REPORT

ADDRESSED TO

THE SECRETARY TO THE COMMISSIONERS

FOR THE

LOAN OF EXCHEQUER BILLS,

ON

THE IMPROVEMENT

OF THE

NAVIGATION OF THE RIVER WELLAND.

BY JAMES WALKER, F.R.S. L. AND E.,
CIVIL ENGINEER, LONDON.

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1839.

RIVER WELLAND NAVIGATION.

J. S. Brickwood, Esq., Secretary to the Commissioners for the Loan of Exchequer Bills.

Sir,

In compliance with the directions of your letter, dated 12th October, I proceeded, on the 23rd of the same month, to survey the works in progress for the improvement of the River Welland, below Fosdyke Bridge. On the 24th Mr. Bonner, Clerk to the Trustees, and Mr. Beasley under whose superintendence the works have been done, accompanied me upon the survey.

I have since received from Mr. Bonner some accounts and other details of information, which on consideration of the subject I had applied for.

Your instructions to me, state that the Trustees had transmitted to you a copy of my Report to them dated November 1835. The Commissioners would see from that Report, and the Plan which accompanied it, the nature of the works then recommended for the improvement of the River below Fosdyke Bridge; and as the recommendations have been followed in the part which has been done, it may be sufficient to refer to that Plan and Report without troubling you with a repetition, and to state that the new course for the River has been formed for about a mile and a half below the Bridge, and that this is the only thing of a public nature which has been done.

You would observe by the estimate in the Report, that the cost of the proposed new course for the River was calculated separately from the embanking of the River, for the purpose of reclaiming the saltings and other land which is covered by the sea at every high water. (See Appendix.)

Now to your first question: "If the proposed works are of a public character and likely to produce beneficial results of importance?"

I reply that although the work of embanking and reclaiming is important, by the conversion into excellent land of several thousand acres, which are now almost entirely useless, I consider this as of a private nature; but that in so far as the embankments, by being raised above the highest tide, would define and confine effectually the course for navigation the work is public; that the embanking is therefore of a mixed nature.

The formation of the straight channel for the River through the bay, which is what has in part been done, and to which the loan now applied for is, as I understand, to be exclusively applied, I consider as decidedly of a public character, and likely to produce beneficial results of importance.

That the River Welland is not better known as a public navigation may be supposed to arise from its very defective state, particularly before the present works were begun. I stated in my Report already referred to, that there was no lift of tide perceptible even at Fosdyke Bridge excepting at spring tides; that I had seen a gang of lighters drawing only eighteen inches unable to get to Spalding even at spring tides; that at low water in dry seasons there were but a few inches in the channel of the River below the Bridge, and that the channel was so extremely tortuous and shifting that the navigation might be said to depend entirely upon the rise of tide; that vessels drawing 3 feet to 3 feet 6 inches, were frequently not afloat at Spalding except during

a few days at the top of the springs; and if of greater draught not at all, unless the springs were high: also that the sudden bends and twists through the sands below the Bridge were if possible a greater evil than the want of depth. In my last visit I was informed that six weeks were sometimes taken in getting up through the 2¼ miles below Fosdyke Bridge.

Notwithstanding the above difficulties the Welland has been navigable after a fashion for 27 miles above the Bridge. Spalding, Deeping, Stamford, Crowland, Peakirk, and Bourn, are the principal towns in the line of it or of the River Glen, which joins the Welland about 3 miles above Fosdyke Bridge and the district of Coventry including Holbeach, Moulton, &c. round the above towns, of which the Welland is the natural navigation for the supply of coals, and the shipping of produce, is at once extensive and fertile. I have said the *natural* navigation, because such are the effects of the improvements of the Nene, and such the bad state of the Welland, that although the latter river runs through Stamford, that town is or was supplied through the Nene at Wansford, from which the coals had to be carted six miles. The effect of this has been a reduction of the trade between James Deeping and Stamford, to one-half since 1832, and a proportionate reduction of tolls in the upper district.

