

# REPORTS, &c.

## KING'S LYNN HARBOUR.

The REPORT of JOHN SMEATON, Engineer, relative to the Harbour of  
*Lynn in Norfolk.*

**T**HE Matters to be reported upon as given me in charge by the Magistrates of *Lynn*, were principally the following :

First, The preservation of vessels lying in the harbour of *Lynn*, from the annoyance of winds and waves ; not only from the sea, but from the broad river above the town, when the wind happens to be in that quarter, and also from the raging tides that often accompany them, and drive the Vessels from their moorings :

Secondly, The preservation of the banks of the river, and more especially those near the town, from the action of the winds and seas, accompanied also with too rapid a tide.

The better to enable me to acquit myself upon these subjects, I carefully examined the channel of the river *Ouse*, from the roads near the *Ferris Beacon* to *German's Bridge* ; and also the banks thereupon, and more particularly those within two miles of the town

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Note.—In the plan of the harbour, Fig. 1. Plate 1. the figures in the channel shew the depths in feet and half feet at low water ; the other figures shew the height of the ponds, lower shores, salt marshes, and banks above low water mark.

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of *Lynn*. I have also carefully viewed and examined the circumstances attending the said river, from *German's Bridge* to *Denver Sluice*; so far as they appeared to me to have any relation to the business before-mentioned.

In the course of these enquiries, I had the pleasure to find, that the channel of the river, and particularly that part to seaward, not only from the accounts of the pilots who attended me, but from my own remarks, compared with former accounts and reports, was, at the time of those observations, *viz.* in the month of *July 1766*, in as good condition as it had been known for many years; and in fact without any material cause of complaint. That a bar had formed itself in the upper mouth of the west channel, and that the current at low water was wholly confined to the east channel, which had in consequence proportionally improved.

This is indeed a very material change in the state of the channel and harbour for the better; the contrary condition having been complained of for years past, *viz.* the choaking of the harbour and channel to seaward with sands, and the great tendency of the current to take the west channel instead of the east; which latter (as it seems) was that, which, according to the unanimous opinion of all those who have reported upon it, was the desirable channel to be maintained, and if possible improved; the doing of which has been the subject of much projection and altercation: but as nothing appears to have been done in consequence, but that Nature has very kindly brought matters into a more desirable state, it seems of the utmost importance to propose nothing for execution, that shall counteract her intentions; nor while we are relieving one evil induce a greater.

According to all accounts, the point below the crutch on the east side of the river, called at present *Nottingham Point*, projected much further to the westward: and another point of land on the west side of the river, below *North Lynn*, but above the said *Nottingham Point* according to the course of the river, projected further eastward; so that, to a person standing upon the quay called the *Common Staitb*, at *Lynn*, the sea was land locked by these two points; but that now, by the gradual wear of one or both of them, an observer standing at the same place, will, at high water, see the sea considerably open between the said points; and the wind being in that or nearly that direction, that is, betwixt N. N. W. and N. N. E. and a strong spring tide of flood, the ships are apt to ride very unquietly that lie within the point formed by the *Common Staitb* and the *Ball*, which may now be reckoned the port of *Lynn*, and where the ships chiefly lie to be loaded and unloaded from the merchants' yards.

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This evil I find has been complained of for many years; and in the year 1741, a scheme was offered by Mr. *John Rosewell*; which was to build jetties from these two points so as to produce the same land lock as formerly: and this he imagined would not only redress this immediate grievance, of too much swell running into the harbour, but also others at that time also greatly complained of; that is, obstruction by sand, too shallow a channel, a high bar in the east channel, and too great a diversion of the current into the west channel.

