# REPORT

OF THE

# COMMISSIONERS

Appointed by the Legislature of the State of New-Jersey,

FOR THE PURPOSE OF EXPLORING THE ROUTE OF

# A CANAL

TO UNITE THE RIVER DELAWARE, NEAR EASTON,

WITH THE PASSAIC, NEAR NEWARK,

WITH

ACCOMPANYING

# DOCUMENTS.

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Morris-Town:
PRINTED BY JACOB MANN.
1823.

# REPORT.

## To the Honorable Legislature

OF THE

# State of New-Jersey.

In obedience to an act of your last session, we most respectfully submit the following Report:

To explore various lines across our state, and select that which seemed fittest for a canal; to find the levels, and calculate the supply of water; to deliberate upon the means of overcoming the elevation, and to form a general estimate of the total cost, are only a part of the labors prescribed by that patriotic and enlightened act. We have examined the mineralogical treasures of our country, specimens of which are now deposited in your Library: these treasures will be developed by, and in return give employment to the Canal; thus acting and being reacted upon, each by the other. We shall endeavor to show the effect which such causes, operating in conjunction, will produce upon the Agriculture and Manufactures of New-Jersey, and we have tested the expediency of the proposed enterprize, by the industry which it will create, and the riches to which it will give birth, over a section containing nearly one half of the population of the State.

Having considered it as a project of internal im-

provement, the canal is then viewed as a measure of finance alone. We have drawn from every accessible source, information relative to the commerce of which it will become the channel; we have visited the New-York canal, as also the coal quarries and canal of the Lehigh; and with the knowledge thus acquired, we present a calculation of the probable revenue to accrue from this great work, on the supposition of its utility being limited to the mere pecuniary profit of its tolls.

The prosperity which the canal will diffuse throughout so large a district, appears of itself a motive sufficient to invite its execution as a public concern, even though no fiscal advantages were to operate as a collateral inducement; but if it be proved that a vast revenue will also be thus created, the enterprize will then appear worthy to call forth the highest efforts of the state. We shall notice the practicability of a system of finance, which in our humble opinion will produce the requisite funds, and will call for no burden or impost whatever upon the people; while a perpetual and immense income is secured, sufficient, not only to banish taxes from New-Jersey, but to accelerate the increase of our school fund, form new canals, improve roads, drain swamps, or defray the expense of similar works.

Such are the topics which we have felt ourselves called to investigate. They may perhaps exceed the strict letter of the act; but it is difficult to stop in the middle of an interesting enquiry, while intimately persuaded that its prosecution must conduce, in a high degree, to the welfare of our country. If the fruits of our zeal and labor do not fulfil your expectations, we dare to hope that the defect may be imputed to the number of branches into which these



important discussions are ramified; the various and distant sources to which we have been compelled to resort for information; the short period of one summer to perform so extensive a task; the appropriation of funds, which did not permit us to call unreservedly for professional assistance; and the difficulty of arranging within one comprehensive view the multitude of facts and reasonings which bear upon this momentous question.

At the head of this report is a map, compiled from the best authorities, of the country through which the canal must pass, with some of the practicable routes marked thereon. This map exhibits the forges and furnaces actually in operation, with those which have fallen into decay. The veins of Iron Ore, with the principal mines within its limits, are also marked.

Of the accompanying documents, (A) is the report of our engineers, Messrs. Renwick and Beach, with an estimate of the probable cost of the canal.

In commencing the preliminary levelling, we found, at the end of a very few days, that the elevation of the summit level above Easton and the tide waters of the Passaic, would exceed any idea formed upon the floating information previously acquired. It became immediately evident, that to overcome this altitude by the ordinary mode of lockage, would put not only the courage, but the funds of capitalists to their utmost stretch; while the unavoidable contiguity of many locks crowded together, would cause an expenditure of water, perhaps too great, even for the vast reservoir of Hopatkung; and the time expended in passing probably 200 locks, would of itself be an impediment of the most formidable nature.

Surrounded by difficulties of such serious aspect, we felt ourselves called upon to look for resources in

the recent European improvements, and to summon to our aid all the science, talent, and experience, which could be brought to bear upon the subject.

Nor was it on slight grounds that we resolved to abandon the routine of canals in this country. Fulton, in his treatise upon inland navigation, expresses himself in strong terms in favor of inclined planes.* The Duke of Bridgewater invented and adopted an inclined plane, which is found to economise three fourths of the cost of the apparatus which it superceded; the best French engineers have long used perpendicular lifts, or inclined planes, in preference to locks, in situations similar to those in which we are placed; and the canals of Ketley, Shrewsbury, Shropshire and Monmouthshire, are a standing proof of their practicability and utility. We trust we shall not be stigmatized as visionary theorists, in acceding to practices sanctioned by such high authority, and tested by the experience of half a century.

But while a system of inclined planes was obviously the only method of overcoming the elevation, at a moderate expense, those which have been hitherto used were evidently inapplicable to our wants. The general object in Europe, has been to carry boats of from 3 to 8 tons, and to perform this task by a costly machinery. For us it was indispensible, not only to carry larger freights, but to avoid the inconveniences, risk and disbursement of complicated engines.

To adapt to the present exigency, new expedients, based on incontestible principles, was a task confided by us to Mr. Renwick. His report on the subject,

*"I do not hesitate to prognosticate the annihilation of lock canals, by "improved Science. If such a system of operation was invariably to be "continued, there would be no more scientific improvement among men "than in a bed of oysters."



marked (B) offers a plan, combining cheapness with the most beautiful simplicity, and will be an acquisition of the highest importance to the science of Inland navigation. Henceforth, the most mountainous regions and the most appalling elevations will be traversed with ease and economy, both of money, time and water. The Gentlemen associated in the labours of Mr. Renwick, are too well known and eminent for every quality necessary in a skilful Engineer, to require any eulogium from us; suffice it that the credence due to their opinions, surpasses what would be claimed by any other combination which could probably be united, either in America, or in Europe.

Plans and estimates thus formed, conduct as far towards rational certainty as the very nature of the calculation will permit. It is not truth, but the nearest approach to truth which can be made, until the canal be actually executed.

In presenting these documents, we are far from affirming, that the indicated line of canal is the best which can be found. Universal experience shows, even after investigations, costing much greater time and money, that improvements upon a projected course are daily made, till the very moment when the plan is carried into operation. Our chief object has been to move upon the straightest line consistent with practicability and economy. Such a line would probably be adopted by a chartered company, whose sole object must be a profit, best attained by following the shortest passage to New-York. But if the Legislature shall extend its arm to accomplish this plan of improvement, the principle of public utility interferes; and the canal should be made to deviate to those points where its presence will call manufac-

tures into existence, or give a new impulse to Agriculture. It may also be desirable to make it approach situations from which advantageous lateral branches could be made to intersect the adjoining districts; not so much for the sake of positive revenue, as in order to spread far and wide a stimulus to industry. Several positions of this sort lay within a short distance, and thus various navigable streams, like veins and arteries, might diffuse life and vigor through the body of the country. In this view, we present our plan, section and estimate, as one out of many, which might have been made. Several routes were explored, each possessing its peculiar advantages and its numerous advocates. If a real canal be staked out, independence and firmness will be qualifications, no less necessary than honesty and intelligence, in the persons who are destined to act amidst so many contending claims.

Lehigh coal being the foundation upon which the chief utility and profit of the enterprize must rest, we have considered it a part of our duty to examine the quality of that fuel, the facility with which it could be conducted hither, the probable cost, the quantity and nature of the supply. To attain a knowledge of these points, we have not only corresponded with the Managers of the Coal company, and conversed with intelligent persons, but have despatched an Engineer to the spot. The report on this subject is marked (C,) which, in conjunction with the letters of the managers of the Lehigh Coal Company, will show that a regular supply is attainable, to answer any possible demand; that the quarries may be termed inexhaustible; that the coal is applicable with advantage to every manufacturing and domestic purpose;* that it

*Within some miles of the various Coal Quarries, farmers go that distance to purchase and draw it, rather than use their own wood. In one instance, an individual living on the Hamburgh turnpike, at a distance of 30 miles from the Schuylkill coal, sends his teams for it in preference to Hickory wood, growing within a few hundred yards of his house.



can be procured at $4 60 to $5 per ton, delivered at the mouth of our canal.

Whenever a demand so enormous, as that to spring from this enterprize, presents itself, competition will be roused throughout the immense coal regions of the Susquehannah, Delaware and Lackawaxen, while vigorous and new exertions will be made to facilitate access to us; we therefore fear neither increase of price, nor curtailment in quantity †

Among the papers laid before you, we feel the highest gratification in submitting (D,) copy of a resolution of the Legislature of the state of New-York.—This document emanates from the enlarged policy there pursued in the department of internal improvement. The co-operation of an Engineer, and the spontaneous expression of sentiments, on a subject where their experience forms the safest guide, alike demand our thanks. We would presume to suggest the propriety of answering this testimony of good will, by a resolution, such as your wisdom may see fit.

The Mineralogical Report (E,) presents a topic of great interest, not only to the Statesman, but to the lover of Scientific knowledge. It authenticates a belief, already general, though vague, that the north of New-Jersey contains a subterraneous wealth of more solid importance than the treasures of any equal por-

†We consider the price above stated, of $4 60 per ton, as capable of considerable diminution. The Schuylkill canal is 90 miles long, and yet coal delivered at its termination, costs the company only $3 25. The Lehigh coal passes through a shorter and cheaper canal; nothing can exceed the facility with which it is obtained, and therefore the price of $4 60 should be modified, and must, if other competitors enter the market.

tion of the Globe. Inexhaustible supplies of Iron, Zinc and Lime, with Copper, Black Lead, Copperas, Manganese, and the finest Marbles, Spanish Brown and Yellow Ochre, await only the proposed canal, to become the copious sources of Industry and Prosperity. The Mineralogical survey has been, in the present instance, only a secondary object. If at a future time it should be deemed of sufficient importance to pursue it as a separate and distinct enquiry, we have little doubt that discoveries remain to be made, and new lights to be thrown on this interesting branch of our national resources.

The water powers of New-Jersey will not be diminished, but on the contrary, increased by the proposed canal. The basis of the project consists in damming up the surplus waters, which, in spring especially, occasion such destruction to Mills and Bridges. These freshets treasured up, will form an ample supply. The soakage from the canal running on a higher level, will find its way into the Brooks underneath. Occasionally, also, during the summer, a local surplus of water, on the canal, will be discharged into some adjacent stream, and thus, by a proper economy in Spring, the water power of the country will, during the dry season, be materially increased. In some solitary instance, perhaps it is possible that a seat may be injured, but in such case, (which can never exist, but to a trifling extent) reparation must be made. It will hardly be contended, that a national work should be arrested by the caprice, obstinacy, ignorance, or self-interest of any single man.

All our facts being established, by these various documents, in a manner as authentic as the nature of the case will admit, and we may venture to say, more firmly than upon any former enquiry of the kind, we



now proceed to the conclusions which they force upon the mind. Perhaps we may thus overstep the literal object of our commission, yet we shall presume to tresspass upon your attention, as citizens who have investigated with peculiar attention, a subject of deep public interest.

If it were required to describe a country in which manufactures will certainly flourish within a short period, we should say that it must abound in unwrought materials; it must be plentifully supplied with provisions at the cheapest prices; it must contain water powers to set machinery in motion, and adequate accommodations as to fuel must exist; finally, it must be situated within convenient access to an extensive market. If the canal be made, we are acquainted with no scite so propitious as New-Jersey, nor one in which the above described requisites are so eminently combined. The termination of the proposed inland navigation in the Delaware and Hudson, and the facility with which the products of the Susquehannah can be made to follow the same course, will secure a cheap superfluity of provisions of all kinds, and of all the raw materials which our country furnishes, such as metals, marbles, colours, lime, coal, wool, flax, hemp, cotton, &c. while a chain of Mill seats affords an unrivalled water power, and the ports of New-York and Philadelphia offer a market vast of self, and a channel to the consumption of the most distant countries.

But it is not in general frabrics of the Loom that our principal strength consists, and we turn to a manufacturing system in which we possess advantages, peculiar, decided, and unrivalled. Nature has endowed New-Jersey with mineral treasures, not as in European mines, to be extracted from vast depths,

but scattered in profusion near the surface. The metals, formerly enumerated, exist in quantities incalculable; a source of wealth to this state, and of prosperity to the whole union, which must remain forever buried until a water conveyance bring coal.

Nor do we possess an advantage solely in the quantity, richness, and facility of obtaining the ores. The Lehigh Coal is pure from Sulphur, which predominates so much in English Coal that the process of coaking is necessary to render it fit for use. Among practical men, no doubt is entertained of its superior heat, and of its capability of being employed in the smelting of metals. That our iron ore is more valuable, is evinced by the fact, that here, Bar-Iron is made at one process, while in England, it must pass through the Furnace on its way to the Forge.* The cartage of Iron from our forges to the New-York market, costs at present, on an average, 10 per cent. of the value, while a canal would carry it for 1 per cent. With these facts in view, we look in vain for a reason why our forges, if a new system, resulting from the canal be introduced, cannot successfully compete with Europe, in the South American, or any distant market. Our chief attention is however attracted to home consumption.

By the report of the Secretary of the Treasury, it would appear that the importation of Iron and Steel, last year, into the United States, was 37,077 3-4 tons.

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| Which reckoned at $75 per ton, is | 2,780,731 |
| The value of manufactured articles of Iron or Steel, was $2,767,757, of which allow one fifth to consist in the material, | 553,551 |
| | $3,334,282 |

*We have it from unquestionable authority, that our ore in its crude state would become a profitable article of commerce to England, and that in Sweden it might be sold for thirteen dollars per ton.



Thus we see an amount of nearly 3 1-2 millions of dollars annually sent abroad for the purchase of Iron, which we have skill, capital, and materials (if Lehigh coal could be distributed through the country) to manufacture for ourselves. The prospect might be carried still farther, for England manufactures 200,000 tons of iron annually, a great portion of which is exported. With superior advantages, and cheaper freights, we must finally become her competitor in foreign markets. This, however, is a theme which we may hint, but shall not enlarge upon; satisfied as we shall be in supplying the established home consumption of our own country. The disadvantages under which our iron masters labor, disadvantages which the canal will remove, have introduced a slovenly process into the forges, and given a bad reputation to much of our manufacture. The fact is however generally admitted, that *well made* Jersey Iron is superior to any foreign, and so well is this understood, that a ship fastened with American iron can be insured in New-York, at a cheaper rate than one in which English iron has been used.

After these momentous facts, it may be unnecessary to add, that, besides iron there are other minerals which would, in themselves, warrant the expense of a canal. We imported last year, 10,692 cwt. of Copperas, of which an inexhaustible quantity lays within two miles of our course. The Manganese, necessary in glass houses, potteries of fine ware, and in the bleaching process, abounds; Zinc, not only for making brass, but as a fire-proof covering for houses, and a substitute for copper in the sheathing of ships, exists in masses sufficient to supply the world; Copper is discovered in several places, with Plumbago, for machinery, crucibles, graphic, and va-

rious other uses. Nothing but a canal is wanting to concentrate in New-Jersey the enormous expenditure which we lavish for these articles upon foreign nations, and even to become exporters, and supply distant markets.

It may perhaps be said that we do not possess capital for such immense manufactures; against which objection we urge the following considerations: Under the present system, forge owners, in order to secure a regular supply of Charcoal, must own from 1 to 5000 acres of wood land, and thus lock up a capital of two to twenty thousand dollars; whereas, under the system which a canal would introduce, one acre suffices. The apparatus, also, of horses, waggons, outfit for wood choppers, &c. which cost almost as much as the forge itself, are rendered unnecessary. Dealers in Coal, a new race of merchants, with a new capital, will spring up; coal and ore will be delivered every where, on a credit sufficiently long to sell the iron before the payment becomes due, and with $1000 a forge may be put into operation. The capital now employed to make 2000 tons of iron, will suffice to fabricate 20,000, without referring to the fundamental commercial axiom, that money always flows to that point where it can be advantageously invested, and lucratively employed.

If we possess the best coal and ore, why should not our iron, which is incontestibly of a superior quality, be afforded cheaper than the foreign, loaded as it is with a freight across the Atlantic, endless port and other charges, both on shipment and landing, and finally with a duty of about 25 per cent. on the value. At present, indeed, the transportation from Liverpool or St. Petersburgh is cheaper than from Morris to New-York; and a forge in Staffordshire, or



even in Siberia, is, for every useful purpose, nearer the American emporium, than a forge in Sussex. A canal will at once rectify this perverted order of things, by reducing the freight from 10 to 1 per ct. He who thinks, that, broken down by taxation, with dear provisions, worse coal, inferior ore, and in the face of a prohibitory duty; he who thinks that the English manufacturer can still undersell the American, must place New-Jersey industry and ingenuity quite too low upon the scale. The facilities of water transportation of coal, ore and iron will probably reduce the manufacturing cost by 15 to 20 per ct., while it will raise the quality. If this prediction be verified, we may not only supply the home consumption, but profit by the French, and other European, and South American markets. Instead of importing coal and iron, we shall export iron and ore.

It is not solely in the production of metals, nor of the various utensils into which they are fashioned; it is not alone in the stimulus to fabrics of cotton, wool, flax and hemp, that the benefits of the projected canal will be felt. The forests which we prostrate for a pittance of charcoal, and then abandon to 30 years of sterility, will yield a lucrative supply of lumber; the lime of Sussex and Hunterdon will increase the harvest of Morris, Essex and Bergen; and the labor now wasted in dragging waggons over bad roads will be expended in tillage, or agricultural improvement.*

Agriculture will also experience the effects of the canal, not only by increased demand for manufacturing consumption, but from an improved cultivation.

*The unproductive labor of transportation by teams, was last year shown, by documents, to amount annually, within the district of the canal, to $164,462!

The three counties last mentioned, require lime as a manure, which can be supplied from the two former, at from 9 to 11 cents per bushel, unslacked.—We are unable precisely to calculate the extent of this demand. but the best information in Morris, authorizes us to say, that 2000 tons would be annually demanded there, for agricultural purposes. Essex and Bergen must require each considerably more; the quantity wanted for building is large; and as the Lehigh coal is not only advantageous, but economical in burning, we see no reason why we should not enter into competition for supplying the markets of New York, Long Island, and New England. We probably might estimate the total demand fairly at 10,000 tons, or a sum of $30,000 annually gained to the counties of Sussex and Hunterdon, for a commodity with which their lands are encumbered.

We may here mention as a large increase of freight to the canal, of profit to the farmer, and of good morals to the community, that apples and cider would be exported instead of being converted into ardent spirits. The land carriage renders it at present necessary to have recourse to distilling as the only means of conveying the produce of our orchards to market.

While adverting to the influence of inland navigation upon agriculture, it may not be improper to mention, that the canals in Ireland were made almost solely for the benefit of the farming interest; that they cost in all about $14,000.000; that their effect within 50 years has been such, that instead of importing to the value of 2 1-2 millions of dollars, the island now exports a surplus produce amounting to about $17,000,000. The Ellesmere canal in England was made solely for the transportation of manure and agricultural produce, and on this canal is the famous aqueduct of Cyselty, which alone cost $250,000. The agricultural wealth of England has been tripled since the introduction of canals, and De Pommeuse mentions that the canal of Languedoc adds annually to the quantity and value of agricultural produce an amount equal to 2-3 of the sum which that canal originally cost.



