PLAN

FOR THE IMPROVEMENT OF DUBLIN HARBOUR:

TOGETHER WITH

A PROJECT FOR A NEW ONE,

DENOMINATED

Dublin Life Harbour;

ALSO,

A DESIGN FOR AN EXCELLENT OUTER-HARBOUR, BY AN NEW ENTRANCE TO THE PRESENT ONE ;

WITH

AN EFFECTUAL METHOD OF CLEANSING AND DEEPENING THEM.

BY WM. M: MENAMY.

MASTER OF THE HIBERNIAN MARINE SCHOOL.

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TO the Right Hon. and Hon. the Directors General of Inland Navigation in Ireland. Sc.

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GENTLEMEN,

AN effectual method for the Improvement of Dublin Harbour, occurred to me many years fince as a matter of mere speculative curiosity, which would always obtrude itself on the mind whenever any melancholy accident happened on our coaft, and occafion much regret at the flow operations of Nature to accomplish what I then had little hopes of ever feeing promoted by Art, until our late Parliament were pleafed to make inquiries as to the practicability of fome general plan for effecting fo defirable an object. I communicated my project to fome Gentlemen high in office, who defired me to draw up my fentiments on the fubject for their perufal, which accordingly I did in November last, after which they were pleafed to advise and encourage me to present the paper to your Honours; therefore I now take the liberty of fubmitting it to your confideration, and of fubfcribing myself,

Marine School. 3 24th Feby. 1801. 3 Your Honors Most dutiful Servant, WM. M'MENAMY.



A Plan, &c.

THE most general and rational project for the improvement of the Bay and Harbour of Dublin, which would afford fafety to fhipping in cafe of ftorms, remove the prefent obstacles to its navigation, and prevent shipwrecks on our coast, we hope will fpeedily be adopted, efpecially as the government has interpoled in the caule of humanity and the profperity of the metropolis of the kingdom, by appointing certain gentlemen as able directors-general of navigation for improving the harbour, and competent of appretiating the most judicious plan for that purpose.-The many valuable lives and immenfe property that are annually loft by fhip-wrecks about our Bay and Harbour, will doubtlefs ftimulate many perfons to offer their fentiments freely on the best means for averting the recurrence of fuch melancholy accidents; in which cafe many visionary ichemes, it may be expected, will be proposed by some who are ignorant of the laws of Nature or of Science, either from humane or interested motives, which necessarily must be rejected : But the

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fuggestions of the well-informed from whatever motive, it is hoped will be fully investigated before they are either neglected or fuperfeded.

The author of the following plan is not however too fanguine in his hopes of preference to his fpeculations on the fubject; yet, professing some knowledge of the fciences, and having made the motion and equilibrium of fluids his fludy thefe many years, which the duties of his public fituation in some measure required, befides having been the FIRST (and only one) that ever calculated and published Tide Tables, exhibiting the daily depth of water on the Bar, to which were affixed a fmall chart with a nautical defcription of the Bay and Harbour; also failing directions for avoiding the banks, and crofsing the East and South Bars of Dublin; all which being greatly approved of by the public, encourages him to hope for an equal attention to his obfervations and reflections on the origin and phyfical caufe of Shoals and Sand-banks, particularly on our own coaft, with the natural means of their radical cure or removal, and confequently the most rational improvement of the harbour, on the general principle of afsisting Nature in her operations, by removing the caufe, whereby the effect will ceafe. The improvement here proposed would require little expense to execute, compared with the importance of the object and the advantages to be thereby derived; and is an improvement that would never decay or require additional expense to perpetuate.

It is unnecessary in the enquiry to discuss the theory of the *Tides*, we shall therefore only mention their general

neral courfe and direction, which is from E. to W. following by attraction the apparent courfe of the Moon. The flood-tide rifing in the northern ocean, glides along the coaft of Norway, from the N. Cape to the Naze ; and because its general course to the westward is interrupted by Great-britain, it ftretches to the fourhward, along the E. coaft of Scotland and England, 'till it falls into the English channel, filling up in fuccession all the vacancies that happen in its way, in whatever direction they lie; for as water must naturally find its own level, and take the easieft passage when permitted, these confequences must necessarily follow : Alfo, while the flood-tide is gliding to the fouthward, along the Weft coafts of Scotland and Ireland, a branch of it falls into St. George's channel fetting to the fouthward paft Dublin, 'till it meets the other part of the general tide about Carlingford, which fets to the fouthward through the Irifh channel.

Tho' the flood-tide about mid-channel fets paft Dublin to the northward, in a direct channel-courfe, unlefs diverted out of its way by some obstacle, yet the tide in fhore must partake of all the meanderings of the coast along which it glides, winding round all the promontories or projections, and falling into all the bays, hollows, cavities and rivers it meets with in its progrefs, as was hinted above, and for the fame reafon that water will find its own level, and takes the easiest passage. Now, if any of those hollows lie to deeply imbayed or greatly land-locked, as to form the much greater fegment of a circle, or has its entrance fo athwart the current as to lie partly on the opposite direction thereof, then

then the stream will strike the opposite projection, and wind in on that fide, caufing a counter-current or eddy in the hollow. Or even in a wide hollow bay the current along fhore fuffers a greater refiftance by the friction of the coaft, than the passing current in the offing; it has therefore lefs energy, befides the current fhould defcribe a greater diftance along the incurvated coaft, than in the direct line of offing in the fame time with a given velocity, which is impossible; and confequently, on both accounts, will also occasion an in-shore countercurrent or eddy, and an indraught* of water on the flood, to fupply or fill up the expansive hollow. Hence we may perceive why the first of the flood or ebb-tides may in many places have a very different direction from the latter part thereof .---- Again, as the current passes along any straight coast, it must move with greater velocity than in the adjacent hollows, and still much greater as it passes round any cape or projection, or thro' any narrow channel oppofite to a straight coast, or opposite any projection of land into the sea ; because in these latter cases, the water is more contracted than in the hollow, where it has more room to fpread itfelf .--Every great wave or fend of the fea must also strike a straight coast or projection into the sea, with much greater violence than in deep Bays or shelving shores : Hence the reafon why the tides rife higher on a flat shelving coaft, and up rivers, than in the open fea, particularly in rivers that are of great extent, of moderate declivity, contracting banks, and their courfe opposed to the course of the flood-tide : For a great wave or fend

* Improperly called an indraught, because the waters are impelled, and not drawn towards the shore.

of

of the fea, must neceffarily make an horizontal motion on those flats or mouths of rivers to a considerable diftance, and before it can return, is met or fucceeded by another wave, which will heap up the former on top of the latter, which is still flowing in underneath, continuing with fuccessive impulses, until the accumulated water by its gravity obtains an equilibrium with the impulse of the wave or furge, and therefore may rise the tides at those places to great heights under fuch circumftances.

If either by a combination of natural caufes, the ravages of time, or any violent convultion of nature, the waters thould rife to an unufual height, or the land fubfide below the level of the fea, then the tide will overflow the lower grounds or flats, and by its rapidity and reciprocation, break down the fea boundaries, delapidate the plains by wathing away the foil, or covering it with fand brought from the adjacent thores, or its own banks, by the recurrence of the waves, or partly from both caufes, occafion extreme terror to every wayfaring mariner.

The natural effects of thefe principles are in general, that as the water violently passes by, or dashes against those bold projecting shores, or through those narrow channels opposite to them, it washes away all the loose fand, earth, finall gravel, or other light substances it meets with, or dashes off the banks into the stream by the recurrence of the waves: the quantity of fand, &c. removed, is proportional to the velocity of the water, which is again deposited in the eddies, flack or still water, deep bays, or retired shelving flats along the coast, that

that lie out of the race of the currents of flood and ebb; or it is formed into banks or bars by its fubfiding at the points of congress, or recession of contrary currents, or where the force of one current is nearly balanced by the force or refistance of the fea inertly opposing, or actively fetting against it. These banks or bars can never accumulate above a certain height, viz. the place of the equilibrium of the re-actions of the under-water; fo that if the place of the equilibrium can by any means be removed to a greater depth, the bank will naturally wear away by the prevailing current; but if it be removed to a lefs depth, the bank will accumulate .- Hence by the drifting of those fands, &c. and their concretion, we have the origin of shoals, banks, and bars (unless those that have not been generated, but either created there at first, the remains of inundated or funken islands, or the overflowing of low grounds, by the violence of the fea breaking down the antient boundaries, &c.) and from the analogy of the drifting of fnow to the drifting of those fands we acquire accurate ideas of their formation; befides an attentive review of the coaft and currents, with a diligent and judicious application of the foregoing principles will enable us to develope their phyfical caufe, and their cure or removal if possible by applying natural means, as may hereafter appear ;-But before we difmiss this part of our enquiry, we wish to confider a certain hydraulic principle which is of frequent use in the improvement of harbours, but has not been fufficiently attended to by any author on that fubject which we have met with.

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Many gentlemen affirm that ftones of great fize have been removed and dashed out of their places, by a heavy furge; we have heard fome of the contractors for building the South-wall declare, that feveral of their largest stones have been torn from their places by a storm and rolled to a confiderable diftance, even after being ftrongly crampted with iron; while other gentlemen of fome knowledge and experience doubt the poffibility of it, by reafon that a ftone specifically heavier than its bulk of water will neceffarily fink, where they imagine it will remain ; but it is eafy to reconcile these seeming contradictions, and show in what cases they are respectively right or wrong; for if a large stone is constantly immersed, it would require a great velocity of the water to remove it; but if it be alternately bare and immerfed with waves, a much lefs velocity of water will remove it, because in the first case the action of the water is by prefsure only, and in the latter cafe by percuffion, which every artificer knows to be vaftly more powerful in its effects. Hence arifes the following curious new problems, whofe folutions would be extremely ufeful to an enginer, who might be required to cleanse an harbour of its fand-banks, build pier-heads, or erect break-water ramparts, &c.

PROBLEM I. Required to determine the magnitude of a ftone of a given specific gravity, that may be in equilibrium with sea-water, moving with a given velocity?

PRO. II. Required to determine the magnitude of a like stone which might be in equilibrium with a given wave of the sea, asting by its percussive impulse.

Now

Now the confideration of the fecond problem not being immediately neceffary in our prefent inquiry, we fhall defer its folution to another opportunity, and proceed only to the inveftigation of the first.

By the principles of mechanics, the refiftance to a plane moving against a fluid at rest, or which is the same thing, the action of the fluid moving against a plane furface at reft, is equal to the weight of a column of the fluid whofe bafe is the plane furface and height equal to the height from which a body would fall in vacuo, to acquire the velocity with which the plane moves ;-and from the fame principles, a globe is refifted only half as much as a plane furface of equal area with a great circle of the globe. These principles premised, let the stone whose magnitude is required, be of a globular form, and let its diameter be represented by x; its fpecific gravity to that of fea-water, equal to $2\frac{3}{7}$ =d; the weight of a cubic foot of fea-water equal to 64 $\frac{3}{6}$ pounds avoirdupois, = e; the fpace thro' which a body would fall in vacuo in a fecond of time, as found by the most accurate experiments, and the theory of pendulums, equal $16\frac{1}{12}$ feet = s; the area of a circle whole diameter is one equal ,7854 = a; and let the velocity of the water = v; then $\frac{v^2}{4s}$ = the height from which a body would fall in vacuo to acquire the velocity v; $\frac{ax^2}{2} =$ half the area of a great circle of the ftone, and $\frac{2ax^3}{3}$ = its geometrical folidity; hence $\frac{v^2}{4s} \times \frac{ax^2}{2} \times e =$ the action or force of the water against the stone to move it. Now it is plain that when the relative weight of the ftone in the water becomes equal to this force, the weight of the ftone

ftone will be in equilibrium with the action of the water, fo that if the velocity of the fluid be ever fo little increased, or the magnitude of the stone diminished, the current will overcome the gravity of the ftone ; but $\frac{2a\times 3}{3} \times e =$ the weight of the water of equal bulk with the flone; confequently $\frac{2ax^3}{3} \times e \times d$ is equal to the weight of the flone in air; and $\frac{2ax^3}{3} \times e \times d - \frac{2ax^3}{3} \times e$ = to its relative weight in the water = to $\frac{1}{4-1} \times \frac{20\kappa_3}{3} \times e$ = by the preceding principles to the force of the water, against the stone when in equilibrium with its relative weight, hence $\overline{d-1} \times \frac{2ax^3}{3} \times \epsilon = \frac{v^2}{4^8} \times \frac{ax^2}{2} \times \epsilon$, and therefore $x = \frac{3^{\sqrt{2}}}{16 s \times d-1}$ feet, or $x = \frac{9^{\sqrt{2}}}{4s \times d-1}$ inches. Q. E. I. Now let the current move at the rate of 4 knots or miles per hour, or $4 \times \frac{5}{4} = 6\frac{2}{4}$ feet per fecond = v, then x = $\frac{9v_2}{4s \times d-1} = 4.35^2$, or $4\frac{7}{20}$ inches, nearly equal to the diameter of the stone in equilibrium with the force of fea-water running at the rate of 4 miles per hour; or a ftone equal in weight to 3lb. 1402.;, avoirdupois; and if the celerity is at the rate of 3 knots, its force will be in equilibrium with a ftone of 2,448, or 2⁴ inches in diameter nearly, and its weight 11 ounces. &c. But the stone must be driven to the distance of 7 or 8 miles during the tide of flood or ebb, to be of use in our plan; suppose 71 miles, or at the rate of 14 miles per hour at a medium, that is at 212 feet per fecond of time, then the velocity of the current acting against the stone, is only the difference of those of the tide and stone, that is $6\frac{2}{3} - 2\frac{1}{12} = 4\frac{7}{12} = v$. Hence by the preceding inveftigation C.

