

ARTERIAL DRAINAGE.
Valleys of the Rivers Glen and Welland.

EXTRACTS FROM A REPORT TO THE BOARD OF AGRICULTURE AND FISHERIES BY MESSRS. GRANTHAM AND BIDWELL.

In accordance with instructions from the Board, we visited, on the 17th and 18th September, the District within the jurisdiction of the Trustees appointed under the Deeping Fen Drainage Act, 1856, and the Welland Drainage Outfall Act, 1867, and the Trustees of the River Glen appointed under the Spalding Enclosure Act, 1801.

* * * * *

We held a conference on the 17th September at Spalding, with the following representatives of the various Trusts—viz., Lord Kesteven, Chairman; the Marquis of Exeter, and Mr. W. Dennis, members of the Deeping Fen Trust; Mr. L. C. Harvey, of Messrs. Calthrop and Harvey, Clerks to the three Trusts; and Mr. H. Bain, Engineer and Superintendent to the Deeping Fen and Glen Bank Trusts.

On that and the following day we made a personal inspection of the District, and were accompanied, on the first day, by Lord Kesteven, the Marquis of Exeter, Mr. Dennis, Mr. Harvey, Mr. Bain, and Mr. F. O. Mawby, Chairman of the Welland Trust, and on the second day by Lord Kesteven and Mr. Bain.

District, Acreage and Drainage Authorities.—The District within the jurisdiction of the Welland Trust wholly covers that of the Deeping Fen Trust and comprises about 82,000 acres, partly within the Parts of Kesteven, but mostly within the Parts of Holland Division of Lincolnshire, and forms an irregularly shaped area having Kirton for its north-eastern and Deeping St. James for its south-western limit. The town of Spalding is its chief commercial centre.

CONSTITUTION OF TRUSTS.

Deeping Fen Trust.—The Deeping Fen Trust dates its constitution from the Deeping Fen Drainage Act, 1856, which consolidated and amended several previous enactments relating to the drainage of the district. The area within the jurisdiction of the Trust is about 30,000 acres (part of the 82,000 acres administered by the Welland Trust) lying between the Rivers Glen and Welland from Deeping St. James on the south to Spalding on the north, but extending, so far as the control of the Trust over the Vernatt's Drain is concerned, to a place known as "the Reservoir" at Surfleet.

Welland Trust.—The Welland Trust was constituted by the River Welland Outfall Act, 1867, but the matters of drainage outfall and navigation with which it is principally concerned were the subjects of at least four earlier Acts.

Glen Bank Trust.—The Glen Bank Trust was constituted under the Spalding Enclosure Act, 1801, and is wholly concerned with the repair and maintenance of banks.

GENERAL CHARACTERISTICS OF DISTRICT.

The general elevation of the land is from 5 to 13 feet above Ordnance datum. Practically all the roads and the two railways (G.N.R. and G.E.R.), which pass over the area, are embanked, and show, according to the Ordnance maps, surface levels varying from 9 to 25 feet above datum.

The soil characteristics appear to answer pretty closely to the summarised description in Mr. A. J. Jukes-Browne's *Geology of South-West Lincolnshire*,* and indicates that above the general bed of Fenland Boulder Clay there are deposits of marine sands and gravels covered in many places with forest peat, intercalated

* *Memoirs of the Geological Survey.*

with, or succeeded by, clays and silts. About three-fifths of the surface soil within the Deeping Fen area is, according to the Geological map, composed of peat, and that of the remainder of the area estuarine deposits.

SYSTEM OF FARMING.

The area comprised in these Drainage Districts is divided into well-arranged and well-equipped farms, varying in size, and occupied for the most part by tenant farmers, but in some cases by owner occupiers. The land, particularly the silt land, is very productive and grows fine crops of cereals, potatoes, mustard for a crop, turnip seed, beans, &c.

Potatoes have in recent years become one of the staple crops of the Fenland, and a large acreage is planted each year, the profits in a fair season being highly remunerative. The area under this crop in the whole of the affected parishes was in 1912, 26,750 acres, of which about one-half would probably come within the Welland area.

