WELLAND RIVER BOARD.

REPORT

ON THE LOWER REACHES OF THE

RIVER GLEN

----------oOo----------

R.L.G. BAXTER, B.Sc., A.C.G.I., A.M.I.C.E.
Chartered Civil Engineer.
Acting Chief Engineer.

Welland House,
Double Street,
Spalding.

Phone - Spalding 2245-6.

Dated:-

January, 1959.

WELLAND RIVER BOARD.

REPORT ON THE LOWER REACHES OF THE RIVER GLEN.

January 1959.

1. The Glen tributaries upstream of Kate's Bridge.

The River Glen above Wilsthorpe has two branches, known as the West Glen and the River Eden, both of which have their source a few miles south of Grantham.

The two rivers run almost parallel about three miles apart in a southerly direction and have their confluence at Wilsthorpe about one mile upstream of Kate's Bridge.

Above Wilsthorpe these two rivers run through fairly steep sided valleys and they have a bed slope or channel gradient which varies from 8 feet per mile to 12 feet per mile.

The general terrain bordering the rivers consists of grazing land with some arable fields. The percentage of arable land has tended to increase since 1939, but the lands adjacent to the two rivers are liable to flood and always will be unless the river channels are increased to 3 or 4 times their present size. The cost of this would be enormous and quite uneconomic for the area of benefit to be obtained.

Above Kate's Bridge it is only necessary to maintain a fair watercourse in these channels to reduce the incidence of flooding, and to drain off the water from the meadows in reasonable time after major floods.

In the case of the River Eden, in recent years the Board have carried out cleansing schemes from Wilsthorpe to Elsthorpe a distance of $12\frac{1}{2}$ miles and a scheme for work above Elsthorpe is under consideration for 1959.

The West Glen has been relieved by the construction of the new Greatford Cut from Greatford to Market Deeping which has been designed to take a maximum flow of 600 cu.secs. which is about 60% of the anticipated maximum flood flow of the West Glen at Greatford. This came into operation early in 1958 and was used throughout last year whenever there was a spate in the West Glen.

The above mentioned facts have to be taken into account before considering the main section of the River Glen between Kate's Bridge and its outfall at Surfleet.

2. The Glen downstream of Kate's Bridge.

The River Glen below Kate's Bridge flows through the fen area, and for the

whole of its length of some 15 miles it is embanked and forms a highland water carrier. At Tongue End, the Bourne Eau with its watershed from the two branches of the Car Dyke joins the River Glen through a sluice incorporating pointing doors. Also near Tongue End Bridge, water from some 3,240 acres of the Bourne South Fen and Thurlby District is pumped into the Glen.

Below Kate's Bridge the banks of the River Glen and Bourne Eau are essential to protect the Black Sluice and Deeping Fen areas, and to a lesser extent, the North Welland area on the North side at Surfleet.

On many occasions in times of flood these banks have been overtopped, and in the past, records show that on an average a breach occurred in the banks about every ten years up to 1910. The last serious breach occurred in 1947.

Considering in more detail the section of the river from Surfleet upstream we have:-

(a) Surfleet Sluice situated 13 chains from the confluence with the tidal section of the River Welland, has a cill level of -1.08 O.D.N. The sluice consists of two culverts of 15 ft span each with timber pointing doors on the tidal side and vertical lift sluice gates on the freshwater side with a retention level of 8.9 O.D.N. The sluice was built in 1879 and the doors and gates were repaired in 1956. The sluice structure and doors are all in a reasonable state of repair at the present time.

(b) From Surfleet Sluice to Herring Bridge, Pinchbeck, the Glen flows through relative high silt land with low banks in relation to the surrounding ground. Below Surfleet Road Bridge, a considerable number of buildings, nurseries, etc., have been built adjacent to the banks.

From Herring Bridge to Bars Bridge, West Pinchbeck, the channel is somewhat narrow and confined by banks and roadways on both sides. On this section any scheme of widening would be extremely expensive.

(c) Upstream of Bars Bridge to Tongue End, the river flows through open country with relatively high flood banks on each side, the South bank protects the Deeping Fen area and is maintained by the River Board. The North Bank protects the Black Sluice area and, as far as is known, is the responsibility of the Black Sluice Internal Drainage Board and is maintained by them.

Both of these banks are somewhat narrow compared with the recently reinforced flood banks of the River Welland and are liable to breach if levels within one to two feet of the top prevail, or if high water levels are maintained for any length of time.