The improvement of the Welland will also be important, in substituting natural drainage for the present very expensive artificial mode of drainage by means of steam-engines, extending over 30,000 acres in Deeping Fen above and 6000 to 8000 acres in other levels which, particularly those upon the Glen and the Washes, are very imperfectly drained, very subject to floods, and of comparatively little value.

The small portion of the work that has already been done has been practically useful, almost beyond my expectation, and is an earnest of what may be looked for.

Already vessels drawing eight feet can after reaching the new channel

get through it and up to the Bridge with as much ease and far greater certainty than those of three feet could do in 1835. The course is now straight and fixed, and the depth regular for a width of 125 feet at the Bridge and 150 feet at the end of the length done; so that there is now no uncertainty as to getting up or down at every spring tide.

In my Report of 1835, I stated, that "if the formation of the new "channel were to be done wholly by excavating the expense would be "heavy; but that I thought this would be useless labour, and that if the "proper directions were given, the requisite size of channel would be "formed by the current itself; so that the principal expense would be, "in supporting the sides by long thorn faggots or fascines, successively "and progressively applied as the depth of the new channel might "require."

This course has been followed most successfully, even without any of the previous embanking or partial excavation referred to in my Report. The sides being formed the excavation of the channel has been done without any expense, and is as perfect as if it had been made by hand; indeed more so as the depth and form are exactly conformed to the quantity and velocity of the current. The work appears to stand well and is very creditable to Mr. Beasley; for in a work of this kind, where tides and currents are to be watched and taken advantage of, more depends on the execution than the design.

In answer to your second question, viz., "the cost of the part done," I beg to report that, by a statement signed by Mr. Beasley, and transmitted to me by Mr. Bonner, the whole expense of the one and a half* mile that is done, including about £900 of debt for materials, a portion of which is not yet used, is £7026 2s. 8d. My estimate for two and a half miles was £13,000; so that I do not see reason for saying that the cost has exceeded the estimate.

* The length of north bank is 1½ mile 100 yards; the length of south bank is 1¼ mile 100 yards.

Your third question is, "Whether the loan of £10,000 applied for if granted would with any other funds under the control of the trustees for such purpose be sufficient to complete with proper expedition and efficiency the contemplated improvement to the navigation and drainage?"

My reply to this is decidedly negative. £10,000 will be sufficient to form the new channel for three miles from the Bridge, which will no doubt effect a benefit of much greater value than the cost, as respects either navigation or drainage; but it will leave the improvement incomplete, which will be to be lamented. An addition of £6000 to the £10,000, making £16,000, exclusive of the present expenditure but inclusive of the £900 due, would take the river out to C upon the Plan, making four miles from the Bridge, which is what my design extended to. I must not, however, withhold my opinion, that even this should not be the ultimate limit of the work; and that where nature is at hand ready to do so much the direction given by art should be extended quite to the Witham, say a mile beyond my idea of 1835, which would probably cost about £7000 additional. A very small sum for effects of which the importance would be almost beyond calculation, upon the value of the property and the improvement of navigation. Ships of the largest class would be seen at Fosdyke; and by corresponding improvements up to and at Spalding vessels of heavy burthen would unload their cargoes there.

The experiment that has been made has been so very successful that there is every encouragement to proceed; and when the magnitude of the interests public and private, and the influential individuals owners of the valuable estates that will be improved without being taxed for the improvements are considered, the idea of stopping half way seems very unreasonable. Whether the loan of £10,000, if to be granted, is to be applied *immediately*, or after the expenditure from other sources of the £6000 referred to, or even reserved to complete the junction with the Witham, is of course entirely out of my department.

The last question is as to the permanency of the work, "Whether it

will require expensive repair, so as to leave a net income applicable to the liquidation of any loan the Board may see fit to advance and the interest thereon ?"