The state of New-York furnishes a recent illustration of the advantages conferred by inland navigation on agriculture, still more pointed than any of the above.

The Holland Land Company possesses a tract of 60 or 80 miles in breadth, intersected by the Erie canal. For a series of years the Stockholders could not raise one per cent dividend, and the distance and difficulties of a market were such as to threaten destruction to all the settlers, whose lands on the tract were under mortgage.

It is now two years since the canal has penetrated that country; already has the aspect of affairs been changed, and the company received during last season a larger sum from its settlers than it had been able to collect for the ten preceeding years.

We shall not attempt to draw these details into a more narrow focus, but leave every Legislator to estimate for himself the beneficial effects likely to result from the concurrence of such weighty causes.

Permit us to contrast this flattering prospect of individual industry, public wealth, and universal prosperity with the dangers which at present threaten to overwhelm the country.

The early settlers of this district embraced the combined advantages of fuel, ore, and water power; forges and furnaces were every where erected, and

wealth thus flowed into a country, which would have otherwise remained untenanted during a series of generations. But timber is a production of slow growth, and being once cut off, men do not willingly wait 25 years for the succeeding crop. Thus the farmer treads on the heel of the Iron Master, the land is clearing up, manufactories gradually recede westward, and will in a very few years be entirely restricted to the mountainous region. We accordingly see large establishments successively abandoned, and our map exhibits 39 forges and furnaces fallen into decay for want of fuel.* This melancholy state of things must inevitably increase till it absorbs our whole active industry, unless means be adopted to furnish a supply of coal. The face of our map demonstrates that forges disappear wherever the country becomes populous, and that, on the streams, whose banks are in good cultivation, they have long ceased to exist. These manufactories were chiefly of the largest class, and supposing a furnace to make no more than a common forge, we are safe to calculate them each at an average of 2 1-2 fires, or 97 fires at 50 tons of iron per fire, is 4,850 tons iron. This at $80 per ton, is $388,000 annually lost to New-Jersey and remitted to Europe, for want of coal.—Reckoning every ton of this iron to require 7 1-2 tons coal, it would make a yearly demand of 36,375 tons of Lehigh coal.

The manufacturing history of England affords an exact parallel to our present circumstances. Its iron works about the year 1600, produced 75,000 tons annually; but, consuming charcoal alone, a scarcity of that fuel ensued, so great that the quantity of iron gradually dwindled to 17,000 tons, and the kingdom

*Further enquiry convinces us that many are omitted.



was supplied by importation. This branch of industry would have been totally extinguished, if the discovery that mineral coal might be substituted, had not been made. From that time the manufacture rose in importance, and now produces 200,000 tons annually.

In like manner, we now approach the moment when our forges and furnaces must yield to the gradual extension of agriculture; nor is this the only cause which threatens them with diminution, and ultimate extinction. On these tracts of wood land which have been reserved for cutting during the greatest number of years, it has been observed that after the fourth or fifth time of stripping the ground, it sends up shoots more reluctantly, and yields a very stinted growth. Thus we have more than one reason, demonstrating that the manufacture of iron must vanish from this portion of New-Jersey, unless mineral coal be introduced; nor is this practicable, save by forming the canal under present consideration. Upon the execution of this enterprize, therefore, it depends whether New-Jersey shall suffer her iron works to perish gradually, but infallibly, or become (for its extent) the most manufacturing country in the world.

But farmers are interested, as deeply as any class of citizens, in this proposed navigation.

The canals of New-York will, in one or two years, bring by water, to that emporium, the productions of the immense regions extending from New Hampshire, in the east, to Lake Michigan, in the west.—Their transportation will be effected at a price as low as that which our land conveyance from Sussex county costs. Thus in a short time, our farmers, with high priced and exhausted lands, will be brought into

direct competition with the remotest settlers of the new countries, living on a virgin soil, purchased under 8 dollars per acre.

Calamity and ruin must ensue, both to land holders and farmers, unless the wisdom of our Legislature adopt some means to avert the impending evil; nor do we see any measure which, in every point of view, would so effectually secure the prosperity of all classes of the people, as the plan now under discussion.

Leaving these general considerations, we now proceed to investigate whether the Canal will be a speculation profitable to that power which shall carry it into execution. The subject involves a variety of distinct topics, upon each of which we have taken much pains to obtain correct information. In such calculations it must ever happen that some items are rated too high, and others too low; but upon the whole, these involuntary errors must nearly ballance one another when, as in the present instance, the only object has been, not to support a favorite theory, but to attain the truth. If we have in any case been guilty of wilful misrepresentation, it has been, by occasionally undervaluing the sources of revenue about to be exhibited; for the purpose of securing unanimous consent to our propositions, and of leaving no ground for rational objection.

The consumption of coal stands first and most important. There are in the canal region, as per map, 54 forges and furnaces in actual operation, or 112 fires, reckoning 2 fires in each, and a furnace at nothing more than a forge. A fire, if properly supplied with stock, and enjoying the advantages of water carriage &c. will probably make 50 tons iron per annum. Thus 5400 tons would be made, and reckoning 7 1-2



tons of coal to be consumed in forging one ton of iron, we shall have 40500 tons required for the manufacture of bar and cast iron, at the existing establishments.*

The increase of the number of forges; the enormous consumption of furnaces, some in actual blast, some abandoned for want of coal, and some which would certainly be built; mines of other metals; corn and cider distilleries; blacksmith's shops, potteries, lime kilns, glass works, brick making; the demand for domestic and manufacturing purposes in the vicinity of the canal, and throughout the districts of Paterson, Newark, Elizabeth-Town, &c., where Lehigh coal will form a large economy; these multifarious channels of consumption will undoubtedly far exceed that of bar iron. We feel safe in stating them at 40,000 tons of coal. This estimate must be considerably too low, for we have shown that the extinguished forges alone would consume 43,000 tons, that the canal will enable iron to be made 15 or 20 per cent cheaper than at present, and that the demand is infinitely beyond any quantity we can possibly make.

The price at which Lehigh coal can be delivered in New-York is an enquiry of the highest importance. We calculate it as follows:

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|---|---|
| Cost, delivered at Easton, per ton. | $4 60 |
| Canal Toll, | 0 95 |
| Tare and wear of boat, wages, towing, and landing in New-York, | 0 73 |
| Mr. Sullivan states, that by employing steam boats for towing, according to a plan formed by him, the transportation from the mouth of the canal to New-York will not cost above | 0 25 |
| Price per ton, delivered at New-York, | $6 53 |

The canal will create a steady, equable and vast

*Charcoal and Lehigh Coal, containing an equal portion of carbon, are of equal effect and value, weight for weight. The price of Lehigh coal de-

demand; it will therefore bring into market a competition of sellers from the Lehigh, Delaware, Susquehannah and Lackawaxen, on each of which rivers mines exist which would singly meet our full demand. Commercial experience teaches, that under such circumstances an article will fall near to, or perhaps a shade under the price for which it can be reasonably afforded; we may therefore safely take $7 as the very highest cost of coal delivered in New-York. It was last spring in great request at $14, and Liverpool coal cannot be imported without loss, under 11 or 12 dollars.

It has been found by experiment, that Lehigh coal gives out, in domestic use, 12 times as much heat as an equal weight of oak wood; thus, one ton of coal is worth 12 tons, or probably 5 cords of wood. Supposing it in New-York to cost $9 per cord, then $7 laid out in Lehigh coal, will be as good as $45 laid out in wood. The carbon contained in Lehigh and in Liverpool coal, are to each other in the proportion of 94 (some say 96) to 44. This analysis is corroborated by the document annexed, which shows that 5 bushels of the former, heats a ton of iron requiring 10 of the latter. Thus $7 laid out in Lehigh, is as good as 22 or 24 dollars in Liverpool coal.

From these ascertained facts, it results that wherever Lehigh Coal can be abundantly supplied, every other fuel must necessarily be banished. A year or two may be required to conquer the prejudice

livered at any point within two miles of the canal, thus comprehending the principal seats of water power, would be as follows:

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|---|---|
| Cost, delivered at Easton, per ton, taken at the high price quoted | $4 60 |
| Canal toll, on an average, | 0 50 |
| Tare and wear of boat, wages, towing, landing and loading, | 0 68 |
| Cartage to an average distance of 2 miles, | 0 42 |
| | $6 20 |



against novelty, but with so decided an advantage in price, intrinsic value, safety, and convenience, (for it emits neither spark, smoke, dust, soot, nor smell) it must soon attain that universal demand in New-York, which it already commands in Philadelphia.

Dublin contains 144,000 inhabitants, and consumes 204,000 tons of coal; Edinburgh and Leith 100,000 inhabitants, who use 213,990 tons. New-York, with a population of 135,000, will, from the average of these other cities, demand annually 231,265 tons. But this calculation is made upon English coal, and the Lehigh being stronger by at least fifty per cent., the quantity actually consumed will be proportionably less. While we thus state New-York at 115,632 tons, we can rely upon that demand; for the very same reason which diminishes the quantity, renders it certain that this coal will come into universal use.

The demand upon the Hudson, Long Island and New England, has been stated to us, on good authority, as equal to that of the city of New-York. If we reflect upon the vast population on the banks of the Hudson, and on the sea coast up to Boston, the large towns, the steam boats and manufactories, which have no *combustible* coal nearer, or so cheap as the Lehigh, we shall certainly undervalue this demand, when we state it at the half of what well informed men from New England reckon, say 57816 tons.

The iron in bars and casting, as also other metals transported on the canal, cannot be less than 7000 tons, nor the ore distributed from mines than 6000 tons.

From enquiry of the best farmers, we estimate the demand of Morris, for lime to be used in agriculture, at 2000 tons. With no positive data, we suppose a similar demand from Essex and Bergen, with the con-

sumption in Masonry or Manufactures to be 3000 tons, only making together 5,000 tons. We are informed that a great demand will arise for New-York, as the Sussex lime is of a quality much superior to that carried down the Hudson, but having no means to estimate its extent, we omit it entirely, as also the possible demand for New-England, which is now supplied from Maine.

By documents presented to the last Legislature, the agricultural produce and lumber carried from Sussex to Essex and New-York is 6,500 tons, Hunterdon, Morris and Bergen, may be reckoned 6,500 tons. The cartage between Patterson and New-York was last year, 1,950 tons.

The transportation of Salt, Plaster, Groceries, Dry Goods, Spirits, Cider, Bricks, Slate, and the Chesnut rails which the highlands of Morris will send into Sussex and Essex, may be taken at 10,000 tons.

The commerce of Easton and its vicinity is reckoned by an intelligent inhabitant at 9,520 tons. From the same source we find that an average of 5,000 tons lumber annually passes down the Delaware. Allow one half, or 2,500 tons to seek the New-York market.

It has already been stated to a former Legislature and is confirmed by the annexed documents, that a very practicable cut of 12 miles, from the Lehigh to the Nescopeck, or another line in the direction of Wilkesbarre, will give to the inhabitants of the Susquehannah counties an option of pursuing the channel of our canal to New-York. To penetrate thus, by the Delaware and Susquehannah, into vast regions, abounding with every species of produce; and to offer to the long range of south western counties of the state of New-York, the same advantages, which their northern brethren derive from the Grand Canal; such an extension of our views is warranted by probability, and would accomplish results, for the calculation of which, we have at present no materials; save that the 22 counties forming the basin of these rivers, and of their tributaries, are calculated at 36,500 square miles, or a region of about half the size of England and Scotland united. The mind is lost in contemplating a result of such vast commercial and political magnitude.* How far this idea is satisfactory to the statesmen of New-York is attested by the vote of their Legislature.



Before we make a summary of the probable profits of the canal in freights, we will mention, that the formation of basins, wharves and ware houses is frequently a source of great emolument to chartered companies, and the waste water and feeders are also turned to very profitable account, as sites for mills. The adoption of a system of inclined planes and lifts will render this advantage peculiarly great on the present canal. The port at each termination will be of immense profit, and should the state reserve for itself a greater space along the whole line than the actual width of the canal, this ground would form, all across New-Jersey, a chain of building lots more valuable, and which in twenty years would sell for more than the cost of the whole concern.

Whether it would be politic or just in the state to appropriate to itself these advantages, is a question for the decision of the Legislature, and on which we

*Were the improvement above alluded to made, the trade thrown into our state, would occupy 3 canals, such as that proposed, and when we assume 10,000 tons as the amount we make a random guess, for it cannot be less than ten times that quantity. We refer on this subject to a bold and expansive view taken by Mr. Sullivan, whose valuable report to us would have been printed had time permitted.

entertain doubts, especially in regard to such land holders as generously grant a free passage. Omitting all these sources of revenue, we also reckon nothing for cost of land, because we are persuaded that every man will rather give the width of the canal, than sell, at their present value, the lots adjoining its channel.

We avoid all mention of the carrying trade between New-York and Philadelphia, both as we think it could not be great, and because it should be considered as the peculiar province of the Raritan canal. Events may now be seen in their germ which will, in a year or two, bring that enterprize forward on a scale suited to the grandeur and importance of its object.

*Recapitulation of the Commerce, and Estimate of the Revenue of the Morris Canal.*

| | *Tons.* | *Cts.* | |
|---|---|---|---|
| Coal consumed in New York, distance 76 miles, at 1 1-4 cents, | 115,632 | at 95 | $109,850 |
| Coal consumed on the banks of the Hudson, and on the sea coast to Boston, | 57,816 | at 95 | 54,925 |
| Coal consumed in New Jersey, for the use of forges actually in operation, | 40,500 | at 60 | 24,300 |
| Coal consumed in domestic, manufacturing and other uses, | 40,000 | at 60 | 24,000 |
| Iron, other metals, and Copperas, | 7,000 | at 60 | 4,200 |
| Ores distributed from the mines, | 6,000 | at 30 | 1,800 |
| Lime, | 5,000 | at 40 | 2,000 |
| Lime to New York and New England, | | | 0,000 |
| Agricultural produce and lumber of Sussex, | 6,500 | at 60 | 3,900 |
| Morris, Bergen, Essex and Hunterdon, | 6,500 | at 50 | 3,250 |
| Paterson, | 1,950 | at 30 | 585 |
| Salt, Plaister, Groceries, Dry Goods, Cider, Spirits, Bricks, Rails, and Slate, | 10,000 | at 70 | 7,000 |
| Commerce of Easton and its vicinity, | 9,520 | at 80 | 7,616 |
| Lumber from Delaware, | 2,500 | at 80 | 2,000 |
| Agricultural produce of Susquehannah and Delaware, | 10,000 | at 25 | 12,500 |
| Gross Revenue, | | | $257,926 |



In order to reconcile those who think the tonnage overrated, we have estimated the tolls lower than usual. Every article could bear double the rate charged, and every trader would most willingly pay it.—Instead, also, of calculating the certain increase of traffic, rising annually in rapid progression, we have taken it on the present situation of Agriculture and Manufactures. How vast this concession is, may be seen from the following statement of the progressive rise of the revenue of the Merrimack canal.

| | | | | | |
|---|---|---|---|---|---|
| Its Revenue in | 1808 | was | $7,000, | in 1815 | $25,000 |
| | 1809 | | 9,000, | 1816 | 30,000 |
| | 1810 | | 14,000, | 1817 | 32,000 |
| | 1811 | | 17,000, | | |

This ratio of increase might very safely have been adopted in regard to the iron and other manufactures, and the coal consumed therein. The increase of population in New-York must augment the demand for fuel, and agricultural products will be naturally multiplied in proportion to the increasing demands of the market and the facilities of conveyance to it.

We desire not to tread upon debateable ground and therefore refrain from any reliance on these contingencies; and in assuming $150,000 as the net revenue of the canal, we make a large deduction. We sacrifice a considerable portion of the strength of the case for the sake of unanimity, and in order to pass on, unfettered by objections, to the remaining argument.*

We are unable to comprehend any method by which a pacific nation can pass from insignificance to power, from poverty to wealth, except by agriculture, manufactures or commerce.

*The annual charges of collection, management and repairs, are estimated by Mr. Sullivan, who for some years directed the Boston canal, at $20,000, thus leaving a clear available income, as per estimate, of about 238,000 dollars.

Our farmers, by an honourable economy and industry, may continue to be, as they now are, the ornament and strength of our country. But can a soil of high price, moderate fertility, and small extent, become the source of public wealth, while in all the principal markets, we must contend with the produce of lands, cheap, new, boundless and from whence the transportation costs as little as from New-Jersey? The hopes of commercial are obviously as desperate as those of Agricultural prosperity, and manufactures remain our last resource; nor can we devise, or even perceive the possibility of any scheme for giving an impulse or new direction and encreased extent to industry, at all comparable to the plan now under consideration.

From the policy, founded upon long experience, of every nation, and from the simultaneous effort now making throughout the union to construct canals, might at once infer that the proposed inland navigation will have an effect highly beneficial to the agricultural and manufacturing interests of our country. Did this point require additional illustration, we think the most incredulous mind will be satisfied with the facts and reasonings which we have had the honor to adduce. But while probably all agree that a canal should be made, it remains to discuss by what agent this enterprize shall be accomplished. Is the state to call forth its energies to the task, or shall it be consigned to a chartered company?

If New-Jersey is ever to avail herself of her immense natural advantages, if she is to sustain her present relative influence, if she is to be preserved from the degrading sense of inferiority to her neighbours, it can only be accomplished by a series of judicious internal improvements. You now stand upon



the threshold of a new system, and will either follow the great example of New-York in making public works, a state concern, or establish and hand down to your successors, the pernicious, the deadly principle of confiding the vital interests of our country to the guardianship of men, whose only view can be pecuniary advantage to themselves. He who controls the very fountain head from whence public prosperity flows, is in fact, master of the state, and by creating an association on whom our industry depends, under whatever modification its sway may be exercised, you run the hazard of introducing an aristocratic goverment veiled under the forms of republican administration.

The social compact is not a mercantile copartnership, we therefore consider not only that it derogates from the dignity of a republic, but that it violates the spirit of the constitution, when a Legislature plunges its constituents into speculative adventures, for the sake of mere fiscal advantage. Not so with the execution of plans for internal improvement.

These render a nation illustrious, and form one of the principal benefits which civil institutions contemplate in their origin, and confer in their progress. While therefore we hesitate respecting canals or other speculations which regard a trading profit, rather than internal improvement, as their ultimate object, we consider the proposed enterprize not only as comporting with the powers vested in the representatives of the people, but, upon the views of the subject which have been offered, it becomes their evident duty, on the present occasion, to exert those powers to full extent. If precedent is required, it will be found in the acts of the General government, in public works constructed by many states, and in

the effort which every Legislature in the union is making to execute public improvement at public expense.