On the South side, along the length known as Counter Drain Washes, the backs of the banks are steep with soke dykes and borrow pits within 10-20 feet of the bottom of the bank. This is again a potential danger in periods of high water in the river.

(d) From Tongue End upstream to Kate's Bridge the nature of the river changes, the bed gradient increases considerably, the banks gradually decrease in height and the soke dykes disappear. From Tongue End Bridge however, on the Bourne Fen side for about two miles, a fair amount of seepage occurs into the soke dyke at high levels and has to be pumped through the Bourne South Fen Pumping Station.

The Bourne Eau has not been surveyed or investigated for this report, but it should be borne in mind that when levels above 13 O.D.N. are experienced at Tongue End, considerable seepage from the Bourne Eau banks takes place into both the Bourne South Fen and the Bourne North Fen areas. Seepage in the Tongue End area is also considerably pronounced after a dry period, due to the shrinkage of the clay core in the banks. This however decreases after a few weeks of wet weather or high water levels.

3. Survey and Report.

The object of the present report is to consider the existing condition of the River Glen from Surfleet to Kate's Bridge and see what can be done to improve conditions for all concerned.

From general observations it has been found, despite the fact that the Greatford Cut has been in operation, and particularly in July 1958, unreasonably high water levels have prevailed at Tongue End and along the whole length downstream to Surfleet whenever heavy rainfall has occurred.

At the same time, the Bourne Eau is unable to discharge its waters into the Glen at Tongue End owing to the closure of the pointing doors, and its water is evacuated by means of an overfall weir (crest level 13.5 O.D.N.) into the Black Sluice Internal Drainage Board area. This is a very unsatisfactory state of

affairs and caused considerable embarrasment to the Black Sluice Internal Drainage Board in July 1958.

Following the Board's instructions at their meeting on July 24th 1958, a comprehensive survey has been carried out and sections taken from Surfleet to Kate's Bridge.

The survey shows that apart from weed growth, the bed of the river is in a deplorable state. The bed level varies considerably and there are numerous bars and obstructions some 2 - 3 feet above the normal bed level. On top of this, throughout almost the entire length there is some 2 - 3 feet of soft mud and cot or blanket weed which is one of the most pernicious weeds to obstruct the flow in a drainage channel, and difficult and costly to remove.

The river section and bed width vary considerably throughout its length and in places the bed width is only 15 feet with shoals on either side. There is no doubt that the overall capacity of the river is much smaller than it was years ago due to shoals, mud banks, together with cot and extensive weed growth.

4. Design Capacity and Run-off.

As no direct gaugings of previous floods are available, reasonable figures must be computed to assess the likely maximum design flow to be taken from Kate's Bridge downstream.

From the 1947 flood report, it was estimated that a peak flow of 2,400 cu.secs. occurred at Kate's Bridge at a level of 26.0 O.D.L. and this went on for several days during which the banks were overtopped and a major breach occurred in the South Bank about half a mile upstream of the Railway Bridge in the Counter Drain Washes section.

It is also interesting to note that Messrs. John Kingston and Alfred Harrison in their report on the River Glen in 1883 observed and calculated the peak flood in the Glen to be 1950 cu.secs.

If the Glen is to be enlarged to give the same capacity as the Welland under the Major Improvement Scheme, this was designed on a run-off of 25 cu.secs. per 1000 acres for the Upper Reaches and 20 cu.secs. per 1000 acres for the skirtland. Applying these figures to the Glen Catchments we get -

West Glen	42,800 acres at 25/1000 =	1,070 cu.secs.
River Eden	40,800 acres at 25/1000 =	1,020 cu.secs.
Bourne Eau and Car Dyke Area	3,684 acres at 20"1000 =	74 cu.secs.
Bourne South Fen and Thurlby pumped area		52 cu.secs.
		2,216
Less maximum capacity of Greatford Cut discharging into River Welland		600
Estimated total discharge at Tongue End	=	1,616 cu.secs.

I am of the opinion that this figure of 1,616 cu.secs. should be taken as the maximum design figure when taking into account the anticipated flows downstream of Tongue End. This figure might be exceeded under very exceptional circumstances. On the other hand 1,616 cu.secs. is only likely to be reached occasionally, say every 10 - 15 years.

I consider therefore the river should be made capable of containing a flow of 1,616 cu.secs. without overtopping or endangering the banks; it should be improved to take about half this flow, say 800 cu.secs. and at the same time keep the water level at or below 13 O.D. at Tongue End, to avoid seepage and spillage over the weir in the Black Sluice area.