The work has the appearance of permanency. The deepening of the River as it is extended outwards, may cause repairs to be wanted in the sides; but as the good effects of this deepening by increasing the trade, will even in point of revenue be likely always to exceed the repairs wanted, I do not think they affect injuriously the question of disposable income. By Mr. Bonner's accounts the tonnage duties from July 18, 1837, to July 30, 1838, were £2298 8s. He states the rate of charge to have been tripled by an act which came into operation 18th July, 1837; but as the amount at which the duties were let for the year 1836 was only £452 13s. 4d., it appears that the trade has much increased since that time; although from the duties having been leased for several antecedent years the exact sums received by the lessees are not known.

My opinion is that the trade is likely to increase as the improvements do. Therefore if the Commissioners are to have the first claim upon the funds of the trustees for the repayment of a loan of £10,000, with interest or even a greater sum I should conceive the security good.

You are I think aware that independently of the tonnage duties about 25,000 acres of land pay yearly taxes to the Welland; but I am informed that this revenue is not mortgageable.

I am Sir,

Your very obedient Servant,

JAMES WALKER.

23, Great George Street,
Nov. 21, 1838.

APPENDIX.

To the Trustees of the Outfall of the River Welland.

Gentlemen,

The resolution of your meeting on the 25th of May last instructs me to report upon,—

1st. The expense of continuing and embanking the River Welland below Fosdyke Bridge, to the extent that I may deem necessary and expedient for rendering the outfall thereof permanent and effectual.

2d. The extent of the necessary embankment, and the acquisition of marsh land and sands now overflowed.

3d. The improvements necessary to be made in the river between Fosdyke Bridge and the Staunch above Spalding.

4th. The effect which any proposed improvements may have on the lands which entirely depend on the Welland for draining. And

5th. Their effect on the shipping interest.

Surveys. The first thing required to enable me to comply with the above resolutions was, to have a survey made, and levels taken, of the unembanked space or estuary between Fosdyke Bridge and Clayhole, and of the river from Fosdyke Bridge to Spalding. This was done by Mr. Comrie, and plans and sections prepared from the survey are now submitted, together with a reduced plan for depositing with the clerk of the peace, preparatory to an application to Parliament, if thought advisable. I may add that I also took the opportunity the dry season afforded of surveying the washes between Spalding and St. James Deeping.

Improvements below Fosdyke Bridge. The first point in the resolutions refers to the improvements below Fosdyke Bridge.

The area of the unenclosed space or estuary below Fosdyke Bridge, supposing the northern boundary to be determined by a straight line drawn from Western point, at the mouth of the Witham, to Holbeach middle sluice, is nearly 5000 acres. This includes the channel of the river; but I think that ultimately about 4000 acres of available land may be gained by extending the banks in something like the direction

shewn by the dotted lines marked B B B on the Plan, though enclosing to this extent at present would be imprudently expensive, from the great height of bank that would be required. The effect of a partial inclosure, by reducing the action of the sea and tide upon the space left open, will cause a gradual deposit or warping up of the unembanked part, after which a further inclosure may be made, which will be attended with much less cost and less risk than if done at present. By this postponement also the direction and proper form of the bank may be more correctly ascertained.

I have shewn by a strong black line A A A on the plan, what appears the extent to which the channel of the river may be inclosed, and the lands reclaimed in the first instance. The site of the northern bank will be almost entirely on ground now so far warped up as to bear herbage; the return or cross banks at right angles with the direction of the river will be on lower ground, and their formation consequently more expensive;—so also will the banks for the proposed straight direction of the river from Fosdyke Bridge outwards if immediately raised; but if the *outer* embankment for the marshes from Western point to the cross or end embankments, and part of such cross embankments be made first, leaving a sufficient opening between the latter for the free admission of the tide, the warping up of all the interior space will be very rapid, and then the banks parallel with the proposed straight channel of the river, and the channel itself, will be made and supported at much less cost.

Estimates, &c., of such Improvements.

By the works I have described the quantity of land inclosed or embanked on the north side of the channel will be about . . . . . 1800 acres

And on the south side 700

Making together . . . . . 2500 acres

The embankment on the north side will be five miles long, and the expense, including sluices, £28,000.

