

It will not of course be inferred, that the engines will be required to work for 69 successive days; this would be to assume the whole fall of wet at one time; neither will the whole of the quantity of water calculated to arise on the land required to be discharged therefrom. The number of days which the engines will require to be worked will abate according to circumstances, and I apprehend, in any one year, will never exceed the number of days estimated.

It will be seen, on reference to the level of the main drains, from their commencement at Cross drain to their termination at Podehole, that the fall which they possess will convey the water with considerable facility to the engines; and as the bottom of these drains is $5\frac{1}{2}$ feet below the mean surface of the land to be drained, the discharge of the water therefrom into the main drains will be continual.

The greatest height, at any time, that it would be necessary to raise the water in the Vernatt's drain would be 7 feet 8 inches, being the gauge allowed by the said Act of Parliament, and which would allow for the fall into the Welland upon the ordinary flood head of 2 feet 8 inches, and generally more.

I propose that such engines should be erected at the junction of the South and North Drove drains, at Podehole. And I further propose, that the engine of 40 horse power should be appropriated to the relief of the waters of the South Drove drain, and the other to that of the North Drove drain, with a communication, so that one engine may be applied for the discharge of the waters of both drains, when necessary. This I consider expedient, as the surface of the lands draining by the South Drove drain is higher than that draining by the North Drove drain, and the waters of the two drains would, therefore, not require to be reduced to the same level.

I feel no hesitation in stating, that the above scheme would render the present wind engines used for the drainage of the said fens unnecessary, *and the drainage of the same fen and commons effectual and certain.*

I would further add, that the improved principle adopted in the construction of steam engines has rendered their operation so certain, and their liability to accident so trifling, as to justify my last observation.

Neither the Vernatt's drain nor the other main drains will require any further expense, beyond what would be required under the existing system.

The only expense, independent of that of the engines, would be a communication between the fourth district and the North Drove drain, that district draining at present into the Vernatt's below the Podehole sluice.

In regard to the estimate, I have allowed for the expense of engines by the most eminent and scientific manufacturers.

I have not deemed it necessary to describe the construction of the engines, the gauge of their waterwheel, or other particulars. I trust it will be sufficient for me to say, that I fully went into these particulars before I ventured to pronounce upon the efficacy of the scheme above proposed.

I have been favoured with the Report of Messrs. Rennie and Jessop, made in the year 1800; from which I find, that, after recommending the adoption of the above main drains, they conclude by stating as their opinions, that in order to render them effectual, and to obviate the necessity for continuing the wind engines used for the drainage of the said fen, it would be desirable and necessary that a powerful steam engine should be erected at the point of termination of the South and North Drove drains, at Podehole.

I remain, Gentlemen,

Your obedient, humble Servant,

THOS. PEAR.

Spalding, 30th September, 1820.

ESTIMATE.

	£.
To two steam engines, one of fifty and the other of forty horse power, with two boilers to each engine, and Yorkshire stone wheel races and waterways, and every requisite necessary to complete the same upon the best and most improved construction; the same to be inclosed in a substantial building, consisting of engine, boiler, and wheel houses - - - - -	16,500
To culvert under the Counter drain, for conveying the water from the fourth district to the engines, - - - - -	500
N. B. The annual expense, upon a supposition that the engines will work at intervals in the course of a year, equal to 69 days (of 24 hours), for coals, oil, tallow, small repairs, and wages, will not exceed 900 <i>l</i> .	

*The Report of Benjamin Bevan, Esq., on the Improvement of the
Drainage of Deeping Fen by Steam Power.*

To the Proprietors of Deeping, and adjoining Fens.

GENTLEMEN,

The great importance of Deeping and adjoining fens, and the necessity of a more complete drainage, has long been felt by the occupiers. Large sums have already been expended, on various plans, towards accomplishing so desirable an object; and but for the incessant operations of Nature, in raising the bed of the Welland estuary, the works already executed would probably have been effectual.

To find a remedy for this growing impediment, is the principal desideratum, not only to the proprietors of Deeping fens, but to all persons interested in lands draining into the general Wash.

In several branches of Art, the various powers of Nature are occasionally made subservient to the removal of obstructions of her own formation.