Accumulation of money is the sole motive of a chartered company, the extension of industry and happiness is the only legitimate object of a Legislature; therefore even if its prospective revenue were insufficient to attract individuals, the enterprize might nevertheless be, on the grounds of public utility, a measure deserving the interference of the state. If an expense of $800,000 could raise manufacturing and agricultural industry to the extent we have demonstrated, we believe that many statesmen would think the sum well laid out, even if it should bring no direct return into the Treasury. The richest country is not that whose public coffers are fullest, but that in which there exists the greatest quantity of individual wealth. In regard however to the present question, we are not called to reconcile contending interests or to weigh opposing arguments.

The profits of the canal are sufficiently evident and large to fill up at once the subscription list of a company, provided the charter be liberal. But if the enterprize combine every advantage; if it act as a source of universal prosperity, while its revenue is abundantly tempting to enlist a class of men proverbially acute, vigilant and intelligent; if it unite public welfare with private emolument, we shall search and search in vain for any sound reason why the state, with full power in its hands, should not reserve for itself the enormous advantage, and trifling risk of the plan.

If the canal be a state concern, the lands will be almost universally contributed as a free gift, and many proprietors have assured us of their readiness to



make liberal donations of labor and money, if the course come into their vicinity. If it be a state concern, every man, feeling himself a proprietor, will discountenance the frauds and injuries committed upon individuals collecting toll. Whoever knows the history of our turnpikes and shunpikes, of gates pulled down and toll houses set on fire, will see the force of this argument, and agree that the state can levy its revenues and conduct its affairs, with a discipline and order otherwise impracticable. We ourselves have witnessed with delight, on the New-York canal, the interesting and beautiful spectacle of a people yielding its rights and property without a murmur, and of a government paternally solicitous to accommodate the convenience, the interests, or even the caprices of individuals. How different a scene would have presented itself if a private company, armed with chartered rights, had invaded the lands of the farmer! If it be a state concern, its course will be inclined towards the places where, without too much deviation, it can influence the prosperity of large masses of population; but if undertaken by individuals, the shortest route to New-York will be adopted, go wherever it may. The object will be changed from internal improvement, to pecuniary speculation. The absurdity of committing to the management of self-appointed individuals, the execution of a plan for augmenting the prosperity of the state, is too manifest to require notice.

But we shall not trifle on a subject so momentous. To a people jealous of its liberties, there is a conclusive argument in favor of the canal being public property. It will soon become the channel of the entire industry of nearly half the state, and in addition to the influence thus created, there will soon be some

thousand persons immediately dependant upon its President and Directors for their daily bread. Exists there a man, who will say that a political engine of such tremendous power, should be entrusted to any number of self-elected individuals, and these individuals probably the subjects of a nation sometimes hostile, always interested in pulling down our manufactures. If this canal realize the hopes of the greatest statesmen of America, and renders New-Jersey the rival of foreign nations in the fabrication of iron, how easily might the industry of our country be at once crushed. There are perhaps twenty establishments in England, any one of which could, without inconvenience to its pecuniary arrangements, buy up the whole stock of the canal, close its navigation, and in a moment spread desolation over a flourishing district. If many intelligent persons have supposed the existence of such a policy during a period uf profound peace, we may fairly judge that a direful blow would be struck in the event of war; that our iron manufactures would be annihilated at the precise moment when they would become indispensible, either for individual utility, or for national defence.

Should our labors produce only the charter of a private company, we trust that the wisdom of the Legislature will reserve for the state such a portion of the stock as will fairly entitle it to a predominant sway in the appointment of the officers. In exchange for an influence so capable of misapplication, but yet which every stockholder very reasonably expects to exercise over his officers, we hesitate not to advise, that a chartered company should obtain the most liberal and encouraging terms. The object of the state being nothing less than to triple the wealth and industry of its inhabitants, it appears to us, that individuals willing to undertake a task, of which our Legislature declines the hazard, should be placed upon the same footing on which the people themselves would stand. The certain prosperity which must result to the state, warrants the concession of a charter, perpetual, without tax, and including all those resources of which we would avail ourselves in our financial system, were the canal to be a state concern. A chartered company should be made to stand on precisely the same ground as the state itself would, for the undertaking is truly national.



The Legislature of New-York has deliberated upon the identical question now to be agitated by that of New-Jersey. Canals were in America an almost untried experiment, when one of stupendous dimensions, and incalculable expense was proposed to that bold and intelligent community. Its utility was a disputed point, and its cost was to be defrayed by loans, yet relying with noble enthusiasm on the credit, patriotism and perseverence of the people, her most distinguished statesmen pledged their fame to the doubtful measure. The results shed lustre on their names; it will be a monument of imperishable glory to themselves, a source of prosperity to their country, and an high example of moral courage to us, and to distant generations.

At present a much smaller portion of political firmness is required for tracing the same path. The cost is no longer conjectural, and that cost is diminished by the tried abilities and experience of Engineers and workmen trained to the task; We are not situated on a frontier where the avocations of peace may be interrupted by the alarms of war; our course does not lay through forests, or noxious swamps, without a road, and distant from the aids of society; nor are

we called upon to borrow money for a series of years, at rates of interest which cannot be predicted, and paying for the use of an unproductive capital during the prolonged time which the completion of so vast a scheme may demand.

With these important advantages, were the state also possessed of funds, perhaps little hesitation would be evinced; and a laudable aversion to contract debt stands the only objection to our adoption of the canal as a public work. It may be urged that New-Jersey, with a low treasury, little resource, no commerce, few manufactures, and averse to taxation of every kind, forms an exception to the general rule followed by New-York and other states. Thus poverty begets pusilanimity, and pusilanimity reproduces poverty, each perpetuating reciprocally the evil from which it sprang. But we deny the allegation, and assert that no community of 270,000 souls, industrious, inhabiting a healthy and fruitful soil, and in possession of vast local advantages, ever was destitute of resources to the extent in question, unless it was at the same time destitute of fortitude, intelligence, and patriotism. Advocates of an expansive policy, we will allude to the nature of some operations suggested by our own limited knowledge of the public finances; and the wisdom of the Legislature, acting upon a more intimate acquaintance with the subject, will devise others less obvious to us.

It is among barbarous nations alone, that the sole pecuniary reliance of government consists in the coffers of its Treasury, or in extortion upon its subjects. While society advances in refinement, the relations between the individual and the state become more complex and less apparent; the public wealth is then insensibly transformed into a compound of tangible



money and financial operations. Of these, the latter furnish a power as real and effective as the former, but being visible only to the mind's eye, they are generally overlooked, or regarded as imaginary nonentities. This, the most extensive and durable species of national resource, is thus suffered to lay unprofitably dormant, or it is wantonly squandered, by the very men who would deprecate the expenditure of a comparative pittance for internal improvement, provided that pittance assumed a form obvious to the sight. How often, in our sister states, has a bank charter worth from 10 to 100,000 dollars, been wantonly conferred on some chimerical scheme, or on some cunning intriguer, by the very men who would shudder at giving away 100 dollars of metallic coin.

Limiting ourselves to these general considerations, we shall mention our conviction, that the unseen resources of the state, with the assistance of a loan of comparatively a small amount, are adequate to this enterprize. *We perceive no imperative necessity of imposing any burthen on the people.* Three years, at most, will suffice to bring the canal into full operation; various means may be devised to pay the interest of borrowed money during this interval, and after that time the toll will speedily annihilate every engagement which the state may have contracted. A plan of finance at once effectual in its operation, and not burthensome to individuals in its details, seems capable of being easily framed.

Taking the cost of the canal from Mr. Beach's estimate, at the round sum of $800,000, it results from the view we have taken of the revenue, that in about 7 or 8 years from the completion of the enterprize, the canal will have paid for itself, and will then pour

a clear annual income into the state treasury of $150,000 at the very least estimate * From thence the School Fund can be increased, taxes paid, roads and canals made, marshes drained, and a system of liberal internal improvement entered upon with spirit and success. The universal industry and individual prosperity, the rise of landed property, the accession of dignity and power to the state, are what every man can easily imagine.

But we will lay aside speculative conjecture and conduct you to a point of view, from whence experience may be seen to throw its unerring light upon the prospect. The following statement of the cost, present value, and yearly dividend of English canal stock, was last year presented to Congress. A table of corresponding nature, but in which the profits are rated still higher, appears in the London Financial and Commercial Record, of 11th February, 1823.

| *Names of Canals,* | *Cost.* | *Present Price.* | *Annual dividend.* |
|---|---|---|---|
| Birmingham, | 25 | 565 | 20 |
| Chesterfield, | 100 | 120 | 8 |
| Coventry, | 100 | 999 | 44 |
| Evwark, | 100 | 1000 | 58 |
| Grand Junction, | 100 | 218 | 9 |
| Leeds and Liverpool, | 100 | 278 | 10 |
| Leicester, | 100 | 260 | 10 |
| Oxford, | 100 | 640 | 32 |
| Stafford and Worcester, | 100 | 642 | 40 |
| Trent and Mersey, | 200 | 900 | 75 |
| Warwick and Birmingham, | 100 | 210 | 11 |
| Warwick and Napton, | 100 | 235 | 10 1-2 |
| Laughborough, | 100 | 2400 | 119 |
| Milton Mowbray, | 100 | 170 | 8 1-2 |
| Mersey and Irewell, | 100 | 650 | 30 |

*This calculation is framed upon the supposition that the whole amount of $800,000 is borrowed. If a sum of $150,000 were raised from the latent resources of the state, the desirable consummation of paying off the debt will be accomplished about the year 1832, leaving us then in possession of the above mentioned clear revenue.



This document evinces that funds invested in forming these canals, yield upon an average, 32 per cent per annum. while an inspection of the map of England shows that a navigation is to be found within every 20 miles of the manufacturing district.*— How far might the taxes of that nation have been alleviated, if the government had made its 103 canals, costing $135,000,000, a public concern? what would be the revenue of one of these canals if, like ours, it had no rival in its vicinity.

These questions will excite a train of ideas upon which we shall not attempt to enlarge. It will be observed that every 100 laid out can now be sold for 609. We shall only add the fact that the Forth and Clyde canal was executed with borrowed money, which was repaid by the revenue in a very few years, and the proprietors now enjoy a clear income, for nothing, averaging $200,000 annually. The canal of Languedoc is reported by M. Dupont de Nemrous, to save to the nation, in 6 years, a sum equal to its cost, although the most expensive canal in France.

The inference from this accumulation of evidence is obvious: If the opportunity now presented be suf-

*In the years 1793, 4 and 5, the sum of $24,000,000 was raised in England by private subscription for making canals. The last treatise upon internal navigation, published in 1822, by M. Huerne, in closing the subject of English canals, makes the following observations.

"We have already remarked that the stock of some of these has been sold at 15 and 20 times their original value. Others, too small for the increase of their trade, have been enlarged in proportion to the importance which they have acquired."

"It is worthy of remark that, though all have been attacked by criticism at their commencement, and though some have even been on the point of being abandoned, yet there is not a single one which has not yielded a profit, and almost all have surpassed the hopes of their projectors. The canals where any loss has been sustained, are only one or two cases, where water failed, or where opposition canals, running the same course, have been made."

fered to escape, if the Legislature lavish upon a chartered company the treasure which they should confer on their constituents, it will be a source of future repentance to themselves, and of regret to their descendants. The citizens of New-York feel sentiments of triumphant exultation in the success of their gigantic plans, and look back with gratitude to those men who dared to summon forth their exertions.—Let us for a moment suppose their canal to be, not a public work, but an individual property, not a stream discharging itself into their national treasury, but an instrument for the aggrandizement of some individual capitalists. If such were the case, with what humiliating feelings would they contemplate this proud monument of courage, guided by wisdom. A policy, timid, in despite of the lofty example before our eyes, will render us the scoff of the present and the reproach of future generations.

We appreciate too highly the liberal spirit, the candor and intelligence of our fellow citizens to entertain any fear that they will act or think with the contracted views of a sectional jealousy. It is true, that the contemplated measure will tend most to the interest of the north, but shall we not all enjoy in common the benefits of an enriched public treasury? It is to be hoped, that similar plans of improvement will be suggested, in which the south will call for, and receive the cheerful co-operation of the north.

Where the prosperity and solid glory of our state are at stake, we feel confident, that every man will act, not as an inhabitant of this or that district, but as a Jerseyman. Most assuredly it is not reserved for the honourable and most respectable body which we now address, to pass a censure so severe, to utter a calumny so gross, to proclaim a satire so bitter upon



their constituents, as by their votes to declare that the people of this state are incapable of acting upon enlarged and general principles, that they have neither magnanimity nor patriotism to adopt, nor energy to execute any plan worthy of an enlightened commonwealth.

The subject presents itself in another light, which we shall venture to exhibit.

From whence arises that sympathy of feeling, that community of sentiment which is the soul of nations, a soul, without which, the body must soon dissolve? Its source is not in geographical vicinity, for though divided by a distance of 500 miles, the frenchman at Bayonne claims kindred with the frenchman at Dunkirk; while he regards as an alien, the Spaniard from whom he is merely separated by a narrow stream. This fraternity arises from public institutions which pervade the whole territory, unite citizens by a bond of common interest, and teach them to regard the welfare of their country in general, rather than the petty profit of each separate canton. And where are we to look in New-Jersey for the links of this golden chain which binds a community. Our state is enclosed by two of the finest rivers and has in its immediate vicinity, the two largest cities of the union, a commanding position which, by a total negligence of national interests, has become rather our bane than our benefit. Our business, our habits, our modes of thinking, make us New-Yorkers or Pennsylvanians, and unless institutions of a national character, and of a diffusive influence be formed, the name of New-Jersey may remain, but its distinct individuality will be merged in the well earned pre-eminence of the neighboring states. Without public works and pervading interests, we can never become a compact,

well cemented and permanent republic, but may vegetate for a time, as a disjointed assemblage of industrious farmers, until some political explosion shatter us into fragments, destined hereafter to revolve as satellites round some planet of superior attraction. Such is the humiliating fate which awaits New-Jersey, if she remain in apathy, the passive spectator of the surrounding energy and enterprize. But let this canal be made, we at once create a subject of common feeling, interest and solicitude, we hold the passage by which important districts of New-York and Pennsylvania communicate with the sea coast; the commercial metropolis of America will depend upon us for one of the prime necessaries of life, the payment for which, will pass through our hands; we shall found a system of finance and internal improvement; but above all, we shall then begin to feel as a people dependant on itself alone for prosperity and power. We might argue on a yet broader scale.—Pursuing her own interests, New-Jersey will contribute essentially to the perpetuity of the institutions of the great American family. Her central position renders her the connecting link of Pennsylvania on the south with New-York, and New-England on the north. The advantages of this geographical situation may be rendered not only a source of prosperity to herself, but in realizing them, our state will fulfil an obligation imperative upon each of the commonwealths of our continent; she will promote the social connection between the members of our Confederation. Commercial intercourse is the most solid basis of political harmony.

With full confidence that every man will concur in the utility of the measure, only two points have appeared open for discussion.



First, who is to undertake it, the state or a chartered company?

Secondly, might it not be advantageously delayed until the increasing population and resources of the country render the task less arduous at some future period?

The former of these points has been already disposed of; upon the latter we offer the following reflections.

It may appear desirable to some that New-Jersey, before she enters upon this undertaking, should wait to see the result of the effort now making by New-York. We are no friends to new experiments, and would fully coincide with this wish, if any useful knowledge could possibly be acquired: But it is impossible to derive from thence that kind of experience and knowledge which is demanded. The New-York canals were made on the same principle on which probably 200 others have been constructed. They have added nothing to the theory of inland navigation; and all the benefit they can hold out to us lays in the great experience of their executive officers and workmen, who have acquired the art of realizing, at the least possible expense, plans familiar to every Engineer. Were we to delay our operation till the result of the New-York canal be ascertained, the vast advantage of their aid would be lost. If we wait a single year, the whole system of New-York will be dissolved and scattered over various parts of the union, before we can possibly be prepared to engage either engineers, contractors, or workmen.

If carrying our caution still further, we put patience to the stretch, and wait to see whether the revenues of the New-York canals fulfil the hopes of the projectors, we shall even then be nothing wiser as

respects our own. The nature of the trade on each is essentially different. The one is based upon Agriculture, the other upon Manufactures; the one might be a total failure, while the other might be attended with the mos tbrilliant success. No analogy exists between them; we cannot argue from the one to the other; as well might a blacksmith predicate the calculations of his shop, upon the profits made last year by a farmer, on a field of corn. To wait is therefore only to waste time and throw away opportunity.

The English Grand Junction canal, executed by the most experienced Engineers, Overseers and Labourers, cost about $40,000 per mile, while the New-York Western canal, with equal dimensions, and overcoming incomparably greater difficulties, will cost only from 17 to 18,000 dollars per mile. The American enterprize was conducted by men of truly eminent talent, but who were at first novices in their profession, and who at this moment could perform the same service at 15 to 20 per cent cheaper. In addition to the inexpertness of Engineers, costly experiments were made, as to the best method of working, by machinery or hand labor, by the day or by the job, while the ignorance and timidity of the contractors presented another formidable obstacle, for on some articles they insisted on 50 per cent more than they are now eager to obtain. Were the Western canal to begin again, it would not cost above $14,000 per mile with its marble locks, its architectural aqueducts, and its stupendous embankments.

Whence comes it that the country where labor is dearest, should perform its public works 60 per cent cheaper than its rival; that America should surpass England in that very species of construction, on which she asserts a pre-eminence? it is because America is a young country, where land is either given as a donation, or purchased at a trifling expense; where buildings are seldom disturbed, or are not costly when their destruction is unavoidable; where water can be had without buying up Mill privileges, or erecting steam-engines to pump it from a lower to a higher level. In England every inch of ground must be acquired at an enormous expense; villages must be penetrated; parks traversed, steam engines erected; and circuitous routes adopted. Every rod of land produces a dispute; every mile a law suit; individual interests interfere; the bad passions are roused; and a canal, such as the Erie, would be an impossibility to the English Government, with all its riches and power.



We are now placed at that precise point of our national existence, when population and resources are equal to the effort, and yet, when improvement and wealth have not yet erected their barriers against it. If this favorable conjuncture be suffered to escape, we shall bequeath to posterity an accumulation of obstacles in the execution of plans on which the future prosperity of New-Jersey must always rest.

But it is not in this view alone, that delay, the invariable expedient of a weak policy, and the infallible symptom of a feeble administration, will be pernicious. New-York is terminating her canal. A corps of the most practised engineers in the world, their contractors and laborers, the whole mental and bodily strength of these great works, are as yet unscattered, and may at once be transfused into our operations.

The procrastination of a single year, will disperse them, and compel us to purchase an experience,

which is worth 15 or 20 per cent. upon the whole capital required.

The words "Now or Never" may be emphatically applied to our system of internal improvement.

We have thus executed to the best of our ability, the important task confided to us; if any deficiency or error be perceptible, we humbly trust it will be attributed to causes other than want of industry or zeal. Perhaps we have transcended the limit prescribed to the enquiry. It is that, in common with our fellow citizens, we feel warm on a subject involving the deepest interests of the State, and because we conceive ourselves bound to present at your bar the collective opinion of an important district of New-Jersey, which we have enjoyed peculiar opportunities of ascertaining.