Carrots, mangel wurzel, cabbages, and other root crops, are largely grown, and celery is a special crop which is now grown largely for the Midland and London Markets. In many parts, on the silt lands, the cultivation of fruit trees, bush fruits, and asparagus, has developed new industries.

In the neighbourhood of Spalding, Holbeach, Surfleet, and Whaplode, a large trade is done by Small Holders and others in the cultivation of bulbs, such as daffodils, narcissus, crocus, and snowdrops, and the producers can, we are informed, compete to advantage with the Dutch Markets.

A limited area of the richest loam soil is still used for the cultivation of "woad"; the fen land is practically the only district where this plant is now grown for dye.

Both on the Peat Lands in Deeping Fen, and on the richer alluvial soil between Spalding and the Wash, the five-course system of farming chiefly prevails, viz., first year, fallow, *i.e.*, sown with potatoes, mangel wurzel, turnip seed, or mustard for a crop, or coleseed; second year, oats or barley; third year, wheat; fourth year, artificial grass seeds, or beans, or peas; fifth year, wheat. Under this system three-fifths of the arable land are in white straw cropping in each year. Potatoes are sometimes taken again in the fourth year.

In addition to the arable lands there is, in parts of the district, particularly in the neighbourhood of Spalding and Holbeach, fine old pasture land which will, with the assistance of cake, fatten bullocks and sheep.

The farms throughout the whole area are readily let and will always command men of capital to cultivate them, at a good rental, provided the drainage of the land is secure.

In 1912 a very considerable loss was sustained by all occupiers of land in this district by the excessive rainfall on the 26th of August; a very large area of potatoes was entirely destroyed, and had to be ploughed in, and the greater part of the Fen Land was flooded.

This season, 1913, has been an exceptional one, and the white straw crops, potatoes, mustard, and the root crops generally, are extremely good, and promise an abnormal return.

The South side of the area under review is bounded by the uplands, which discharge their waters through the fen lands, ultimately, into the Welland.

SYSTEM OF DRAINAGE.

The Welland.—The outfall of the Welland is confined for about 3 miles below Fosdyke Bridge by training banks, on each side of which are considerable areas of salt marsh, or outmarsh, not yet reclaimed from the sea, but which are comprised in the area allotted to the Lincolnshire Estuary Company, under their Act of 1851. Beyond the training banks, the river follows a more or less irregular channel through the shifting sands of the Wash. The area of land within the watershed of the Welland above the fen area is about 204,650 acres. The training banks, when made, did immense good by increasing the scour of the channel between them and lowering the low water level. They should in our opinion be continued.

The Glen.—The River Glen, a tributary of the Welland, discharges through a tidal sluice into that river at "the Reservoir" and flows through Pinchbeck and Surfleet. From Pinchbeck Bars, upwards, the water is carried across the fen land

between banks, parts of which, as far as Kate's Bridge, are about 12 feet high; the bed of the channel for some distance is on a level with, or even a little higher than, the general surface of the land. This part of the river is merely a carrier for the upland water, and receives no drainage from the land in its course. The area of land within the watershed of the Glen above Kate's Bridge is about 75,600 acres.

Deeping Fen.—Deeping Fen is drained, internally, by the Counter Drain, the North Drove and the South Drove Drains. The water in the Counter Drain flows by gravitation past Pode Hole into the Vernatt's Drain, whilst the water in the North Drove and South Drove Drains is raised at Pode Hole, by two old-fashioned scoop wheels, driven by beam engines, into the Vernatt's Drain. Since the Autumn floods of last year, the Deeping Fen Trustees have arranged to erect at Pode Hole pumping plant, comprising a centrifugal pump and a Diesel engine, to supplement the present pumping power, and to clear out the North and South Drove Drains and the Vernatt's Drain at a total estimated cost of £10,000.

The Vernatt's Drain discharges into the Welland through a tidal sluice close to the Glen Sluice at "the Reservoir."

Present State of Drainage.—We have seen no longitudinal section of the present condition of the bottom of the Welland, but judging by an inspection of some points in it, there can be no doubt that it is very irregular and in some parts very shallow.