In the present case, when the immense powers of the tides are considered, few persons will doubt the sufficiency of the agent, provided the mode of operating can be properly controlled, and subjected to our guidance. In my view of the subject, this most desirable object is possible, and not highly improbable. Provided a few regular and well-directed experiments and observations were made on the operations of the waters, under various modifications, within the reach of practice, it is possible that some of the laws of Nature may be discovered that move the shifting sands in the open channel, and give us the power of regulating them to our benefit, so as to keep the main channel of proper depth and capacity at all times for the free discharge of the downfall and upland waters, and for the desirable purposes of navigation.

At present, however, we have not discovered this key, and it would be presumptuous in me to limit a time for its discovery, and for obtaining the desired result.

In the meantime, it is necessary that some immediate improvement should be adopted in the condition of these extensive fens.

Taking, therefore, into account the certainty of action, and the short time required to make the necessary provision, and the general economy in expense, the use of *steam-engines* must have the preference.

The principal and collateral drains being already formed, it remains only to elevate the surplus water of the district a few feet, to place it in a condition to find its own way into the ocean.

The general district being cleared of water to a proper depth below the surface of the land by the proposed engines, it will open a complete and secure opportunity of using all the principal drains for navigation, and thus confer an additional value to the land by offering a ready and cheap conveyance of all heavy articles at one-third of the expense of land carriage.

In the present artificial state of the drains, and necessary height of the water in the same, and the comparative risk and pressure upon the banks, it would be unsafe to use the drains generally for the purposes of navigation; but when the water is kept constantly under the surface of the land, the navigable use of the drains, instead of being prejudicial, will assist in keeping the drains open and more serviceable.

For this advantage it will be fair to expect some revenue may be derived, in aid of the general expenses, and thus, by rendering the land secure from damage by water, and easily accessible, produce a two-fold benefit, and virtually lessen the expense of the general operations.

The principle of drainage by *steam-engines* being admitted, it becomes a question of some importance as to the power of the engines? On this point some persons might form a wrong conclusion by considering the requisite power to approximate the aggregate of all the wind machines now employed in the district; but when the defective state of many of these engines is considered, and the porous nature of the soil, which suffers a large proportion of the waters raised to return again into the general flat or level, together with the great uncertainty of the wind, it will be found that no proper conclusion can be made by a comparison of the strength of the existing machinery.

Having for many years been attentive to questions of this nature, and having had opportunities of actually measuring the surplus water of a district comprising about seventy-seven square miles, so as to find the *daily* quantity discharged for twelve months, and of comparing the quantity falling in rain in the same period with the surplus thus discharged, as well as from registers of a similar nature made in other parts of the country, and at other times, I am enabled to give my opinion in the present case, that two engines, the united powers of which being equal to raise 7,200 cubic feet per minute to the height of six feet, will be sufficient to keep this district free from damage by excess of water, under proper regulations and good management. Two engines of fifty horse power would be equal to this work.

The next material object is the capacity of the present drains. From the levels and sections of the respective drains furnished on my late view, and from what I had obtained in 1812, I have been able to calculate the conducting powers of the present drains, and find *Vernatt's* drain fully capable of conveying the water raised by two engines

of the power above described, with a declivity of four inches in its whole length, when kept free from weeds. North and South Drove drains, if kept clear from weeds, and of the full specified dimensions in the Act of 41 Geo. 3, would be capable of supplying the proposed engines with water in their present state. But as the disposition to produce weeds in the summer is very strong in these drains, and as they may be made capable of conducting double the quantity they are now able to do, at a moderate expense, without interfering with their present banks, it would be adding an additional security to the land, during the time of weeds growing, to have this improvement adopted.

The improvement consists in making the bottom of the drains concave, instead of flat. By this operation the drain called South Drove would have its conducting power increased in the ratio of 86 to 115. By the same plan, North Drove drain would have its conducting power doubled.

It possibly may not be found necessary, at one time, to improve in this way the whole of the drains; but when the water is drawn out, and workmen are upon the spot, it will probably be found best to complete the whole in one season.

As the drains, when kept under the surface of the land by the engines, will be rendered perfectly safe and eligible for navigation, it will be desirable to provide in the present Act powers for the Trustees to set up and maintain locks or sluices for that purpose, in such places as they may find necessary, and to charge such reasonable sums for the use of them as will leave a durable benefit to the whole district.

It remains only for me to conclude my Report with an estimate of the probable expense of effecting the several objects above noticed, leaving, for the present, the suggested improvements in the general estuary.

ESTIMATE of the probable Expense.