The minds of men seem universally opened to this truth, that internal improvement is the soundest policy of the State, and the most legitimate object towards which her resources can be directed. At the head of this system stands the inland navigation now to be discussed by your honorable body. As the leading measure of a plan for ameliorating our agriculture, manufactures and general industry, the universal sentiment is that it may be postponed, but never can be abandoned.

The tide of public opinion which has set in motion the exertions of all the surrounding States, begins evidently to be felt among ourselves, and will collect strength, until it carry us into the same channel which our neighbors have successfully explored.—Ten years must consummate this revolution, and it remains for the present Legislature either to render itself illustrious by leading the way, or to yield the



palm of wisdom and courage to its successors, to earn by one bold measure, the gratitude of its country, or to abandon that noble reward to some future assembly of more energetic statesmen.

GEORGE P. M'CULLOCH,
CHARLES KINSEY,
THOMAS CAPNER.

Morris Town, Nov. 1, 1823.

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The beneficial effects which this canal will produce upon the interests of the whole union, have attracted the attention of the Legislature of the state of New-York and of the General Government itself. The former has sent its chief Engineer, Mr. Wright, to inspect our labors, and Governor Clinton, ever the first in exploring sources of national greatness, has also visited the whole line and examined the subject to its very foundation. Mr. Calhoun, the patron of internal improvement, with a promptitude which enhances the favor, dispatched General Bernard and Colonel Totten to the spot, and these gentlemen have instituted a very laborious and patient investigation.

To General Swift, whose patriotic assistance was so important in the earliest stage of the enterprize, we are again indebted, for a continuance of his zealous and effective co-operation.

The result of these various enquiries are submitted in the following most valuable documents, which were received at a period too late to be annexed in the body of the preceding paper. Let them speak for themselves, for it would be presumption in us, either to enlarge upon the merits of these reports, or of the high authorities from which they emanate.

We congratulate our fellow citizens of New-Jersey, that this first plan for the encouragement of their depressed agriculture and manufactures, appears under the sanction and auspices of the most profound political wisdom and scientific experience of America. Nor shall we, perhaps be blamed for expressing an honest pride at receiving this powerful corroboration of views, plans and calculations, which we were the first to project, and to recommend to public attention.

# DOCUMENTS

APPERTAINING TO THE

## COMMISSIONERS' REPORT,

RELATIVE TO THE

# Morris Canal.

## A

*To George P. M'Culloch, Charles Kinsey and Thomas Capner, Esquires, Canal Commissioners of the state of New-Jersey.*

GENTLEMEN,

In conformity with your instructions, and in obedience to the act of the Legislature, I have explored one practicable route for a Canal, from the Delaware river at Easton to the tide waters of the Passaic.

This route I have carefully levelled, and made all the preliminary investigations necessary for making a close estimate of the cost of the undertaking, so that nothing remains, should it be authorized, except the actual special location of the canal and its several works.

In exploring this route, the principle of inclined planes has been adopted as the basis of the survey, the fall has in consequence been accumulated into as large descents as possible; still, however, it has not been in my power to dispense with locks entirely; the scheme will therefore present a mixture of the two methods.

Its principal features, its direction, and the position of the several descents may be more fully understood by the inspection of the map drawn by James Ren-

wick, Esq. of Columbia College, which accompanies the several reports, and to which you are respectfully referred.

In addition to the above route, I have examined several lateral passes in the eastern section in different directions, which I have found to be practicable, and probably at as low an expence as the surveyed route.

On the western section, a partial survey of a route has been made, from Stanhope, on the eastern side of the Musconetcong to the mouth of that river; this route is marked upon the map as far as Saxton's falls, from thence it pursues the course of the river so nearly, that any other delineation is thought unnecessary; therefore, the course of the river may be taken for the line of the canal, should that route be adopted.

Various other routes present themselves, that have not been fully examined, but which, from the most authentic sources, may be considered as feasible, some of which are also marked out.

Between these several courses, I cannot at the present juncture pretend to discriminate, the comparative expense can only be determined by a survey of the other routes, of equal minuteness with that made of the principal one, and it may so happen that when this is ascertained, the least costly may not be that which will prove of most benefit to the state.

In making the estimate, I have been principally confined to the route which has been most minutely examined, and have endeavored to annex such prices to the several items of the contemplated operations, as I trust will not be found underrated when the work shall actually be performed.

The canal being calculated for boats of 60 feet in length, 8 feet in breadth, and 3 feet draught of water, I would propose the following dimensions, viz: Through a country where the soil is composed of loose materials, easily susceptible of washing or sliding, the canal should be 32 feet wide at the surface of the water, 16 feet wide at the bottom, and 4 feet depth of water, giving a slope to the banks of two horizontal to one perpendicular foot: but, where the soil is hard and adhesive, it would be more economical to make it 30 feet wide at the top and 18 feet at the bottom, giving a slope to the banks of 1 1-2 horizontal to 1 perperpendicular foot; thus, (allowing the top banks to be 6 feet above the bottom) making a saving of land occupied by the canal, of 4 feet in breadth; or in other words, the canal would be four feet narrower than upon the former plan.



The locks are calculated to form lifts of 10 feet each, 70 feet between the gates, and 8 1-2 feet wide, constructed of solid masonry of hammered stone.

The expense of inclined planes is based upon the calculations of their projector, Professor Renwick, which I have carefully examined, and believe the estimate to be liberal. I have also, (in conjunction with others) examined the principle upon which they are projected, and do not hesitate to express the utmost confidence in their utility and practicability.

For acqueducts, culverts, &c. I have had reference to the expense of works of similar construction on the New-York canals.

For a canal of the above description, in order to obtain a sufficient quantity of earth to form the necessary banks, about 16,000 cubic yards of excavation per mile, will be required. That there is a sufficient supply of water to meet all exigencies that can be anticipated for the contemplated work, a single view of the resources is sufficient to place the

question beyond a doubt; for further elucidation see Mr. Renwick's report on that subject.

The foregoing observations form the principal data upon which are based the following calculations.

Beginning at the river Delaware, at Philipsburgh, (opposite Easton.)

| | M. | Ch. | Cubic yd's. | Cts | |
|---|---|---|---|---|---|
| From thence to Hacketts Town, | 25 | 77 | 415,400 Exe'n | at 10 | $41,540 |
| Extra deep cuts on the above line, | | | 43,144 | at 12½ | 5,393 |
| From Hackettstown to Brookland, | 11 | 53 | 186,600 | at 12½ | 23,325 |
| Deep cut on summit at Brookland, | | 40 | 168,960 | at 25 | 42,240 |
| From thence to Drakesville, | 1 | 60 | 28,000 | at 12½ | 3,500 |
| Thence to mouth of Steven Brook | 3 | 30 | 54,000 | at 10 | 5,400 |
| Thence to point of Pine Hill, | 4 | 1 | 64,200 | at 12½ | 8,025 |
| Thence to foot of Tomkin's Hill, | 1 | 43 | 25,800 | at 10 | 2,580 |
| Deep cut through Tomkin's Hill, | | 27 | 104,740 | at 25 | 26,185 |
| Thence to Little Falls of Passaic, | 16 | 46 | 265,200 | at 10 | 26,520 |
| Rock at Little Falls, | | 24 | 5,640 | at $1 | 5,640 |
| Thence to head of falls at Paterson | 4 | 10 | 66,000 | at 10 | 6,600 |
| Rock at Paterson Falls, | | | 5,000 | at $1 | 5,000 |
| Embankment at Paterson, | | 18 | 25,344 | at 25 | 6,336 |
| Thence to tide at Aquacknack, | 5 | 20 | 84,000 | at 10 | 8,400 |
| Excavation of feeder, and erection of dams at Brookland, | | | | | 3,500 |
| Embankment between Easton and Paterson, at different places, and not included above, | | | 120,000 at 12 1-2 cts. | | 15,000 |
| Acqueducts and Culverts, | | | | | 42,287 |
| Locks to overcome 244 feet elevation, at $400 per foot, | | | | | 97,600 |
| Inclined Planes to overcome 1400 feet elevation, at $180 | | | | | 252,000 |
| Dams, waste weirs, &c. | | | | | 10,000 |
| Bridges for roads and farms, say 150, at $100, | | | | | 15,000 |
| Grubbing, | | | | | 15,200 |
| Fencing Canal, including each side, 152 miles, at 75 cents per rod, | | | | | 36,480 |
| | | | | | $703,751 |
| Add for contingences and unforseen expences, 10 per cent, | | | | | 70,375 |
| For Engineering superintendence, and expences connected therewith, 5 per cent, | | | | | 35,187 |
| | | | | | $809,313 |



In thus laying before you, gentlemen, in a consise, and I trust comprehensive manner, the results of my observations and surveys, and statements of my estimates and calculations, I have endeavored to bring this important subject home to the plainest understanding, with a view that the whole community may judge of the expediency of a measure in which all are deeply interested; but as the subject is to be examined by gentlemen, in whom are combined science, talent, experience and integrity, and from whom an able and candid developement of its merits may be expected, I forbear to enlarge, and have now only to acknowledge the high sense of the able support and enlightened aid which I have received from a free communication with you, and to express my full conviction that this Canal will be found feasible in itself, cheap in its accomplishment, and auspicious in its consequences to the best interests of New-Jersey, whose prosperity, as the place of my nativity, and as an important member of the Union, will always be cherished by me with fervent and affectionate regard.

EPHRAIM BEACH.

Morris-Town, Oct. 4, 1823.

*To George P. M'Culloch, Charles Kinsey of Essex, and Thomas Capner, Esq'rs. Commissioners appointed by the Legislature of the state of New-Jersey, to explore the route of a Canal between the waters of the Delaware and Passaic.*

GENTLEMEN,

Having completed the examination of the several subjects in relation to the contemplated canal to form a navigation between the waters of the Delaware and Passaic, that you have done me the honor of submitting to me, I beg leave respectfully to report:

1st. There exists in the vicinity of the ground chosen for the summit level, and at a position whence it may be readily drawn by a short feeder, a supply of water far more than adequate to the exigencies of the canal, even in the driest seasons. Should the lower level, indicated by Captain Beach's survey, and for which the estimates are calculated, be chosen, this water may be drawn from beneath the tail race of the Brookland works. These consist of a forge with four fires and two hammers, a grist and saw mill. They are situated on the Muskonnetcong river, about a mile below its rise in Lake Hopatkung. To ascertain the quantity of water that passes at this point, the whole of which might if needed, be made disposable, the several gates of the works were measured, with the head of water pressing upon each of them, and the number of hours per day, and days per year for which they are opened, ascertained from the best authority. It was found that in addition to the water actually employed in the works, or discharged by the waste gates, there was a considerable leakage constantly going on through the dam; it was also represented to me that for six weeks in the spring, at the time of the melting of the snows, the waste was much greater than indicated in the calculation. Had



there existed any question of the sufficiency of the supply, it would have been essential that these discharges should have been accurately guaged. but the simple quantity furnished by the daily routine of the works, being far more than sufficient, it was not conceived necessary to carry the investigation farther. The following is the result of the measurement on the above mentioned principles.

| *Gates.* | *Breadth.* | *Height.* | *Head.* | *open per day.* | *d's per year.* | *cubic yd's* |
|---|---|---|---|---|---|---|
| No. 1 | 4 ft. 8 in. | 0 ft. 5 in. | 9 ft. 7 in. | 4 hours | 313 | 10,143,904 |
| 2 | 4 3 | 0 6 | 9 9 | 4 | 313 | |
| 3 | 3 7 | 2 10 | 10 0 | 24 | 42 | 19,384,242 |
| 4 | 6 6 | 0 3 | 10 0 | 6 1-2 | 313 | 6,050,603 |
| 5 | 2 9 | 0 4 1-2 | 8 9 | 16 | 313 | 18,443,242 |
| 6 | 1 3 | 0 4 | 9 9 | 16 | 313 | |
| 7 | 1 3 | 0 4 | 9 9 | 16 | 313 | |
| | | | | | | 54,021,991 |

That this supply will far exceed any demand that the Canal can ever have upon it, will be evident from the following considerations:

The capacity of a lock suited to the vessels for which the canal is designed, will be 200 cubic yards. The estimated trade of the canal is about 360,000 tons per annum, passing from the west towards the east, and this is about as much as the proposed system of inclined planes will permit to pass 360,000 tons may be transported in 14,500 boats of 25 tons each; and each boat will require a lock of water on each side of the summit level, say 29,000 locks of 200 cubic yards each,

| | *Cubic Yards.* |
|---|---|
| | 5,800,000 |

It is usual in the navigation of canals to make the return boats wait until it is necessary to use the locks for the passage in the opposite direction, of those which

*Amount carried forward to page* 9, 5,800,000

are loaded; in this way the same water may be employed for the passage of both the ascending and descending trade.—That no delay may take place, we shall allow for each returning boat the same expenditure on each side of the summit level, or 5,800,000

Should the whole supply of water be drawn from the reservoir at the summit level, the several items of evaporation from the surface of the canal, leakage through its gates, and through the sides and bottom, are also to be provided for. The canal is intended to be 16 feet wide at bottom, 32 at top, and 4 feet in depth; its length, being with the feeder, 76 miles, it will present to the air a surface of 1,426,480 square yards. A series of observations made at Salem, in Mass. makes the annual evaporation amount to 56 inches; from this is to be deducted the rain that falls, which at Cambridge, within a few miles, was found to be 35 inches. The difference being 21 inches, it will be perfectly safe to estimate the evaporation, over and above the rain, at 3 feet per annum on the above surface, or 1,426,486

To this is to be added the evaporation from basins, &c. which, supposing them to be one sixth part of the surface of the canal, may be taken at 237,747

The leakage through the sides and bottom of the canal will depend much on the nature of the ground, and upon the

*Amount carried forward to page* 9, 7,464,227



care with which the banks are constructed. The ground is naturally of good quality throughout the whole line of the canal, but allowing for the extreme case that it shall expend in this way twice as much as is wasted by evaporation we shall have 3,300,000

The leakage past the two gates that close the extremities of the summit level of a canal, is estimated by Gauthey, at 50 inches of water. This will suffice for the supply of the corresponding waste at the gates closing the lower levels, and amounts, when reduced, to 470,000

3,770,000

*Amount brought from page* 7, 5,800,000

*Amount brought from page* 8, 7,464,227

17,034,227

As this does not amount to one third of the waters furnished by the outlet of Lake Hopatkung, and is less even than what actually runs to waste through the gate No. 3, it is almost needless to state that the certainty of a constant supply of water is attainable beyond the possibility of a doubt. In addition it is to be remarked, that three constant streams of considerable magnitude, may be conducted into the canal, on the eastern side of the summit level, without interfering with any mill privileges, and that no less than nine spring brooks are met with under similar circumstances, on the western section.

2nd. It will be evident from the above detail, that reservoirs would be unnecessary, were the canal alone in question. It may however be proper to make such dispositions as will prevent the proprietors of water privileges upon the Musconnetcong,

from having the slightest shadow of complaint. For this purpose it would be well in the first instance to tighten the dam at Brookland, and introduce a greater economy of water into the expenditures of that forge. It is also practicable to raise the level of the Lake.— The dam at Brookland, at present raises the waters of the lake about 5 feet; in September, 1822, after a season of unprecedented drought, it had fallen within a few inches of its pristine level, but a stream was still discharged adequate to all the purposes of the forge and grist-mill. On the 12th September, 1823, it had fallen 3 feet, leaving a depth of 2 feet over and above the expenditure, for from the setting in of the fall rains, the surface begins again to rise. It is practicable, at a very small expense, to raise the waters of the lake at least four feet more; this may be done by increasing the height of the Brookland dam, and forming an embankment across the cedar swamp, of not more than two feet in height and 100 yards in length. By this increase of the depth of the Lake, no land of value will be flooded. I should therefore recommend that this object be kept in view, if not as a part of the original outline of the canal, yet as essential, when the trade shall approach its maximum limit. The quantity of water that may be thus retained against the season of drought, may be estimated from the magnitude of the surface of the Lake. A rapid survey of it was made, by measuring a base on the neck near the Indian wharf, and laying down a series of triangles with a pocket sextant, from which its surface is inferred to be about 1500 acres.

3d. The party under the direction of Captain Beach, was visited several times during the period he was engaged in levelling the route, and I am in



consequence enabled to bear testimony to the skill, fidelity and accuracy with which that part of the duty has been performed. He will himself report the results of the survey, and the estimates he has based upon it. The whole line has since been examined by me, and I have to express my opinion that the canal may be executed within the limits, particularly as several points present themselves where the actual location may be advantageously diverted from the surveyed line.

4th. The map which is herewith presented, is based upon the canal survey, as plotted from the field books, by Mr. Freeman; the contiguous country is filled in, on the eastern side, by an enlargement of the circular map of Eddy, in the middle, from surveys furnished by Lemuel Cobb, Esq while the courses of the Museonnetcong and the neighboring streams, are copied from manuscript materials furnished by Judge Gordon. The shape of the ground is the result of my own observations, except a small part to the north of the Rockaway; for information in relation to which, I am indebted to Major Kinney and Mr. Freeman. For the forges and furnaces I have consulted a manuscript map furnished by Mr. Losey, of Dover. I have however to present this map as a mere sketch, and as by no means aspiring to the rank of a minute and accurate survey; the time during which I have been acquainted with the country, and the laborious duties in which I have been engaged, have not permitted me to acquire the minute topographical knowledge, that is essential to the successful performance of such a task.

All which is respectfully submitted,

JAMES RENWICK.

Columbia College, New-York, 5th Oct. 1823.

*To George P. M'Culloch, Charles Kinsey, of Essex, and Thomas Capner, Esq'rs. Commissioners appointed by the Legislature of the state of Jersey, to explore the route of a Canal between the waters of the Delaware and Passaic.*

GENTLEMEN,

I beg leave to lay before you some remarks upon the subject of the methods that may be employed to overcome the altitude of the summit level of the projected Morris Canal, on terms cheaper than it can be effected by the use of stone locks. Having been long under the impression that expedients of this kind would be found necessary, to bring the cost of the Canal within feasible limits, I have devoted a portion of my time to this object. This impression having been fully confirmed by the result of the levels, I conceive it my duty to lay before you a report in relation to substitutes for lockage, in order that you may be enabled to make up a definitive opinion thereon, before it becomes necessary to go into the estimates of the cost of constructing the Canal.

There can be no question but that, in countries where the necessary changes of level in a canal are few and of small amount, where water is to be procured in abundance, and where the adjacent navigable waters require the use of large vessels, locks are to be preferred to all other methods. But the change of level that can be effected by a lock, is necessarily small, being limited by the increase that additional altitude makes, in the difficulty and expense of construction, and in the expenditure of water. Locks being considered the only legitimate means of passing from one level to another, it has hence happened, that schemes of canals have been rarely formed in countries of rapid elevation, even when the ground was in other respect favorable, and the supply of water abundant. It has however luckily happened, that

a few men of great genius have overleaped these narrow bounds, and proposed plans by which every change of altitude, however great, may be easily effected; it is no less fortunate for us that some of these schemes have been put into happy and successful operation in Europe, and that in adopting them, or others similar in principle, we shall be compelled to venture upon no untried ground.