gation, x or the diameter of the ftone whole weight is in equilibrium with the action of the tide on it during the fix hours of its motion, and carried 7' miles, the tide moving at 4 miles per hour, is equal to 2,0571, or $2\frac{1}{13}$ inches nearly, and its weight equal to 6⁴, ounces: but if the current was only to move at the rate of 3 knots, then the diameter of the ftone that would be driven 72 miles during the time of the tides motion, would be \$336, or ¿ inches nearly, and its weight equal to 4379, or $\frac{7}{16}$ ounces nearly, &c.---Again, as the flone is fpecifically heavier than the water, it must remain at the bottom, and can only move by rolling or fliding along, and confequently must have fome friction from the roughness or tenacity of the bottom, which will increase the difficulty of moving it, and therefore diminish the fize of the stone that can be moved with a given celerity, which is an additional confideration that must now be taken into the account. Theory informs us, and experiments confirm the principle afferted by every writer on mechanics, that the quantity of friction is directly as the weight of the moving body, and the tenacity or roughness of the rubbing furfaces, let the fize of the rubbing furfaces and the velocity of the moving body be what they may, and is therefore found to be some constant part of the weight of the moving body, as the 1, 1, 1, &c. part or even the whole weight of the body; suppose in this cafe it were the whole weight of the body, which is very improbable, then the weight to be overcome by the force of the water would be double to what we had affigned, and confequently the diameters only half of what we had found before,

before, and the weights only a part of the formerweights, and fo in any other proportion of the friction, the diameters and weights may eafily be found by our theorem .---- Hence we may juftly infer, that if ftones of fuch confiderable fize as we have determined above, can be driven to the diftance of 7 or 8 miles during the flood or ebb tide, that fand which is fcarce the hundredth part of an inch in diameter, and its weight not the millioneth part of an ounce avoirdupois, will be carried to a much greater distance before it be deposited in flack or still water, or thrown up on the retired shores, and the diftance is nearly equal to the whole run of the flood or ebb. We likewife perceive by our theorem, that a much smaller velocity of the waters than is usual about our bay and harbour, is competent to remove fand, and confequently to remove banks or bars, if judicioully directed or applied. Here we might proceed to calculate the force of waves or heave of the fea, but as their force is already known to be very great in drifting fand, pebbles, small stones, &c. for the fake of brevity we decline its investigation, and pursue the other parts of our fubject.

The courfe of the Tides, the caufe of eddies, and counter-currents, together with the formation of fandbanks, being heretofore in general accounted for, we are enabled the better to account more particularly for the caufe of those eddies and currents about the bay and harbour of Dublin, and their effects in generating the bar or other banks, and confequently to propose the best means of removing them, by removing the caufe of their generation.—Thus; the line of coast from

from Bray to Rush, being greatly incurvated and broken by headlands, islands, bays and inlets, occasion counter-currents in Killynee-bay, Dalkey-found, hollow of the South Bull, along the South coaft of Howth, in the found of Ireland's Eye, and past the Nose or Head of Howth, also complete and contrary eddies at the green Baily; befides oppofing, receding, and jarring eddies and currents at the bar; and their velocity being in general between 12 and 3 knots per hour, is of fufficient force to give motion to the fand; all which are eafily deducible from our theory and preceding Theorem: But to particularize these eddies and counter-currents, and to estimate their duration and effects, is a subject of greater expansion than our limits will afford room, which would require all our research and knowledge of Science to inveftigate; however by the preceding principles, and the help of a good draught, or our aquaintance with the coaft, we hope to furmount the difficulty without any material diviation from what may be determined by the best observations, which is the test of every phyfical inquiry.

Having a good chart in review before us, we perceive that Bray-head, (or even Wicklow-head) Dalkey-found, Sutton Creek, Ifthmas of Howth and Portrain, are all nearly in a right line, confiderably clear of the reft of the Coaft, and exhibiting the whole Peninfula of Howth, projecting itfelf into the fea beyond any other Head-land between these extreme places, bearing nearly N. N. E. and S. S. W. of each other by compass. We perceive alfo that the flood tide in the offing opposite Bray fets about N. N. E. ' E. to clear Howth Head, but when it arrives arrives nearly abreaft of Dalkey, a branch of it must neceffarily be impelled over the the Man of War road towards the Bar by the fhortest passage to fupply the. Bay, the Harbour and the great extent of ftrands on on either fide; on its arrival at the Bar it is oppofed by the ebb-current of the Liffey, for a time proportional to the reach, declivity, and momentum of the natural land-waters of the river ; because every river must neceffarily run into the fea for a confiderable time after the flood-tide in the offing commences, or until fuch time as the river current is overpowered by the impulsive force of the accumulating flood tide in a contrary direction : the central current of flood when arrived at the bar, is again divided, the greater part it going to fupply the South-Bull Strand, and the remainder the North Bull; but the part urged towards the South Bull, and falling into the hollow thereof, must by our theory occasion an in-fhore counter-current, along the coaft thro' Dalkeyfound, till it unites with another branch of the offingtide urged into the hollow, and forming a counter-current alfo in Killynee Bay, and their duration will continue while the caufe remains, that is until the ftrand and hollow of the South Bull and Killynee Bay are nearly half charged with the influent waters, after which, until high water, the tide having acquired greater energy by the acceffion of fo much additional water, will fet along the Coast in the contrary direction, towards the Harbour : The remainder of the offing-tide which does not feperate abreaft of Dalkey with the central branch, continues its proper courfe for Howth Head until it arrives at the green Baily (a great projection of land stretching due South from

from the S. E. part of Howth for near half a mile) on which it impurges caufing an in-fhore western curtent along the South coaft of Howth, making for Sutton-Creek, and Dublin Bar, where it is also opposed and arrested by the last of the ebb-current of the Liffey until the Bay has partly filled, and the tide to pour in more rapid by the central current, to overpower the current from the Harbour, which we may eafily judge to be about the end of the first quarter of the offingflood, because it is evident that the tides run swiftest at half-flood and half-ebb, and flowest or almost to be stationary at high and low water ; hence if we take a mean of the times when the flood moves quickeft and flowest, we cannot err much from the true time when it overpowers the ebb-current of the Liffey, which is about the end of the first quarter; the waters at this time pouring in over the center of the Bay more abundantly than neceffary for the fupply of the Harbour, the North, and South Bulls, on account of Howth intercepting a great body of the water in its natural course, by projecting fo much into the fea, beyond any other Head-land within the efficient reach of the tides. The redundant waters which are not accellary for faid fupply, must pass Eastward along the South coast of Howth till they arrive at the Baily, overpowering the former languid west current while redundant waters come into the Bay, that is until high water .- The last of the ebb from the Harbour being thus opposed at the Bar by the central and west currents on the first of the offing-flood, must wheel round the Light-house, and fall into the counter-current in the hollow of the South Bull, that fets fouthward along the coaft. The

The remainder of the primative tide, with which we commenced, paffing Howth head, must be forced into Ireland's Eye-found to fupply it, together with Baldoyle strand and gut, with influent waters, fo that the current will pafs to the northward through the found, as well as on the east fide of the Island, until the found, and ftrand along the coaft are pretty well charged, fo as to form an extended Bay, between Howth head and Rush pier, which will require a greater body of water to supply together with the strands and inlets at Malahide, Turvey, &c. than can poffibly enter northward thro' the found ; it is therefore urged inwards by the greater momentum of the deeper waters in the extended mouth of the Bay, than in the found, which will caufe an in-fhore counter-current, to the fouthward along fhore, and through the found for the remainder of the flood tide; and this effect commences when the tide runs quickest, and the Bay partly formed, which is about half flood, at which time the two currents meeting and oppofing each other about the north end of Ireland's Eye, they become nearly stationary for some time, hence by their re action, and the fubfiding of the floating fand, a ridge is formed across the North entrance, which has only 9 feet on it at low water fpringtides, while the South entrance and found, has 5 fathom water in it at the fame time.

From half flood to high water, the counter-current from the found paffing the nofe of Howth, and the eaft current from the Harbour meet at the Baily, and circulate in an eddy round Rofsbeg, a bank of fand projecting W. S. W. from the Baily point, about 2 miles long long, and 1 mile broad, beginning about 1 mile from the Baily, and having 18 feet water on it at low water fpring tides.

Having thus far, which is fufficient for our purpole proceeded with the flood tide and explained its eddies and counter-currents, we fhall return with the ebb, and in like manner account for its eddies and counter currents, at the different points of inflection which were noticed before, and then affign their united effects in generating the Bar, and other banks within our preceding limits.

The ebb current coming from the northward, butts directly against Ireland's Eye, and Howth, and no counter-current can then poffibly happen in the found; for the fame caufe which occafioned the counter-current there on the laft half-flood still remains and confpires with the natural course of the waters during the entire of the ebb-tide, fo that the currents within the found fet to the northward for about 3 hours only of the whole tide, and to the fouthward for the remaining 9 hours .-The Bay, the Harbour of Dublin, the ftrand on either fide, and their different channels being charged by the flood tide, the waters on the ebb must principally retire over the center of the Bay, where it begins first to fubfide, and is followed by the 'waters of the Harbour and either strand, as they fucceffively defcend, the course of the central ebb current being in a direct contrary direction to the former central flood current, while the infhore current from Killynee Bay and Dalkey found preferves the courfe it acquired from half-flood, which is now a counter-current, falling into the hollow of the South

South-bull, and winding round by the Light-houfe'till it. unites and paffes along with the central current, making for the general ebb abreaft of Dalkey; but the waters fubfiding from the N. Bull and Sutton Creek, pafs eaftward along the S. coaft of Howth, till they arrive at and fall in with, (oppofite the Baily) the ebb current fetting fouthward paft Howth-head ; for the interior waters in the harbour, and on those extended strands being more elevated on the flood, as appears by our theory, than the exterior water in the Bay, must by their gravity prefs upon and follow the exterior retiring water, until the in-fhore water becomes nearly level with that in the offing paffing Howth, which must take place after halfebb, or rather about the beginning of laft quarter, when on account of the greater momentum of deeper water, the interior fhoal water is preffed or impelled inwards, overpowering and changing the direction of the former currents, viz. the east and central currents to west currents on each fide of Rossbeg, setting for the Bar, where they are met by the current from the Harbour, and after their collifion unite and pafs fouthward along the coaft, contrary to the counter-current, which will continue fo, during the remainder or laft quarterebb .- We may now recapitulate the total fetting and duration of these several currents and eddies in their respective places; for a whole tide, or that of both the flood and ebb-tides in the offing, to be fouthward along the coaft through Dalkey found, during the last quarter-ebb and the first half flood, and northward for the remaining five quarters, that is from the first of half flood to the last of three quarters-ebb nearly; the central current making for the Bar, from the third quarter ebb to high water.