Two steam-engines of the best construction, of fifty horse power each, with wheel and wheel race, waterways, buildings, and every requisite	£8,500
Deepening and improving North and South Drove drains, and securing the north bank of the Vernatt's drain	3,000
Contingencies on the above	1,000
	<u>£12,500</u>

If locks are constructed, an additional expenditure of two or three thousand pounds may be required.

B. BEVAN.

Leighton, March 1st, 1823.

The Report of William Shadwell Mylne, Esquire, on the Steam Engine Drainage.

To the Commissioners of Deeping Fen.

GENTLEMEN,

According to your desire, I proceeded, on the 31st of May, to Spalding, and surveyed Deeping fen and the two steam-engines erected under the directions of Mr. Bevan for the drainage thereof. I find that the same error has taken place in this instance as is generally committed where the several mill powers have been concentrated, which, previously, had been distributed over various parts of the fen.

In all these cases I should never recommend two steam-engines of such great power being erected at the same spot; for it must be evident to every fen-man that the drains required to feed those wheels must be much larger in proportion than what would be required to feed the wheels were they placed in different situations; and the result must necessarily be, that the water in the drains *near the engines* would be kept at a level far below what is beneficial for the cultivation of such land, without which a sufficient current cannot be maintained in the drain to clear the water from the further portion of the fen; and in doing so, the lift of the engines are so materially increased as to cause an additional expenditure in coals, which must be found very prejudicial to the interests of the landed proprietors.

Such has been the error which has been committed, and to remedy it now without a large sacrifice, would be difficult; besides which, the drains have been so laid out and executed, that I fear it is impossible to do otherwise than improve the present system.

The wheels of both these engines, during the greater portion of the year, are laid much too high to work beneficially; and yet the occasional head, in flood time, against which they have to lift, is such that it would not be advisable to lower them, unless a moveable threshold be introduced, which I conceive might always be done beneficially; and when the engines are but lightly loaded, much coal might be saved by working them with a greater speed, if the line of the side walls of the race which lead to the wheel be sufficiently splayed to admit of the water passing to the wheel without obstruction.

By the log-book kept by the engine-worker, which I consider an excellent document, and highly creditable to him, it will appear that

the quantity of rain which fell on the fen in one month amounted to about 84,000,000 cubic feet, and that the engine worked 376 hours during that month. On making the same computation during other months, I do not find the result sufficiently agree to enable me to make any comparison between them, or to come to any conclusion as to the quantity of water *actually* raised by the scoop-wheel, as compared with the usual work done by pumping-engines.

Since surveying your fen, I have had the opportunity of examining and making some valuable experiments in the Littleport district, in Cambridgeshire, the result of which is as follows:—

	Coals consumed by the engine per hour.	Mean lift at which the engine worked.	Mean dip of the scoop.	Quantity raised in cubic feet per hour.
	<i>Bushels.</i>	<i>ft. in.</i>	<i>Feet.</i>	<i>Cubic feet.</i>
First hour's trial -	7	6 9	4.4245	187,884
Second do. do. -	9	7 1 $\frac{1}{2}$	4.0548	159,255
Third do. do. -	15	8 0 $\frac{1}{2}$	3.8256	183,704

The improvements I recommend in the steam-engine and wheel are, that the wheel might be lowered, a moveable threshold might be introduced with advantage, and the engines might be worked to a greater speed than they now are. I should also add that the draught of the chimney is not so good as it ought to be; and if the subdivisions of the flues were cut out from the upper thirty feet, and twenty feet extra height added to the chimney (or even less would be of use), the coal would be consumed in the furnaces much better, and a considerable saving in the expense of working them would be the result.

On the subject of the drains much may be said; but from the circumstance of all the original sections being lost, it is now impossible to judge what might have been the motive of the engineer in laying out the drains as they now are; but I think it very probable that since the fen has been so well drained, the moor land, in particular, is very likely to have settled, *and that portion* which is now the lowest and at some distance from the engine, might have been at that time the highest part of the fen. As it now is, the drains are evidently insufficient in their capacity for the object required, and I must recommend certain alterations hereinafter described.

The cross drain on the top of the fen has been made as large as any other, and is maintained, with the adjacent forelands, in its original state. *This drain is of little importance*, in comparison with the others, and if the forelands adjoining, with the exception of about twelve feet on each side, were sold, it would raise a sum sufficient to defray the

expense of enlarging the main drains, so that the water from this drain might be carried off more efficiently.