That those jetties might be of some use in checking the swell of the sea, cannot be denied; but the ill effects they were likely to have by encreasing the tendency of the out channel to the westward, is set forth with great justness and spirit, in a small pamphlet, published in the year 1742, entitled, *Some thoughts on Mr. Rosewell's and other Schemes, now proposed for amending Lynn Channel and Harbour*\*; which, as I suppose it in every ones hands to save repetition, I recommend to a re-perusal, from the beginning to and including the 9th page. And indeed Mr. *Rosewell's* reasoning, if such it can be called, concerning the improvement of the east channel by means of those jetties, has not been more solidly refuted by the author above referred to, than it has since been by Nature herself: for it seems very manifest, that in proportion as the points, particularly *Nottingham Point*, have been worn away, the channel has tended more eastward; and has improved in proportion as the west channel has decayed, which must be expected from an union of the two forces. As therefore the maintenance of the channel out to sea, in the good condition in which I found it, I look upon as a *primary* consideration; I entirely agree with the author before-mentioned, that it would be a dangerous expedient to reinstate the two points above-mentioned, by the building of jetties: on the contrary, I am of opinion, that where a channel must be maintained through a vast mass of sand, capable of shifting by winds, seas, currents, and every temporary impression of power thereon, that the more directly the waters make their passage out to sea the better.

Nor am I very clear, that the reinstating of the points would entirely cure the evil at present complained of; they being at too great a distance from the interior harbour, and must necessarily be placed at so considerable a distance from each other, that unless the entry was entirely spoilt, I apprehend the seas would still find the way within the heads: and in so long a fetch to the place where the ships lie, would gather and still disturb them at their moorings.

Nor can they be of much use in checking the too great indraught of the tides, at present complained of; for the passage between them must be very narrow to produce a

\* This pamphlet is anonymous, but I since understand was wrote by Mr. *Elfobb*. See Appendix to this Report.

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fenfible effect, and in proportion as it was contracted, it would wear deeper, and thereby ftill admit nearly the fame quantity of water to pafs. Yet, if they could be fo made as to check the raging tides, they would check the moderate ones too; and I believe all agree in opinion, that in the fituation of *Lynn* harbour, the greater the efflux, which in great meafure depends upon the influx, the better channel may be expected to be maintained: too great tides may be a partial and temporary evil, but it appears to me in the prefent cafe a fault on the right fide; and it feems that in this, as well as many affairs of human life, the judgment confifts in chufing *the leaft of two evils*.

I cannot however agree in recommending the expedient mentioned in the latter part of the pamphlet above quoted; that is, damming up the old river at the weft point, and cutting a new one through the land, down to the road; for this, if not made equal with the mean capacity of the old river, would check the influx of the tides; and if fo made, would be a moft monftrous expenfe, and at laft the event would be uncertain; for by producing an alteration in the fet of the currents, without the mouth thereof, it perhaps is out of the power of human foresight to fay with certainty, that (after fo great an expenfe) fome bar or impediment might not be thrown up, producing an equal obftruction to thofe then complained of; but thanks to Nature for relieving us from the neceffity of fo chargeable an expedient, and giving us the opportunity of *knowing when we are well*.

The fimple point of view, that in my opinion is neceffary to be attended to for the prefervation of the channel, is to do nothing *materially* to affect the indraught of the tides, or to diminifh the quantity of frefh waters coming down the river from above: as to the reft, it muft be left to Nature, and though in fuch a multitude of acting forces and difturbing caufes, the goodnefs of the channel muft by turns become *better and worfe*; yet the grand principles of prefervation being maintained in all the vigour poffible, after a wrong turn happens a right one will fucceed, as experience has fhewn to be the cafe; at leaft leave Nature to herfelf while tending right, it is time enough to help her when we are fure fhe is going wrong.

It is obfervable, that the point formed by the *Common Staith*, and running out betwixt that and *Common Staith Lane*, may be confidered as the jetty, whereby the fhips lying above in the interior harbour, are ultimately defended from the fwell coming in from the fea; and it is only the fwell that gets round this point from the fea that affects the fhipping; for in fact, the fhips that lie in the channel of the river, between the *Purfleet* and the *Ball*, are land locked by this point. This jetty has very much the appearance of having been artificially carried out as well as defended by ftone wharfing for this very purpofe.

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purpose. The river is however still a furlong, that is, 220 yards, wide at this point, according to the plan; the channel lies over to the opposite shore, where it is ten or twelve feet deep at low water, whereas it gradually shallows towards the *Lynn* side, leaving the ground dry at low water for above a chain in breadth.