About 7 miles below Fosdyke Bridge there is not a greater depth in the channel than 2 to 3 feet of water at low water spring tides.

Below Fosdyke Bridge the banks appear to be in good order, but we are without information as to the state of the bottom of the river. Higher up, at the outfall of the Glen and Vernatt's Sluices, we saw shoals, and at Spalding the channel is narrow and irregular. Below Market Deeping, although the river is fairly wide it is very shallow, containing, when we inspected it, not more than about 2 feet of water.

The trouble in the River Glen arises, as the Memorial points out, in the channel between the banks above Pinchbeck, and this is due to the insufficient depth of the bed from the Sluice upwards. In 1879 the Sluice was rebuilt and the sill lowered 6 feet, and it was then proposed to deepen the bed correspondingly: this latter work was not, however, carried out, owing, as we understand, to want of funds; the consequence is that the flood water from the uplands rushes down with great velocity and rises against the banks to such a height as to burst them. Some of the upland water, which at one time flowed into the North Drove Drain, is now intercepted by a catch-water drain alongside King Street, this drain discharging into the Glen at Kate's Bridge. When the Glen is in flood it holds back the water in the drain and causes flooding of the land on the west side of King Street (Roman Road from Bourn to Ufford). Deepening the bed of the Glen would, by lowering the water level, therefore, not only relieve the pressure which the banks are quite unfit to withstand, but would also relieve the lands on the west side of King Street in flood time. It is doubtful whether, under a central authority, this diversion would have been permitted.

Mr. Bain, the Engineer of the Deeping Fen Trustees, submitted to us the longitudinal and cross sections which accompanied reports made by himself and Mr. Sanderson Robins in November and December, 1911, on improvements in the Glen and the deepening he then proposed. He and Mr. Sanderson Robins also made estimates of the cost. Their first estimate amounted to £141,900, but as this was considered too costly they prepared other estimates amounting to £62,438 and £44,398.

The difficulty, however, of doing anything to this river lies in the fact that the deepening of the bed and the control of part of the banks is vested in four authorities, viz., the Deeping Fen Trustees, the Glen Bank Trustees, the Black Sluice Commissioners, and the Bourne South Fen District Drainage Board.

* * * * *

Serious breaches in the banks of this river have occurred in the undermentioned years, viz., 1830, 1831, 1837, 1872, 1877, 1880, 1882, 1897 and 1910.

* * * * *

In considering any improvements to the outfall of the Welland where it enters the Wash, it is necessary to refer to the Witham Outfall Improvement Act of 1880,

under which it was proposed to make a new cut for the Witham through the sands into Boston Deepes.

During the passage of the Bill through Parliament it was opposed by the Welland Outfall Trustees on the advice of their then Engineer, who apprehended that the cut would be detrimental to the outfalls of both the Witham and the Welland: in the result, the Welland Trustees obtained the insertion of a Clause (17) to the effect that if within 20 years of the completion of the Works in the Witham they desired to cut and form an improved channel from the (then) point of confluence of the two rivers, and intimated their desire to do so to the Witham Outfall Board, that Board should, after approval of the Witham Scheme, pay one-half the cost of the Welland Cut, or £20,000, the Engineer's estimate being £40,000. We are informed that the reason why the Welland Trustees did not take advantage of the Clause was that they lacked sufficient funds.

The results of the works in the Witham Outfall, which were completed in 1886, may perhaps be of some assistance in considering what might be effected in the Welland.

The cost of the Witham Outfall works was £168,000, and the area deriving benefit is 194,649 acres. The effect of the works has been to lower the low water level 4 feet at the Black Sluice at Boston and 4 feet at the Grand Sluice at Boston, an immense benefit to the whole area.

The Welland Outfall Trustees obtained estimates for making a similar cut, and these varied from £40,000 to £150,000. The difference was due to the different methods proposed by the Engineers consulted.

The whole area being so exceedingly flat, the efficiency of the outfalls is of the greatest importance.