There is a staunch in this drain which, when shut, prevents the water from the south-west end taking its most direct way to the engine, which would be along the North Drove; but by this staunch being kept shut, the whole of the water of that end of the fen is forced down the South Drove drain, and through the stop-gate, where the opening is only eight feet in width, delivering into the South Drove drain, and leading to the engine. There is also a similar stop-gate on the North Drove drain; therefore any enlargement above these two points would be useless.

In all these drains the banks are loaded with the material which was excavated at their formation, and being generally silt, the weight presses in the sides of the drain, and causes the bottom to rise. This weight of silt should be removed; and if every opportunity were taken to encourage its removal, the farmers would (I should conceive) find a use for it. Boats being employed, it could be done at a small expense.

From what I saw of the state of the South Drove drain (where there are some impediments under the Road Bridge, which should be removed), I am not surprised at its not conveying the water to the engine, as it is much silted up, and full of weeds.

The alterations I should propose in the drains would be to form them as near as possible to the accompanying sections, and to keep them, after they are so formed, as free from weeds as possible by the machine called the *bear*, much used in the rivers under the Bedford Level Corporation, which I have observed has a very good effect in taking them up by the roots, or otherwise killing them, so that the drains are free for a long time after it has been employed.

If the improvements above recommended are carried into effect, I have no doubt that the upper lands of the fen will be as well drained as those adjoining the engine.

I remain, Gentlemen,

Your obedient Servant,

WILLIAM SHADWELL MYLNE.

*New River Head, London,
July 16th, 1830.*

P.S.—I should recommend an additional column being added to your log-book, giving the quantity of coals burnt each week, which might easily be obtained by the use of barrows holding three bushels each, strike measure: and if counters were affixed to the beams, the work done by the engines could be read off at any time, and comparisons might then be made between the work done and the fuel consumed.

*The Report of John Rennie, Esq., on the Improvement of the Outfall of
the Vernatt's Drain in the County of Lincoln.*

*To the Proprietors of Lands in Deeping Fen, and others interested
therein.*

GENTLEMEN,

The drainage of Deeping fen has been a subject which has for many years occupied the attention of its proprietors, and the advice of several eminent engineers has been taken on the best mode of effecting it. Various schemes have for that purpose been laid before them, and large sums of money expended on the cutting of drains, building of sluices, and erecting windmills; but hitherto with very little effect.

The whole of that fen and land draining by the same outfall, containing upwards of 40,000 acres, is at present, I may almost say, in a lost state; and this is not to be wondered at, when the measures taken for effecting its drainage are considered. The drainage of Deeping fen is now effected, as far as it can be called a drainage, in the following manner: Near the southern extremity of the fen, and within a short distance of Deeping, is a cross drain, commencing near the west bank of the Welland, and running in a north-westerly direction to near the bank of the river Glen. This drain may be said to be a kind of catch-water drain, though it has few of the qualities of such a drain. About two miles from its eastern end, is a drain, called the "South Drove drain," which departs from it and passes through the fen by a circuitous course to Podehole, the northern extremity of the fen.

About a mile and quarter from its western extremity, another drain departs, called the "North Drove drain," which passes in a direct course to Podehole, where it joins the former. Another drain commences at the north-eastern extremity of the parish of Langtoft, and runs in a north-westerly direction by the northern extremity of the parish of Baston, until it approaches within a quarter of a mile of the river Glen, being a length of about two miles and a half; it then turns to the north-east, and runs nearly parallel to the Glen, for about four miles and a half, and afterwards takes a direct course to Podehole. This drain is called the "Counter drain." And there is a tunnel under the river Glen, called "Sir Gilbert Heathcote's," which conveys the water from some thousand acres of land, lying west of