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water, and its return by the center of the Bay during the first three-quirters-ebb; the east current along Howth continues from the first quarter-flood to the last quarter-ebb, and the west current from the last quarter-ebb to the fecond quarter-flood : lastly, the eddy. current at the Baily circulates round Rosbeg, from half-flood to high-water .---- Hence we clearly comprehend the immediate reason why the Bar and other banks about the Bay and Harbour of Dublin are formed and maintained. The opposing currents from the third quarter-ebb to the second quarter-flood, and the receding currents from the first quarter-flood to high water, will occasion the sand to be thrown up and heaped at bottom, and the floating sand to subside, and on both accounts must generate the Bar to a given height, which is deeper toward the South Buoy, where the currents conspire most in each other's directions ;- The complete circular eddy at Rosbeg, forms that bank .- The indraught into Killynee Bay, forms a ridge towards the fouth end of Dalkey Island .----The South Bull being now protected by the fouth wall or rampart, must be driven inwards and accumulate by every heave or fend of the fea from the S. E. quarter, and confequently the fouth end of the Bar and the fouth Channel must shift inwards closer to the South Bull, which is now more incurvated and steeper along its edge than formerly before the wall was built; in like manner the formation of the ford and patches in the Harbour, Burford, and Bennet's banks outfide the Bay, the Kish, and other banks called the Irish grounds, &c. might be accounted for, but the cause

of

of the Bar, is our first object which may be confidered under another point of view; thus, were there no river; then the N. and S. Bull's would only be one continued bank or strand formed both by flood and ebb-tides, and by every fend of the fea from the eaftward; but there being a river it must find a paffage, and when the force of its current is nearly balanced by the force or refistance of the fea from without inertly oppofing, or actively fetting against it, must generate the Bar so often spoken of, and so injurious to the trade of the metropolis.—The fand on the Bar is more compact and constipated than on either Bull, by the continual agitatition of the water over it; so in the fand on both strands within the limits of the recurrence of the waves more constipated than elfewhere about the bay.

The preceding principles and reafoning being premised and duly confidered, will qualify us to form a right judgment of the merits of the plan, we are at length prepared to propofe for the improvement of Dublin Harbour, which is, to convert the Peninfula of Howth into an Ifland, by cutting a large canal acrofs the ifthmus near the green fields, to be continued both ways to Sutton-creek, and Baldoyle-gut, which would change a great part of the prefent ifthmus into a found, calling it the Sound of Howth.

If Howth were an Ifland, having deep water in the found and the bar, the North Bull and the ftrands on both fides the prefent Ifthmus removed, with good anchorage for large Veffels all round Howth, and Ireland's Eye sheltered from every wind without the terrors of the North Bull or bar to encounter, the vast importance

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to the trade and profperity of the city, and the prefervation of great number of valuable lives would be evident to every confiderate perfon; but what Nature has almost completed let Art accomplish, denouncing the total extinction of the fatal North-Bull and Bar, by infulating Howth, and affisting Nature to procure us a fafe harbour free of obstacles to its entrance, which may be effected at a finall expence compared to the great and important advantages that must neceffarily be obtained by adopting our plan.

Let us now enquire into the consequences of our project were it adopted ; it is plain that inftead of those jarring conflicts at the Bar, North-Bull, and Northfound of Ireland's Eye, the flood currents would confpire together and rufh violently through the found of Howth, fcouring the Bar, North Bull, and Baldoyle Banks, and depositing their contents in the wake on the fhores of Malahide, Portrain, &c. but no part of this drifted fand can fubfide on the fhores of Howth, Ireland's Eye, or in the North entrance to Ireland's Eye found; becaufe the flood-tide which comes round Howth Head and falls into the found, confpires with the current paffing through Howth found to discharge the drifted fand far beyond these places; for if stones of great a fize as 5 of an Inch in diameter, and near 5 of an ounce in weight, as appears by the folution of our problem, can be driven to the diftance of feven or eight miles during the flood or ebb tide, when it moves at the rate of three Knots, that fand which is of fmall magnitude, and not the millionth part of an ounce weight, must be driven in vast quantities to a great distance before it is deposited

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on the fhores, or in flack or ftill water, tho' the current through Howth found were even much lefs than ufual in fuch places; befides the flood-tide having paffed through the found, will fpread itfelf with fufficient force to clear away in a great meafure the fand which lies to the weftward of the Pier and abreaft of Howth Town; and the middle current will deepen the North entrance to Ireland's Eye-found by removing the caufe of the counter current on the last of the flood, which at most is very languid or nearly stationary, the defect of influent water through the fouth entrance to fupply Baldoyle strand that occasions the counter current, being then abundantly obtained directly in its natural courfe. through the found of Howth,----- This plan will likewife greatly diminish the eddy current at the Baily, as the redundant waters will mostly pass through the found of Howth, and confequently diminish Ross-beg bank, by lessening the cause of its formation.

Thus have we purfued the flood-tide through our propofed plan, and found every good effect that could be defired, without a fingle evil one to encounter.—Let us in like manner inquire what the confequence of the ebbtide would be.

The current coming from the northward through the found of Lambay makes directly for the found of Howth for the entire ebb, and as it cannot all enter at once, it must divide, part of it washing the Northern Shore of Howth, and westward of the Pier, stretching towards Howth-head, bearing with it all the fand washed from the aforefaid places, which it must carry to a great diftance fouthward of the Bay of Dublin to flack water banks,

banks, eddies or shelving shores; but not a particle depofited on either Bulls or Bar for there would then be no west current fetting round Howth towards the bar, this part being fupplied by the ebb-current through Howthfound .- Thus we fee that what the flood-tide would leave undone towards cleanfing the northern Coaft of Howth, this part of the ebbtide would finally accomplish. The other part of the ebb-tide which makes for the found of Howth, violently rushes through, because the found is more contracted than either extremity; and because Howth projecting fo much into the fea beyond the line of Coast, imbraces a vast body of water in rapid motion making for the found, hurrying with it the fand and gravel of Baldoyle banks, the North bull, and the Bar, clear of the harbour; or to the fouthward of the Light House, the velocity of the current being more than fufficient for these purposes, as appears from the folution of our problem to which we refer, showing that large pebbles may be driven to the diftance of 7 or 8 miles when the velocity of the stream is only at the rate of three Knots, and confequently fand to a much greater distance, were the velocity even confiderably less than can happen in the found of Howth, which would at least be equal, if not for very good reasons much greater than the Race of Dalkey, whose rapidity is fully competent to effect all the purposes ascribed to our plan were it adopted; besides none of the drifted fand can be deposited on Howth side, because no part of it has slack water, but ftrongly brushed by the ebb-current, except Candlestick-bay to the westward of the green Baily, but any fand left their on the flack of ebb-tide, would,

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be carried away the next flood, acting directly against it. Again, no fand can possibly fubfide in the harbour mouth or on the bar, because the ebb-current of the river acting latterly on it would completely confpire with the ebb current of the found by their conjoined force to carry the fand quite to the fouthward of the bar and Light-House into still water, or thrown up on the South bull, being the nearest retired strand or shore; it is evident that the river would clear its own passage, and the current of the found would be sufficiently rapid until it passed the Harbour for fome distance fouthward of the Light-house, as may be inferred also from the folution of our problem. And here, as in the flood-tide, every good that could be wished for would be effected without the shadow of one the least injurious.

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We have reafoned all along about the confequences of one flood and one ebb-tide on the completion of our plan, and found these banks so often mentioned to be partly carried away and deposited where they could do no manner of injury ;- Hence by a fucceffion of those tides the whole of these banks would be carried away in a fhort time were our plan adopted, and confequently obtain a fafe and excellent harbour for the depth of water, free of any obstacles ot its entrance, those which now exist being then removed, befides a spacious road. ftead in the prefent fide of the North Bull and Strand, in the found of Ireland's Eye, and every where round the Island of Howth, having good anchorage and well sheltered from every wind.-But as we came to this general conclusion by a long train of close physical reafoning, it might be more agreeable to some Gentlemen to

to come to the fame thing by an eafier method founded on facts and common experience which may be stated; thus :--- It is a matter of fact and common obfervation, that a finall Ifland fituated in the race of the tides at a fhort distance from the main or projecting coaft, has always a deep found, and steep shores both towards the main land and the Ifland; but the cafe is different when the Island is fituated close to the shore in the hollow of a deep Bay out of the race of the currents of flood and ebb, for the stream would be less rapid in the latter found than outfide the Ifland, and confequently the fand would be thrown up into the flack water of the retired found which in time would completely fill it .- And among the many instances we could adduce for the proof of the first cafe, we need only refer to those more immediately at hand, to wit, Dalkey Island, Ireland's Eye, Lambey and St. Patrick's Island, but more particularly Dalkey Island, which would be exactly in point were there a river emptying itself into Killynee Bay, at a small distance fouthward of the fouthern head-land of Dalkey main, which inftead of injuring the entrance at the found, would greatly confpire with the flood and ebb-tides to deepen it, by increasing the currents, neither could there be any bank or bar thrown up oppofite the river, for any fand brought down the river and falling into the crofs current through the found, would be fwept away by its rapidity, as there never would be any still or opposing water to permit the fand to fettle near the mouth of the river : now if Howth was an Island the cafe would be exactly fimilar to this of Dalkey, and the like confequences would naturally follow, that

that is, leave a clear Harbour free of Bar or banks, a thing fo defirable at the port of Dublin.

St. Patrick's island, opposite the small Town of Skerries, is also in many respects fimilar in fituation to Howth if converted into an Island, the Saint having first landed there on his arrival in Ireland, the natives had a church built on the ifland under his immediate direction which they dedicated to him, and then ferved as a place of worthip for the inhabitants of the main-land, the island at that time being seperated from the main by a very finall stream of water and that only at spring-tides which could not then prevent their devotional duties, being accefsable on foot of which they were not over fcrupulous of wetting, but the interval is now impaffable at the loweft ebb, on which account the facred pile has been fuffered to fall to ruins, to fupply which the inhabitants of Skirries have built a new church on the main-land which they call St. Patrick's new church : here we have direct proof by analogy what would be the confequence of affifting nature in making Howth an island, as it lies more in - the race of the tides way, and imbraces a much greater body of water than St. Patrick's island, which was once joined to the main but now feperated by a very deep channel or found, by the rapidity of the currents of flood and ebb without the affistance of art.

Opposite Dunmore-head, (the most western point of all Europe, called Mary Gurnane's house, a point as much celebrated as John of Groot's house, which is the utmost extremity of North-Britain,) lie the Blaskett's or Feriter's Islands, being twelve in number, derived E.

from the word Blaosc (or Blaosg,) which fignafies in Irish scale or shell, faid to have been scaled of the main-land: on the great Blasket one of these islands, faid by tradition to have been formerly joined to the continent, the country people as a proof flew the remains of an old ditch which they fay points to an opposite one at Dunmore that were once joined; there is the ruins of a very antient church on it, and the found between it and the main-land is of great depth, the currents of flood and ebb are capable of producing great effects, fetting through it with prodigious force and velocity : but it is needlefs to multiply inftances of the powerful effects of waves or rapid currents in producing caverns, natural fountains, or converting Peninfula's into Islands, &c. as they come under the observation of any person who does not shut his eyes against facts, nor scruple to study the natural history of his own country.

