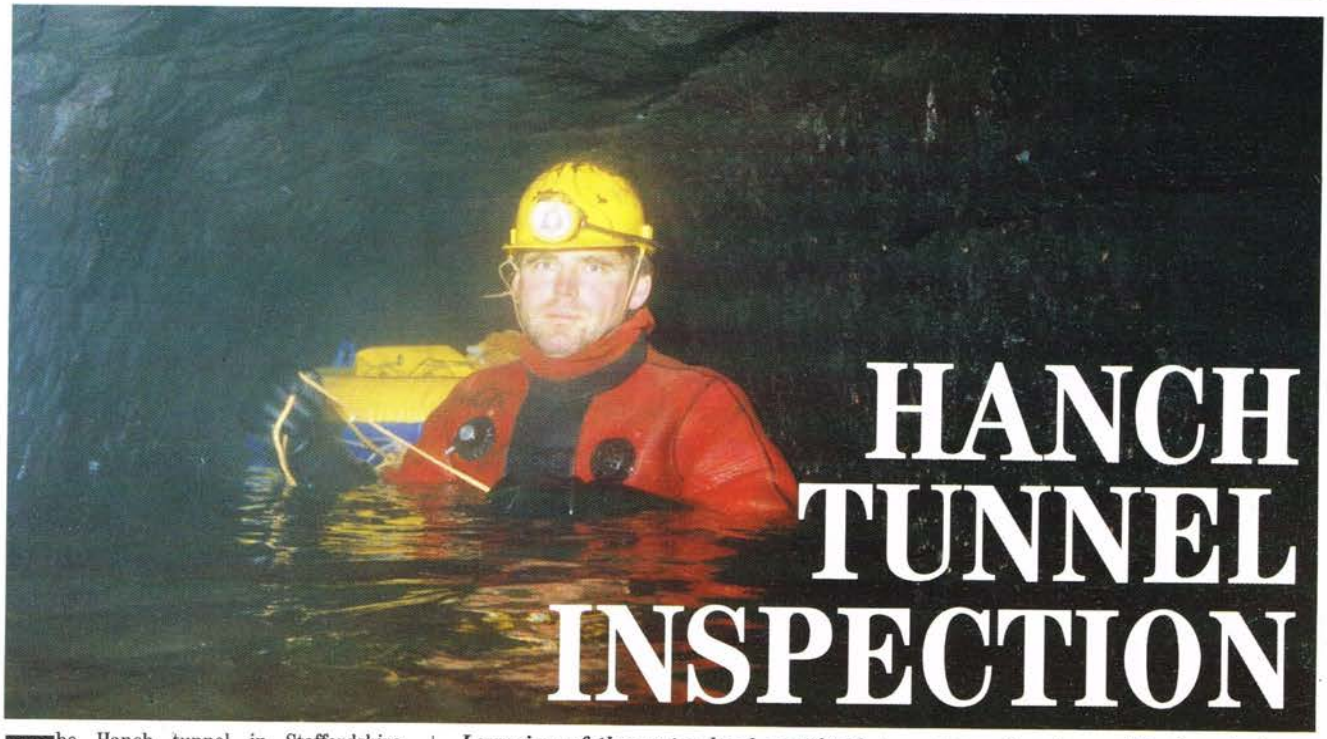


HANCH TUNNEL INSPECTION

The Hanch tunnel in Staffordshire, England, was dug in the 19th century to convey fresh water from the Seedy Mill Pumping Station to Sandfields Pumping Station. Infiltration into the tunnel results in a gain of 4·5 M1/d. Hence the tunnel, as well as being a conduit, is a source.

Under the control of the South Staffordshire Waterworks Co. the tunnel, as far as can be ascertained, has not been inspected since its construction.

The tunnel is approximately 3·8 miles (6 km) long, it has 29 shafts maximum depth 130 ft (40 m), and the length of tunnel between shafts varies from 250 ft to 1,450 ft (75 m to 440 m). The average tunnel cross-section is 3 ft × 5 ft 6 in high.

SHAFTS

The shafts were sunk from the surface from which the tunnel was dug. The information regarding the positon of the majority of the shafts has been lost over the years. When the tunnel was completed the top cover slabs were left below ground level and covered over in most cases. A few shafts only are available for inspection, only two having any form of permanent access.

Lowering of the water level permitted sufficient headroom for access between shafts.

The major cause for concern is the lack of knowledge regarding the condition of the tunnel and the position of the shafts.