the river Glen, into this Counter drain. The water brought down by these three drains, which all terminate at Podehole, is conveyed from thence by another drain, called "Vernatt's drain," to the river Welland, at a place called "The Reservoir," near the junction of the river Glen with the Welland. At Podehole there is a sluice which has three openings of 10ft. wide each, making a total water way of 30ft. And at the junction of the Vernatt's drain with the Welland, there is another sluice, which has two openings of 15ft. wide each, together 30ft. the same as the former. The length of the South Drove drain from its departure from the cross or catch-water drain to Podehole is $8\frac{1}{2}$ miles, and the fall from the surface of the land to the sill of Podehole sluice is 6ft. 2in. The length of the North Drove drain is $5\frac{1}{2}$ miles 13 chains, and the fall from the surface of the land to the sill of Podehole sluice is 5ft. 2in. The length of the Counter drain, from Sir Gilbert Heathcote's tunnel to Podehole, is $4\frac{3}{4}$ miles 14 chains, and the fall from the surface of the land at that tunnel to the sill of Podehole sluice is said to be 8ft. The length of the main or Vernatt's drain which conveys the whole of the water from Deeping fen and such lands as drain into it, from Podehole sluice to Vernatt's sluice, is $6\frac{1}{2}$ miles 14 chains; but instead of having a fall, it rises, the sill of Vernatt's sluice being 1ft. 4in. higher than the sill of Podehole sluice; so that from the head of the South Drove drain to the sill of Vernatt's sluice, a distance of $15\frac{1}{4}$ miles 14 chains, there is only a fall from the surface of the land of 4ft. 10in.

In the North drain, a distance of $12\frac{1}{2}$ miles 7 chains, the fall is only 3ft. 10in.; and in the Counter drain, from Sir Gilbert Heathcote's tunnel to Podehole, a distance of $12\frac{1}{2}$ miles 8 chains, the fall is about 6ft. 8in.

Were the sill of Vernatt's sluice always clear of water, the falls I have mentioned, though small, would effect the drainage of the lands in question, though not so well as they ought to be; as a good drainage should be capable of keeping the water at least two feet under the surface of the land. But this is not the case; for there is seldom less water on the sill of Vernatt's sluice than two feet, and in ordinary floods it is frequently four feet more, so that for many weeks together the gates of Vernatt's sluice are shut, and the water accumulates in the fen, to the great injury of the lands. These evils have been attempted to be remedied, by means of windmills having a communication with the drains leading to Podehole.

That these mills have been of some service, no one will deny; but the quantity of service depends jointly on the wind and rain. If rain falls when there is little wind, the service is small, and even with good breezes, the quantity of water they can raise by no means clears the

fen so as to prevent injury to the land. In this state of things, some effectual measures are imperiously necessary, without which the lands of Deeping fen can never be cultivated to advantage.

Among the schemes suggested for the complete drainage of Deeping fen, was one upwards of twenty years since, and for which an Act of parliament was obtained, namely, that of making a new cut, from near Vernatt's sluice, through the embanked lands to the river Witham a short distance above Hobhole, and near to a public-house called "The Ship," having a sluice at its junction with the Witham, through which cut the waters of the Welland and Glen, as well as the water from Deeping fen, and those lands lying to the north of it, were to be discharged. Various efforts have been made for carrying this work into execution; but hitherto without effect, owing, as I suppose, to the difficulty of raising the necessary funds. This scheme, although the most rational of any that has been proposed within my recollection, is objectionable, namely, that as the Welland and Glen waters, and those brought down by Vernatt's drain, would all pass to sea by one channel, it is evident that the water that came down most rapidly would be the first discharged; and as the floods of the Welland and Glen, having their origin in a high country, would come down more rapidly than the water from the low district of Deeping fen, they would naturally find their course to sea before the other, or they would revert back into the fen and drown it. To prevent so serious an evil, it would have been found necessary to place a sluice on Vernatt's drain, with gates pointing downwards; and this, though it would not admit the flood waters of the Welland and Glen into Deeping fen, would prevent the fen water from going off until these flood waters were discharged; for it can hardly be supposed, that the new channel from Vernatt's to Hobhole would have been made sufficiently large to contain these flood waters, without over-riding the fen water, even during the short period that the gates of the sluice intended to be made at the mouth of this cut were shut by the tide in the Witham. Although, therefore, the drainage of Deeping fen would have been much improved by the execution of this scheme, it would by no means have been made complete within any reasonable bounds of expense.

