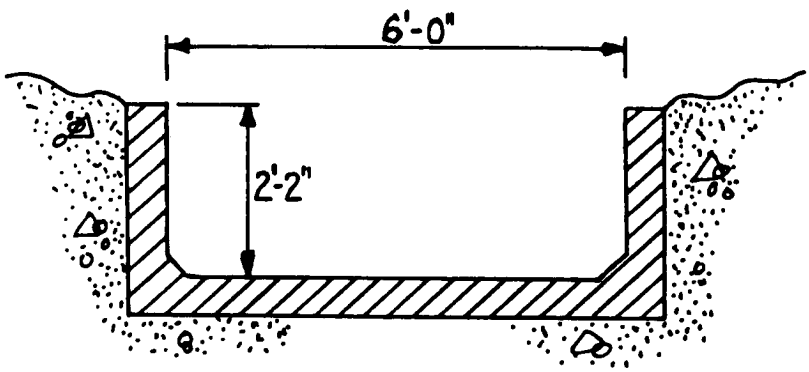

FIG. 6
CANNOP CONCRETE
CHANNEL

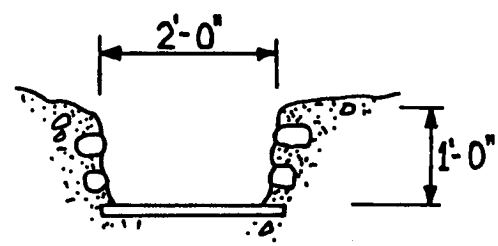

FIG.7
HOWBEACH TROUGH

TROUGH & CHANNEL SECTIONS

Noxon Trough and Trowgreen Trough

These are two separate troughs which meet at the razed site of the China Engine iron mine, (Grid Ref 589068) at the west end of the Oakwood valley and carry small streams from off the limestone shales. The troughs do not extend over the whole of the carboniferous outcrop, only over those beds which contain the iron ore deposits which have been extensively worked here by not only the nineteenth century China Engine Mine, but by earlier miners who have left a long line of surface excavations passing close to the junction of the two troughs. The Noxon trough, together with an old trackway both cross this chasm on a natural bridge. The trough is similar to Figure 4 but only 2 feet wide and 200 yards long, its age is uncertain.

The 300 yard long Trowgreen trough commences near the hamlet of Trowgreen (5) and seems likely to be of early seventeenth century origin. According to "Place names of Gloucestershire" (10) in 1618 Trowgreen was known as Trolley. By 1635 the name had changed to Trowfield. It would seem not unreasonable for the change of name to have been due to the construction of the trough which would have made quite an impact locally.

Hoarthorns Iron Pipes Grid Ref 590137

An active swallow hole in the limestone north of Hoarthorns Farm near Edge End, takes water from several small streams draining from higher coal measures. As there were no iron mines nearby no action was taken until the early 1900's when it was thought that the water emerged in Cannop Colliery two miles away. It is normally unlikely for underground water to migrate from limestone to coal measures, a fact which 'Forest' miners would have been aware of at that time, however, in this case the sink is close to the Lydbrook fault which trends towards Cannop pit, making the traverse a little more likely.

In 1914 a dye test was carried out, green colouring matter was put into the hole Good Friday morning and green coloured water was pumped from Cannop pit on Easter Monday morning, and although the colliery manager thought the test inconclusive, pipework was later installed to bypass the sink. (11)

Three hundred yards of 15 inch bore pipe have been used, starting at a five feet high concrete dam. Pipes below ground are glazed earthenware and above around cast iron carried on concrete supports. A small tributary is also piped and joins the main pipe in a concrete inspection chamber. Today the pipework is damaged and all water again disappears into the sink.

Many other sinks occur in this area (12) but cause no problems as there are no iron mines to be affected and also local subsidiary folding of the strata causes underground drainage to flow, not into the main basin, but towards the valley of the river Wye.

Conclusions

As can be seen from the preceding descriptions, the age of the troughs and channels, apart from the trowgreen trough, is early nineteenth century or twentieth century. However it is possible that some watercourses were waterproofed at an earlier date. Most 'Forest' water courses have downstream a long history of milling, smelting, forging, etc (13) which depended on the stream for a power supply. Upstream some or all of the water would have been lost into sinks in the limestone and it is likely that these industries carried out some form of waterproofing to stream beds to ensure a continuous supply. These early attempts at sealing sinks were subsequently obliterated by the current waterproofing features constructed by the large iron mining companies.

In spite of this detailed attention to the surface 'Forest' mines were still very wet and extensive pumping was still necessary. However the troughs and channels, for low initial cost and minimum maintenance, must have made considerable savings in pumping costs.

Today, most troughs and channels continue to serve a useful function in keeping water courses on the surface and thus keeping the waste free from the mineral pollution which would take place whilst percolating through underground mine workings. (14) Water which has been contaminated in this way, especially that from coalmines, becomes acid and ochreous and resurges on the surface as ochreous seepages and springs. The most notable is the ochreous out fall from the flooded Norchard colliery.

All of the works described are easily accessible from roads and public footpaths and all on Forestry Commission controlled land except for the lower part of the Westbury brook trough.

References

1 Trotter, F.M., 1942, Geology of the Forest of Dean Coal and Iron-ore Field.

Institute of Geological Sciences, 1978, Geology Map, Monmouth Sheet 233, Solid and Drift.

2 The iron tubes may originally have been steam boilers.

3 Sopwith, T., 1841, The Awards of the Dean Forest Mining Commissioners.

4 Trotter, F.M., Ibid.

5 Oxford English Dictionary:
Trow: Troth (pledge), boat, etc and variant of trough.
Trough: A channel, pipe, or trunk for conveying water (dialect) usually trow.
to furnish with a trough for irrigation or drainage.
1668 Demise of a coal mine (Arncliffe Hall Mss.) "To carry a sough or water gate through the demised ground and to leave the same trowed and scoured".

6 Sopwith, T., 1835, Map of the Forest of Dean, Sheet 8.

7 Richardson, L., 1930, Wells and springs of Gloucestershire, p86.

8 Trotter, F.M., Ibid.

9 Tuffley, D., 1988, Royal Forest of Dean Caving Club Newsletter No 101.

10 Smith A.H., 1964, Place Names of Gloucestershire, Part 3 p239.

11 Richardson, L., Ibid.

12 Ford, T.D. (ED), 1989 Limestone and Caves of Wales (Chapter 10 Limestone and Caves of the Forest of Dean).

13 Hart, C., 1971, The Industrial History of Dean.

14 Aldous, Smart, and Black, 1986, Groundwater management problems in abandoned coalmined aquifers, Casestudy of the Forest of Dean, Quarterly Journal of Engineering Geology, Volume 19, pp375 - 388.