If I were obliged to recommend something in the *jetty way*, it would be to run out this wharf about a chain further, that is, twenty-two yards, being one-tenth of the whole width of the river. I am very clear that such a projection, immediately before the shipping, would afford more protection than six times as much work done at the two points below; which are at the mean distance of a mile and half; and this without being attended with any ill effect upon the channel below. The only objection that I see to this scheme is, that by narrowing the channel in this the narrowest place, it would in some measure check the influx of the tides; and throw the water more powerfully upon the opposite shore, just below the ferry, the defences of which are already too weak: but if this bank were effectually defended by a sufficient body of rubble stone, applied in such a way as I shall mention, when I come to speak upon the defence of the banks, the effect would be to scour out a channel so much deeper in this place, as, by creating an equal section, would furnish the same quantity of tide water as at present, and probably might deepen the channel on the *Lynn* side; at least something might be done to induce it to act in that manner.

It is observable, that at the end of *Common Staitb Lane* there is a considerable prominence of rubbish that has gradually been formed, and that something of the same kind has been thrown out partly from the lanes, and partly from the houses, quite away to the *Purfleet*, and higher: I look upon it, that it is owing to this body of rubbish, that the channel of the river edges over so soon to the west side; if this body of rubbish were dug away as near to the buildings as can be done with safety, and taken down to or below low-water mark as far as the *Common Staitb*; that the ebb tides, accompanied with the land floods, would improve the channel, and enable the ships to lie not only lower down, but closer in, and thereby more effectually shelter them from the seas, which would be broken off by the *Common Staitb* point; and this is a step that I would recommend, whatever becomes of the proposition of an extension of that point.

I come now to the defence of the shipping when the wind is at S. W. or westerly; that is, when it blows right down the broad river which extends above the town; and with this view it obviously occurs, that if a jetty or break-water were carried out upon the sands from the point above *Old Lynn*, this would in some degree shelter the shipping that lie from the *Ball* downwards: but yet, unless the jetty be extended from A to B in the plan,  
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that is, the length of a furlong, or 220 yards, the vessels lying at or near the *Ball* will still be exposed almost as much as before: on the other hand, this work will throw the current more forcibly into the bite or great hollow opposite this point, where the water sets already too hard, and is making daily depredations. I would therefore beg leave to suggest, that as no ship lying from the *Ball* downward, can be subject to a direct fetch of more than a mile in length; and since in this length no great swell can be raised, but only a short chopping sea or windwash, which would signify little, independent of the force of the wind and a strong tide of ebb, both which must remain; I say, I would put a query, whether it would not be adviseable at once to endeavour to encrease the security of the vessels in the harbour, by improving their moorings; which I apprehend might be done by putting down a row of strong *dolphins* on the west side of the channel in the middle of the river; and continuing the line lower down, and increasing in number those that are on the east side. This measure, independent of every thing else, would be a great security against disturbance, both from land and sea. However, if the magistrates are inclined to begin a jetty or break-water from the S. W. point in or near the direction specified in the plan, in order to try the effects of it, I would not be understood to discourage the attempt; and if not carried beyond the limits there specified, I apprehend any ill effects that it might have upon the opposite bank might be guarded against. It may be begun with rice and rubble stones, and afterwards by sinking old vessels; or continued with the former materials, as shall appear in the execution best to answer the end.

I come now to the subject of the banks: and on this head, as I have already declared that my opinion is in general, to discourage all attempts to prevent the free influx and efflux of the tides and land waters, in order to preserve the channel out to sea in the most effectual manner, upon which both the navigation and drainage dependent on the *Ouse* entirely hinge; nothing remains to be done with the banks, but to make them stout enough and high enough to stand against all extremes: my business will therefore be, to shew how this is to be effected. To give directions about the particular parts would be endless, and will be the proper business of the surveyor, who shall be entrusted with the execution thereof; I shall therefore content myself with shewing the general principles, which will easily be applied by the judicious artist to the particular cases.

In the first place, I entirely disapprove of all jetties built into the stream, as a defence for saving the banks or foreshores from the action of the water, as I am convinced from many observations that they have a direct contrary tendency; for they seldom fail of producing a deep pit, either opposite to, or on the downstream side of the jetty, which  
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tends to undermine the banks, and even the jetty itself; so that thereby the *rent is made worse*.

