

THE DRAINAGE OF THE FENS

Not only are the Fens themselves a most ~~in~~teresting part of the landscape of Great Britain, but they provide an immense range of engineering interest - not just civil engineering, but mechanical too.

What are the Fens? And where? We mean, of course, the great Fenland of the East. There are other fens, e.g. in Somerset, but all are quite small compared with "the" Fens.

Fens 2.

Generally the silt and peat fens pose different problems. The silt was **alluvial** and the peat was deposited from thousands of years of marsh **vegetation**. The silt is a stable mineral soil now; the peat is an unstable vegetable (organic) soil which is still wasting away. Thus the problems in recent times have been more severe in the peat fens.

The Romans, whom we have already seen to be no mean engineers, did a lot of work in the Fens. There are several waterways and many miles of banks known or thought to have been constructed by them. The great "Roman Bank" around much of the Wash still exists, and although proof of its Roman origin is lacking, there are no other claims to it.

But nothing appreciable was done to the Fens during the many centuries following the Romans, and the drainage deteriorated up the beginning of the 17th century. The Anglo-Saxon invaders occupied the fenland by building their huts on the highest places. The early Christian missionaries and monks found the isolation of the fens attractive, and built monasteries there; parts of some remain (though not from Saxon times). Boston - one of the chief towns of the northern fens, was St. Botolph's Town, founded by St. Botolph in 654 - name changed to Boston less than 3 centuries ago. The Danes also appeared in Fenland, but the Normans were held out for a long time. All have heard of Hereward who resisted the Normans. Eventually the Normans conquered the Fens, but not altogether the Fenmen, who remained pretty independent all through the centuries, and bitterly opposed the draining in the 17th century.

Now we are concerned primarily with the engineering problem. What was it? There were two sources of inundation, causing the fens to be wet marshy places:-

- (a) the sea **breaking** into the land
- (b) the rivers bringing water from the highlands

Sea banks, such as the Roman bank, gave some protection against (a). There was really no protection against (b). The water falling on the highlands ran down towards the sea, and found the Fens below high-tide level and often barely above mean sea level. Obviously there was insufficient gradient to enable the waters of the rivers to flow properly into the sea, and so they just spread over the land. Things got worse as improvements in agriculture in the highland areas led to better drainage of the highland fields, and therefore faster run-off of the rain water.

There were several reasons for this being regarded as an unsatisfactory state of affairs:-

- (i) the waste of land that could otherwise be used for agriculture
- (ii) the destroying of crops and property on land that was often dry but subject to flood
- (iii) the interference with communications.

The last arose because the only normal channels of communication were the waterways - i.e. rivers in those days - but these were silted up, shallow, variable in course, with silted outfalls to the sea, all because their low gradient prevented any scour. Even as late as 1791 Robert Mylne complained he found only 8 inches of water above the cill at Clayhithe Sluice; and in 1802 John Rennie found no water at all passing down the Witham at Boston - Grand Sluice completely silted up. But we're going too fast.

It was towards the end of the 16th century that feeling became aroused that the Fens should be drained. Many schemes were put forward, and the general principle accepted by nearly all was that the gradient of the rivers must be increased to provide scour all through and especially in the tidal reaches and the outfalls. (Remember that the land was not above high tide level). The increased gradient was to be obtained by straightening and shortening the rivers. Of the rival schemes, that of Cornelius Vermuyden, prepared in 1630, was adopted; and although he was only partially successful, his works exist to this day. (So too do some earlier ones, usually carrying the name of their sponser - e.g. Morton's Leam, after Bishop Morton who about 1490 straightened out the Nene near Peterborough. Also Popham's Eau, after Lord Chief Justice Popham, 1609).

The main effort at this time was directed at the Great Level, which may roughly be defined as the Peat Fens South of Wisbech. The Earl of Bedford owned 20,000 acres of this, and in association with many other fenland owners, contracted to drain this Level - later (and still) known as the Bedford Level. He appointed Vermuyden, whose chief work was the Bedford River (now the Old Bedford River) running straight from Earith to Salter's Lode, 70ft. wide and 21 miles long raised above land level by 10-20ft. Sluices at both ends. Many other and minor works. There was at this time no expectation of providing complete freedom from flooding - only the expectation of dry ground in the Summer.

The Civil War raged from 1642 to 1649, and during this time the drainage works were neglected or seriously damaged. But a new Act was passed in 1649, with the Earl of Bedford once again (but this time the son of the former Bedford) the chief agent. He and his collaborators were called "adventurers" and Vermuyden was appointed Director of the Works. Vermuyden was generally unpopular and much detracted, but he did achieve considerable success amidst huge difficulties.