Another scheme has been proposed, namely, that of making a new cut for the Welland, from Fosdike bridge to Holbeach middle sluice, the sill of which sluice is about 2ft. 5in. above the level of Podehole sluice; and as the level of low water opposite Holbeach middle sluice is about 8 ft. below it, this would give a fall from the sill of Podehole sluice to the said low water of 5ft. 7in. The distance from Vernatt's

sluice to Holbeach middle sluice is seven miles, and as at least two inches per mile would be required for the fall in the surface of the river, were it even in the best state, the surface of the Welland at Vernatt's sluice would thus be lowered 4ft. 5in., which would of course deepen the channel of the river upwards. But as the floods of the Welland and Glen are often 6ft. above the sill of Vernatt's sluice, or 7ft. 4in. above that of Podehole, it is quite clear, that during the continuance of these floods no complete drainage could be had for Deeping fen by this scheme: and as, to obtain the effect of such a measure, the sands on each side of the open channel of the Welland must be embanked, whereby the back water arising from the flux and reflux of the tide would be diminished, and the Welland and Glen supply but little water in summer, the channel so made could not be maintained to the extent I have mentioned, namely, that of lowering the water 4ft. 5in. at Vernatt's sluice.

This will appear more evident, when the exposed situation of the new proposed mouth of the Welland is considered.

It lies open to the whole range of the sea, brought in by easterly winds, with an immense extent of soft mud and sand in front of it, over which the seas range without any projecting point of land to shelter it. And if a sluice were to be placed on this cut, it would be liable not only to the objections of the scheme proposed for the north side of the Welland, but the exposure of the sluice would be such as to render its maintenance difficult if not impracticable. In short, I do not see that either of these schemes would be attended with the desired effect. I beg leave therefore to propose what appears to me, under all the circumstances of the case, to be the most effectual and least expensive scheme of draining Deeping fen and the lands draining with it, which I hope will be approved of by those interested.

I propose that a new cut or drain shall be made from a little above Vernatt's sluice to the river Witham at Hobhole, having its termination a short distance above where the drain from the East fen, on the opposite side of the river, terminates. This drain I propose to be 30ft. wide at bottom, where it departs from the Vernatt's drain, and to increase to 32ft. at Risegate Eau or Gosberton outfall, and to continue of this size until it joins the Witham.

This new proposed drain will pass under the river Glen, by means of an aqueduct, and run along the north bank of the Welland, to near Fosdike. It will then run to the north of the public-house, and along the inclosures for about half-a-mile; it will there cross the sea bank and continue along the uninclosed marshes, and through a small inclosure in Wyberton, and across the open marsh to the Witham, at Hobhole.

On the mouth of this drain I propose to have a sluice, of three openings of 12ft. wide each. The lengths and falls of this drain, according to Mr. Pear's levels, will be as under :

	Length.			Fall.	
	miles	qrs.	chs.	ft.	in.
From the cross or catch-water drain along the South Drove drain, to Podehole - -	8	3	0	6	2
From Podehole to Vernatt's sluice - -	6	2	14	10	10
From Vernatt's sluice to the Witham, at Hobhole - - - - -	8	1	6		
Total	23	3	0	17	0

The sill of Hobhole sluice for the drainage of the East fen is about 3ft. 3in. under the ordinary low water of spring tides. Hence the surface of the said low water is 13ft. 9in. under the surface of the land in Deeping fen, at the head of the South Drove drain.

Now if two feet be allowed for the land to be above the surface of the water in the drain, the clear fall will be 11ft. 9in. which is about 6in. per mile; a fall quite sufficient for the full and effectual drainage of the lands in Deeping fen; and indeed is a greater fall than what the drain of the East fen has, which effects its object so satisfactorily.

This drain will likewise improve the drainage of all the lands which discharge their water through the Gosberton five towns and Kirton outfalls, amounting together to 18,000 acres, which should therefore contribute to its expense. The channel of the river Welland should be continued in its present course as far as Fosdyke bridge, except a bend near Vernatt's sluice, which should be cut off; and as the out marshes grow up and become fit to be embanked, the works should be continued so as to preserve and improve this channel; and for this purpose, it will be for those interested to consider what portion of the taxes or revenue should be annually allotted to that purpose.

It will perhaps be said that by diverting the water from Deeping fen, and those lands which now drain into it on the north side of the Welland, from their present course, the navigation of the Welland will be seriously injured.