We muft however obferve, that the antient Irifh were wont to confiruct large inclofures of flone called *Bawn's*, built as places of ftrength or fortification, to prevent their cattle being carried away by the Wolves, or their more rapacious neighbours, and to which feveral clans would retreat upon a fudden irruption of fome powerful enemy, and were formerly the only appendages to great men's caftles, near to which they alfo built their churches, that in cafe of hoftilities they might perform their religious ceremonies without being molefted, as it could eafily be defended by a fmall number of men; but along the coaft every little Peninfula prefented itfelf to them as a moft complete Bawn

Bawn formed by nature, and of greater ftrength than could be conftructed by art ;-----Hence we fee the reafon why almost every finall island along the coast, is graced with the ruins of fome antient church or other venerable pile of building, which are ftrong proofs of their being formerly Peninfula's, but mostly lying in the race of the currents have been feperated from the main in the courfe of a long feries of years, and the buildings fuffered to fall to ruins, for the fame reafon as that on St. Patrick's Ifland; for to what purpofe could thefe great ftructures be erected on fuch' fmall barren islands, many of them not affording fresh water, much less the other necessaries of life to any great concourfe of people, if there were no other communication with the main-land than the fmall wicker boats called Cott's used by our ancestors, which could not answer the purpose of ferrying over rapid currents fuch numbers as reforted thither .- We would infer from all this that Dalkey Island, Ireland's Eye, St. Patrick's Ifland, &c. were formerly Peninfula's, as they respectively exhibit the criterions of Irish Bawn's, and feperated fince only by the violence of the fea and the currents of flood and ebb-tides, and as they all have deep water round them, fo would Howth were it infulated, becaufe it lies even more in the race of the currents, and imbraces a greater quantity of water, that would pass through the found with great rapidity, which we doubt not will one day or other be the cafe, unlefs prevented by rampart walls, as the Ifthmus is a very narrow low neck of land, composed of fand, earth, and small pebbles easily removed, but that

that happy event for the metropolis and kingdom in general may be too diftant to be of any fervice to the prefent generation, unlefs the exertions of nature be rendered more effectual by the affiftance of art.

That fome harbours and channels that were once navigable, may now be entirely choaked by the fortuitous alteration of the currents is equally manifeft, as fhewn before from principles ; and here we might instance several fuch places, but it is sufficient to mention only fome of them, as the Harbour of Cloghnakilty, once navigable for the largest veffels, is now to obstructed with fand that only boats and small floops can come to Timologue, about two miles from the harbour mouth ;-Rofs-carbery is another Harbour, which according to Camden, was formerly navigable for large ships, but these many years is fo choaked with fand, that no veffel can come to the town; the inference we would draw here is, that as thefe and many other inftances of filling up, happen out of the race of the currents, they exhibit collateral proofs that if Howth, which lies in the race of the currents, were infulated, its found would never fill up, but on the contrary would conftantly be deepening, till it come to its limit, without bar to its entrance or bank any where round the island.

We may also collect from facts, what we had before infered from principles, that what is washed from the coast in one place by the violence of the fea, is depofited in fome other place, or while the fea is making encroachments on fome shores, the shores of fome other place are reclaiming from the fea :—The large extended tended strand at Youghal, whose Bay butts directly against the sea, was certainly an encroachment of the fea, its violence breaking down the ancient barriers and overflowing the lower ground, for this strand as far as the lowest ebb uncovers it, and probably much farther, is no other than a common turf-bog, with a thin covering of fand, from whence not only good turf is cut annually, but great timber-trees, fuch as Fir, Hazel, &c. are found in great plenty in it :- The skeleton of a monstrous animal was also discovered here some years ago, one of whose shoulder-blades weighed above one hundred weight :- This bog was entirely divested of its covering of fand and gravel fome years fince by violent high winds agitating the fea to an uncommon degree, when great quantities of the stumps and roots of large trees lay exposed to view, until they were again covered by the fand brought from the adjacent coaft, or washed in from the fea; for as the ftorm was very great, the recurrence of the waves extended a great way, 'till they met the currents of the tides, which totally carried away the covering of fand, fo that the fubfequent covering must be brought from some foreign place; numberless other instances might be adduced to shew the great encroachments of the fea, and as many inftances of the great quantities of land reclaimed from it, as at Cork, Dublin, Manorcunningham, Cloghnakilty, Rofs-carbery, &c.

The ftrand on both fides the Ifthmus of Howth, is undoubtedly caufed by fuch encroachments which is ftill gaining on the land, as may be perceived by the banks

banks frequently falling in, by the workings of the fea, tho' not in fo great a degree as it might have done formerly, for the waves coming over a great extend of strand before it reaches the banks, their violence and confequently their effects must be greatly diminished from what they were before the strand became of fo great an extent; but if Howth were infulated thefe encroachments would be compenfated by waft tracts of land reclaimed from the fea, by the great quantity of sand drifted through the found from the Bar, North Bull and both strands, which would be deposited on the retired distant shores that lie out of the race of the currents, but not a particle could fubfide in the race of the found, about any part of the Island, or in the mouth of the Harbour, as there never would be any still or eddy water while the fand were afloat, to permit it to fettle in any of these places.

Several other arguments to inforce the expediency of adopting our plan for the improvement of Dublin Harbour might here be introduced; but as they eafily may occur to those who have attentively perused the preceding ones, we think the recital of them needless at prefent; we shall therefore make a few remarks only on the practicability of executing our defign by the least expensive method, and then humbly submit the truth of our reasoning, and the justness of our conclusions, to the decision of the more experienced engineer, and to the greater penetration and fagacity of those Gentlemen whose duty it is to inquire into the merits thereof.

The Ifthmus of Howth, is only about 400 yards broad in the narrowest part or the middle of the proposed found, is a very low neck of land not more than four feet above high water-mark ; is composed of fine loofe fand and earth, without either rocks, stones, or quarry intersperfed therein; the strand and banks on both fides the Ifthmus, have been bored to a great depth, on account of other inquires, and is faid to contain a clayey bottom all along from Dublin-Bar to the North entrance of Ireland's Eye-found, at the depth of between five and fix fathoms under low water-mark :--- There is indeed on Howth fide of the Ifthmus a lime-ftone quarry eafily worked with the crow or pick, but we are informed by the workmen that it does not extend near our proposed found; as the men affured us that in following the veins of stone, they find them terminate, or as they call it run out, before they come near the low narrow part of the neck of Howth ; now should our project be approved of, and the truth of the above circumstances appear upon a fpecial and more particular examination of the facts, then the expence of executing our defign, compared to the advantages expected to be derived from it, would amount only to a mere trifle.

Several frugal methods to fave expense will here prefent themfelves, as prudence, varying circumstances, or the nature of things may require; suppose the following for example. Let a canal of ordinary breadth, but of a good depth, for instance five or fix fathoms, be cut nearly across the issue in the middle of intended found (the execution of which will either confirm or invalidate the

the truth of most of the foregoing particulars) and the excavated earth and fand thrown on the banks; then, if there appear neither rocks nor quarries to the further hindrance of completing the work, cut a channel pretty deep from each end of the canal, as far on each strand as thought neceffary, and boldly open both ends of the canal, thro' which the water will rufh with aftonifhing rapidity (except on the flack of the tide) bearing away great quantities of earth, fand, gravel, &c. which in time would complete the found and entrance on both fides over the strands to a fufficient breadth and depth, for large veffels to pass at any time of tide, and convert the prefent fite of the North-bull and strands into a fafe and spacious roadstead, &c. But here Nature must be afsisted to hasten her operations for more immediate advantage to the community, by employing a number of men and boys to root up the fand and gravel of both strands, as far as they can advance when the tide is out, the contents of which they may throw up on both fides of the channel, or gut, which lead to both ends of the canal; but when they cannot work on the strands from the depth of water, let them be employed (about halftide when it runs most rapid) throwing the banks into the found, as if they intended to fill it up again, only fcattering the earth and fand as much as possible, which instead of subsiding would be hurried away by the rapidity of the current as fast as they could difcharge it, without any danger of filling up the canal any more than they could fill up the found of Dalkey by fuch means, which every one knows would be abfurd to immagine. Now, by purfuing the fame round, the canal and channels
think ought to be a quarter of a mile at least) and when the labourers are prevented, by reason of under-water, from descending farther on both strands, the following contrivance may be used, viz. to employ a number of fmall craft fuch as fifting boats and wherries, letting them drift thro' those channels and canal when the tide is rapid, trailing after them a machine like a large iron harrow with fhort teeth, or another of a cylindrical form called by mariners a Porcupine, to root up the fand and gravel, &c. that they might the fooner and eafier be carried away by the current. These machines should afterwards be used to accelerate the removal of the Bar, N. Bull and other banks .- Hence our plan is the best external improvement of Dublin harbour for the prefervation of Life and Property; requires the least expense to execute, and no additional expense to perpetuate ;--it is founded on the immutable Laws of Nature, and therefore the most rational. Without infulating Howth every other project for improving the harbour, would only he partial, of little avail to benefit fociety, and fome of them might even be injurious; as we are confident the North-bull would still protrude his horns, to gore the vitals of the commerce of the metropolis of the kingdom.

Should our plan be adopted, it might be thought neceffary, at least for some time, to preferve the communication between Howth and the main land, by building a substantial wooden passage on piles over the Sound, having one or more draw-bridges near the cen-

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ter, which might be conftructed on fuch fimple principles, by means of equipoife acting as a balance on its fulcrum, to open and fhut with vaftly greater expedition and eafe than ufual.

Thus have we fhewn how a fafe harbour may be obtained at the port of Dublin, free of impediments to its entrance, by only afsifting Nature in her operations, and promoting her effects ; and having already exceeded our intended limits in the discussion, we shall for the prefent difinifs the fubject, only with this remark, that we regret the misapplication of the genius of those projectors who are continually torturing Nature to fuit their plans, instead of accomodating their plans to the Laws of Nature, and the effects of her operations ; here we beg to be underftood, that tho' we ftrongly recommend our own plan, we mean not to depreciate or be thought the arbiters of any other, assigning that bufinefs to the proper judges; but that every improvement of the harbour of Dublin which convenience, and the nature of things require for the public good, may speedily be accomplished, is the hearty defire of.

Marine School, 5th Nov. 1800. } WM. M: MINAMY.

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To the Right Hon. and Hon. the Directors General of Inland Navigation.

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GENTLEMEN.

YOUR Letter of the 22nd ultimo. to the Governors and officers of the Marine School, defiring their refpective observations and opinions of the different plans for the improvement of Dublin Harbour, a copy of which you were pleafed to fend them; I had the honour of laying before the Committee of the fociety, as early as polfible, on Monday the 11th; But, befides that part of my duty, I conceive myfelf bound, through the refpect I hold to the Directors General and the public, to offer fuch additional remarks, on the most effectual method of improving the Harbour, as occured to me fince I had the honor of fubmitting my plan to your confideration, together with the reasons of my objections to the different other plans .---- Opinions on public concerns, especially in what relates to science or art, should be discuffed with the utmost freedom, as they are fubject matter of inquiry for found intelects, or good understanding, with deference only to good breeding and close investigation .---- I shall proceed therefore without farther apology, only beg leave to premise a few propositions founded on philosophical experiments, and the observations of the most intiligent philosophical Engineers, as lammata or principles in our present refearches.

1st Pos.

1st Position. Rivers, (or canals) of fufficient length, acquire train by their declivity and the refistance of their borders, that is at last move with an equable velocity.— And their beds and fides obtain a regimen or stability of dimensions, suited to the tenacity of the foil, and celerity of the stream.

2nd Position. I calculated in my former address (which I believe to be first of the kind) the effect of water moving with a given velocity in a given bed, which I am happy to find, is fince confirmed by the most palpable observations of the strictest observers of nature's general procudure in these cases; viz. that water moving with the celerity of 3 inches per fecond at the bottom, will just begin to work upon fine clay fit for pottery, and however firm and compact it may be, it will tear it up in time, tho' no beds are more stable than clay, when the velocites do not exceed this; A velocity of 6 inches per second will lift fine fand; 8 inches per second will drift fand as coarfe as flaxfeed; 12 inches per fecond, will fweep away fine gravel; 24 inches per fecond will roll away rounded pebbles an inch diameter; and 3 feet or 36 inches per fecond at bottom, will fweep along thivery angular ftones of the fize of an hen's egg.

3rd Position. It is a natural phenomenon in the progrefs of rivers, that their mouths expand themfelves fomewhat in the form of a bell or trumpet, or rather that formed by the revolution of an elongated trochoid round its axis; we would venture to affert, that double the quantity of water might be difcharged from the fame head, and thro' the fame channel in a given time, the water running in *train*, by giving the entry a proper form, than could otherwife be done; or that we could increase the heights of the tides up the river fome feet, by properly adjufting the form of entrance to the hydraulic ofcillatory reach of the river.—The inveftigation of the nature of the curve forming the entrance, is extremely difficult, and and involves all our knowledge of hydraulics which is unneceffary here, as we proceed on facts and experiments, the teft of every phyfical calculus, the proportions in the leaft whole numbers being found as 3. 4. 8. ie the diameter at the gorge 3. at the mouth 4. and the diftance of the diameters 8. or any multiples of thefe dimensions in given measures.