The south embankment, being limited to the proposed extent of the new channel of the river, will be about two miles and a half long, and the expense £13,000.

These works will confine within banks two miles and a quarter of the river below Fosdyke Bridge, being nearly half of the length from the Bridge to the outfall of the river Witham. In estimating the expense of the forming a permanent straight channel in these shifting sands, it is extremely difficult to approach correctness; if the work were done wholly by excavation, the amount would be heavy, but I think this would be useless labour, and that if the proper direction be given, the requisite size of channel will be formed by the current itself, so that the principal expense will be in supporting the sides by long thorn faggots or fascines, successively and progressively applied, as the depth of the new channel may require.

The formation of this new channel should be concurrent with the making of the side embankments, because the excavated material, where near, will go to form the embankments, and because the warping up will add to the solidity of the soil through which the new channel will be formed. I have estimated that this new cut and the fagotting of the sides will cost about £13,000.

I have not calculated the expense of doing any works in the first instance lower than above mentioned; but the direction of the Welland waters through the sands further outwards may be regulated by fagotting, as may be found necessary.

Effects of Improvements on river.

Supposing the works below Fosdyke Bridge to be done to the extent I have proposed, their immediate effects, or the capability of improvement afforded for the lands drained by the Welland, will be best judged of by reference to the present state of the channel and the rise in its bed, caused by interruptions and want of scour, of which the following statement will give an idea.

On 24th September last, being a good spring tide, the lift or rise of tide was found to be as under:

	Ft.	In.
At Clayhole	25	3
At the junction of the Witham and Welland .	20	1
At Fosdyke Bridge	8	6
At the Reservoir	5	5
At Spalding	3	6

There was therefore a fall of five feet two inches in the two miles, and a quarter of open channel between the point of confluence of the Welland and Witham, and Clayhole, which is equal to two feet per mile. This great fall is owing to the nature of the soil forming the bed of the channel, which is of clay too tenacious to be moved by the current.

If advantage were taken of low tides, increased depth of water might be obtained in the passage to Clayhole, by casting down the small hills

or *hummacks* of clay that stand above the regular bottom of the channel. I think at least a foot might be gained in this way at little expense, and the passage to Clayhole and the scour of both rivers would be improved.

It is, however, with the Welland that I have chiefly to do; and it appears by the statement I have given, that in the five miles and a quarter from its junction with the Witham to Fosdyke Bridge, there is, at low water, a fall of eleven feet seven inches in the surface of the river, supposing (which is nearly correct) high water at the two places to be horizontal. Now I think that the embankments I have proposed, and the straightening of the channel, and guiding it below the cross embankments in a direction towards Clayhole, will have the effect of deepening the passage up to Fosdyke Bridge at least five feet, thus still having a foot of fall per mile in the river from the Bridge downwards. This fall will not be confined to the part below the Bridge: I think the same addition may be calculated on up to the Reservoir, still leaving the present inclination of three feet in three miles, or a foot per mile. Until stability is secured, some extra pains and expense must be incurred both above and below the Bridge, in keeping the fagotting, as it sinks, up to the proper level. The additional expense attending this work may be taken at £500 per mile for two years, or £3000.

There are shoals and pools in various places below the Reservoir, caused by inequalities of the section or area. Such inequalities should therefore be removed. The greatest irregularity in section or in depth is, as might be expected, near the Reservoir, at the point where the Vernatt's drain and the river Glen are discharged into the Welland. The velocity of their shoot into the river deepens the part immediately under, where an eddy is formed, and the sand is deposited at the extremities of the pool, thus forming a bar at the lower end of the length that goes up to Spalding, and at the upper end of that going down to Fosdyke Bridge. This effect is to some extent unavoidable, while the cause exists; but the directions of the outfalls, and the widths under them, may be so regulated as to lessen the evil, and certainly to reduce the awkward turn of the Welland at this place, and at the same time improve the outfall of Vernatt's drain.