Vermuyden's biggest work this time was the New Bedford River, parallel to the Old Bedford River and 1/2 - mile to the east. It was 100ft wide and designed to cope with the whole flow of the Ouse and to contain the tide-waters. It had no sluices therefore. The Old Bedford River now became just a drain for the fen itself, and the old River Ouse a drain for the South level and for the rivers from the eastern uplands. The functions remain thus to this day. So we have the interesting phenomenon of the River Ouse dwindling almost to a ditch at Earith. But navigation has been preserved and a lock is provided.

Earith.

Denver Sluice.

There is a high bank to the West of the Old Bedford River and another to the East of the New Bedford River, thus providing a large flood ~~reservoir~~ i.e. "washlands".

Improvements have continued, but, apart from Rennie's drainage north of Boston, ~~early~~ 1800's, not on any ~~big~~ scale until recent years. A new cut straightened the Ouse from Denver to Kings Lynn and improved the outfall; this was completed only in the last decade. Further improvements are in hand.

So the rivers are now carried up high, above land level.

Drainage.

So much for the freedom from flooding by river water from the highlands. But to make good agricultural land, drainage is needed to keep the water table low enough.

In the silt fens this has mostly been by gravity. The land elevation of 10-15' above MSL enables land water to be conducted to the sea and emptied out at low tide. Some pumps are provided for emergency use, e.g. at Boston Black Sluice, but are indeed only rarely needed. The land remains relatively stable and drainage has not caused it to sink very much. Indeed, some of this land has had adequate drainage for so many centuries that it is a very beautiful part of England, with winding country lanes, old churches and cottages, even winding streams! e.g. around Bicker, Wigtoft, Donington.

The real problem arises in the peat fens. There always was a problem, but the shrinkage of the peat has greatly accentuated it.

For example, peat shrinkage and erosion, burning (accidental nowadays, once deliberate to reduce acidity), etc. Influence on railway embankments, river banks. Old courses of rivers now above land level, and so on. 12ft. shrinkage in many places already, and half the soil gone. Only gravel below the peat.

So we see that land water has to be raised to the level of the rivers. Machinery has been used to do this at least since 1555. The windmill was the source of power. We discussed in Lecture 2 how unreliable was a windmill, with suitable winds blowing only 5-20% of the time. But nevertheless, fen drainage was dependent on them until steam came. Fortunately, as the land sunk, necessitating even more powerful pumps, so better power sources came along:

Wind → Steam → Diesel and Electricity

The actual pump was not usually a water lift device, but a scoop-wheel.

It operated in a narrow channel which it fitted as closely as possible - often to within 1/4" but sometimes only 3/4". A sluice gate prevented water running back when wheel not operating.

The angle of the paddles was critical.

Circumferential speed of 8ft./sec was found optimum.

These were later driven by steam.

By the end of the 18th century there were approx 700 windmill-driven scoopwheels in the Fens.

The first steam-driven scoopwheel was installed in 1821* by the Littleport and Downham Drainage District. A very famous steam-driven scoop-wheel, now preserved as an "ancient monument", was that at Stretham near Ely, built in 1831; it was a single-cylinder condensing beam engine of 60HP, costing £4000, the scoopwheel being 30ft. diam. Manufacturer was the Butterley Co. later increased to 37'2".

15 steam engines installed between 1817* and 1835 (note slight discrepancy in different sources)

24 1835 and 1852

A modern pumping station e.g. Black Sluice Pumping Station at Boston.

Opened 1946.

Centrifugal pumps.

Pump Sth 40ft. drain into Witham estuary.

Level of bed of drain at Boston - 8.75 rel to ordnance datum (MSL)

(N.B. Drain bed slopes 3 inches/mile over 20 mile course and drains 101,000 acres fen and 64,500 acres highland).

High-tide level + 7.0 to + 18.0ft O.D.

Pumping capacity against head of 18ft. - 900 cusecs.

13ft. - 1200 cusecs.

5ft. - 1590 cusecs.

Engines are diesel, 3 engines each 900 H.P. (if windmill - 50 HP.)

References.The Draining of the Fens.

1. W. H. Wheeler, "A History of the Fens of South Lincolnshire," Newcomb (Boston) and Simpkin, Marshall (London) 1896.
2. H. C. Darby, "The Draining of the Fens", Cambridge, U.P., 1956.
3. G. I. Smith, "The Land of Britain", Part 69, "Lincolnshire (Parts of Holland)", Geographical Pubns (London), 1837.
4. A. K. Astbury, "The Black Fens", Golden Head Press (Cambridge) 1958.
5. R. L. Hills, "Machines, Mills and Uncountable Costly Necessities: A Short History of the Drainage of the Fens", Goose (Norwich) 1967.

See also the Ordnance Survey Maps: 1-inch O.S. Map No. 135
"Cambridge and Ely" is particularly interesting in showing old watercourses.