4th Pos. A permanent river will rife, if it receives any addition, and the fquares of the difcharges are nearly as the cubes of the heights; but the velocities are nearly in the fubduplicate ratio of the difcharges, a principle in hydraulics eafily deduced from theory, and confirmed by numerous experiments.

5th Pos. Another curious and useful principle of information, fuited to our prefent purpole, and founded only on experiments is, that the difference between the fuperficial and bottom velocities of any fiream, that is, in train is proportional to the fquare-root of the fuperficial velocity :--Alfo, if from the fquare-root of the fuperficial velocity in inches, you take one, or unity, and fquare the remainder, you will have the bottom velocity, and the medium velocity is half the fum of thefe two;--The medium velocity regulates the train, the difcharge, the effect on Machines, and all the important consequences of the motion of waters.

6th Pos. A paffing tide, or crofs current, at the mouth of any river, prevents bars or banks at its entrance, if the ebb-current of the river falls in with the paffing fiream into deep water ;—But rivers not circumfanced fo, will produce fhoals, banks, or bars, and fometimes iflands ; the reafon is clear, and I imagine the principle fully eftablifhed in my former addrefs.—No river can be fairly urged as an exception ; but all we know of advanced in confirmation of it, it is an immutable law of nature, and evident to the moft common obferver ; I never knew any one hardy enough to contradict it. 7th Pos.

7th Pos. Water in a canal runs only in confequence of the declivity of its lurface; but it is quite otherwife in a river which ebbs and flows .- The tide after flowing fome time, coming to the mouth of a river with greater force than that of the current of the river, (on account of the greater quantity of motion of the flood from the energy of deep waters,) must not only check the river's velocity at its mouth, but give it motion for a finall distance in the opposite direction of the current, and confequently accumulate the waters between thefe points, and therefore rife higher than at the point of congrefs .-----Now from a continual fucceffion of these impressions the water in the river will accumulate more and more, and with greater heights, to greater and greater distances from faid point of concourfe, while the influent water urges forwards at bottom, making the whole to move that way, affisted by the hydrostalical pressure, until the water may at last raife to a very great height above the level of the fea at the mouth of the river, fuited to the form of the entrance, and difference of the productive heads of the tides and river velocities ;-For the fame reafon, the water may fubfide in the river greatly below the level of the fea, and yet preferve a current of reflux; the hydraulic reaches and heights of coexistant high or low waters of different rivers above or below their mouths, are matters of curious and extreme ufeful information to the civil engineer, required to improve harbours; and did this place require it, we would detail the investigation ;- Observations however shew that at Annappolis-royal the tide rifes above 100 feet. At St. Malow 50 feet. At Bristol 45 feet, &c. and at Carlifle-bridge Dublin 12 feet at least, (by my own observations) above the level of the fea, at the mouth of the river. In the fame manner the depths below faid level are various in different places on the ebb; the fubstance of this I gave in other words in my former addrefs.

We shall now proceed in the application of these principles to the objections we have to make to the plans be-

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fore us, and the confirmation of the eligibility of our own, with fuch additional remarks as may occur to ns in the difquifition.

The difficulty conceived of improving the prefent harbour of Dublin, occafioned the many plans for building detached dry harbours pier-heads, rampart-walls, and ship canals for the convenience of its trade; but until it appears that the prefent harbour cannot be improved, or unlefs the expence be greater than fuch additional works require, I conceive it prudent to direct our whole attention to the improvement of the channel of the Liffey, and the more eafy accefs to its entrance. I have little to add to the well grounded objections of Capt. Bligh, and Mr. Rennie, to fuch detached works, unlefs the remark of a very learned and experienced naval officer, extremely well acquainted with the bay and harbour, who was defired feveral years fince by the then Lord Leiutenant, to examine along the fouthern coaft of the bay, and to report whether, or if any harbour of general use to the trade of the city, could be constructed in that quarter; and having executed his orders, gave it as his opinion" That any attempt to convert Dalkey-found, Dunleary, &c. into a harbour for ships of burden, trading to or from the metropolis, would only be a lure to the hazard of the lofs of more lives and property than could otherwife happen." In confequence of which report, the project was discountenanced.

I am convinced that continuing the North-wall of the Liffey to the Spit of the North-bull, having a proper form at its termination, fuited to the reach, flope, and capacity of the river, would be of great advantage to its navigation, when confined to its own proper form ; but any openings permitting the water to fpread over Clontarf-ftrand, would be like fo many breaches in the wall ; and not only the fame confequences would follow, of veffels being hurled through them, as in the breach which happened a few years fince in the South-wall, but probably

bably worfe, the lofs of many lives, the injury of the channel, and the diminution of the rife of the tides in the river .- Again, if Ballybough river be not discharged into the Liffey, but made to run along the back of the propofed North-wall, it would greatly injure the wall, efpecially in freshes, unless the wall be extremely well backed; it is therefore advisable and probably lefs expenfive as well as more advantageous to the public, that Ballybough river be confined to its own bed between parallel walls, to empty into the Liffey in the direction, and clofe to the N. wall of the lots, and by deepening its channel may be made navigabl to the bridge, its stream would be of fervice to the Liffey; befides the whole ftrand of Clontarf would fooner be reclaimed, by the great quantities of fand thrown in behind the wall on the flux, and deposited on the reflux of the sea, these depositions may be greatly promoted by placing bundles of furz, &c. at proper intervals on the strand, secured by stones attached to them, to be shifted at pleasure, the certainty of which effect I have fully proved in my former address, or may be eafily inferred from the 7th Pos. The project for constructing an embankment, from the Spit-bouy to Clontarf, even according to the corrected plan, I imagine to be liable to many objections; for tho' the narrowing of the mouth of the harbour would undoubtedly occasion a very rapid current there, and confequently greatly deepen the entrance, yet the other effects would be quite contrary to what the plan purposes, the flood-tide coming to the mouth of the harbour, with a given momentum its velocity must be increased as you diminish the entrance, until you arrive at a certain width where the velocity is a maximum, after which diminishing the width would diminish the velocity, the limit is a matter of curious and useful investigation, with which we may difpence at prefent, as we are certain the proposed width would greatly accelerate the motion of the flood, confequently difturb and carry in with it, a great quantity of fand, &c. And as the water in fupplying the river must fpread itself over the

whole of Clontarf strand, &c. the velocity of every fection within the gorge or entrance must be diminished, and confequently most of the fand brought in would be deposited at fome diftance within the entrance, and there form a fecond bar as destructive, or more fo, than the present one. Nor would the ebb-tide have any of the fcouring property with which they flatter themfelves .- The flood-tide arriving at the mouths of rivers acts at the bottom, forcing in underneath, while the waters are heaping at top, until by a fucceffion of impreffions, they are all urged in the fame direction; but the ebb-tide begins by fubfiding of the waters at top, and this fubfiding is fucceflively communicated from the mouth along the river until the whole begins to ebb; therefore the current of flood in a level canal, communicating with the fea would be greater at bottom, and of greater continuance than that of the ebb; fo that unless the natural current of rivers compensated for the difference of velocities of the flood and ebb-tides at bottom, they would foon be choaked, and rendered unfit for navigation fee, Pos. 7. now as the natural current of the Liffey does not feem competent to this defference, should the embankment from the Spit-buoy to Clontarf be executed, worfe confequences are likely to happen than we encounter at prefent.

It is afferted in the plan, that by narrowing the mouth of the harbour, it would increafe the quantity and height of the flood-tide, and by widening, proportionally diminifh it, tho' the inner breadth be continued as at prefent; the contrary of which would be the abfolute fact, as may be perceived from what I have already faid, efpecially in the 3rdPosition,—Befides, should the entrance be fo contracted, and afterwards the waters be permitted to spread over fo great a strand as Clontarf, there would be fo prodigious a joggle of fea at the Pier-heads, as would render it morally impossible for a vessel of burthen, with any degree of prudence or fafety, to attempt entering the harbour in a gale of wind.

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I am alfo perfuaded that fuch a plan would greatly injure the rife of the tides in the river, as may alfo be feen by the 3rd Pofition;—And that it could have no effect in deepening the bar, is fufficiently proved by Mr. Rennie, but more clearly by Pofition the 6th.

By compairing Sir Thomas Page's effimate for building the North-wall, viz. $f_{..}$ 168000, and Capt. Cornelly's, for building the imbankment from the Spit-buoy to Clontarf, viz. $f_{..}$ 174240, it appears that the former is much lefs expensive than the latter, tho' the wall be much the longer of the two; the wall being in the run of the ftream would require lefs labour, materials, &c. in the execution than the imbankment, which must lie acrofs, and oppofe fo vaft a body of water as daily fets in, over, and round the Bull, and that frequently with immense violence; at all events the continuance of the North-wall would be a certain improvement of the harbour, and the imbankment from the Spit-buoy to Clontarf at beft, but a very uncertain one.

The plan for continuing the South-pier as far as the bar, and building another, from the Spit-buoy as far alfo, would undoubtedly deepen the prefent bar, but it is equally evident it would occafion another bar at about a quarter of a mile to the Eaftward of the Pier-heads, as deftructive as the prefent one, and probably more fo. Indeed the Gentleman himfelf has candidly acknowledged, that little advantage could be derived to the harbour, tho' the expence of executing the different works he propofed would be immenfe, a fufficient objection to the whole.

Other plans are fo many and different, that it would require a volume to comment on them feverally; but one obfervation applies to them in general, that the projectors refpectively fhift and change them at pleafure, or propose new ones as they meet objections to the old; a proof that they have been too hastily formed, or fo ill digested, that the proposers themselves do not approve of any of them. Nothing Nothing could induce me to be thus free in my remarks, but the importance of the fubject, and my defire for the public wellfare.—I fhall now offer a few hints for improving, cleanfing, and deepening the River itfelf, &c. in addition to my plan for improving the harbour.

The usual stream of the Liffey is thought too inconfiderable to preferve Aability at a fufficient depth, to keep vessels of burthen afloat at low water, or to fcour the river of the filth of the city and deepen the channel; continual dredging, with a proper number of lighters, may lefsen, but never can wholly remove the evil; natural means, assisted by art, only can remedy it; we should therefore look towards the fource along the river, and fee whether any other rivers, brooks, streams or rivulets, can be turned into the courfe of the Liffey at a moderate expence to encrease its waters; if we can confiderably increase it, we shall in time have all the advantages of a clean river and deep channel.-I am not fo well acquainted along the Liffey to its fource, as to be able to fay whether fuch additions can be made, but if it can, the inhabitants along the course of the river, need not be in the least dread that it would overflow its banks, tho' the waters be encreased to double or triple the usual discharge; for it appears by the 4th pofition, that the heights are in a lefs ratio than the difcharges, and the velocities in a much lefs ratio :- About the year 1600, the waters of the Panaro, a very confiderable river in Italy were added to the Po, which greatly improved its navigation, but the project of uniting the Rhenno, another great river to the Po, fo alarmed the inhabitants of the valleys adjacent, as to become the fubject of near 100 years litigation, until 1720 when their fears were overcome, and the junction of these great rivers effected, fince which the Po has greatly deepened its channel with prodigious advantage to its navigation, draining extensive marshes which lay for ages under water, and lefsening the danger of overflowing flowing its banks in time of freshes.—Many other instances we could adduce of the great advantage to navigation by the junction of rivers, but the principle is too evident to require much elucidation.