To this I answer, that as a general principle, every diminution of the ordinary quantity of water which flows down a river is no doubt injurious to it; but in the present case this injury will be found trivial; for when the quantity of water in the Welland is considerable it overrides the waters at Vernatt's sluice, and consequently prevents them from running; and no tide water is ever allowed to enter it. When the water in the Welland is low, it is likewise low in the Vernatt's, and very little indeed, if any, runs into the Welland. It is

therefore only when the waters in the Welland do not override those of Deeping fen, that they will run at all, or can be of use in scouring the outfall; and then there must be a considerable quantity of water in the fen itself. But is it reasonable to suppose that for this small advantage the proprietors of land in Deeping fen should be deprived of a drainage, by which their property is rendered valuable? Or, in other words, are the proprietors of Deeping fen to suffer so material a loss, for the sake of so small a deprivation of water from the Welland? Surely not. And particularly, as will afterwards be shown, that as far as regards navigation, an improved means of carrying it on will be afforded.

To render the deprivation of the water from the Welland as little injurious as possible, I propose that the Vernatt's sluice shall be maintained; and that whenever it gets into a bad state of repair, the sill shall be lowered, so that whenever the surface of the water in the Welland will admit, the water from Vernatt's drain will run into it, and assist in scouring the channel to sea. Thus the outfall of the Welland will have all the advantage that can reasonably be expected, and beyond this, I do not think the proprietors of Deeping fen ought to go. The drain I propose from Vernatt's to the Witham will be of a size sufficient to allow barges to navigate on it; and by placing a navigable sluice adjoining the drainage sluice, having land doors to the sluice, this drain will be navigable, particularly in the summer season, when there is a scarcity of water in the Welland; and by forming a junction between this drain and the Welland, by a lock at a convenient place, perhaps at or near Spalding, the whole navigation upwards will be benefited by it, and indeed will, in my opinion, be in a much better condition than it now is.

Another objection has been started, namely, depriving the Welland of the waters of Deeping fen, sand banks will be formed at the outfall, by which the waters in time of flood will be obstructed and penned back on the Welland banks, and thereby occasion breaches, to the great injury of Deeping fen. This objection I think of little or no weight; for even in the present state of the outfall, without any deprivation of the Deeping fen waters, the channel of the river between Vernatt's sluice and the toll-bar south of Spalding is very narrow and shallow, and the ordinary produce of the river does not seem to be able to enlarge it, or even to keep it in its present state; and while the water below Fosdyke bridge expands over so large a surface of mud and silt, little effect can be produced by the water from Deeping fen in scouring away this extensive flat; but when the water is confined to one channel, as will be the case after the outmarshes are embanked, the outfall will be improved, even without the assistance of the Deeping

fen waters, and therefore the channel upwards will be deepened, and the banks subjected to less hazard of breaking than they now are.

On the whole, therefore, I am decidedly of opinion that the scheme I have proposed will prove the most effectual for the drainage of Deeping fen and the lands draining with it, and, under all circumstances of the case, the most practicable.

I am, Gentlemen,

Your most humble Servant,

JOHN RENNIE.

London, October 16th, 1818.

ESTIMATE of the probable Expense of a new Drain from the Vernatt's Drain to the Witham, opposite Hobhole Sluice.

To widening and deepening Vernatt's drain, between Podehole sluice and the place where the new drain is proposed to depart, being 36,100 floors, at 8s. per floor -	£14,440
To a new drain from Vernatt's drain to the Witham, at Hobhole, 126,500 floors, at 9s. - - - -	56,925
To an aqueduct under the Glen - - - - -	6,675
To a sluice at the Witham - - - - -	12,000
To one road and six occupation bridges - - - - -	5,000
To the purchase of land for cut and cover - - - - -	8,000
Contingencies - - - - -	20,610
	<u>£123,650</u>

DEEPING FENS.—ADVENTURERS' JOINT WORKS.

Mr. Cubitt's Report.

To the Right Honourable Lord Carrington.

MY LORD,

In obedience to your Lordship's instructions of the 9th, I proceeded to Spalding on the 12th, and devoted the two following days to a view of the levels and outfall in general, and the engines at Podehole and the Vernatt's drain, the wreck of the Vernatt's sluice, and the works in progress for the erection of a temporary dam and sluice at the outfall in particular.

I had also interviews with Mr. Carter and Mr. Bonner, the solicitors of the levels and the Welland respectively, with Messrs. Theophilus Johnson, Carter, and other gentlemen as adventurers and proprietors, from whom I received much information as to the objects of my visit; and was attended in my view of the locality and works by Messrs. Trickett, Johnson, and Pitcher, the resident engineer and surveyors of the works and levels, from whom I received every attention and practical information that the circumstances of the case permitted.