Potential problems include a rock fall which could block the tunnel, and pollution from the surface via the shafts which would make the water unusable.

With the shafts lost and inaccessible and without the access into the tunnel at regular intervals, a rock fall could not be located nor any attempt made to clear it.

Similar problems would be encountered should pollution enter the tunnel, and the most obvious points of entry for pollution are the shafts.

Shoreline Engineering, a marine and underwater engineering specialist contractor, was approached by South Staffordshire Waterworks Co. with a brief to undertake a structural/observational survey of the tunnel between the two pumping stations, and to locate where possible the positions of shafts and identify their location.

Helium balloons were used to position sondes in the shafts.

Access is only possible through known Shafts Nos. 11, 16, 19, 20, 21, 23, 25.

Approximately 2 miles from Shaft No. 11 a hoist was established over the manhole with a drop of 130 ft to the water level.

Access at the remaining Shafts Nos. 19-25 is via purpose-made steps.

PROBLEMS

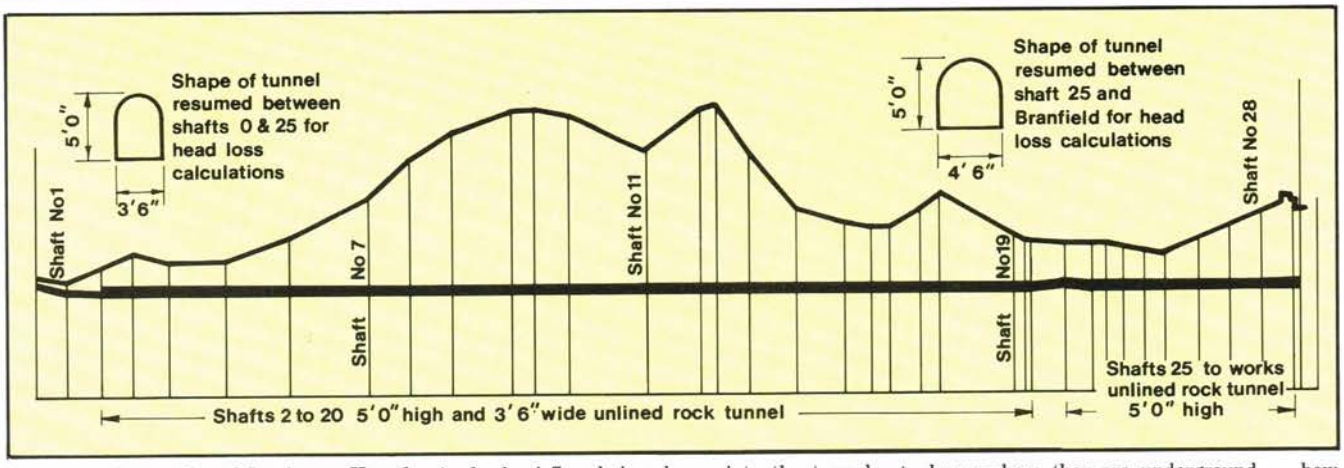
Several problems had to be overcome before work could start as no previous knowledge of the tunnel was available. It was possible to lower the water level to provide an average 600 mm of headroom. However, should the tunnel roof dip below the lowered water level then no further progress would be possible.

Siltation within the tunnel creates arduous conditions to walk in. The initial surveys between neighbouring accessible shafts enabled supplies of breathing air to be carried with full-face masks, with a portable gas detection unit with back-up positioned in front of the inspection team. This unit was equipped with an audible alarm for dangerous or toxic gases.

The very confined nature of the tunnel restricts the type and quantity of equipment that can be used. The silt depths, varying between 0·2 and 1·2 m, cause a slow and tiring progress. Also the roof height of the tunnel prevents one standing upright. Hence for a 1·6 m tunnel height, typically silt depth 0·4 m, water 0·6 m and 0·6 m headroom. All access along the tunnel is therefore walked at a slow pace.

Compressed-air breathing supplies (for emergency use), first-aid, cameras and survey equipment, together with back-up lighting and gas detection units, were transported in small inflatable boats.

On occasions when the tunnel headroom ▶



Section along the 6 km-long Hanch water tunnel.

lowered, the boats were partially deflated to pass through areas with down to 250 mm headroom.

SAFETY

With such large distances between access points, a portable air supply capable of allowing evacuation from the tunnel is not possible. An escape can be 2 h away.

The potential of a surface supply unit is not sufficient when considering the length of umbilical required and restrictions on movement.