Locks are by no means the most obvious method of passing from one level of a canal to another. In the earlier history of canal navigation we find single gates or sluices used, when the difference of level was small, and the inclined plane when it was of a greater amount. The accidental juxta-position of two sluices appears to have led to the invention of the lock, and this being sufficient for the purposes of the internal navigations of Holland and Italy, in which countries most of the structures in use at present on canals were brought to the state of improvement at which they now stand, no other method was deemed necessary. Had it happened however that the fortuitous, but simple and beautiful discovery of the lock had been delayed, there can be little doubt that other expedients, arising from improvements of the inclined plane, and adapted to the unceasing demands of commerce, would have been investigated. When canals were first introduced into hilly countries, the prejudice in favor of navigating them by large vessels was at such a height as to preclude even the mention of any other expedient than the lock. Upon the principle then of locks, the canals of Briare and Languedoc were constructed, and their plan has been servilely copied in most of the other canals of Europe. Advanced experience has gradually led to a reduction in the size of canals, and of the vessels



that navigate them—they are therefore gradually becoming better fitted for the introduction of substitutes for the lock; and the size I had the honor to propose, in my communication to Mr. M'Culloch of the last season, for the canal we have at present under consideration, is probably within the limit that will permit of their use. It would be unreasonable to suppose, that when no physical obstacle exists, when water is found in abundance to be employed as a moving power, when the wants of the country call for navigable communications, and when the prospects of a lucrative traffic holds out the most ample encouragement for the investment of capital, the science of Hydrodynamics does not possess resources fully adequate to the removal of every obstacle. Should therefore the altitude of the summit level of the proposed canal amount, as it probably will, to 900 feet, I should say that, in a country of the nature through which it is to pass, the difficulty is not insuperable, theoretically speaking; but as I should be loath, even in the absence of all experience, to propose any untried scheme, however feasible in appearance, I shall first state what has been actually done in Europe in relation to this subject, and with what success.

The methods which have been successfully applied in that quarter of the world may be limited to two distinct classes; the Perpendicular Lift, and the Inclined Plane. The Inclined Plane is, as has already been stated, among the earliest structures made use of upon canals; in its original state, the vessel was raised, or its too rapid descent impeded, by the direct application of human power, and in this rude manner it is still employed in Holland and in China. At an early period in the history of the canal navigation of

Great Britain, Duhart, a Sardinian by birth, proposed to make use of the inclined plane, with improvements of his own, upon a canal in Ireland. His project received the approbation of the celebrated Smeaton, but was not carried into effect at the time of his death, when the works were suspended, for want of an engineer of sufficient intelligence to comprehend and execute his views. The approbation of Smeaton, however, who united the two requisites of profound science and great practical skill in a higher degree than any engineer that ever lived, is no small testimony in favor of the correctness of the principle; its success in practice would have depended, of course, in a certain degree on the abilities of the engineer by whom its execution was, for the first time, superintended.

The first successful execution of an inclined plane upon proper principles, was effected by Reynolds, upon the Ketley Canal. He may fairly assume the credit of having shewn how the difficulties existing in mountainous countries are to be surmounted by a canal. His first inclined plane had but 73 feet rise, but when employed as engineer on the Shropshire canal, he projected and executed three others, one of which has a fall of 207 feet.

Much about this time our countryman, Mr. Fulton, undertook the investigation of the subject of canals fitted for mountainous countries; his views are novel and ingenious, but in attempting to subvert the existing system of canals he appears to have aimed at too much. England was already traversed by numerous and successful canals; his project of the introduction of four ton boats into the navigation of his lateral canals was too great an innovation, and inconsistent with the interest of the proprietors of the



routes already formed. For this reason it seems that no experiment was made in England to test the accuracy of his principles. This indeed is little to be wondered at, for in the district to which the attention of the public was drawn as suited for canals, the elevations were rarely of any great height. No English canal has a summit level of more than 500 feet above the level of the sea, while in France, the summit of the *Canal du Centre* is elevated 1000 feet. In England, therefore, the advantage to be derived from the successful application of Fulton's views was not of any vital importance. It may however be stated that while the general principles laid down by Fulton are entitled to the most implicit credit, his application of them to practice does not appear to be happy, and it is probable that had he obtained the opportunity he so much desired, of actually carrying his plans into execution, they would have derived their success, not from his primitive idea, but from his invention, fertile in overcoming difficulties, and from those resources of mind to which the world owes the introduction of the Steam Boat into full and happy operation. But when we cite Fulton as an authority for principles, we cite a name second to none in the annals of applied science; and his prediction that hereafter the system of locks will be considered as the infancy of canal navigation, appears to be now more probable than that by which he anticipated the success of steam as the propelling power of ships fitted to navigate the ocean did, even at the time of his death.

Besides the Ketley and Shropshire canals, there are two others in England. viz: the Shrewsbury and Monmouthshire, in which inclined planes constitute the basis of the plan. They are all in successful op-

eration, but their navigation is limited to boats of 8 tons burthen.

But by much the most important work of the kind that has been executed in that country, is the inclined plane constructed by the Duke of Bridgewater, and forming a part of the subterraneous navigation of his mines at Worsley. As the Duke may be considered the highest authority when inland navigation is concerned, and as he long and strenuously opposed the system of inclined planes, the description of that which he himself afterwards executed and found to be practically beneficial, will probably have more weight than any argument drawn from mere theory.

Between the two levels of his subterranean canal is interposed a mass of soft sandstone, the strata of which have a natural inclination of 1 foot in 4; this circumstance has been turned to a good purpose, the rail ways of the inclined plane being placed upon this natural slope. The rail ways are 453 feet in length, and the locks at their upper extremity 54 feet; about 282 feet of the upper portion of the inclined plane has a double rail way, in order to permit the cars on which the boats are mounted to pass each other; at the lower end, the two rail ways unite for the remaining distance of 171 feet. The whole breadth of the double rail way is 19 feet, of the single, 9 1-2. The rail ways are formed in the usual manner, of cast iron, and are fastened to sleepers of wood firmly inserted into the rock. At the top of the inclined plane is a double lock, the basins of which admit loaded boats from the upper level, and empty boats from the lower, alternately. The drum on which the cables that suspend the boats are wound, is 5 feet in diameter, the cables are of 7 inches in circumference, and are salved with a cord of about an inch. The



drum is set in motion by a large wheel with 372 teeth arranged on its circumference in segments of cast iron, and this is driven by a pinion of 11 levers; two men, exerting their strength upon winches connected with the axle of this pinion, are capable of setting the whole apparatus in motion, or of stopping it at will. The cars that receive the boats from the locks, in order to deliver them into the lower level, and vice versa, are 30 feet in length; their whole load weighs 21 tons, and they are supported upon four wheels. In consequence of the success with which the operation of this inclined plane was attended, the Duke of Bridgewater received their annual gold medal from the British Society of Arts.

The inclined plane has also been successfully applied in France upon one of the branches of the *Canal du Centre.*

From all these experiments it may be concluded, that it is not presuming too much to say that inclined planes have, after full and severe trials, been found sufficient, and may be depended upon as means for passing from one level of a canal to another. In order that they shall exhibit the full extent of their utility, it is proper that the fall should be great; an elevation of less than 30 and 40 feet may probably be overcome at less expense by other methods.

When descents of more than 30 or 40 feet are not to be procured, or when the canal can be readily conducted to the verge of a vertical descent, the perpendicular lift may be advantageously employed.—The original idea of this contrivance appears to be due to Dr. Anderson; he proposed to suspend two vessels, or moveable locks, containing water and closed at each end by gates, from the opposite sides of a wall; these vessels being of size sufficient to re-

ceive the boats navigating the canal, were, when full of water, exactly in equilibrio; one of them being in contact with the upper, the other with the lower level of the canal, the gates closing these levels and those at the nearest end of the moveable locks being opened, the communication would be established and the boats from each level might be admitted. In performing this, the equilibrium previously existing would not be disturbed; if now the gates were closed, and an opening made in the lower lock, a part of the water would run out, the lock in contact with the upper level would preponderate, descend and raise the other to the height whence itself fell. The only practical difficulties attending this invention appear to be, the finding of a scite where the expense of excavation and of erecting a breast wall will not counterbalance its other advantages, and the mode of making the moveable locks apply themselves so closely to the two levels as to prevent the escape of the water. The first of these depends upon the nature of the ground, the second has been fully removed by Forry, a French engineer, whose lift shall be presently mentioned.

No lift appears as yet to have been constructed upon the original plan of Dr. Anderson, although in simplicity and saving of cost, it appears to have the advantage over those that have been actually executed with success. There is upon a canal in England, in the neighborhood of the city of Gloucester, several lifts at this moment in successful operation.— They consist of a moveable basin with gates, suspended between pillars of wood, by means of counterpoising weights of iron. The apparatus is set in motion by manual labor, exerted through the intervention of wheels, pinions, and screws. These lifts



having been contrived merely for the purpose of saving water, have not been executed under favorable circumstances; their expense in breast walls, in excavation, but still more in about 100 tons of cast iron counterpoise weights has been great, and they are merely to be adduced as an instance of the practicability of the principle, but not as worthy of imitation in their detail. For the information in relation to them I am indebted to my friend Mr. Carson, of the West Point Foundery, who is in possession of accurate draughts of their several parts, made by himself upon the spot. They are the invention of Bramah, so well known as the discoverer of the hydrostatic press.— A contrivance of the same sort has been put into successful practice upon a branch of the *Canal du Centre.* The engineer under whose direction it was constructed was the celebrated Gauthey; after receiving certain improvements in relation to the waste of water, from Forey, it was found in falls of from 25 to 40 feet, to possess properties superior to those of the inclined plane. Navier, in consequence, the editor of the papers of Gauthey, states that it is no longer to be doubted that there is a cheap, permanent, and easy method of overcoming differences of level of from 25 to 40 feet, upon small canals.

Upon a fair view then of what has been actually performed by means of inclined planes and lifts, I should not hesitate to recommend them as certain and practicable means of bringing the contemplated canal within reach of the funds that may be readily procured for its execution. Indeed were the state, or individual capitalists ready to embark a capital sufficient to execute the whole with locks of the ordinary construction, I am inclined to think that from other considerations the inclined plane would be

thought of the greatest practical value. In the first place, there would be a great saving of the time of passage; upon the Duke of Bridgewater's canal, the inclined plane is passed by two boats, the one ascending and the other descending, in the space of 16 minutes; the same time would be necessary for passing two locks of ten feet fall each, and the descent of an equal height by that method would occupy 1 hour and 20 minutes. In the second place, but little water is expended in the use of these expedients, so that the water required for lockage in those parts of the canal where it is indispensable, may be passed down through the intervention of the mills already seated on the streams, or used in other points for the advantage of the proprietors of the canal.

It now merely remains for me to state the manner in which these principles, considered as established, may be applied to the case of the canal under consideration. And first, in relation to the inclined plane. The trade upon the western side of the summit level will be most probably an ascending trade, for coal must be the great staple; on the other hand, boats loaded with raw materials for manufacturers, must rise on the eastern side at least as far as Paterson. It would not therefore be compatible with our views to imitate too closely the plans of the Ketley and Bridgewater canals, where the loaded boats in descending draw up the empty ones on their return.—As it is now well ascertained, that water for every purpose may be had in abundance at the summit level, the suggestion of employing this as a moving power naturally presents itself. The more immediately obvious method of doing this, would be through the intervention of water wheels and mill works, as actually attempted at Hadley, and as proposed by Fulton in his plan of a medium inclined plane. This method would however give rise to a great expenditure of money, and would require much more water when the descent was great than could be provided, for it would far exceed that required for locks of the usual fall. The perpendicular wells proposed by Fulton are not altogether free from the first of these objections, and both methods are defective in simplicity. In the canals of Reynolds and the Duke of Bridgewater, two locks are constructed of masonry at the top of the canal. I should propose to substitute for these, two moveable locks, or vessels of wood mounted upon triangular cheeks, in such a manner as to remain constantly horizontal, and moving on truck wheels upon the iron rail way. If the chains suspending these be so connected that the one shall be drawn up by the descent of the other, the discharge of a small quantity of water from either will set the apparatus in motion.



A basin 50 feet in length, 3 feet in depth, and 9 in width, will contain 45 tons of water, and the basin with its carriage wheels, &c. may probably weigh 15 tons more, in all 60 tons. If the number of truck wheels be eight, and one fourth be suspended by the chains, each will have 5 2-3 tons to support, and the weight will be distributed over 60 feet of the inclined plane. Axles of iron to support this weight need not be of any very great size; it may be inferred, from the experiments of Banks, that a bar of cast iron an inch square, and supported by props distant one foot from each other, will support a strain of a ton weight, and an axle of 3 1-6 inches in diameter 7 1-2 tons. But the strength of good wrought iron is, by the experiments of Muschenbroek, double that of cast iron; axles of wrought iron of the above diameter will therefore be amply sufficient.

In order to support the locks, chain cables which are now manufactured at Dover, may be employed in lieu of those of hemp, which were used by the Duke of Bridgewater. The weight of each basin and its appendages being taken at 60 tons, 45 will be supported by its pressure upon the inclined plane, and 15 will remain to press upon the chains. Chain cables made of inch iron are subjected at Dover to a proof of 18 tons. One of these may therefore be relied upon as a support, but if two be employed, the apparatus may be considered as beyond the reach of accident; for should one of the chains break, the other will support the load during the transit; while the precaution of having the chain cable made in lengths, and spare parts constantly at hand, will restore it at once to its original situation before it can be exposed to any new strain.

As the motion would be accelerated, in some degree by the unwinding of a great length of chain, stoppers similar to those employed with the chain cables, on shipboard, should be provided, and, as by means of them any resistance not capable of breaking the chains may be overcome, the motion may be regulated at will to any degree of velocity. These stoppers will be also of use in another case that will be hereafter mentioned, and will serve to retain the car in close contact with the gates.

Where a cavity of 15 feet in depth can be excavated beneath the level of the bottom of the lower portion of the canal, and the water drained from it either entirely, or in a great degree; the water of the lower level may be shut out by gates, similar to those that terminate the upper extremity of the inclined plane; in this event, the chains may be wound around a single horizontal shaft, those attached to one moveable lock in one direction, and those attached to the other in the opposite; the recoiling of one pair will in that case be accompanied by an equal involution of the other pair. But a position affording this facility will probably but seldom occur, and therefore an expedient of less simplicity, but of equal practicability, must be adopted; each pair of chains must be wound around a separate shaft, and these must be so arranged that they may act upon one another by the intervention of spur-wheels; if one of the shafts have two wheels firmly fastened to it with the number of teeth in a proportion to each other similar to that which exists between the total length of the inclined plane, and that portion of it which is above the surface of the water in the lower reach of the canal; while two similar wheels are moveable by means of a lever upon the axle of the other shaft, in such a way, that either may be connected, at pleasure, with the wheel of a different number of teeth attached to the first shaft; it is obvious that by such means a velocity of motion may be given to the ascending lock that shall draw it through the whole height of the inclined plane, during the time that the descending lock proceeds no lower than to touch the surface of the water, while the excess of water in the descending lock, above the joint weight of a boat and its cargo, will furnish a sufficient moving power, except when the plane is very short; the stoppers that we have already mentioned, being now applied to the chains, the wheels may be thrown out of gear, and then by relaxing the pressure of the stopper on the descending lock, it may be permitted to sink gently into the cavity beneath the bottom of the lower level, into which the inclined plane must be extended so far as to permit the surface of the water in the moveable

lock to become the same with that of the lower reach of the canal.

As the general aspect of the country presents every chance of finding favorable localities, the inclined plane itself, with its rail ways, will be attended with but little difficulty. Supposing the ground to present the usual surface of boulders and gravel, this must first be smoothed to the proper angle, and excavated to a suitable depth to admit the superstructure. Upon the ground thus smoothed and sloped, the foundation may be laid of fragments of stone and gravel to the depth of 18 inches; and it should be exposed for a winter to the effects of frost in order that it may settle. Upon this foundation are to be laid at intervals of 3 feet, from centre to centre, blocks of stone to support the railway; these should be at least 18 inches in thickness, and weigh not less than 2 cwt. each; the plane of their upper surfaces may be brought nearly to the proper slope by wedges of stone, and must then be finished and opened to admit the rails by the chisel. The intervals of the stones are then to be filled up with lesser stones and chips, and the whole smoothed into one regular plane surface; so that the rails may bear uniformly and equally in every part. The rails cast into the usual lengths of 3 feet, are to be fastened to the stones laid and chiselled for the purpose, in the manner of a common railway.

Should however, any doubt arise, although I entertain none, of the sufficiency of this method, which is the usual European mode of laying rail ways; a small additional expense will place the structure beyond the reach of suspicion; let each of the outer rails be laid upon a firm wall of masonry, and a similar but thicker wall laid to support the two inner rails.



The intervening space may be filled with chip stone, or may have a wooden channel laid in to carry water to the lower levels.

In relation to Perpendicular Lifts, I should advise a recurrence to the original outline of Dr. Anderson, adding to it all the improvements that have been applied in practice to lifts with solid counterpoises.—The advantages of his over the others, consist in the greater facility they afford to navigation, passing double the number of vessels in the same time; in greater ease of manœuvre, it being effected by a discharge of a portion of the water contained in the lower moveable lock; and in the reduced expense of counterpoises, they being in this case a vessel of water instead of metallic weights. In constructing a lift of this kind, a suitable position being obtained, and the upper level of the canal conducted to the verge, it must be closed by two gates similar to those at the upper end of a common lock; in the most favorable circumstance of the descent being in perpendicular rock, no support would be required, but in other cases the upper canal with its terminating gates and piers, must be supported by a vertical wall. The pillars to support the moveable locks should be built of solid masonry, in situations where suitable stone is to be procured, in other cases a firm frame of wood will suffice. The water contained in each of the moveable locks will be the same as in the case of the inclined plane, and if each lock weighs 9 tons, the whole weight to be supported will be 108 tons. Twelve chain cables of 1 inch undergo a proof of twice this, or equal to 216 tons; this number may therefore be depended upon as affording an adequate strength to place the apparatus beyond the reach of accident; these may be made to play over 6 drums, supported upon seven stone pillars.

The action of the apparatus may be regulated by centrifugal brakes, by friction applied at will to wheels in connection with the axles of some one of the drums, or as in the draught, by a crank pinion and spur wheel.

In relation to the manner in which any excessive discharge of water may be prevented at the time of vessels passing from the levels into the moveable locks, some difficulty must exist; I do not however propose any plan of my own in that respect, but should advise that a model be obtained, before any exertion is commenced, of that of Forey. We have every evidence of its being effectual. After I had completed my own researches on this subject, a letter addressed to Mr. M'Culloch, by Col. Sullivan was submitted to me; it gives me great pleasure to be thus enabled to quote the authority of an engineer of his reputation in favour of the general principle of Lifts, particularly as his views are directed to a navigation for boats of 60 tons, while I have not ventured to extend mine beyond one for 25 tons. In reducing his plan to this scale, his estimate will be diminished at least one fourth, and I should with pleasure concur in its adoption in suitable positions, if its detail be of equal merit with its general features.—And should even my own original view of a double set of moveable locks prevail, it is not to be doubted that the ingenuity of Mr. Dearborn will furnish many practical expedients, for the use of which, under his patent, an adequate remuneration may be afforded.