The current of the channel of the Liffey, I suppose on a medium to be at least 2 knots, that is about 3 ; feet, or 40 inches per fecond; now by the 2nd Position, it is plain that this velocity is confiderably more than fufficient to cleanse the river and preserve the regimen of a deep bed, if the waters were in train, which they are not, for want of a competent reach, the waters being allowed to fpread at the end of the North-wall before any train takes place; if we could therefore double the depth, we should halve the medium velocity, or reduce it to 20 inches per second, to discharge the same quantity of natural waters, and by the 5th Position, that would give us about 16 inches per fecond at bottom, which also appears by the 2nd Polition, to be more than adequate to preferve the regimen; indeed if we could treble the prefent depth at low water, we would have 9 inches per fecond, a velocity fully fufficient for the purpose; so that the Liffey might have more than 12 feet at low water in every part of the river, a fufficient flotage for most of our trading veffels.

This is farther confirmed by looking at the draft of the harbour where its mouth is from 12 to 16 feet deeper at low water than in the river between the walls, but it is a principle in hydraulics, (see position, 7,) and a common observation, that the bed of a river may be as low, or even lower, than the bed at its entrance; the reafon is obvious, for in a river which ebbs and flows, the reflux water will drag the reft along with it by its adhesion, and confequently may fubfide many feet below the level or point of ofcillation during the ebb, in conformity to all the laws of motion.-----Hence the river may be deepened above 14 feet, before it be on a level with the bed at the Light-house, which depth would tend to preferve its stability or confervation, and prevent its accumulating mud and filth. It It is a matter of fact that the mud, &c. has greatly increafed between the walls these 20 years paft, efpecially on the fouth fide, and that the channel of the River has been reduced to a very fmall breadth, tho' the tides certainly rife higher than before the completion of the new South-wall; the caufe of both is plain.—The fhipping lying moftly by the South fide checks the velocity of the water, occafion eddies about their keels, and confequently to depofit the filth, &c. it carries down with it. If the veffels continued afloat, the current under their bottoms would be more rapid, but the misfortune is, that before it has fufficient velocity, the veffels take the ground and prevent the defired effect, which would not be the cafe, had they fufficient depth of water.

It might greatly promote the cleanfing and deepening the river, if the proper officers were authorifed to caufe all the veffels in the port to moor with head and sternfasts across the Liffey, mid-channel, at the time of great freshes when the celerity of the stream frequently happens to exceed 100 inches per. fecond ; and confequently vaftly more than competent to fcour the river : fee Pofition, 2nd .- The shipping being moored amid-chnnel, the current would neceffarily pafs at their heads and fterns, with additional force, by contracting the ftream, and confequently clear away all the filth bare to the fand or coarfe gravel, which might be greatly promoted by employing a Number of hands in boats to ftir up the mud with porcupines or other contrivances, by which more good might be done to the River in one winter, by a proportionate number of men, than could be effected in 50 years with 10 times the number by dredgeing alone, though dredgeing be abfolutely neceffary when the bed becomes too stable for fuch natural means :- Befides the channel of the river would itfelf be deepened by mooring the thips fo, by the water passing under their keels (being afloat,) with accelerated velocity. After fuch cleanfing, the river should be dredged by a number of Lighters; then by a fucceffion of of fuch operations, the bed of the river might be leveled and cleared to what depth we pleafe; and I apprehend at vaftly lefs expenfe, and more fervice to the trade of Dublin, than all the fhip canals that could be projected; fchemes that would coft more in the execution, and more to preferve permanency, than all the advantages the Trade could warrant.

I must again urge the neceffity of continuing the N. wall, to infure the fuccess of these improvements, and afterwards to preferve the *regimen*.—The continuation might be nearly in the direction pointed out by capt. Bligh, except that the mouth should be confiderably wider; this would occasion the tides to rise higher, be more rapid, encrease its cleansing power, afford more shelter, &c. &c. than at present; at any rate it would become a kind of natural canal, vastly more advantageous to the trade of the metropolis, less expensive to execute, and preferve permanent, than any canal that could be devised.

The river fhould be cleanfed, even between the Bridges, as far as the Weft end of the town, and not permitted to tumble over fords or wires, but made to pafs at the bottom, through a very long fluice or fluices of folid mafonry, calculated to the ufual difcharge of the river, the head of water to be raifed as much as poffible, but not fo high as to endanger the upper reach to be inundated by additional waters in time of frefhes, this would give fmooth water above and below the fluice, bring it fooner into train, and even augment the uniform velocity; The building of this fluice might be the work of a future day, but deepening and cleanfing the river fhould be immediate.

Tho' all thefe improvements of the river are very defirable, they are only fecondary and trifling compared to the great *Plan*, for preferving the lives and properties of the most valuable of the community.—There is no possible method of effecting this, but converting the *Ifthmus* Isthmus of Howth into a Sound ;-Of the many I have converfed with on the fubject, none could deny the practicability of doing it at a very moderate expense, or that the removal of the Bar, North-bull, and Baldoylebanks, would not be the immediate consequence, except one gentleman who faid that the Bar, and Ifthmus were rockey, the first objection is fully refuted by the experiments of Capt. Corneille, who examined the Bar by dredging, in obedience to your orders, and reported it to be composed of a loofe running fand under the upper stratum; and as to the second, I have made myfelf as well acquainted with the fubject as I could, by frequently visiting the place near the proposed found, and inquiring of the oldeft, and most inteligent of the inhabitants as to the fact, who all agree in affirming the contrary, viz. that there is neither stone, rock, or quarry, from near 200 perches to the Eaftward of Sweetman's Ale-house, all along the Isthmus to the Westward for fome miles, but a loofe running fand under the foil, for many fathoms deep; it is needlefs to use arguments here, where the matter may eafily be put to the teft, by deep finking or boring .- The fact is, that we would have at least 4 or 5 fathoms at low water, on the Bar, Bull, Sound, and Banks, were my project adopted .- I might here (like other gentlemen) display my nautical knowledge, by shewing the advantages of my Plan in expediting the paffage of vefsels, bound to or from the Northward, which is by far the greater number, the moral impoffibility of any vefsels being loft while they could lie under the lee of fuch an island as Howth, at the very mouth of the harbour, with excellent anchorage and deep water all round, &c. &c. but I confider the difquifition unnecessary to gentlemen of your discernment in those affairs.

There is probably no fituation in the world, where nature fo propitioufly invites man, to afsift in her operations as at Dublin, to convert one of the most dangerous, to

to one of the fafeft harbours .- The Engineer who expects fuccefs and permanency of his works, must mould his plans and schemes to her laws; his exertions must be made in conformity to the general train of the operations of mechanical nature. When we have any work to undertake relative to the course of rivers, we must be careful not to thwart her general rules, otherwife we shall sooner, or later be punished for the infraction; things will be brought back to their former flate, if our operations are inconfistent with that equilibrium which is constantly aimed at, or some new state of things, which is equivalent, will foon be induced. The fpeculift may as well pretend to command the elements to obey, by the force of numbers, as the mere practitioner unacquainted with the laws of hydraulics, and the calculations of the force and equilibrium of fluids, to improve the harbour and enfure stability .---- A nobleman of the first distinction, who devoted fome of his leafure hours to mathematical studies, at a meeting of the Navigation-board, in July 1771, gave it as his decided opinion, that to enfure the fuccefs of the public works then intended to be carried on, the planning and execution of them, fhould be intrusted only to a perfon emenent for his mathematical abilities ; all others, however plaufible and refined their arguments, being liable to mistakes and to impose on themfelves, as well as on others, notwithstanding the boasted strength of their natural good fenfe.

There is a paragraph in *Capt. Bligh's* Report in which he fays, that a gentleman of his acquaintance, "obliged him by taking the level of the bottom under the center arch of Carlifle-bridge to Dublin Light-houfe, and found it 14 feet higher than the bottom at the latter place."—I have found from repeated obfervations, made at the Marine-fchool, that the curb *fone* of the Quay-wall oppofite the hall-door of the nurfery, is exactly in the apparent or tangent level with the gallery of the Lighthoufe

house, which is 20 feet above its platform, or the top of the wall there, and deducting 9 feet for the curvature of the earth, at the diffance of the Light-houfe from the school, leaves 11 feet for the difference of true levels between the faid curb-ftone and platform ;- The platform is about 1 foot higher above 22 feet water-mark than the curb-ftone at the fchool, fo that the furface of the water at the Nurfery on the top of the tide, is about 12 feet higher than at the Light-house.-The bed of the channel oppofite the fchool, is 21 feet below the faid curb-ftone, (by feveral foundings I have taken) and the bed of the channel oppofite the Light-houfe is 35 feet below the faid platform, (as appears by the foundings of Capt. Bligh, allowing 17 feet to be the mean depth at low water on fprings, 14 feet of rife, and 4 feet from 22 feet water-mark, to the top of the platform) fo, that the difference of depths between the bottom of the river opposite the faid curb-ftone and platform, is 14 feet, to which add 11 feet their difference of levels, gives 25 feet for the true difference of levels between the bottom of the river opposite the Marine-school, and the bottom of the channel opposite the Light-houfe, and I dare fay it is a foot more at Carlifle-bridge, making in all 26 feet, inftead of 14 feet, nearly double what that gentleman affirms .--- I have been the more circumstantial in my remarks here, as the cafe abfolutely required it, because any determination, afserted as the refult of obfervation, fhould be as accurate as poffible, otherwife it may lead to very fatal confequences if depended on, efpecially in those matters. I believe the gentleman may have been deceived, by conconfidering the furface of the water at both places (on the top of the tide) to be horizontal, and then taking the difference of the depths (viz. 14 feet) for the difference of levels, a supposition very erronious, even in rivers which ebb and flow if they are of any reach or extent, as I have fhewn in my 7th Position .- I have taken

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ken the following dimensions of the Light-house; viz. from the platform to the gallery 20 feet;—From the gallery to the lamps 22 feet;—From the lamps to the top of the dome 13 feet; and the diameter at the gallery 33 feet.—The whole height of the Light-house therefore above the platform is 55 feet, or above high water-mark about 60 feet.

I have been as delicate as poffible; confiftent with truth, in my remarks on the plans of others, and expect the fame treatment in their ftrictures on mine; I have little to apprehend from the criticifms of the man of real fcience, however I may dread the carping of the illiterate.—As I am conscious of the truth of my Pofitions, the fuperior excellence of my Plan, and the juftnefs of my conclusions, all which I fubmit with the utmost deference to your decision.

Marine School, 13th Sept. 1803.

I have the honour to be Gentlemen,

Your most dutiful Servant,

WM. M : MINAMY:

To the Right. Hon. and Hon. the Directors General of Inland Navigation.

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GENTLEMEN.

Have the honor of fubmitting to the confideration of the Board, fuch addition to my plan for improving Dublin Harbour, as occured to me fince my fecond addrefs on that fubject.—I may, perhaps, in that written in 1800. and the fubfequent one written in 1803, have entered too much into mathematical and phylofophical difquifitions for the fubject.—My prefent one however, fhall neither be fo abftracted or prolix, taking facts for principles, and from thence reafon by the method of induction to the conclufions confequent to my plan.

You will pleafe to recollect that I had fuggested, and freniously recommended, the infulating Howth, and converting the present lithmus into a found, as the best external means of improving Dublin Harbour, afterwards I described such local improvements for the river and Harbour itself, as I judged might be most conducive to the prosperity of the commerce of the city.—I have now only to add a Project for an entire new harbour, which I denominate *Dublin Life Harbour* in contradistintion to the old fatal one, as no possibility of ship-wrecks, could then happen either in the harbour itself, or at their entrance, or departure from it.—I shall chiefly ground my present arguments on the very ingenious description of the tides and and currents about the Bay and harbour given by capt. Bligh in his Report, and alfo by Mr. Rogers in his elegant and perspicuous views, in the sketches of the Bay annexed to his late printed observations on the feveral reports; both of which may be depended on as true, as they agree in general with each other, and with the information of inteligent and experienced mafters of many trading veffels with whom I have converfed on the fubject; but Mr. Rogers sketches are much superior to description, as the effect of currents can be eafily contrasted with our ideas of improvement at one view, without any painful effort or ftretch of memory, which otherwife would be neceffary .- The addition to my plan for infulating Howth, is to conftruct a new wall in a very long S-like form commencing from Ringsend watch-houfe, towards the North-Bull channel, till it arrives near the vegetable Bank or Island on the N. Bull opposite Baymount, (or farther if found neceffary) giving thereby a new direction to the Liffey, but at the fame time a very gentle deviation from its prefent courfe, and therefore without the fmallest violence to nature. This wall and the Sound of Howth would effect in a fhort time what I term Dublin Life Harbour, and which I shall now effay to prove.