Access was made against the direction of water-flow (except from Shaft No. 25 to Sandfields Pumping Station), and an extraction unit was established at the access position by sealing off the shaft and opening the exit shaft to draw fresh air through the tunnel. This worked successfully between Shafts Nos. 11 and 20.

However, upstream of Shaft No. 20 there is no entry point for fresh air. A suitable air entry point has now been drilled into the roof of the tunnel near Shaft No. 2 and capped with a removable lid. This section of the tunnel investigation is to be undertaken in the near future.

It is imperative for the reduced water level to be maintained in the tunnel. An increase of 150 m may prevent exit if a lowered roof level exists in the section between the access and exit points.

Constant monitoring of the water depth was carried out by South Staffordshire Waterworks Co. and checks were made prior to entry into the tunnel. An emergency phone link was established at the access point with two-way contact with the pumping station.

A lifeline, incorporating a hardwire communication link, was unreeled as the survey team progressed up the tunnel.

This provided a route back out along the tunnel (on occasions the tunnel forks with a short length to a sump — presumably used in the construction of the tunnel), and means of surface/inspection team contact and data logging.

The method of drawing air into the tunnel ensured that progress was always into the fresh airflow being drawn into the tunnel. Any gases disturbed were flushed downstream of the inspection team. The breathing equipment carried had a capacity of approximately 1 h.

The inspection team consists of a Chartered Engineer/Diver and a back-up team member also qualified to use compressed-air breathing equipment.

Two surface personnel are also present to monitor the progress, record data and monitor the air extraction unit. Should an increase in water level be detected at the pumping station an immediate message can be rung through to the surface team and passed to the inspection team currently up the tunnel.

Equipment includes:

— 3 No. inflatable boats (one as back-up)
— compressed-air breathing equipment
— marked lifeline/communications cable to relate chainage distances
— gas detection equipment
— lighting and back-up equipment
— underwater camera
— survey equipment.

SHAFT LOCATION

The requirement to locate the lost access shafts was most important, to provide entry points into the tunnel if required.

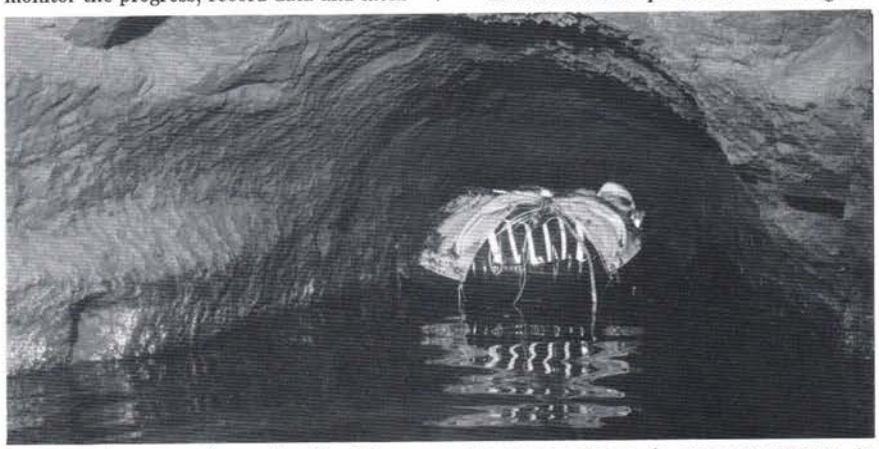
Conventional surface techniques of detection had been tried by South Staffordshire Waterworks Co. without success.

Shoreline Engineering approached the problems from the other position, i.e., we know where they are underground — how can we pinpoint this position on the surface?

The route of the tunnel prevents the use of conventional survey methods of distance and bearing.

Shoreline Engineering carried out tests on the use of a transmitting sonde located up to 8 m below ground level by means of a hand-held receiver with both audible and visual location indicators.

To overcome the problem of situating the transmitting sonde at the top of a shaft, helium balloons were filled within the shaft at water level and used to carry and position the transmitting sonde. No other access was available up the shaft. It was also impractical to transport any other type of equipment to the required position.



In some places it was necessary to deflate the survey dinghy to pass.

Once in position the depth of burial and actual position were determined and recorded. To date this has proved successful where the existing cover to the shaft does not exceed 6 m.

A complete written log with photographic records has been provided between the Sandfields Pumping Station and Shaft No. 11.

An attempt to complete the tunnel investigation and location of shafts between Shaft No. 11 and the Seedy Mill Pumping Station is to be undertaken in mid-1990.

by Nick Bunch

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