Whatever works are attempted for the preservation of the foot or banks of foreshores, when too hard a *set* of the water tends to undermine them, ought to be disposed parallel, or according to the direction of the stream; so that the water, instead of being stopped or thrown off, shall glide gently by, with the least interruption possible; for thereby the water gets away with the least possible action upon the banks, and consequently wears them or their defences the least. For this reason all angles and sudden turns are to be avoided as much as may be, and where a turn must be made, as very frequently happens, let it be made with as easy a sweep as possible, keeping it as near as may be the same with the natural, that is, the general *bend* of the river, cutting or rounding off all small sudden turns, angles or extuberances, which may happen in the general sweep; which directions will hold, as well for forming the base and middle lines of the artificial banks themselves, as for preserving the foot of the natural foreshores, whereon the other is founded. To act otherwise is to oppose a natural current, and to oppose a natural current is to give it something whereon it may incessantly act, towards the destruction of the opposed work; which in the case of banks and their defences, is to do something contrary to the very intent of doing it.

This doctrine cannot be better illustrated than by the two great jetties, in the turn above the *Ball-fleet*; opposite and just below which are five and six fathom water; whereas the natural bottom or depth is not more than as many feet. By this means their foundations are sapped, as well as the adjoining banks, which in consequence must be subject to very expensive repairs, as the bite of the river will grow deeper on every alteration.

This is also the case with a number of jetties on the west side of the river below the ferry: to say the truth, I scarcely ever saw an instance where this sort of works, when applied as a defence to the banks, did not do mischief; it would be very well that they were all removed, or if this is thought too much expense, at least never more to be repaired in their present form.

Where the sides of a river or foreshores grind away by too great streifs of water, the most infallible, secure, and lasting method of doing it is, after the sudden extuberances and irregularities of the curve are taken off as low as the water will admit of by hand, to line up the foot with rubble stones, thrown in promiscuously, so as to form

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form their own natural slope against the shore, till they appear above water, at low water. This being done for the whole length of the galled place, with the regularity before described; and being further supplied with a fresh quantity after a settlement has happened, in consequence of succeeding great tides and floods; will prove a lasting security against further depredations at the foot; and the foot being well secured, Nature will, in most cases, where there is room to do it, form of herself such a natural slope to neap tide high-water-mark, as will need no artificial defence. The chalk and clodlime rubble that is brought down the river, seems a very good material to be employed in this way, but the rubble of any stone that will bear wet and dry will do, which can be procured cheapest; the larger and more irregular, both in point of shape and size, the better.

The same defence, where stone is wanting, may be procured by the application of stakes and rice; but disposed, as before directed, even and parallel to the stream\*, without jettings or extuberances; but nothing can be done with these materials comparable to rubble stones, on account both of want of weight and duration.

It may possibly be objected, that a sufficient quantity of rubble stones, to secure the foot of the banks and foreshores in this manner, will be expensive; and in some cases possibly it may; but it must be considered, that here will be no expensive tide-works, with a number of men, and that there will be very little additional charge beyond that of bringing down the stones; but in preference to all methods that are in themselves ineffectual, the cheapest way is to do nothing.

The base of the bank and foreshores being secured as above described, it has already been said, that where there is room enough, Nature will herself form a slope upon the foreshores up to the high-water-mark of neap tides, which will be of itself a sufficient defence against waves and currents; and where there is no want of room to form a sufficient slope above the neap tide high-water mark to the top of the bank, there is no better way than to slope and turf it over, in the manner that has already been put in practice, but above and below the town of *Lynn*; and also on the other side of the water. I can give no better directions than these specimens will afford, which seem done with great judgment; only that, instead of using any wood at the foot of the turf about neap tide high-water-mark, I would advise to rely wholly upon a *lay* of rubble stone; and if some of it is broken small so as to fill up the interstices of the larger pieces, this will form a more complete union between the rubble and the turf, than if composed of large stones only.

\* The ends outward, and a little inclining down stream.