Supposing Howth infulated and the new wall completed, the ebb-current and freshes would foon cleanse the channel and render it uniform, making it confiderably deeper than the present one to the Light House, not only because the direction along the proposed wall and N. Bull channel are even now very nearly as deep as the ford, patches, and shoals of the present channel, but because of the then greater reach, the current water would be sooner in train to cause a deeper and more uniform channel, as I have fully proved in my second addrefs.—If it be objected, that the new channel could not be much deepened, on account of a black lime-stone quary extending from Clontarf shore, which some may affert, yet the opinion of Mr. Rennie and Mr. Rogers, &c. of accomplishing accomplifning a fhip canal, much nearer to the fhore than the propofed new channel of the Liffey, is a fufficient refutation; at all events, the matter might eafily be determined, by boring at different places in the line of the new channel; I am inclined however to disbelieve the truth of fuch objection, becaufe there are feveral deep guts croffing the courfe of the propofed Wall, which indicate no fuch quarry and were it even the cafe, if not of too great extent, means might be ufed to fink the Channel to a fufficient depth, much eafier than to accomplifh fuch canals, as we might by a fmall deviation in the direction of the wall, avoid the quarry, without militating the leaft againft the project or encreafing the expense.

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Granting the found and new Wall accomplished, and the Channel along it and the N. Bull fufficiently deep (which we may reafonably fuppole 20 feet on high water fpring-tides at least) let us fee what the effect of the feveral cnrrents through the new Channel and its entrance would be .----- With Mr. Roger's drafts of the currents before us, we fee, that during the first quarter flood, the current fets Northward into Sutton-creek, to fupply the channel of the N. Bull, as well as to the Northward thro' the found of Irelands-eye, while the Ebb-current of the prefent channel of the Liffey falls round the Light-house into the eddy, along the hollow of the S. Bull, and fo on towards Dalkey, &c. being opposed by the current of flood from the S. E. at the mouth of the prefent harbour rooting in underneath, and confequently forming the Bar, part of the flood current falling in with the ebb of the Liffey, and generating the South-end or tail thereof .---Now it is evident, that a river stream, must run into the fea, for a confiderable time after the flood-tide commences, and that in proportion to the impetuofity of its current, forming a greater or lefs Bar accordingly, unlefs the stream at its exit, falls in with the current of flood : But the current of flood entering Sutton-creek, paffing through Howth

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Howth Sound, joined by that of ebb from the new Harbour, and uniting with the Current of Irelands-Eye found, will all three pafs uninterrupted to the Northward, and confequently, their mutual direction can generate neither Bars, Banks or Shoals; but on contrary will difperfe those that may lie in the way :- Again, when the flood-tide rifes fo high, as to change the direction of the river current, by the hydraulic principle of fluids finding their own level, which will be about the commencement of the fecond quarter (whether sooner or later is immaterial to our present purposes; besides the investigation might be rather irkfome to those not much conversant in fuch refearches) there is no opposition to the ebb-current until the river begins to defcend on its furface, which can have very little effect, on the bottom of the Channel, and its effects more than compensated by the subsequent ebb, until the regimen of the channel is established, and equilibrium takes place; fo that the fecond quarter of flood can generate neither Bank or Bar in the new Harbour.-But from half flood to high water, the current in Irelands-eye Sound fets to the Southward towards Howth head, while the Flood-tide throughout the Bay and Sutton Creek, fets to the Northward ; it may be then objected, that were Howth infulated there would be opposing currents about the Sound; but the objection is too puerile, becaufe the eddy-current in Irelands-eye Sound, is of valtly lefs force than the Body of flowing water in the Bay tending to the found of Howth, and paffing through it with vaft rapidity, the water would tend all one way, or its natural course to the Northward there being then no eddy water in Irelands eye found, the defect of water in fhore caufing the eddy, being fupplied through the found by the fhortest paffage, and confequently no deposition of fand, but on the contrary, the removal of what may lie in the way of the current .---The race thro' Howth found would not only remove the eddy current in Irelands-eye found* but alfo that round Rofs-beg.

* Befides fhould the eddy current in Irelands-Eye found, not be changed by the race in Howth found, yet they would not claffh or occafion any bar, but on the contrary would only confpire to fend up a much greater tide in the new Harbour to the City, to the great benefit of Commerce. Rofs-beg, and confequently would foon remove or at leaft greatly diminish that Bank; these and much more are fully confirmed by the rules of malogy, by comparing Dalkey island with that of Howth.* Again, by viewing Mr. Rogers 5 and 6 plates we incendiately perceive, that from the first to the last of true ebb, the Currents of Dublin Life Harbour, Sound of Ireland's-eye, Sound of Howth, Sutton-Creek, and Bay of Dublin tend all the fame way, viz. to the Southward through the middle of the Bay towards Dalkey, and confequently from the preceding principles can form neither bank, bar or shoal.

The new harbour would be fo fituated that no ftorms could possibly effect fhipping either within the harhour itfelf, or near to it, being sheltered to the Southward and Westward by the North-bull and new-wall, to the Northward by the line of coaft, and to the Eastward opposite its mouth, it is sheltered by the high mountain island of Howth, making fmooth water within, and confequently, vefsels riding at eafe and fafety in the midit of the greateft storms from any quarter :- Shipping with any wind, could enter or depart from it : and eafily obtain plenty of fresh water both at Howth and line of coast; the plan would promote numberless pleafure parties, there not being then the smallest danger at any feason of the year, and therefore greatly contribute to the invaluable maritime fpirit of the nation; it would afford every fecurity and difpatch to his Majefty's mails to or from the harbour ; increase the fishing trade by diminishing the failing diftance, and danger of fishing-fmaks ;-In short it would increase the mercantile prosperity and comfort of the metropolis, and confequently of the nation to an incalculable

[•] Note here, for fear I might be mifunderflood. I mean not to fay that the direction of the currents about each Island at the fame time is the fame way, but that the currents about each Island refpectfully would be the fame at the fame time, and confequently no Banks or Ears about Howth any more than about Dalkey.

culable degree.—But as all thefe, and numberlefs other advantages would follow in confequence only of first infulating Howth. Let us fee what effects from the tides, and advantages to trade, would arife by infulating Howth only, and adhering to the fituation of our prefent harbour;—Thefe effects I have fhewn by various arguments in my first addrefs, but not having then the advantage of Mr. Rogers drafts, or Capt. Bligh's defcription of the different currents in and about the Bay, my reafonings might not have carried fuch conviction to others, as they appeared irrefragable to myfelf; but thefe I offer now, being apparent or ocular as it were, will place my former arguments of the good effects of infulating Howth beyond a poffibility of doubt.

During the first quarter of the flood, the current fetting into Sutton-creek would be vaftly increafed, becaufe part of it would be required to fupply the Northbull channel as at prefent, but the much greater part would pass through Howth-found, to unite with the current through Ireland's Eye-found, all tending the fame way. One effect is obvious, that the very rapid ftream would afsist in hurrying away with it the tail of the North-bull and Baldoyle fands; but another very great effect of the first of the flood-tide in the Bay and at the Bar, having a free paffage through Howth-found, would be the preventing of the ebb-current of the Liffey from falling into the eddy of the hollow of the Southbull, by dragging it over the East bar round the tail of the North-bull, and fo on through the found to the Northward, thereby greatly destroying the caufe of the bar, and confequently greatly promote its removal, caufing in a fhort time a deep channel to the Northward thereof, as was always the cafe until very lately, being . the principle entrance to the harbour, as appears from a furvey taken in 1740 by Wm. Cuthbert and Francis Mc. Daniel, by order of James Palmer, Esq. Patentee, who had buoys placed at each end of the Bar accordingly, but

but the deterioration of the bar fince, evidently proceeds from the late improvements of the Ballast office ! To return, the whole effect of the first-quarter of flood, would be fimilar to what I fhewed would happen from the completion of our Life Harbour, to which I refer ;-And during the last three-quarter-flood, its effects on the bar and harbour would exactly be the fame, as I described it would be in the new harbour, from secondquarter to high water, which you will pleafe alfo to recur to .---- But here I must remark, that the flood would pass in a more direct manner over the Bar to the harbour than at prefent, on account of a much greater body of water, then tending towards the Sound of Howth ;-I beg likewife to refer your honours to my reasonings on the effects of the whole of the ebb-tide in the new harbour being equally applicable here, with this remark, that during the last quarter-ebb, when its current has the greatest effect to remove fand (and confequently to form banks and bars if opposed by a contrary current) will pass directly over the bar, and not fall round the Light-house into the hollow of the Southbull as at prefent, being then drawn by the great body of water paffing through Howth-found, &c. making directly through the center of the Bay for Dalkey .--The ebb-current of the Liffey by thus passing more directly over the bar will deepen it, as well as the very rapid current thro' Howth-found will fcour all before The amazing fcouring property of fo rapid a current it. as in Howth-found, which would be at least 4 or 5 knots, may eafily be conceived or if more agreeable, the computation may be seen in my first address in 1800; but in all these designs Nature should be assisted to expedite her operations, by means of iron barroads, porcupines, &c. as I first suggested in that address;-In short by only infulating Howth, and the endeavours of nature afsisted by art, we obtain almost every advantage I have enumerated would arife from completing the Life Harbour

bour, indeed all we could modeftly defire .- But as the bassis of the new harbour, or the real improvement of the prefent one, is the infulating of Howth, every idea of improvement but this fundamental one, should be suspended until that be fully accomplished, after which fome of the detached improvements about Howth and Ireland's Eye, as also at Dalkey, might with great propriety be executed, fome of them promifing very extenfive advantage. _____And tho' I may not be endowed with the irrefiftable (tho' not always convincing) powers of perfuation, yet as I know that facts are stubborn, and fcientific reafons incontrovertable, I am bold to challenge any Engineer in the kingdom at the peril of his character, publickly, to offer even one rational objection to my plan for improving Dublin harbour, by infulating Howth, either as to the impracticability, incommefurate expence in the execution, any injury to the prefent harbour, 'till completed, or even any deficiency in the great benefits I have fo frequently expressed to be expected thereby.

I shall now mention a few of the evil confequences that will arife from completing the propoled plan of the Ballast office, or the farther extension of it as recommended by Mr. Rennie, but as I cannot avail myfelf of the prerogative of some gentlemen of making general. assertion, and assuming affirmation for proof, I must necessarily appeal to reason, and the laws of nature ;-First, the South-bull, in a short time, will be hollowed much more than it is at prefent, nearly to its prefent center, by the S. E. winds, eddy-currents, and encreafed ebb-current of the Liffey, from the third-quarter of true ebb, to the fecond-quarter of flood, that is, while it has the greatest power to produce the effect; also it will in the fame time extend the bar as far as the Southbull channel, (for the fame reafon that the bar is formed) curving it inward, to nearly the faid center, the bar also approaching nearer to the Light-house, and so increafed

creafed, that no vefsel of burden can directly approach the harbour, thefe evils will certainly take place on completing the proposed improvements of the Ballast office, which is the subject of your honors late representation to the Lord Lieutenant. Other injuries attendant on the execution of their plan, I have reprefented in my fecond address; even Mr. Rennie's extension of their project will only the fooner expedite thefe evils, encreafing the hollow of the South-bull, and eddy, incurvating and extending the new bar, much more than the old one, and rendering the pilotage and navigation vaftly more difficult than at prefent; caufe more fhip-wrecks, and the lofs of more lives and property than has ever yet been experienced; the rampart wall if completed, will never prevent a fingle fhip-wreck in the Bay or its vicinity; it can only afford additional shelter within the present Harbour, a defect little complained of, and the advantage expected infignificant, compared with the expense of accomplishing the defign; and the greater injury it will occafion by generating a fecond and infurmountable bar within the Harbour itfelf, as may appear from my fecond address; and should it be adopted in preference to what I have fuggested, I have only to remark, that future generations will have for ever to lament the decifion.----Your honours having obliged me with fome of Capt. Bligh's reduced maps of the Bay, &c. enables me to accompany this paper with a fketch of my plan for the improvement of the prefent Harbour, as also the project of what I denominate Dublin Life Harbour ; indifposition prevented me from submitting it and the preceding reflections to your confideration fooner.