Although it will be proper in all practicable cases to substitute either the lift or the inclined plane for locks, yet locks are not to be entirely dispensed with. In the construction of these, I would beg leave to suggest the introduction of cast iron as a permanent and



lasting support for a lining of wood. The objection to locks entirely composed of wood is to be found principally in their liability to decay at the part where they are alternately exposed to the action of air and water. When this affects the plank only, it may be removed and replaced, but when it affects the timber frame there is no remedy. If, however, the foundation of a lock be laid as in the New-York canals, of a solid bed of timber, and if at proper distances upon this, cast iron buttresses be bolted firmly down, and the whole lined with plank; if the plank be double, and the joints caulked and payed with pitch; we shall have a lock, whose essential parts are indestructible, and which is absolutely impervious to water. This lock will be, when compared with a lock of masonry, of great cheapness; and in relation to the durability of cast iron, I have to state two circumstances within my own knowledge. Major Delafield has presented to the Trustees of Columbia College a cannon dug from beneath the beach at Old Point Comfort; from intrinsic evidence it must have lain there near three centuries, and yet the mouldings upon it are as perfect as the day they were cast; the railing around the Bowling Green in the city of New-York is of cast iron, it was put up previous to 1770 and has not even received the usual renewal of paint on its surface, yet it manifests no symptoms of decay. Cast iron has also been successfully used, in the form of locks upon the Rochdale canal in England, and in that of culverts upon the New-York canal. The Rochdale locks differ from that I propose, merely in their lining being of the same material with their buttresses. I have in other respects adopted their form and proportions, merely adding to the number of buttresses in pro-

portion to the difference of resistance to pressure, afforded by wood and iron.

Annexed, I beg leave to present to you,

1. An estimate of the cost of an inclined plane with a descent of 100 feet.
2. An estimate of the cost of a perpendicular lift.
3. An estimate of the cost of a lock of cast iron with plank lining.
4. A draught of an inclined plane.
5. A draught on a larger scale, of a car proper for the inclined plane.
6. A draught of a perpendicular lift on the principle of Dr. Anderson.
7. A draught of a Lock of cast iron and wood.

I have the honor to be, Gentlemen,

With much respect,

Your obedient servant,

JAMES RENWICK.

*Morris-Town, N. J. 30th August*, 1823.



## APPENDIX, No. I.

### *Estimate of the Cost of an Inclined Plane of one hundred feet descent.*

| | | | |
|---|---|---|---|
| Excavation, | 2000 yards, at 12 1-2 cents, | $250 | |
| | 1500 do. at 25 cents | 375 | |
| Stone & gravel, | 1100 do. at 37 1-2 cents, | 412 50 | |
| Stone, | 2200 do. at $1 25, | 2750 | |
| Chiselling and drilling 626 stones, | | 313 | |
| Wall at foot of Plane 800 perch at $1 50, | | 1200 | |
| Walls at head of Plane, 184 perch at $2 50 | | 460 | |
| Timber, 1200 feet, at 6 cents | | 72 | |
| Plank, 2000 feet at 3 cents, | | 60 | |
| Laying foundation, | | 132 | |
| | | | 6024 50 |
| Two gates at head of plane, | | 150 | |
| Two moveable locks (plank, timber and carpenter's work,) | | 600 | |
| | | | 750 |
| | IRON WORK. | | |
| Rail way, 640 yards 1 Cwt. per y'd. 32 tons at $80 | | 2560 | |
| Fitting and laying do. | | 440 | |
| Chain Cables, 4 of 80 fathom each, at 56 lbs per fathom—8 tons, at $200, | | 1600 | |
| Cast Iron Wheels, 16, of 1 cwt. each, at $80 per ton, | | 64 | |
| Wrought Iron Axles, 8, 2000 lbs. at 8 cents, | | 160 | |
| Spur Wheels, 4, 8 cwt. at $6, | | 48 | |
| Gudgeons and Sockets, $50—fitting, $150 | | 200 | |
| | | | 5072 |
| Two Shafts, | | | 50 |
| | | | $11896 50 |

Should the rails be supported on walls of masonry, the estimate will be,

| | | |
|---|---|---|
| 1400 perch of masonry, at $2 50 | 3500 | |
| 1370 cubic yards chip stone, at $1 25, | 1712 50 | |
| | 5212 50 | |
| Instead of 2200 cubic yards at $1 25, | 2750 | |
| Making an addition of | 2462 50 | 2462 50 |
| | | $14359 00 |

Say 150 Dollars per foot of descent.

## APPENDIX, No. II.

*Estimate of the Cost of a Perpendicular Lift of 40 feet, supposed to be erected when the Canal reaches a vertical descent of rock.*

| | | | |
|---|---|---|---|
| Wall at head of Lift 184 perch at $2 50, | $460 | | |
| Timber, | 72 | | |
| Plank, | 60 | | |
| Laying, | 132 | | |
| | | 724 | |
| Same at bottom, | | 724 | |
| | | | $1448 |
| 4 Gates at $75 | | 300 | |
| 2 Moveable Locks, | | 500 | |
| | | | 800 |
| Wall of Masonry, 1100 perch at $2 50 | | | 2750 |
| 6 Drums with Shafts, | | | 300 |
| 8 tons Chain Cable, | | 1600 | |
| Gudgeons and Sockets, | | 150 | |
| Fitting do. | | 200 | |
| Spur wheel and Pinion, | | 96 | |
| Fitting do. and wrought iron crank, &c. | | 50 | |
| | | | 3096 |
| Dressing the face of the rock, | | 500 | |
| Excavation of Earth at bottom. | | 500 | |
| | | | 1000 |
| | | | 9394 |

Say $250 per foot of descent.

As in cases, when a great excavation is to be made in earth, and a wall erected to support the upper level of the canal, the cost would exceed that of stone locks, it has not been considered requisite to give an estimate.



## APPENDIX, No. III.

*Estimate of the Cost of a Canal Lock formed of Wood, supported by Cast Iron Buttresses.*

| | | | |
|---|---|---|---|
| Excavation, $225, | | | $225 |
| 40 Buttresses of Cast Iron, 10 cwt. each, | 20 Tons. | | |
| 8 at 2 cwt. | 00 16 cwt. | | |
| Gate Posts, | 2 4 | | |
| | 23 tons at $60, | | 1380 |
| 1200 feet of Timber, $6 | $72 | | |
| 4500 feet of plank at | 270 | | |
| Laying down and workmanship, | 400 | | |
| 3 Gates, | 225 | | 967 |
| Large bolts 2750 lbs. at 8 cents, | 220 | | |
| Smaller do. 600 lbs. at 10 cents, | 60 | | 280 |
| Embankment, | | | 150 |
| | | | $3002 |

Say $325 per foot fall.

*To George P. M'Culloch, Charles Kinsey, and Thomas Capner Esq'rs. Canal Commissioners of the State of New-Jersey.*

In compliance with your instructions, after having completed the survey of a route for a canal through the counties of Essex, Morris and Sussex, I visited the country through which the river Lehigh passes, as far up said river as Mauch Chunk, the works at that place, and the Coal Mines.

The object of my visit, was to ascertain the practicability of constructing an ascending and descending boat navigation to the Coal region; the extent of the Coal Mines, and the probable benefits which may be derived from the use of Lehigh Coal, for manufacturing purposes.

From the best information that I could obtain, connected with my own observations, I believe the waters of the Lehigh, at Mauch Chunk, (from which place the Coal is shipped for market) are 300 or 350 feet higher than the waters of the Delaware at Easton; that the construction of an ascending and descending boat navigation, from Easton to that place, is not only practicable, but comparatively easy; and I am authorized by the managers of the Lehigh Coal and Navigation Company, to assure you that by the time a canal shall be completed across the state of New-Jersey, they will have an ascending navigation completed to the sources of the Lehigh, and that the distance from the Lehigh to the Susquehanna River at Wilkesbarre, does not exceed twelve miles.

Over the latter country a canal may be constructed with comparatively small expense, and without any fear of deficiency of water, which, connected by the Lehigh with the New-Jersey Canal, will effect a complete navigation from Wilkesbarre, on the Susquehanna, to New York. The region of country



through which this navigation will pass, abounds with Coal to that extent, that I think it sufficient to meet any, or all demands that may be made for any length of time, and the descending navigation now used is sufficient for present purposes.

In relation to the use of Coal for manufacturing purposes, I shall confine my statements to the result of my own observations. I saw at Mauch Cunk, a perpetual Lime Kiln, which they supply with coal and limestone at top, and at the same time draw burnt lime from the bottom. In this Kiln, one bushel of refuse coal (after being screened for market) will burn five bushels of lime stone. I also saw it used in a Smith's shop, without any mixture of charcoal, and think it succeeded as well as any charcoal. It succeeds equally well in the melting of iron. I saw castings made of iron melted in a Cupola Furnace, with the aid of Lehigh Coal, and never saw a blast made in so short time, nor with better success. Its use for domestic purposes, is too well known to require mention. In some instances I understand it has been used for making bloomery iron, and the quality of the iron is said to have been superior; but this has not yet been done on a large scale. Well informed iron masters, think nothing more is wanted than to alter the form of the chimney and the position of the bellows.

EPHRAIM BEACH.

# State of New-York.

## IN SENATE, April 23, 1823.

WHEREAS, the Legislature of the State of New-Jersey has ordered the survey of an inland navigation, to connect the rivers Hudson and Delaware, a communication which cannot fail to produce the most beneficial effects upon the agriculture, manufactures, and general industry, not only of that, but of this State—And Whereas the Legislature of the State of New York is desirous of giving a public testimonial of its approbation of this branch of the great system of internal improvement.

*Resolved*, (if the Assembly concur) that the Canal Commissioners shall send to the line of the above mentioned contemplated Canal, one of the Engineers in the employment of this state (if in the opinion of the Commissioners one can be spared) for the purpose of making a survey and estimate thereof, under the direction of the Commissioners appointed by the state of New-Jersey, to whom he shall report, as also to the Canal Commissioners of this state.

ORDERED, That the Clerk deliver a copy of said resolution to the Assembly.

JOHN F. BACON, *Clerk*.

## IN ASSEMBLY, April 23, 1823.

*Resolved*, That this House do concur with the Senate, in their said resolution. By order,

E. LIVINGSTON,
*Clerk of the Assembly.*



## To the Hon. the Legislature of New-Jersey.

*Report of a Mineralogical Survey made of the country contiguous to the Route surveyed for the Morris Canal.*

The country comprised within the survey may be divided into two great portions, the Primitive and the Secondary. The junction of these two formations may be traced in a direction about N. N. E. along the eastern side of Mount Kemble, to Morris-Town, thence to the westward of Littletown and by Parsippany to Booneton; from this point it skirts the foot of the mountains to Pompton, where the survey ceased. The Secondary formation is for the most part composed of regularly stratified rock, principally of a red colour, and varying through every shade and difference of texture, from a coarse conglomerate, to the red marle of Carrybean and Philips, or as it is commonly called throughout the country, red shale. The most remarkable features of this region, are its numerous trap ridges. These, as far as they have been examined, are all columnar, rising in vertical masses from the surface of the stratified rock. The phenomena attending the meeting of the trap with the stratified rocks may be observed to great advantage near the town of Paterson, in the channel worn by the river beneath the great falls of the Passaic.—In this place a coarse sand stone is to be seen alternating with conglomerate and with sand stone of a finer grain, while the upper stratum presents an indurated surface on which the trap rocks rest; the precise line of division being marked, and in the highest degree distinct. Near the meeting of the two different classes of rocks the trap is at first vesicular and amygdaloidal, presenting in its cavities, at this particular locality, little but calcareous spar. In the

vicinity, however, in a similar position, it contains that rare mineral the Datholite, of which specimens are herewith presented. In places, the cavities are found entirely empty, and the rock there presents the most marked resemblance to vesicular lava. The trap becomes more compact and loses its vesicular structure as it recedes from the stratified rock; the contained minerals become more rare, and finally cease to appear; still higher, the rock at Paterson becomes mixed with nodules of Chalcedony, that on the north side of the falls assumes the form of the finer agates. Occasionally a deposit of Chalcedony appears, forming the surface of the nodule, while the siliceous matter shoots within into chrystals of Quartz, while at Baskingridge, and on the Packhanack mountains, masses of radiated Quartz are to be found without any mixture of Chalcedony. In the higher part of the rock, and close to the great falls, Porhrite is found imbedded in the trap, and it is also met in rolled masses in a neighboring brook. Several varieties of the minerals, known formerly under the general term of Zeolites, also occur. There appears to be one prominent central, and two lateral ridges of the trap; the first of which is nearly continous from, and may be traced to its rise near the primitive mountains to Pluckamin; the eastern lateral chain is also regular and continues parallel to the other from the first rise of the Tolaway hills, three miles north of Paterson, to Springfield, where it terminates in an imposing eminence, and is not to be again seen until the principal ridge has bent in a western direction, in the vicinity of Somerville. The western trap ridge is by no means as regular as either of the others; It first appears as the Packanack ridge, running nearly parallel to the Central or Preck-



ness chain, its continuation constitutes the Hook mountain, a ridge of a crescent like figure that bounds the course of the united Rockaway and Passaic for several miles on the north; an eminence next rises from the low ground between the Hanover and Caldwell turnpikes, and merges in the central ridge north of the Chatham turnpike. South of Chatham the western lateral ridge again appears, and is known by the name of Long Hill. It probably bends in a semicircular form and terminates at Baskingridge.

In these trap ridges, almost every variety of the rocks included under that general name is to be found, from compact and homogeneous basalt, to a coarse grained greenstone, yet the whole are so connected by similarity of geological character and position, as to afford well founded presumption of their being the production of one great and general cause. It has never been observed to traverse the sandstone in dykes, but wherever the point of contact can be reached, has been found to lie upon its upper surface.

In this part of the surveyed district the most important substance in relation to the canal, is the freestone, which is frequently of most excellent quality, and well adapted for all the purposes of building the several erections that will be required on the canal. The trap rocks themselves are occasionally of a decomposing nature, and would, in the absence of water lime, afford a valuable ingredient of the nature of Tarras, for water proof mortar. Throughout the whole region from Paterson to Somerville, indications of Copper are to be perceived, and mines have at different times and places been worked to advantage. Among these may be mentioned the mine of

Schuyler, at Belleville, and that of Van Horne, at Somerville. If none be at present in successful operation, it is to be ascribed rather to the want of skill in conducting mining operations, and the deficiency of the large capital that such undertakings require, than to any difficulty in finding ore in abundance.—The ore of Somerville, appears by accounts furnished by Dr. Liddell, to have occurred in trap rock, and was probably a ferruginous oxide; Schuyler's mine furnished that more profitable variety the Sulphuret, and the same seems to have been drawn from mines in the vicinity of Woodbridge. Under the circumstances it appears that it would be highly politic in the State Legislature to pass laws that might attract capital from the neighboring great cities, to be applied to the great enterprize of exploring and working mines of Copper.

In many of the vallies of the primitive district, are to be met masses of transition Lime Stone; this may be first observed at Mendham, and again on the banks of the Muskonneteonk. It forms the whole north western shore of this river, from Hacketstown to its mouth, and extends along the Delaware for many miles. It occurs in regular strata, much inclined to the horizon, and contains nodular masses of hornstone. As a stone for building it is only inferior to the better quality of the freestone of the eastern portion of the district under consideration. In some cases it appears likely that it will furnish fine Marble, of the compact kind; at Mendham, in particular, a variety occurs with deadritic impressions, in which it resembles the beautiful marble of Florence. The Green Pond mountain is composed of Granwacke; this rock extends from this mountain to the Rockaway river, on the south side of which it again ap-



pears, and is to be traced through Succasunny Plain, and to the south of it for several miles. A much greater formation of this rock appears to have once existed; it is to be found in rolled masses upon the top and clothing the eastern side of Whatnung and the Trowbridge Mountains; is abundant in boulders at Morris-Town, and lies scattered as far as the southern extremity of the Mount Kemble range; the hills extending from Morris-Town towards Bottle-Hill, are chiefly composed of this rock out of place, and it lies throughout the low country from that ridge to the Rahway river.

At Mendham, a stone possessing all the characters of the Water Lime of New-York has been discovered, and little doubt remains that it may be made applicable to the same purposes. Similarity of Geological structure would lead to the inference that it may frequently be found associated with the beds of the common Lime Stone in other parts of the district adjacent to the canal.

The staple mineral of the primitive region is Iron. The ore is of the variety known by the name of the magnetic oxide, or more properly, as the protoxide of Iron. It is of the same kind, and in some instances even superior quality to that of Sweden, where their celebrated Iron is manufactured.

Iron of fully equal quality to the best Swedish has been manufactured in Jersey, but generally speaking, from want of capital and care, it possesses no other character in common with that but its strength; in this it not only equals but surpasses the Swedish, and is pre-eminent for the purpose of manufacturing chain cables and bolts for shipping. As this will and must be the great manufacture of the state, might it not be advantageous to place it like the staples of oth-

er states, under a system of inspection, by which its quality might be determined, and its deterioration prevented. On the north western limit of the primitive region, ore of zinc occurs in great abundance. It has not yet been of an object of sufficient emolument to induce its conversion into the metal. But when it is considered in its relation to the ores of Copper and the abundance of cheap and excellent fuel that the canal will furnish, it may be viewed as an object of the greatest importance.

Manganese also occurs in several places in the primitive region, and may, in all probability, be worked, when a cheap mode of carriage is provided, with great success. It has the advantage over iron and copper of being used in its mineral state, without its being necessary to smelt it. It will therefore require but little capital to work it successfully. In many places there are strong indications that the opening of quarries would lead to the discovery of valuable Marbles. On the Pompton mountain, Carbonate of Lime has been found mixed with noble serpentine, forming a beautiful variety of the verde-antique. A similar rock is met above Philipsburgh on the Delaware. The noble sepentine occurs in fine masses in both places, and might be employed by the Lapidary in his works.

Annexed is given a list of the specimens collected during the survey; it is not as extensive as it might have been, had it not been for the ill health of one of the commissioners, and circumstances which confined the duties of the principal Engineer to the vicinity of Morris-Town, for a great portion of the time he was in the employ of the Commissioners. In forming this collection, it has been endeavoured to present only such articles as from rarity, utility or beau-



ty, might be considered worthy of notice; by collecting every variety of geological structure that occurs, it might have been very much swelled, but would not have probably been rendered more interesting than it is at present.

The only novelty discovered on the survey, is a new ore of Cerium, found at the mine of Andover, in Sussex county; it appears to be of a variety that has not hitherto been described.

CHARLES KINSEY,
JAMES RENWICK.