Between the Reservoir and Spalding, a distance of four miles and a half, the fall in the surface at low water was one foot eleven inches, or six inches per mile. Supposing an increase of five feet in the depth of water at the Reservoir to be the effect of the proposed works, I think

that three feet additional may be expected at Spalding; but some guiding and regulating will be necessary to produce this result, of which I estimate the cost at £2500.

The whole of the works thus estimated amount to £60,000, and if £15 per cent. be added for contingencies, superintendence, &c., the gross amount will be about £70,000.

Effects of Improvements on land and drainage.

Having arrived at what may be taken as the end of the improvements at present recommended below Spalding, I proceed to state their probable effect.

The reclaiming of 2500 acres of land, the greater part of which is at present sand, and the residue of but little use, but the whole of which, when embanked and secured from the tidal waters, will be extremely valuable, has been named.

The Bourn and Thurlby pastures, containing 1000 acres, and Bourn South fen common, of equal extent, drain by a culvert under the river Glen into the counter drain, whereby their waters are discharged into Vernatt's drain, at Pode Hole. This drainage is much at the mercy of the powerful engines at the latter place; and I am told that although their surface is at a much higher level than Deeping fen, the lands are almost always flooded in winter, from the water raised by the engines standing as a wall between them and their outlet. Now as the deepening of the Welland outfall will accelerate the passage of the flood water to sea, the head of water raised by the engines will be less, and will go off more quickly, and consequently the Bourn and Thurlby fens, and also the Glen washes, containing 400 acres, which now form a reservoir to receive their drainage, will be benefited. The same beneficial result will be found in the drainage of the Cowbit and Crowland washes, and in short it may be said, that all the lands and washes, however distant, that depend upon the Welland for their drainage, and are at present subject to injury from floods, or want of depth in the river, will be essentially benefited and improved. From their situation and liability to be flooded, which, I believe, they almost always are during winter, the Cowbit and Crowland washes will derive the most important and immediate benefit: but it would require great local knowledge to state positively the absolute or comparative value of the improvement upon different lands; this must depend upon the degree in which they at present suffer, and their situation, because generally those near the river will profit more than those at a distance, and I apprehend there will be no other means of determining the proportion of benefit than by a

survey of their present state, and a comparison of it with their condition after the contemplated improvements have been made, and their effect felt.

The banks of the Glen appear in many places bad, and I am informed that breaches are not unfrequent: the expense of supporting them must be great, from the country which drains into this river being high, and sending down the floods rapidly. The proposed improvements in the Welland, below the point where the Glen joins it, will take off the waters as they come down more quickly than at present, and by thus affording direct relief to the banks, add to the security of the lands liable to be injured by breaches.

Effects on shipping interests.

I now come to the effects upon the shipping interests:—On 24th September, the day before referred to, the tide flowed

At Clayhole	5 hours.
At the meeting of the Witham and Welland . .	$3\frac{1}{2}$
At Fosdyke Bridge	$1\frac{1}{2}$
At the Reservoir	$1\frac{1}{4}$

I have already stated that the above was a high spring tide—neap tides are much lower: during several days that my surveyors were near Fosdyke Bridge, there was no rise of tide there, and therefore none any where above it, and this is a common occurrence. While I was last at Spalding, a gang of lighters, drawing only eighteen inches, lay below the Reservoir, unable to get up to the town, although the spring tides were then on.

At low water in dry seasons, such as the last, there are but a few inches of water in the bottom of the channel below Fosdyke Bridge, and the channel is so narrow, and so extremely tortuous and shifting, that the navigation may be said to depend entirely upon the tide, and when *no tide, no navigation.* Vessels drawing only three feet to three feet six inches, are frequently not afloat, except during the high water of a few days at the top of the springs, and if the opportunity be not watched for them to get away, they are stuck fast for a fortnight. Vessels drawing more than six feet, cannot depend upon being afloat at all, even during the springs, and if these tides are not good, they may be detained for a month: there are, indeed, cases of detention for several months. Vessels of this draught, therefore, remain at the bridge, and have their cargoes taken up and brought down by small craft, few vessels drawing more than three feet venturing up to Spalding, from the liability to long delay here.