The scheme of drainage as it exists is good and, generally, could not be very well improved upon, but the rivers and outfalls have become very seriously silted up, and, owing to a series of comparatively dry years, the cleansing and deepening of interior drains have been much neglected. Evidence of this appears from a statement made by the Deeping Fen Trustees to your Board that some part of the South Drove Drain has not been cleansed for 40 years.

From 1875 to 1883 there was a series of wet years in this part of the country, which was then terribly flooded. This was followed by a series of dry years, when the rainfall was below the average. These dry years continued with a few exceptions up to August, 1912; the excessive rain at that time and in the following autumn demonstrated the inefficient state of the drains all over the low-lying parts of the country. The South Drove Drain has been recently thoroughly cleared out, and work was in progress in the North Drove Drain. These drains, however, conduct the water to the pumps at Pode Hole, and they derive the full benefit of the clearing, but the Counter Drain, the Vernatt's Drain, Risegate Eau, and the Glen, all of which discharge by gravitation, cannot get the benefit of clearing and deepening, so long as the Welland remains as choked as it is. A new cut for the outfall is absolutely necessary in order to relieve the fen land above in times of flood. Moreover, if the Welland could be improved the cost of pumping at Pode Hole would be much reduced. To relieve the land entirely of such a flood as occurred in August last would be, in our opinion, impracticable, but at any rate the water might be discharged much more rapidly, and would not remain so long on the surface.

Value of Land.—The total area of these Fens has not depreciated in value during the last decade; on the contrary, notwithstanding the loss sustained last year (1912) there has not been a period for many years past, when these Fen Lands would more readily let, or sell, than at the present time. This is greatly due to the fact that they are inexpensive to cultivate, and give a good return in normal seasons.

The letting value may be taken to vary from 35s. to 60s. per acre; the fee simple value in recent years has been enhanced, and good, well-equipped farms, to pay 4 per cent., will readily find purchasers.

* * * * *

DRAINAGE RATES.

Deeping Fen Trust.—The Deeping Fen Trust possesses no borrowing powers other than those exerciseable by the ordinary process of mortgaging prospective revenues, but "with the consent of the owners, &c.," has unlimited powers of taxation above the rate of "one shilling per acre" provided by Section 103 of the Spalding Inclosure Act of 1801, and confirmed by later Acts.

The rate made for the year 1913-14 is five shillings per acre (including the statutory shilling rate. This compares with rates which between 1904 and 1912 have varied from two shillings to three shillings and sixpence per acre for general works purposes. The average for the past ten years is two shillings and sevenpence per acre.

There is a separate rate of one shilling and sixpence per acre charged in perpetuity on about 10,000 acres in the parish of Deeping St. Nicholas, known as "Adventurers' Taxable Lands." These lands, which form part of the 30,000 acres, are also subject to the general rate levied by the Trust.

In addition to revenue from rates, the Trust is entitled to rents and other payments which, last year, produced about £1,400.

Welland Trust.—The Welland Trust has, under Sections 27 and 28 of the Act of 1867, power to borrow or re-borrow, on the security of its revenues, lands, or other property, such sums, up to £10,000, as may be requisite for the purposes of the Trust. Its rating capacity is limited to eightpence, sixpence and fourpence per acre upon lands which are separately scheduled to the three rates in Section 21 of the Act, which also confirms to the Trust, in addition, "any taxes payable under the Welland Outfall Acts (1794 and 1824) or otherwise." The two sets of rates appear from the accounts to be inelastic and to produce about £1,635 and £553 per annum respectively. The larger sum is collected from the whole of the 82,000 acres comprising the Welland area, and the smaller from that part of the area which is comprised in the Deeping Fen area.

The Trust receives various dues under the heads of "Tonnage," "Port," and "Pilotage," which in 1912 amounted to about £955, and certain rents and other small payments which in the same year yielded about £90.

The Trust is liable, in addition to its own charges, for one-third of the cost of maintenance of the buoys and beacons within the jurisdiction of the Boston Harbour Authority: the proportion so payable averages about £293 per annum, but appears from the accounts for 1911 to have been, in that year, £324 4s. 8d.