# LIST OF MINERALS.

## METALLIC ORES.

| | |
|---|---|
| Ores of Copper, | Somerville, |
| Copper, with Coal, in red Marle, | Belleville. |
| Native Copper with Red Oxide, and green carbonate of copper, | Mount Kemble. |
| Red Oxide, with green carbonate of Copper, | do. |
| Magnetic Iron from the bottom of Dickerson's Mine. | |
| Do. from the top, | Randolph, Morris County. |
| Magnetic Iron Ore, | do. [Forge. |
| Magnetic Iron, | M'Farlan's Mine, near Washington |
| do. | Randolph's Mine. |
| do. | King's Mine. |
| do. | Jackson's Mine. |
| do. [2 specimens.] | Hopping's do. |
| do. | Mount Pleasant Mine. |
| do. [2 specimens.] | Dickerson's Mine. |
| do. | Schooley's Mountain. |
| do. | Large Mine Franklin Furnace. |
| do. | Hibernia Mine. |
| do. | Mount Hope. |
| do. | From the mountain, Franklin furnace |
| do. | Ringwood. |
| do. | Franklin Mine. |
| do. | Little Mine at Franklin Furnace. |
| do. | From the wheel pit, Fr'klin furnace. |
| do. | Kerr's Mine, Succasunny. |
| Native Magnet, | Gov. Dickerson's. |
| do. | Heath's Mine, Schooley's Mountain. |
| Brown Hæmatite, [2 specimens.] | Mendham. |
| do. | Gov. Dickerson's. |
| Iron Ore, with a trace of Zinc, | Andover. |
| Franklinite, | Franklin Furnace. |
| do. | Sterling Mine. |
| do. in carbonate lime, | Hamburgh. |
| do. chrystalized, | Franklin Furnace. |
| do. with yellow Garnet, | do. |
| Bog Iron Ore, | M'Farlain's Mine. |
| Plumbago, | Cumming's farm, near Andover. |



| | |
|---|---|
| Plumbago, | Hamburgh. |
| do. | do. |
| do. | Near Morris-Town. |
| do. | Franklin Furnace. |
| do. | Baldwin's Store, Hamburgh. |
| Magnetic Pyrites, used as an ore of Copperas, | Henfrey's Mine. |
| do. two specimens, | Green's Mine. |
| do. | Graham's Mine. [Great Pond. |
| do. | Randolph Mine, near the head of |
| Granular Ferro Silicate of Cerium, | Andover, |
| Compact do. | do. |
| Black oxide of Manganese, | do. |
| Red oxide of Manganese, | do. |
| do. | Hamburgh. |
| White oxide of Zinc, | Sterling Mine. |
| Red oxide of do. with Calamine & Franklinite, | do. |
| Silicate of Zinc, | do. |
| White silicious oxide of Zinc, [2 specimens] | do. |
| Red Oxide of Zinc, [2 specimens] | Hamburgh. |
| Cadmia, | Andover. |
| Molybdena, | Vernon, Sussex county. |
| Jeffersonite, | Franklin Furnace. |

## MISCELLANEOUS.

| | |
|---|---|
| Fluate of Lime, | Hamburgh, |
| Water Lime, | Mendham, |
| Carbonate of Lime, | Near M'Kean's tavern, Byram township, Sussex County. |
| Water Lime, | From the kiln, Mendham. |
| Fluate of Lime, [2 specimens.] | Franklin Furnace. |
| Flesh colored carbonate of Lime | do. |
| Calcareous formation, | Hamburgh, |
| Yellow Ochre, | From the banks of the Delaware below Belvidere. |
| Black Earth, | |
| White Clay, | |
| Carbonate of Lime with Hornblende, and Quartz, | Franklin Furnace. |
| Brucite, | Sparta, Sussex Co. |
| Prehnite, with Fibrous Zeolite, | Paterson, |
| Prehnite, | do. |
| Prehnite with Zeolite, | do. |
| Toad Stone, | do. |

| | |
|---|---|
| Zeolite, | Paterson. |
| Argilite mixed with Carbonate of Lime, | Hamburgh, Sharp's Quarry. |
| Serpentine with Steatite, | Pompton Mount'n, near S. Cook Esq. |
| Calcedony, | Preakness Mountain. |
| Agates, [8 specimens.] | Patterson. |
| Ferruginous Quartz, | Succasunny. |
| Species of Burr stone, | Hamburgh. |
| Actinolite, | Jenny Jump Mountain. Sussex Co. |
| Noble Serpentine, | do. |
| Talc, | do. |
| Indurated Talc, | do. |
| Serpentine, | do. |
| Indurated Talc, | On the Delaware near Easton. |
| Spinel, | Franklin Furnace, |
| Granular Spinel, | do. |
| Crystalized Spinel, | do. |
| Crystalized Mica, | Hamburgh. |
| Yellow Garnett, | Franklin Furnace. |
| Earthy Calamine, | do. |
| Brown Garnet, | do. |
| Primitive Green Stone, | Schooleys Mountain. |
| Sahlite, | Pompton Mountain. |
| Green Stone, | Second Ridge from Morris-Town. |
| Oil Stone, [3 specimens,] | Mendham. |
| Grauwacke, | Water Gap on the Delaware. |
| do. | Forming the base of the Blue Mountain, at the Water Gap, on the river Delaware. |
| do. | Succasunny Plains. |
| Zircon in Hornblende, | Schooleys Mountain, |
| Zircon with Magnetic Iron & Quartz, | do. |
| Hornblende, | do. |
| Hyperstene, [2 specimens,] | Paterson, |
| Augite, | Franklin Furnace. |
| do. | Vernon, Coperas Mine. |
| do. in Green stone, | Paterson. |
| Carnelian, | Pompton Mountain. |
| do. | Schooleys Mountain. |
| Coccolite, | Near M'Kean's tavern, on the Newton Turnpike. |
| Scapolite, [3 specimens.] | Franklin Furnace. |
| Datolite, | Paterson. |
| Hornblende, with Carbonate of Lime, | Franklin Furnace, |
| Horn Stone, | Found near Morris-Town. |
| Organic Remains, | Paterson. |
| Ferruginous Quartz, | Andover Furnace, Sussex county. |
| Calcedony, | Hunt's farm, near Newton, Sussex co. |
| Amorphous Scapolite, | Hamburgh. |
| Fetid Quartz, | Schooley's Mountain. |



| | |
|---|---|
| Quartz Rock, | 5 miles from Morris-Town. |
| Actinolite, | Jenny Jump, Sussex county. |
| Green Quartz, | From Gov. Dickerson's Morris co. |
| Magnetic Pyrites, | Randolph's Mine, near the head of the great pond, Randolph, Mor's co. |
| Amorphous Quartz, | Gov. Dickerson's do. do. |
| Arragonite, | do. do. |
| Sandstone, tinged with green Carbonate of Copper, | Somerville. |
| Melanite, | Franklin Furnace. |
| Indissolute of Keating, | Sterling. |
| Cyanite, | Found near Dover, Morris co. |
| Amphibole, | Franklin Furnace. |
| rystalized Mica, | Hamburgh. |
| Sahlite, | New Prospect, Bergen county. |
| Stilbite and Laumonite in Felspar, | Paterson. |
| Radiating Quartz, | Preakness Mountain. |
| Tubipores, | Paterson, |
| Epidote, | Schooleys Mountain. |

*To George P. M'Culloch, Charles Kinsey, and Thomas Capner, Esq'rs. Commissioners appointed by the Legislature of the state of New-Jersey, to explore the route of the proposed Canal to connect the waters of the Delaware and Passaic Rivers, through the counties of Sussex, Morris, and Essex.*

GENTLEMEN,

In conformity to directions I had the honor to receive from the Board of Canal Commissioners of the state of New-York, acting under a resolution of the Legislature of that state, I have visited the ground on which it is intended to carry the proposed canal; and I beg leave to report the result of my observations.

Ephraim Beach, Esq. the Engineer who has run all the levels, to ascertain the practicability of the proposed work, accompanied me through the line.—Commencing at Acquacknonck, near the landing on the Passaic River, at tide water, and from thence to Paterson; thence to Little Falls, and through Dover, on the Rockaway River, to Brookland, near the outlet of Hopatcung Pond; thence following the valley of the Musconnetcong and Pohatcung, in a pretty direct course, to the Delaware river at Philipsburgh, opposite the mouth of the Lehigh river.

The ground through the whole line, is very favorable for the construction of such a work as contemplated, with the exception of the elevation to be overcome, and of that I shall speak more particularly hereafter.

The soil is generally of a character easy to move, and with few exceptions, good to retain water.—There are some large round rocks to be removed, and some ledges to be encountered, where powder must be employed; these are particularly mentioned in the report and estimate of the Engineer, and do not form a great item of expense.



Mr. Beach, the Engineer, has been so good as to show me his estimate of the expense of this work, and has given explanations of the data and grounds of his calculation, and I have compared them with the experience we have had in the state of New-York, on the Erie Canal, the result of which has satisfied me that the sum total as stated by Mr. Beach, of eight hundred and nine thousand three hundred and thirteen dollars, will accomplish the work, and may be said to be a fair and liberal estimate.

The size of the canal as proposed by Mr. Beach, viz: 32 feet surface, 16 feet bottom, and 4 feet depth of water, or where the earth is a solid and compact substance, 30 feet surface, 18 feet bottom, and 4 feet depth. The locks to be 70 feet between the gates, and 8 1-2 or 9 feet width in the chamber. This size and dimension I fully approve, as well adapted to the localities and intended trade upon this canal.

The great elevation above tide water, which it is proposed to carry this canal, would at first view, appear a heavy item of expense, provided this elevation was to be overcome by locks exclusively, built after the manner of those on the Erie canal. Happily, however, James Renwick, Esq. of Columbia College, has projected and nearly matured a plan of rising or falling, from one level to another, by means of inclined planes, to be erected at all eligible and favorable positions, to overcome 1400 feet of the ascent and descent, and the remainder to be conquered by locks of various lifts, to be constructed of hammered stone, and made upon the most economical plan and durable structure. Mr. Renwick has explained to me the plan and operation of his inclined plane in his report on this subject, and in our several interviews, and has satisfied me of the prac-

ticability and utility of adopting it as a great saving in expense, in water and in time, upon the proposed canal, and I feel the greatest confidence in its successful operation.

I have seen Mr. Renwick's measurement and remarks upon the quantity of water to be obtained on the summit and at other places along the line of the proposed canal, and have personally examined these waters in nearly their lowest state, and I can freely say, I am satisfied that abundance of water can be obtained for the object, without materially injuring any of the present hydraulic works in the vicinity of the proposed work.

I will close, gentlemen, with only this remark, that after passing through the country intended to be intersected by the proposed canal, viewing the great local advantages nature has placed throughout the whole extent, and anticipating the prosperity and wealth that must result from its completion, I hope to see your state patronize and foster a project so well calculated to confer lasting and permanent benefits on the present and future generations.

Respectfully submitted,

BENJAMIN WRIGHT.

New-York, Oct. 24, 1823.



*To George P. M'Culloch, Charles Kinsey of Essex, and Thomas Capner, Esq'rs. Commissioners of the state of New-Jersey, in relation a Canal from the Delaware to the Passaic.*

GENTLEMEN,

The Canal Commissioners of the State of New-York having duly considered the request of the Legislature of that state, in relation to the contemplated Canal between the Delaware and Passaic Rivers, determined that it would be most advisable and beneficial, and at the same time correspond with the sense of the Legislature, to direct their Chief Engineer to review the operations of the Engineer of New-Jersey, (after his levels were taken and his surveys completed) to explore the route of the canal, and the localities of the country, and to furnish the best conclusions of his judgment and all the resources of his experience in aid of the undertaking. Under these impressions, Judge Wright, who has been employed on the Erie Canal as a Chief Engineer from its first inception to its present state, has lately complied with the direction of the Canal Board in that respect: And having, as President of that Board, had opportunities of becoming acquainted with operations of this nature, I considered it my duty to comply with an invitation to attend to this subject at the same time. The interests of the States are so closely connected, that the improvement of one state has a beneficial influence on the prosperity of all. And I am persuaded that the internal trade of a country, is the great lever of its prosperity, because it supplies the products of agriculture and manufactures with a certain market, and furnishes the elements, and animates the enterprizes of external commerce, as well as of the great departments of productive industry: And it is very evident that internal trade

cannot flourish without easy and cheap communication. To a considerable portion of Pennsylvania, this canal will furnish a choice of markets, and particularly an advantageous sale of the coal with which it abounds. New York will be accommodated with this invaluable mineral, and in many other respects; and New-Jersey must feel the propitious influence of the contemplated measure, in all the sources of public prosperity.

Under the government of these impressive considerations, and in company with the Chief Engineer of New-York, and the senior Commissioner and Engineer of New-Jersey, I have visited and reviewed the whole route of the projected canal: And I shall now communicate to your respectable Board my views on this interesting subject, which shall, for the sake of perspicuity, be condensed under four distinct heads.

1. The physical practicability of the Canal.
2. The Financial Practicability.
3. The inducements to the measure.
4. The organ or agent of its accomplishment.

And 1st. *As to Physical Practicability.*—Wenever water can be obtained in sufficient quantity on the summit level of a canal, there is no invincible physical impediment to its execution. Give an Engineer plenty of water, and he can make any canal. It then becomes a question of expense not of feasibility. In the present case, there is at least three times as much water on the summit level as will be requisite. Hopatkung Lake itself, furnishes a superabundance, and if necessary a lake of considerable dimensions, called Green Pond, can be introduced as an auxiliary. This whole region is uncommonly well watered, and without any interference with hydraulic establishments, supplies can be obtained along the whole



course of the canal. The great height of the summit level may be considered an objection against the undertaking, but altitude is like distance, it creates no insurmountable obstacle. It only augments the expense. Through the instrumentality of locks this elevation may be surmounted; but from considerations of economy, and with a view to the rapid passage of boats, it has been proposed to substitute inclined planes to a certain extent: and this measure cannot fail of success: To remove, however, all doubts with respect to its efficacy, preliminary experiments can be instituted.

On questions of this nature, we must rely on the counsels of experience and science, and the opinions of professional men. Mr. Beach, the Engineer of New-Jersey, has been employed as an Engineer on the Erie canal, and he is intelligent, experienced and deserving of high confidence. Judge Wright is a principal Engineer on the Erie canal, and there is no man in this country whose opinion is entitled to more respect. In conducting that great work to its present prosperous condition; his agency has been of primary importance, and I have no hesitation in saying, that in all points relative to the construction of canals, I would place implicit confidence in his judgment. I have read the official reports of these gentlemen, which are decidedly friendly to the object, and which meet my approbation: and when we combine with this aspect of the subject, the corroborating opinions of Gen. Swift, formerly the Chief of the Corps of Engineers of the United States, of Gen. Bernard, and Col. Totten, eminent members of that institution, and of Professor Renwick, of Columbia College, gentlemen distinguished for profound science, for accurate judgment, and for extensive information,

there can be no room for doubt. The practicability of the work is as certain as any future event can possibly be, whose accomplishment is not yet realized.

Secondly, *As to financial practicability*.—Without pretending to a minute acquaintance with the financial resources of New-Jersey, I am fully of opinion that this measure may be carried into effect, without imposing any burdens on the people, and without encountering any serious difficulties.

The canal will be seventy-five miles long. It is to be in general, thirty-two feet wide at the top, sixteen at the bottom, and four feet deep. The whole expense will not much exceed eight hundred thousand dollars, and it can be accomplished, with ease, in three years.

This money can be borrowed on the credit of the state, at six per cent. The annual interest on the whole sum, will be but 48,000 dollars. For the first year, 200,000 dollars will be required, and for each of the two remaining years, $300,000. There will then be essential in order to pay the first years interest, $12,000

For the interest of that and the second year, 30,000

For the interest on the whole sum borrowed, 48,000

$90,000

After providing for the payment of this sum, the income of the canal will be fully adequate to defray the interest afterwards accruing, and to extinguish with rapidity, the principal.

On looking with an eye of scrutiny to the revenue which will arise, in time, from this navigable communication, it is not extravagant to state it at two hundred and fifty thousand dollars annually: but making allowance for the repairs which will be from time to time required, and for the expenses of superintendence and collection, I do not scruple to set down the nett annual income at 150,000 dollars. This will not only pay the interest but in a few years the whole debt.



I should suppose that it would require no great financial skill to devise the ways and means of paying 90,000 dollars in three years, without resorting to taxation. The avails of lotteries and banks might constitute important items, and auxiliary expedients may be successfully adopted.

Thirdly, *The inducements to the measure*.—On this point there can be no diversity of opinion. There is every motive for adopting the project which ought to operate on an enlightened Legislator and a devoted friend of his Country.

1. It will make New-Jersey the greatest manufacturing country in America. The mountains near the route of the Canal are inexhaustible masses of valuable iron ore in all its forms and varieties.—There are besides prolific stores of Copper, Zinc, Manganese, Coperas, Plumbago, Serpentine, Marble and Lime. All these will be brought into active and abundant operation by this Canal.

The agency of fire, is essential to very extensive manufacturing operations, and water power is a most eligible auxiliary. In the latter respect this part of New-Jersey is unrivalled. But her forests are rapidly wasting away, and many of her iron works are already prostrated for the want of fuel. The anthracite, or glance coal of Pennsylvania (which perhaps contains more of the matter of ignition than any other substance), can be obtained by the Canal to any extent, and in the most economical manner. New-Jersey will be thus enabled to manufacture iron in such quantities, as to supersede the necessity

of foreign importation, and upwards of three millions of dollars annually will thereby be saved to the United States. In our tour through New-Jersey, we saw foreign iron worked by foreign coal, and as if this sight were not sufficiently humiliating, we could see at the same time mountains replenished with the richest ore, and a day's journey would have brought us to the inexhaustible Coal Mines of Pennsylvania.

There are many flourishing institutions at Paterson and other places, where cotton, flax, wool and hemp are manufactured into useful fabrics. As these establishments become more extended, the power of steam will be demanded. Coal will therefore be indispensable, and it is now much wanted, as well as iron and steel, for the purpose of making and repairing the machinery of those important establishments.

2. It will essentially ameliorate the agriculture of the country, by supplying the farmer with lime, gypsum and other valuable manures, by facilitating and cheapening the transportation of his commodities, by furnishing him at reduced prices with necessaries and accommodations, and by establishing a market at every manufactory, and opening a passage by water, to the two great cities of Philadelphia and New-York, and to Paterson, Newark, Elizabeth-Town, Amboy, Brunswick, Easton, Trenton and the villages lower down on the Delaware. The mountain lands which are now exclusively appropriated for providing fuel for the iron manufactories, can then be applied to agricultural purposes, and the population of the state will be greatly augmented.

3. The population and opulence of the state will not only be greatly increased from these causes, but from the natural and necessary operation of a most



extensive and prosperous inland trade, which is the invariable offspring of the flourishing state of productive industry and easy communication. The whole line of the Canal will exhibit manufacturing establishments and rising villages, boats crowded with the productions of nature and the fabrics of art, and the enterprising efforts of man improving the bounties of heaven. To adopt the sublime language of holy writ, "the wilderness and the solitary place will become glad, and the desert will rejoice and blossom as the rose."