The sudden twists and bends through the sands below the bridge above alluded to, are, if possible, a greater evil than the want of depth. The plan will give an idea of them as they now are, but after a flood the course may be very different, so that it is almost in vain to attempt to mark out a channel.

Such is the navigable river Welland in its present state; it cannot, I think, always have been so, or Spalding would not have been built as a shipping town, with its warehouses and other accommodations, although I do not see sufficient cause for a very great diminution of water. The Vernatt's drain certainly takes the water from 27,000 acres that used to pass into the Welland, at a higher point than it now does, and there are various draughts from the river by tunnels into the North Level and South Holland, which are also injurious. If parties have a right thus to supply themselves with fresh water, the number and size of the tunnels, or rather the quantity of water to be issued, should at least be defined, and the sooner this is done the better, for the security of all.

If the effect of the measures I have proposed be to deepen the water to the extent I have stated, or even approaching to it, the benefit to shipping must be immense. It will probably enable a vessel drawing ten feet water to get to Fosdyke Bridge, and one drawing six feet to Spalding, with a tolerable prospect of getting away early on the return of the springs.

At present the width of the river between Spalding and the Reservoir is 60 to 70 feet at the surface of low water; between the Reservoir and the bridge the width is about 120. The former is probably too narrow for the quantity of water, and the latter too great for a regular channel; both may be altered beneficially, but I would advise that attention and money should be in the first place bestowed upon the works below the bridge, and that the effect of these on the part above should be seen before any great expense is incurred with the upper part, which, if done without experience of the works below, might be in a great measure useless, from the channel being too large or too small for permanency.

Trade of Spalding.

How far the trade of Spalding may be extended after the Welland has been improved to its greatest capability I cannot say; but there must be something of peculiar advantage in the situation that attaches trade to it, while the river is in its present deplorable state, and there is therefore every encouragement to improve it; not only with a view to the prosperity of the town and surrounding country, but in reference to the increase of trade, and, consequently, of the river dues, which will amply compensate for any judicious outlay.

Future Works. Such are the works as they appear to me expedient at present; if the results prove beneficial, still further improvements may be contemplated. Of these the extension of the sea embankment in the lines B B B on the plan, will be a first and principal one, as it will increase all the effects described as arising from the first embankment, besides tending to the improvement of the outlet of the Witham, of which the embankment next the sea may be considered as forming one side.

Between Spalding and Deeping the Welland is circuitous and shallow, the South Drove drain comparatively straight and deep. If the outfall of the river be deepened to near Spalding, it will be well to consider the effect of making the South Drove the main drain, connecting it with the river by a cut behind Spalding at the lower end, and another cut to Deeping at the upper; a lock, with gates to lock both ways, and a sluice being placed at each end of the drain when so extended. If this were done, the present course of the Welland through Spalding deepened and widened, and having gates at its extremities communicating with the South Drove drain and with the river, might form a convenient dock; the South Drove drain would be a good navigation to Deeping, the gates at each end regulating the height of the water in it; the upland floods might wholly or in part be taken through this channel, to the great relief of all the district between Deeping and Spalding, which is now often flooded by the Welland; and probably Deeping fens now drained by steam would have a good natural drainage. But the proprietors of these fens, like the owners of Tyd and Newton, in the North Level, would not be likely to trust to this drainage alone, without full experience; nor need they, for the lock gates I have named would prevent any annoyance to them, and to say the least, the expense of pumping would be reduced. These views are, however, given as distant ones, to be corrected by a nearer approach, which the works I have before recommended will, when executed, afford.

I am, Gentlemen,

Your obedient Servant,

JAMES WALKER.

SPALDING, 7th November, 1835.

John Cunningham, Printer, Crown-court, 72, Fleet-street.