Glen Bank Trust.—The taxable area of the Glen Bank Trust comprises about 32,000 acres in Deeping Fen, parts of Baston, Thurlby, Bourn and Spalding, and the whole of the old enclosed lands in the parishes of Pinchbeck and Surfleet and Crowland Common.

The rates made by the Trust were originally levied upon owners having frontages to the river in proportion to the lengths of frontage in each case; these were afterwards converted into an acreage rate in such proportion as then existed, and that rate remains a charge on the land notwithstanding any subsequent division or change in ownership. The average receipts for the past 10 years have been about £600 per annum, showing an average rate of about 4½d. per acre. The rate levied for the current year amounts to £595 14s.

Other Drainage Authorities.—Apart from the rating areas of the Deeping Fen and Glen Bank Trusts, there are within the limits of the Welland area (82,000 acres), lands within the rating areas of ten other drainage authorities—viz., (1) Black Sluice Commissioners, (2) Boston Court of Sewers, (3) Crowland and Cowbit Washes Drainage Board, (4) Deeping Fen Washes Drainage Board, (5) South Holland Drainage Board, (6) South Holland Embankment Trust, (7) Spalding and Pinchbeck Drainage Board, (8) Holland, Elloe and Sutton St. Edmunds Commission of Sewers, (9) Moulton Salt Marsh Drainage Board, and (10) Fourth District Drainage Board (separated from the Deeping Fen Trust in 1832). It thus appears that no fewer than 13 separate bodies have executive jurisdiction and powers of rating for drainage and kindred purposes within the area.

* * * * *

FINANCIAL LIABILITIES.

The **Deeping Fen Trust** has no loans outstanding, but has recently incurred a financial liability estimated at £10,000 in respect of the works to which previous reference has been made.

The **Welland Trust** has an outstanding debt of £3,500, being the unpaid balance of a loan contracted many years ago, principally for the improvement of the outfall.

The **Glen Bank Trust** has no loans outstanding.
(B 1300-5)

MAINTENANCE OF BANKS, WORKS, AND WATERCOURSES.

Deeping Fen Trust.—The Deeping Fen Trust is responsible for the maintenance of the whole of the banks, channels, sluices, pumps, and other works within its own area (including the Vernatt's Drain from Pode Hole to "the Reservoir"); for the channel of the River Glen from Kate's Bridge to "the Reservoir," and for the north bank of the Welland from Town End Tunnel, in the parish of Deeping St. James, to the High Bridge at Spalding. The same Trust defrays about one-third of the cost of maintenance of the south bank of the River Glen from Kate's Bridge to "the Reservoir"; the average contribution towards such cost has amounted during the past ten years to about £123 per annum. The Trust also pays Welland rate, amounting to about £19 per annum.

Welland Trust.—The Welland Trust is responsible for the maintenance of the Welland navigation and outfall channel and for both banks of the river from "the Reservoir" seaward. (From the High Bridge, Spalding, to "the Reservoir" the banks are maintainable by the frontagers.)

Glen Bank Trust.—The Glen Bank Trust is responsible for the maintenance of the south bank of the River Glen from Kate's Bridge to "the Reservoir," and for the north bank within the same limits, except for a length of $5\frac{3}{4}$ miles between Thurlby Rails and Pinchbeck Bars, which is maintainable as to 5 miles by the Black Sluice Commission, and as to $\frac{3}{4}$ mile by the Bourne South Fen Drainage Board.

The minor drains of the general system are maintainable by the owners of the lands traversed by them, and are not subject to the control of either of the Trusts.

Works Required and Probable Cost.—The amount required to effect a substantial improvement is very large.

We have already mentioned the variation in the estimates, those for the Welland Outfall varying from £40,000 to £150,000, and those for the Glen from £44,000 to £141,900, not including legal and parliamentary expenses.

The £40,000 estimated for the Welland Outfall is certainly too small. It was considered that by making a training bank on each side of the channel the scour would remove a great deal of the silt to be excavated; but there is a considerable bed of clay at the north end, as the name Clay Hole denotes, and no scour would remove it. The channel required for the Welland is not so large as the Witham channel, but judging by the expenditure on the latter, it would not be safe to calculate on a sum of less than £120,000 for the Welland Outfall. This does not allow for removal of shoals or deepening the river from Fosdyke Bridge, or for improvement through Spalding up to the Vernatt's and Glen sluices, a distance of 8 miles. These works would probably cost not less than £80,000.