I was also, at the request of Messrs. Carter and Bonner, met by Mr. Beasley, under whose immediate directions the outfall works below Fosdyke bridge are being carried out upon the general plan as laid down by Mr. Walker in 1835, for the trustees of the river Welland, and had the opportunity, accompanied by Mr. Beasley, of seeing the whole of those very interesting and (if fully carried out) very efficient works to their whole extent, at the low water of a spring tide.

The state of the works forming the immediate object of my journey is as follows:—The Vernatt's old sluice, recently blown up, is lying in ruins at the mouth of the drain on its former site; a dam has been placed across the Vernatt's drain, about one-third of a mile up the drain, and a temporary discharging sluice, with four culverts and tide doors, is in course of being erected within a dam, in order to

the security of the fens, and the discharge of the waters from the steam-engines and Counter drain, during the ensuing winter; and till such time as the adventurers, and all the parties interested in the drainage and works, shall have investigated the subject and determined on some plan of proceeding for the due and efficient drainage and security of all the district depending upon the river Welland, below Glen sluice, for its outfall.

I have therefore the honour to state to your Lordship, by way of a preliminary report,

Firstly, That the works now being constructed in the Vernatt's drain, to serve as a temporary dam and outfall sluice, are well calculated to answer the intended purpose, and will, if carried out as proposed, keep out the highest tides and discharge all the water that can be thrown out by the engines at Podehole.

Secondly, That these works may be completed and at work in a month from this time, and at an expense probably of about 1,000*l*.

Thirdly, That to enable me to come to any definite conclusion either as to the best situation for the new sluice, or to ascertain its probable cost, it will be requisite to have the ground surveyed in the immediate vicinity of the outfall, taking in portions of the Welland, the Glen, and the Vernatt's drain, at their confluence, and also to have cross sections of the same taken, so as to enable me to make proper plans of the proposed works, whether considered with regard to the adventurers' wants only, or to the more extended view of the case in relation to both drainage and navigation.

The expenses of this survey, and taking the requisite levels, and producing the same upon plans and sections, I cannot precisely state. I do not think it could be done for less than about one hundred pounds, but will undertake that it shall not exceed one hundred and fifty—nearer than this I cannot say—and if the adventurers deem it right to have this necessary preliminary step taken at once, I will, on receiving instructions to that effect, take the earliest opportunity of sending down competent persons to carry it into execution.

Fourthly, That should a meeting of the adventurers and parties interested be deemed expedient, I would suggest that the most desirable time for such a meeting would be just after the completion of the temporary sluice and dam, when the subject might be discussed on the spot, and an opportunity afforded me, whilst examining the efficiency of those works, of explaining verbally the various modes by which the ultimate drainage may be carried out; the best time for such meeting would, in my judgment, be some time in July.

Fifthly, Touching the expense of reinstating this sluice, it is quite impossible for me to say with any certainty, without going into plans

and estimates of the works to be done; but if a navigation lock is to be combined with the drainage sluice, I have no hesitation in saying that, without looking forward to any thing beyond the due security and proper drainage of the fens on the present system, the cost of reinstating the sluice, &c., on a proper site, is not likely to be less than ten thousand pounds.

I have the honor to be,

My Lord,

Your Lordship's most obedient Servant,

WM. CUBITT.

London, May 18th, 1842.

The Report of Benjamin Bevan, Esq., addressed to the Committee for the Improvement of the Navigation and Drainage of the River Welland.

GENTLEMEN,

I have taken considerable pains to obtain a knowledge of the present condition of the South Lincolnshire fens, and of the state of the navigation of the river Welland, and have been able, with the assistance of Mr. Pear, upon whose abilities and accuracy I can fully rely, to obtain sections and comparative levels of nearly all the drains connected with the river Welland between Deeping and the sea.

These sections are objects of the first necessity and importance to enable me to point out the present defects in the drainage and navigation, and thereby also to discover the least expensive and most effectual remedies to both.

From the sections above-mentioned, it appears that there is no part of the Deeping or other fens, draining into the wash at Fosdike, but what is susceptible of the most complete natural drainage, without the aid of a single mill or other artificial mode of raising the downfall waters, inasmuch as the surface of the lowest lands in Deeping fen is found to be about sixteen feet above the outfall, and lying within eighteen miles of this outfall, in the direction of the drains. It also appears that the average surface of the said fen is upwards of seventeen feet above the outfall, and that the general surface of the lands in Crowland Wash is about twenty feet above the said level or outfall.