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Where the artificial banks stand steep upon the foreshores, I observe that the practice about *Lynn* has been to defend them by a boarded wharfing. This at first seems to promise much security; but experience has proved that this is only *outside*: and if we consider the action of the waves upon it, we shall find this method not at all calculated to sustain their shocks for any length of time, the very union of the parts being the cause of their destruction.

If the sea dashes against the end of a faggot or a stone, these having no solid connection with their neighbours, the impression goes no further; but the tremors raised in one part of a boarded wharfing is communicated to the whole, or to a large area; which, accompanied with the great shocks that must ensue when a considerable part of the surface is struck together, these agitations by little and little shake and loosen the earth behind, which by the rise and fall of the tides is by degrees washed out at the foot and through the crevices, which brings the whole to ruin. This, accompanied with the speedy decay of all wood work exposed to wet and dry, makes it seem to me quite eligible totally to discard this method in all future repairs. In lieu whereof I would recommend the following: wherever the foreshores are not broad enough from low water to neap tide high-water-mark, to stand by a natural slope, I would advise them to be reduced to a slope of two to one; that is, to batter two feet to one foot perpendicular; and this being covered a foot thick with rubble stone of all sizes bedded together, and footed upon the rubble, supposed to be thrown in to support the ground under low-water-mark, will, as I have often experienced, make a very lasting defence, and is capable of great resistance in all ordinary cases; but if exposed to the waves of the open sea, the cover must be increased in weight and thickness. This method will answer the end, if the batter is three to five, or even one to one; but the latter I would not recommend without extreme necessity.

With respect to the upper part of the bank, from the high-water-mark of neap tides, to the high-water-mark of the equinoctial spring tides; I would, in all cases where it is possible, shift back the banks, till they will admit of the slope and turf method above referred to; but if this be not possible, to continue the same batter as the foreshore, and to face the artificial banks with stone in the same manner as already described.

I do not know of any security against *inundations*, in a country that is defended by banks, otherwise than by making those banks, not only sufficiently strong, but high enough to sustain the greatest extreams, without being overflowed: and it is from *experience alone*, that these extreams are to be learnt.

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The greatest extream of a flood or tide that has been known at *Lynn*, appears to have been one on the second of *December* 1763, when the water flowed one inch deep in the compting house of Mr. *Elfdon* of *Lynn*, and left a very visible mark, which he shewed me. This mark should at high-water of some spring-tide, be transferred to the Custom-house, or some public place near the river, to which recourse may constantly be had. Though this is the largest tide we know of, yet there are accounts of several tides within a few inches as high as this; I do not therefore look upon the banks to be safe, unless they are proof against such another tide as this; and to this, as a standard, I would constantly refer: I cannot, however, look upon them as *proof*, unless they are made up at least one foot above the level of this mark, and maintained, after settlements, at the height of half a foot above the same. It is not, however, necessary, to preserve the same slope above the high-water-mark of equinoctial spring tides to the extreme height, as below that mark; because they will but seldom come to a stress; yet when they do, they must be *sufficient*, or they answer not the end.

In order to this, they ought to be three feet at least broad at the extreme height; and at least three times as much broader at the level of the equinoctial spring-tide mark, as the extreme height exceeds that height. The artificial banks below that mark should be at least four times as much broader, in their base or seat, upon the natural level of the ground, as the perpendicular height of the said extreme tide-mark is above the natural level of the ground, whereon each part of the said bank respectively stands. These proportions will be very sufficient in the neighbourhood of *Lynn*, where the earth is good; but where the earth is loose, sandy or moory, the bases or seats and tops should be respectively broader.

These are the best methods that I know of putting the town and country in a state of security; every other attempt to lessen the tides themselves will not only be vain and fruitless; but even, if effected, hurtful to the general drainage and navigation of the country.

If the expense be objected to of making up the banks in this manner, I answer; that if we take the compass of a few years, it will be a great saving; but since this is the only permanent and secure method that I know of; if it is not worth while to put the properties into a state of security, then the proprietors must be contented to possess them in a state of insecurity:

After having declared it as my opinion, that every attempt to check the free influx and efflux of the tides (that is, while it remains an open river) is likely to be hurtful to the  
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