Scheme 'A' has therefore been designed and costed on these lines.

Scheme 'B' has been designed on the same basis as the River Welland Major Improvement Scheme to take the maximum design capacity throughout the system and to keep the peak water level below 13 O.D.N. at Tongue End thereby avoiding any discharge into the Black Sluice area, or fear of seepage or danger to banks under almost all conditions of flood.

5. Operation of Greatford Cut.

It should be borne in mind that the design figures of flows and capacities allowed for in both Schemes 'A' and 'B' assume that the Greatford Cut can be used at all times in accordance with the original design of the River Welland Major Improvement Scheme and that the recent goodwill and relaxation of the Minutes of the Deeping Fen, Spalding and Pinchbeck Internal Drainage Board and the North Level Commissiomers will remain. Otherwise 600 cu.secs. would have to be added to the

maximum capacities in both schemes. This would either increase the overall cost to achieve the same results or increase the maximum water levels in flood periods in the section of the river Glen under consideration.

6. Existing Channel.

The results of the survey, combined with extensive hydraulic calculations and investigations show that:-

(1) The existing capacity of the channel at a level of 13 O.D.N. at Tongue End is only 300 cu.secs.

(2) The maximum bank full capacity of the existing channel is 1,500 cu.secs. and that any flows in excess of this figure must cause overtopping and danger of breaches in the banks.

7. Scheme 'A'.

As mentioned in a previous paragraph, this scheme would allow for a flow of 800 cu.secs. at a level of 13 O.D. at Tongue End and would be capable of containing the maximum design figure of 1,616 cu.secs. within its banks.

To achieve this it would be necessary to clean out the river from Surfleet to Kate's Bridge to the maximum width and capacity obtainable within its present banks and apart from minor protection works, the present bridges and roads etc., would remain.

In more detail the scheme consists of dredging the channel to what is considered its original depth, commencing at the cill of Glen Sluice - 1.08 O.D.N. rising to + 4.00 O.D. at Tongue End. Above Jubilee Bridge the channel has a gravel bed and widening only will take place in this length.

From Surfleet Reservoir to Surfleet Road Bridge an average bed width of 40 feet will be obtained. Removal and cartage of the dredged spoil will be necessary for some distance on this length. Dredging operations will be confined to one side of the channel due to buildings and properties adjoining the stream, and this will necessitate an extra long-jibbed dragline.

From Surfleet Road Bridge to Herring Bridge, Pinchbeck, the channel will be dredged to an average width of 30 feet and the spoil dumped and spread on the adjoining land.

From Herring Bridge to Bars Bridge, a road runs along the top of the bank for

virtually the whole length on both sides. The bed will be dredged to an average width of 25 feet and all the excavation will have to be carted away to a suitable dumping ground. It is suggested that the borrow pits excavated during the Banks Rehabilitation Scheme could be suitably used for dumping purposes.

Some distance upstream of Bars Bridge are the 'Tares' where a long slipe in front of each bank is available for widening purposes and through this length a bed width of 60 feet can be obtained, thereby reducing the hydraulic gradient. Above this section and through to Kate's Bridge the maximum channel width will vary from 45 ft. to 25 ft.

All dredged spoil along this length will be utilised to heighten and strengthen the banks on both sides.

The total estimated cost of this scheme amounts to £173,300 as per detailed estimate attached.

8. Scheme 'B'.

This scheme, which would give a maximum water level of 13 O.D.N. at Tongue End under almost all conditions, would involve very extensive widening of the existing channel together with the disturbance of roads and property, renewal of all road bridges and a new sluice at the outfall.

In more detail it would consist of the following:-

An additional sluice with two 15 ft. openings would be provided at Surfleet Reservoir with tidal doors and freshwater retention doors.

The channel would be widened to a bed width of 80 ft. and regraded from the cill of the sluice to + 2.00 O.D.N. at Tongue End.

The existing bridges at Surfleet Railway, Surfleet Main Road, Pinchbeck Railway and Counter Drain Railway would be retained but extensive piling works would be necessary at each structure to give maximum channel capacity and to protect the footings against scour.

From Surfleet Reservoir to Surfleet Road Bridge, to obtain the necessary 80 ft. bed width, widening would take place on the South side and this would mean the removal of two permanent bungalows and the temporary structures at Surfleet Reservoir.

From Surfleet Road Bridge to Herring Bridge widening would take place on the North side and no properties would be involved. The reconstruction of Flaxmill