We understand that Messrs. Robins and Bains' estimate of £62,438 for deepening the Glen was for works alone, and did not include allowances for law costs, compensations and contingencies. In our opinion the estimate should be increased to £75,000. The deepening and widening of the Vernatt's Drain lower down to its sluice is also necessary for the effectual drainage of the District.

Without entering into further details it appears to us that an expenditure of not less than £300,000 is required for the effectual improvement of the two rivers and the Vernatt's drain.

* * * * *

The first and most important work is, undoubtedly, the deepening of the outfall of the Welland below the existing training banks to Clay Hole or to some other point in the Wash to be determined upon. Upon this work depends the improvement of the Welland, of the Glen, and of the Vernatt's Drain, as the effect of it would at once result in a lowering of the low water level just as the Witham Outfall lowered low water level at the Black and Grand Sluices at Boston. This work by itself would not, however, do all that is required to relieve the whole district in times of flood. It must be followed up by the deepening and improvement of the Welland, especially through Spalding, and of the Glen and the Vernatt's Drain. One benefit from the deepening of the Glen up to Kate's Bridge would be, as previously stated, the relief from flooding of the lands on the west side of King Street, which are not in the rateable area of any of the Authorities, and the benefit from the widening and deepening of the Vernatt's Drain would be the reduction in the pumping necessary at Pode Hole.

We were informed by Lord Kesteven that he had bought the Mill above Kate's Bridge, and intended that it should no longer be an obstruction to the discharge of flood water.

The deepening of the Outfall of the River Welland and an improved channel from Fosdyke to deep water would necessarily increase the value of the lands contained in the area under the jurisdiction of the Welland, Deeping Fen and Glen Bank Trustees; chiefly because by lowering the Outfall the drainage would be materially improved, and the risk of this area being flooded by an abnormal rainfall minimised. Occupiers of farms would, therefore, feel that their crops were safe.

The Witham Outfall works were, as we have said, carried out at a cost of £168,000. The rate collected from the rateable area of 194,649 acres in respect of interest, sinking fund and maintenance averages for the differentially rated districts within that area about one shilling per acre. The loan in respect of works was for 35 years, at the end of which term the larger proportion of the present acreage rate will cease.

Assuming a similar basis of charge for the Welland Outfall, our estimate of £120,000 would show a rate on the 82,000 acres of 1.68 shilling, or rather more than eightpence per acre above the Witham Outfall rate.

* * * * *

Disabilities of Existing Authorities.—At present the difficulty of any combined action on the part of the Drainage Boards, Trusts, and Commissions already established appears insuperable. As an illustration, we have been informed that after the breach in the Glen Bank in December, 1910, the Glen Bank Commissioners and the two other bodies of Trustees endeavoured to combine for the purpose of carrying out improvements in that river, but that the project fell through.

Suggested Inclusion of Areas.—In any comprehensive Scheme such as we suggest we think that the area of control and rating might with advantage be enlarged by the inclusion—*e.g.*, of an area of 7,918 acres comprising the Maxey Drainage District, and of a smaller area of about 2,000 acres east of the Car Dyke and north of Market Deeping, not at present within any drainage district.

The Maxey Drainage District was formed in 1863 under the Land Drainage Act, 1861. The water from a small part of the area, about 700 acres, is pumped, but the larger part of the District is drained by gravitation into the Welland, near Peakirk. If advantage were taken of the facilities for improving the upper part of the Welland, which would be afforded by a new outfall and the upper part of the river were improved, the discharge of water from the main drains of the Maxey District would be greatly accelerated; that District would not, however, derive direct benefit by the suggested new outfall alone.

* * * * *

(Signed) RICHARD F. GRANTHAM,
M.Inst.C.E., F.G.S.

(Signed) CHARLES BIDWELL, P.P.S.I.

December 4th, 1913.