Marine School, 18th Nov. 1805.

I have the honour to be, Gentlemen,

Your very dutiful Servant,

WM. M MINAMY.

To the Right Hon. and Hon. the Directors General of Inland Navigation of Ireland.

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GENTLEMEN.

HAT I am fomewhat anxious about the reception which your honors are pleafed to beftow on my projects for the improvement of Dublin Harbour, it were diffimulation to deny, but to be ambitious of obtaining your approbation of them, is an honest ambition, which should not be restrained when it tends to benefit our commerce, and to the prefervation of our mariners :--These motives impel me once more to lay before your honors, fuch addition to my general plan for that purpofe as occured to me fince I had the honor of laft addreffing you ;- It is now feven years fince I first had that honor, during which period I have frequently, with the utmost attention, confidered the various plans propofed by other gentlemen, and alfo re-confidered my own as impartially as I possibly could, without being able in the least to reconcile any of theirs to the nature of things, or to make any reafonable objection to my own, as to the arguments on this head, I beg leave to refer you to my preceding papers ;-It will be recollected that I always endeavoured to adapt my plans to the operations of nature, and the fituation of our port; her laws I took for my principles and guide, as the furest means of fuccefs

fuccefs in fuch undertaking, becaufe they are forimperious that any infraction of them, will furely render the refractory schemes abortive in time, by either overturning those schemes altogether, or inducing such a new state of things as to make them entirely ufelefs : or otherwife to accelerate and increase the evil they were intended to remove .- In my first letter I recommended the infulating Howth as the best external means of improving the harbour; In my fecond I proposed means of deepening and cleanfing the river itfelf. And thirdly, I defigned a project for an entire new harbour, which I denominated Dublin Life Harbour, in contradistinction to the old fatal one: -And now I would recommend another new entrance to the prefent harbour, by which we would obtain a fafe and commodious outer one, with deep water, well sheltered from S. E. storms; of easy access, and shorter paffage than at prefent, without any bar, or other obstruction to the entrance, and affording the greatest fecurity and relief to vefsels deeply imbayed in hard gales blowing infhore, when they neither could ware or ftay to work it out, turn the Light-house, or ride the gale out in the Bay .- But the better to understand the reafon of the necessity and advantage of fuch an entrance as here proposed, we must be well acquainted with the fetting of the tides and currents in and about the harbour .- During the first three-quarters-ebb, the united current of the Liffey, Dodder and Ballybough rivers glides along the South-wall, part of it fetting due-east over the bar towards the Bailie, 'till it falls in with the true-ebb fetting South paft the nofe of Howth, while the other part unites at the bar with the eddy current that comes north from Dalkey-found along the coaft, falling into the hollow of the South-bull and winding back again from the Light-houfe to the fouthward over the center of the bay 'till it falls in with the true ebbcurrent in the offing oppofite Dalkey ;-During the laft quarter-ebb, and the first quarter-flood, the currents fet Weftward

Westward from the Bailie, and Southward of Rof-beg towards the bar, where they are met and opposed by the current from the harbour setting Eastward, and after their collifion at the bar they all conjoin and fall into the hollow of the South-bull and along the coaft, through Dalkey-found, &c .- During the fecond quarter flood the stream sets in for the harbour over the center of the Bay, but divides at the bar, a branch of it falling into the eddy in the hollow of the South-bull, and along the coaast towards Dalkey, &c. while another branch fets Eastward towards the Bailie and round Howth into Ireland's Eye-found ;-From half-flood to high-water the tide fets alfo over the center of the bay for the harbour, but there is no eddy in the hollow of the South-bull, as the tide comes from Dalkey along the coast and round the Light-house into the harbour, while the east branch feperating from the main body at the bar, makes for the Bailie, and forms an eddy to the Southward round Rofsbeg ;-There are therefore above three hours opposing currents at the bar, and that while they have the greateft power in generating that bank, viz. during the laft quarter-ebb and the first quarter-flood ; there are besides above four hours and a half continuence of the seperation of the tide waters at the bar, making flack water there, and confequently tending to its accumulation by affording time to the floating fand to fubfide, and that while the waters are most replete with it, viz. from first quarter-flood to high-water, making in all above feven hours and a half's continuence of contrary currents at the bar, or above fifteen hours in every twenty-four. The bar cannot accumulate higher than the place of the equilibrium of the under waters, which height it will always preferve until an alteration be induced in the place of that equilibrium, by fome change in the generating cause either by art or nature.

We may affume also as a fact fufficiently established by many affidavits, and numerous reports, and charts, that formerly

formerly there was a deep and wide channel to the Northward of the bar, which was the principal entrance to the harbour; the bar was then but of a fmall extent, in form of an oval island, having also a fouth entrance as at prefent, there was also a channel called the South pafsage from Cock-lake in Salmon-pool, a little to the Eaftward of the place where the Pidgeon-houfe now flands, through which many ships chose to pass, being far more fecure and fafe, and a much fhorter paffage, to or from the Southward :- But the Directors of the Ballast office (established in 1707) observing that the current from the City fet directly East over the bar during the first three quarters of the ebb tide, very naturally conceived that if a work of piles or ftone was conftructed in that direction, it would preferve a stability and uniformity of channel, which was before fubject to great mutation every winter from South Easterly storms, besides the shelter it would afford fhipping in the harbour from the effect of those winds .- This very laudable defign has been accomplished at an expense of upwards of f. 200,000, But alas! tho' we have gained a more permanent and uniform channel in the harbour than heretofore, and shipping lying in the harbour afforded some additional protection from fouth easterly winds, yet melancholy to relate, that more ship-wrecks have lately happened in paffing the bar, and the lofs of more lives and property in a given time fince the completion of the South-wall than ever had been before it. The east channel or entrance to the harbour has been entirely filled up, the bar rapidly increasing and extending in an incurvated manner across the mouth of the harbour, which will foon be shut up, by the south end of the bar stretching so far to the South-westward as to make the navigation vaftly more difficult, precarious and dangerous, than even at prefent ;- The South-bull hollowed out much more than it formerly was, which is now very fteep close to its edge, as appears by foundings lately taken by order of the

the Ballast office Directors, whose officers report that there are 11 feet at low-water fpring-tides clofe in with the Bull, whofe edge has removed greatly to the Weftward, the fand being thrown up, which generates the white bank :--- All these growing evils are occasioned by completing the South-wall, before that, the last two hours of the ebb, and the first two hours of the flood nearly, the east current of the Liffey had a free passage to the Southward through the South-bull gut at Cocklake in Salmon-pool, and alfo through other finaller guts in a fouthern direction to which it naturally tends at those times, and thus the West current at the Bar, and the East current of the Liffey by that avoidance, did not clash or counteract each others effects, to generate those evils which they do at prefent, by the East current of the Liffey on the laft quarter-ebb and the first quarter flood, being now obliged to run as far as the Light-houfe, before it can let to the Southward in its natural course at those times; and in getting round the Light-house, it is prefied into the hollow of the South-bull by the Weft current from the Bailie, which occafions the South-bnll to be greatly hollowed, efpecially near the wall at the Lighthouse, and the edge of the bank which was formerly thelving, is now very fleep, the fand being thrown up by the joint action of these currents after their collision, affisted by easterly winds, and collected against the back of the wall which protects it, and forms the white bank. -Thefe facts being premised, let us but " remove the caufe and the effect will ceafe,"-All the evil effects of compleating the South-wall will be removed, while all the advantages it affords will be retained, by only making a fufficient breach in the wall close to the Pidgeonhouse between it and the white bank, to permit the East current of the Liffey, &c. to pafs freely in its natural courfe to the Southward into the South-bull channel during the last two hours ebb, and the first two hours flood at the bar; -The plan is only to open the old paffage

paffage through Cock-lake in Salmom-pool, which will foon, by the rapid current through it, become navigable for the largest veffels trading to Dublin :-- No fand, in confequence of the breach, will ever be driven through it into the prefent harbour, as the first half-tide of flood, and the first three-quarters-ebb, has always and ever will come in and go out in the direction of the South-wall but from half-flood to high-water the tide will make alfo for the harbour through the new channel, the water being then of fufficient depth, can have little power of removing fand; and what effect it has in diffurbing the fand, or what fand may fubfide during flack-water, on the top of the tide, is more than compenfated by the much greater strength of the contrary current for an equal length of time, viz. for the last quarter-ebb, and the first quarter-flood, when its power to remove fand is the greatest possible.-But it may be found necessary hereafter to conftruct a work of piles or ftone on the eaft fide of the new channel, along the South-bull gut and the Weft fide of the White-bank, to protect fhipping from the violence of Easterly winds, and to preferve a greater uniformity of channel thro' the new paffage :---By thus adopting our plan to the endeavours of Nature, we shall have an excellent outer harbour to the Southward of the new wall, of eafy access in the greatest Easterly winds, well sheltered by the White-bank and East piles or rampart wall, with fmooth water and of fufficient depth within, free of any bank or bar at its entrance.-The fea is never very turbulent in any part of the South-bull gut, its violence being broken off by the White-bank, and will be much more broke off when the new work is constructed ;-- Many people affirm, that the gut from the tail of the White-bank to its mouth is already as deep or deeper than any part of Poolbeg:-There never was, nor ever will be any bar or bank at its entrance to prevent a free paffage through it, becaufe no contrary currents at the fame time can ever K happen

happen there ;- I fay that this beach will remove in a fhort time all the evils complained of fince the completion of the South-wall, without the fmalleft injury to any of the advantages it has produced; befides it will occafion a fafe and commodious outer harbour, of eafier accels and thorter paffage to the Southward than the prefent; prevent shipwrecks about the Bay, as veffels may with eafe and fafety run in for the new harbour, where they will be well sheltered from those dangerous winds which have proved fo fatal heretofore .- I have often been asked by very intelligent men as to fome me-thod of remedying the evil effects of the South-wall, without injury to the great advantages it affords, and I have as often answered that a fufficient breach between the Pidgeon-houfe and White-bank would have the defired effect, at the fame time giving my reafons, which was never objected to except in the fituation of the breach, which fome gentlemen thought fhould be made tome where between the Light-house and White-bank, as for inftance about the elbow of the wall, or about the five-gun-battery, in more immediate deep water on both fides of the wall; but in my opinion it would afford only a temporary remedy without ftriking at the root of the evil, occafion a great joggle at the Pier-heads and a turbulent fea without any sherter in Poolbeg in the best of the water, to the great hazard of shipping and injury to the trade of the metropolis, especially in fouth easterly storms, which have proved already but too fatal to the lives of our mariners ;---all which evils not only are avoided, and those already complained of removed, but many and great advantages would be obtained, by making only a fimple breach between the Pidgeon-houfe and White-bank as herein proposed; the effect of the current to deepen the paffage to and along the Southbuil gut may be accelerated by means of dredging, porcupines, harrows, &c. as formerly recommended for de pening the found of Howth, &c. The

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The effect of a breach where I have proposed is at least worthy of an experiment, especially as it may be made at a very trifling expense, and can induce neither inconvenience or injury to the prefent harbour; and the communication of the South wall may eafily be preferved by draw-bridges as recommended at Howth found .- The plan does not in the smallest degree clash with the advantages obtained by the great work lately completed by the Corporation for improving the harbour, but is only a farther extension of that improvement; we have not therefore to encounter the delicacy of undoing what they have already done, nor they the necessity of acknowleging any defect in their original defign. But here I beg to remark that this and every other plan for the improvement of Dublin Harbour, are only fecondary to the vaft improvement and advantages that would be obtained by the infulating of Howth, as recommended in my first address in the year 1800.

If honored with your commands, my ideas of this plan shall also be sketched out on the reduced maps of the Bay, on which I have traced my former defigns, and which will give a connected view of all my proposed improvements of the Port and Harbour of Dublin.

Marine School, 15th Sept. 1807. 1 am Gentlemen,

Your most dutiful Servant,

WM. M'MENAMY.

FINIS.