4. The revenue arising from the canal will forever supersede the necessity of taxation, and will form a vast fund applicable to other internal improvements, to the diffusion of the lights of science and to the dispensation of the blessings of education. In Great Britain, it has been remarked that a canal is always lucrative, where there are coal mines in its vicinity. The demands of the City of New-York, and the other cities and villages on the Hudson, the consumption of various parts of New England, and the manufactories of New-Jersey, for this indispensable article, will forever increase, and forever secure a great revenue from the Canal. Add to this, the fossils and the metals before mentioned, the products of the forest and the field, and the fabrics of art, and there is no question but that this canal will enrich New-Jersey in her finances, as well as in other respects.

5. Reputation is as important to states and communities as to the individuals who compose them. A measure of this character would encircle the State with honor, and erect a monument of renown as lasting as time. It would excite into activity the energies of her sons, and present to all her population an object of patriotic exultation, and to her sister states

a model for patriotic imitation. And when the triumphs of ambition, the pageantry of power, and even the splendor of scientific glory are lost in the abyss of time, the magnanimity and public spirit which effected this great work, will be cherished in the grateful hearts of all future generations.

Fourthly, *The organ or agent of accomplishment.* —This Canal may be made, 1st by an individual: 2d by an incorporated company, or 3d by the State. As the first will not be attempted, nor ought it to be permitted, and as the second is very exceptionable, and perhaps not feasible, it follows as an inevitable consequence that the work ought to be achieved by the State exclusively.

In Europe, with the exception of Great Britain, improvements of this kind have been, I believe, always undertaken and accomplished by the Governments. In Great Britain, the superabundance of private capital, has enabled companies to effect, what in other countries has been the exclusive work of the constituted authorities; but even some cases have occurred in that kingdom when it became necessary for the Government to extend its munificence in order to produce the intended results. The same state of things prevails in this country as in Europe generally with respect to great surplus capital, which either does not exist, or is already employed, or can, as it is supposed, be more lucratively invested. All the Canals that have been attempted in the United States, through the intervention of incorporations, have failed, I believe, and principally for the want of funds, except the Middlesex Canal, which although a merritorious, is comparatively a secondary work. And if New-Jersey does attempt this expedient, either the stock will not be filled up or not paid for,



and the consequence will be a failure greatly to be deprecated. But this is not the only objection.— The Company will consult its own interests, not the prosperity of the State. The route of the Canal will be designated, not with a view to the accommodation of the great manufacturing institutions, but with a view to a cheap, facile and rapid construction: the tolls may be burdensome, and the superintendance may be vexatious. The cardinal interests of the State may be subordinate to the cupidity of a private association. The capital, if it comes at all, will proceed from abroad; and New-Jersey, that has from the war of the Revolution to the present period evinced a high sense of character and an honorable spirit of independence, will be bound hand and foot by the shackles of a non-resident company.

I have thus, Gentlemen, at your request, with entire respect, and without the least reserve, given you my views of the contemplated Canal; and I feel persuaded that this communication will be considered in its true light, not as the obtrusive interference of a stranger, but as the candid opinions of a sincere friend to the best interests of New-Jersey.

I have the honor to be
With perfect respect,
Your most obedient servant
DE WITT CLINTON.

New-York, Oct. 24, 1823.

*New-York, Oct.* 28, 1823.

DEAR SIR,

It is now about fifteen months since the zeal and intelligence of Mr. M'Culloch, invited our attention to the subject of the Coal and Iron Canal across New-Jersey; (such a name it will deserve, whether made of earth, wood, or stone, when its effects, by means of those great products, are duly estimated); and much time has been occupied in devising a plan to pass the highlands; for the hills opposed appalling difficulties to mere Lock navigation. Your invention of a new adaptation of the Inclined Plane, has, in my opinion, given means to obviate this difficulty. I am glad to learn that Gen. Bernard and Col. Totten coincide with me in this opinion. I have examined the subject with some care, and am entirely satisfied that the Planes can be easily constructed, and that they would be safe and sure in their operation, and would enable the Engineer to transport with facility, any desired quantity of Coal, or Iron, or other products, across the hills of Jersey, in the route of the canal.—I am pleased to hear that Mr. Clinton, accompanied by the Engineer, Mr. Wright, from the New-York Canal, has examined the route of the canal, and your plans, with Mr. Beach's surveys. The opinion of those gentlemen will be important, for they have both been long conversant with the subject of canals.—If it should be necessary for me to furnish a more detailed opinion of the practicability of constructing the canal. or in relation to the Inclined Plane, I will, when called upon, give those subjects my farther attention.

The promotion of the domestic industry of New-Jersey is not only highly important to the true interests of that State, which is abundant in Minerals, but also to that of those marts, New-York and Philadelphia, and as it relates to Coal and Iron, to the interests of the whole Union.



Your Respectful Humble Servant

JOSEPH G. SWIFT.

JAMES RENWICK, Esq.

*Professor of Natural and Experimental Philosophy and Chemistry, Columbia College, New-York.*

WAR DEPARTMENT,

November 10, 1823.

SIR,

In conformity with the instructions of this Department, the Board of Engineers have placed in your hands a copy of their Report on the projected Morris Canal. As the aid of the Board was afforded, with a view of assisting the Commissioners of the Canal, in carrying into effect the intentions of the Legislature of the State of New-Jersey, in making the proposed communication through the State to New-York, you are at liberty to make such use of the Report as may best accord with the intentions of the Legislature.

I have the honour to be sir,
Very respectfully,
Your obedient servant,

J. C. CALHOUN.

G. P. McCulloch, esq.
*Of Morristown, now at Trenton, N. J.*

UNITED STATES ENGINEER DEPARTMENT.

GEORGE P. McCULLOCH, ESQ.

NEW-YORK, NOVEMBER 5, 1823.

DEAR SIR,

I herewith send you a copy of our Report to the War Department, and, with a view to save time, I have requested the Engineer Department to permit you to use this copy as you may think proper. Such an arrangement will make it unnecessary to make out and send to you a copy from Washington; and the permission, I think, you will soon receive.

Wishing you all the success so great a project, and such distinguished zeal, deserve,

I remain, with high regard and esteem,

Your most obedient,

JOS: G. TOTTEN.

NEW-YORK, OCTOBER 5, 1823.

*Brevet Maj. Gen. Alexander McComb,*
*Col. Comd. U. S. Engineers.*

SIR,

The Board of Engineers being directed, by orders of the 15th of August, to visit the proposed Canal through the mining districts of New-Jersey, to confer with the Commissioners of the State on the subject, and to report to the Engineer Department the result of their labours, having complied with the first part of their instructions, have now the honour to present the following

## REPORT.

Of all the means which human ingenuity has devised for facilitating communications between different parts of a country, canals occupy, at the present day, the highest rank; and, when well planned and judiciously located, they not only become sources of individual wealth, but they diffuse prosperity over extensive regions, and result in economy and advancement to the nation at large. In Europe, for some time, opinion was in favour of canals of large dimensions, and, in these, magnificence was often as much regarded as utility: now-a-days, however, experience and more precise calculation has taught that it is necessary to reject every useless expense, and that the cost of construction and repairs must have a



certain ratio to the revenue; being, in this respect, like all commercial speculations. When viewed, however, with reference to general, rather than individual advantage, the condition, that the income must have a certain proportion to the principal invested, cannot be considered as absolute; for the revenue from a canal may be much less than that on ordinary investments, and yet the benefits amount to much more, as regards national economy and advantage. On this hypothesis, the defect of revenue is amply compensated, as regards the nation, by the greater facility and speed of transportation, thereby making the articles conveyed less costly, the circulation of capital more rapid, and a larger proportion of the labour of men and animals disposable for the other branches of industry; and also, by opening extensive regions to a market, which, without this cheap mode of conveyance, would be inaccessible.

These considerations shew that canals, when considered by a comparison of their cost with the revenue derived from them, may be divided into two classes. 1st. Those which are made with a view to the general interest of the country; the revenue being a secondary object. And 2d. Those in which the revenue is the principal object. The first can only be undertaken at the charge of the public treasury; the other may be either the work of the nation, of particular states, or of private associations.

The proposed Morris Canal belongs, from the manner in which the project originated, to the last class above mentioned; and though it well deserves

to be classed with those promising greatest national advantage, we shall nevertheless consider it only in the relation of the probable cost with the anticipated revenue. To establish this sort of comparison, it is necessary to state, successively, the particular objects in view in proposing this canal; the income which will result from the attainment of these objects; the proposed manner of construction, and the calculated expense.

### *Of the objects in view in projecting the Morris Canal.*

This canal, following nearly an E. and W. course, is to unite the Delaware and Passaic rivers. It leaves the Delaware opposite Easton, Pa., or rather opposite the mouth of the Lehigh river, and keeps along the north side of the valley of the Pohatcung river to about one mile to the N. W. of the Brick Tavern, where it crosses this little river, and passes over to the north side of the valley of the Musconetcong river. It then pursues its course, along the north side of this valley, to Stanhope, where it crosses the Musconetcong, and runs up the south side near to Brookland, and within two-thirds of a mile of the south end of the Great Pond, Hopatkung. Here is the summit level of the canal; to be filled by a feeder from the Great Pond, which is to supply both the eastern and western sections. Descending along the south side of the valley of the Rockaway river, it crosses that river about two miles above its junction with the Passaic: about one and a half miles further,



it crosses the Passaic itself; after which it pursues nearly a straight line to the Little Falls: thence it runs straight, cutting off a bend in the river, for about two miles, when it descends into the bed of the river, which it follows to Paterson. At Paterson the canal leaves the river, and, running nearly south, falls into the Passaic at Aquacknock; whence there is tide water navigation to the city of New-York. Since the trace of the canal just described was surveyed, it has been ascertained that another, and probably a better, route may be found for a part of the eastern section; to wit, by crossing the Rockaway, first at Dover, again one mile to the N. E. of Col. Glover's, and lastly at Scott's forge; thence to the Pompton river, over the Pompton Plains; and, after passing the Pompton river, keeping on to the N. side of the Passaic, and dropping into it about two miles below the Little Falls. This proposed change is shewn on the map herewith, by the dotted red line.

The Morris Canal, as appears by the above delineation, is a summit level canal, deriving its supply of water, for both sections, from the Great Pond. The surface of this pond is about two square miles, and the annual supply of water is stated to be 55,021,991 cubic yards. The elevation of its surface is 902 feet above the tide of the Passaic, and 753 feet above the surface of mean water of the Delaware, at Easton. The bottom of the canal, on the summit, being 14 feet below the surface of the pond, the descent into the Passaic will be 888 feet, and into the Delaware 739 feet. The total length of the canal will be

about 76 miles, the summit level being just about midway.

The map accompanying this report makes it unnecessary to give a more minute description of the location of the canal. Upon the map are shewn the trace, the different levels, their respective elevations above the Passaic and Delaware, the several falls from level to level, the streams crossed in the route, and the general relation of the trace to the several rivers and smaller streams of the country.

The chief object of the Morris Canal is to open a communication between the great beds of coal (anthracite), on the Lehigh river, and the iron-works of New-Jersey, the manufactories of Paterson, and the city of New-York.

The Lehigh is now navigable to within nine miles of the coal-beds, from which point a sort of rail-way extends to the quarries, and coal can be delivered at Easton (at its mouth) for $3.94 per ton. Reckoning $2.62 for the total transportation to New-York, the total price at that city will be $6.56 per ton. Deducting from this the transportation from the end of the canal, in the Passaic, to the city, there will remain $5.50, as the highest price for coal furnished to the forges of New-Jersey, and to the works at Paterson. As the ton of Liverpool coal costs $10.50 in New-York, and that of the Lehigh can be furnished at $6.56 there will be, in this point of view, a saving of $3.94 per ton; and there being 45,000 tons imported annually, the yearly saving to the city will be $178,300. Here it should be remembered, that the



whole sum of $472,000, now paid for Liverpool coal, will be retained in the country, to the advantage of the nation at large. This diminution of price, while it will effectually exclude foreign coal, will greatly increase the consumption of that brought by the canal. But this economy in the price per ton is not the only saving which will accrue; for the results of chemical analysis, and also of trial, give to the Lehigh anthracite nearly twice as much of the principle of combustion as to the Liverpool coal; or, in other words, they prove that one ton of the former is worth two of the latter; thereby giving an economy of $14-.44 for every ton of anthracite consumed.

The above calculations make it obvious that when once the Morris Canal is in operation the Lehigh coal must come into general use, not only as a substitute for all foreign coal, but also for wood, which must annually increase in price, and which is now not very different, in that respect, from Liverpool coal.

The results will be analagous as to the iron-works in New-Jersey. At present charcoal only is used, because the high price of land transportation forbids the use of mineral coal. The proprietors of the forges and furnaces find it indispensable to an economical management of their concerns, to own extensive tracts of woodland in the vicinity of their works, and make their own charcoal: these forest lands absorb more than two-thirds of the whole capital; that is to say, if a single forge requires a capital of $8,000, the woodlands necessary to supply this forge with fuel will cost, at least, $16,000. This necessary weight of capital,

of course, goes to increase the price at which they can afford to sell the manufactured article. But, besides this, the gradual clearing of the country by an increasing population, and the consumption of the forges themselves, so enhance the price of wood that the time may come when the working of the mines, and the carrying on the manufactories of iron, will entirely cease: this period can indeed hardly be considered as distant, when we see annually a diminution in the number of forges. Of ninety-three forges in the county of Morris, thirty-nine are at this moment extinct for want of fuel. By supplying these forges with good fuel, at a fixed, and, compared with the present, a very moderate price, there will result—1st. A reduction in the capital necessary for the establishment of a forge; so that with the same amount as is now invested there may be three times as many forges, and, consequently, three times as much iron made. 2d. A reduction in the price of the manufactured iron, both on account of the greater cheapness of fuel and of the diminution of capital necessary to produce a given quantity. 3d. A greater activity in working the rich and numerous mines of the vicinity; and 4th. A reduction of the quantity of imported iron: this being a certain consequence of the cheapness of fuel, the vicinity of the ore, the good quality of the iron, the abundance of water power, and the communication, by a canal, with a market. It is proper to notice here, that a ton of New-Jersey iron is now worth, at New-York, about $70, but that if the forges were well supplied



with the mineral coal, and the transportation to the city could be made by a canal, it could be sold for $55. A ton of Swedish iron costs, in New-York, $90, and the annual importation amounts to above 37,000 tons.

On the above considerations, it is easy to perceive how much the consumer, in particular, and the nation at large, will benefit by the impulse which will be given to the Jersey iron-works by the successful operation of the Morris Canal. We must not, however, omit to state, while on this subject, that supplying the forges with coal from the Lehigh will give a large extent of country, now devoted to furnishing charcoal, to be appropriated to agricultural purposes, thereby greatly increasing its capacity for population and its disposable productions.

The Morris Canal will not only traverse the rich iron regions of New-Jersey, but will also communicate directly with the flourishing manufacturing village of Paterson. Great as are the advantages of this situation, from its abundant supply of water power, its proximity to the rich emporium of New-York, and its water communication with that city, it is certain that these advantages will be greatly enhanced by the execution of the project under consideration. At present its operations are confined to wool, cotton, hemp, &c.; but once furnish to that enterprizing village the ores and coal of the interior, and the additional water power and greater facility of transportation, to be derived from the canal, and we may look thither for the supply of the numerous articles of

wrought metal, for which so much is now paid to foreign, to the detriment of native, skill and industry.

Such are some of the immediate advantages appertaining to the projected Morris Canal; but there are others to be pointed out scarcely less important. Of these, some will contribute to the revenue of the canal, from the moment of its completion; while others only promise to become fruitful sources of profit hereafter. Besides the transportation of ores and coal upon the canal, there is to be added the transportation—1st. of iron to the city of New-York: 2d. of the products of agriculture: 3d. of lumber from the Delaware: 4th. of the trade between Easton and New-York: 5th. of lime for agricultural purposes, from the western to the eastern section: 6th. of lime for the New-York market: and 7th. of the several articles furnished by the city to the interior of New-Jersey. As to the future—*first*, it cannot be unreasonable to anticipate, from the low price at which the Lehigh coal will be delivered in the city of New-York, and from its excellent quality, that its use will be very greatly extended, both to the east and to the north of that city: and *secondly*, a cut of about 12 miles will connect the waters of the Lehigh with the waters of the Susquehannah, and thus (with the improvement of the navigation of those rivers) open a direct communication between New-York and all the upper basins of the Delaware and Susquehannah rivers; that is to say, with an extent of country more than 36,000 square miles.



*Estimate of the Revenue of the Canal.*

Embraciug only those objects which will begin to contribute to the revenue from the instant of the completion of the canal, and estimating them at the lowest rate, we obtain the following *minimum* revenue.

The principal article transported upon the canal will be coal from the Lehigh, for the supply of the city of New-York. That city and the village of Brooklyn contain 135,000 inhabitants: but the only means of approximating to the consumption of coal by this population is, by comparing it with other cities in a similar climate, where coal is the principal fuel.

| | |
|---|---|
| Dublin contains 144,000 people, its annual consumption of coal is 204,000 tons, | 204,000 |
| Edinburgh and Leith, 100,000 | 213,999 |
| Total inhab. 244,000 | Tons 417,999 |

This gives to each inhabitant a mean annual consumption of 1 ton and 713 thousandth parts—and for 135,000 inhabitants. 231,255 tons.

But, as the Lehigh anthracite contains about twice the principle of combustion as the coal in use in the cities we have chosen for comparison contains, we will reduce the quantity found above one half; that is, to 115,627 tons. This consumption may be regarded as a *minimum;* for neither the quantity required by manufactories in the neighbourhood, nor by steamboats, is inclnded.

**The above calculation gives to each person 0.857 tons per annum, which at $6.56 per ton (as stated before) will require for a family of ten persons an annual expense of only $56.22.**

| | | |
|---|---|---|
| 115,627 | Tons of coal transported to New-York, at 1 1-4 cents per mile per ton—or $0.95 per 76 miles per ton, - - - - | $109,845.00 |
| | The Morris county forges and furnaces, in actual operation, are 54 in number; making, at 2 fires each, 108 fires: these should produce, if properly supplied with ore and coal, 50 tons of iron each, or 5,400 tons in the whole. Reckoning 7 1-2 tons of coal to 1 ton of iron, they will consume 40,500 tons of coal. | |
| 40,500 | Tons of coal transported to the above forges, at a mean distance of 48 miles, at 1 1-4 cents per mile per ton, or 60 cents per 48 miles per ton, is - - - - | 24,300.00 |
| | In the same district are 39 forges and furnaces extinct for want of fuel; these being of the largest class may be averaged at 2 1-2 fires each, making in all 97 fires, which, at 50 tons per fire, will make 4,850 tons of iron, and, at 7 1-2 tons of coal per ton of iron, will require 36,375 tons of coal. | |
| 36,375 | Tons of coal, at 60 cents per ton, - - | 21,825.00 |
| | The iron made in the above works will be sent to New-York. | |
| 10,250 | Tons of iron, at 60 cents per ton, will give | 6,150.00 |
| 6,000 | Tons of ore (a part being sent to the works by land) conveyed a mean distance of 24 miles, at 1 1-4 cents per mile per ton, or 30 cents per ton per 24 miles, - - - | 1,800.00 |
| | Paterson, Newark, Elizabeth-town, and the other villages and settlements within reach of the canal, will require, either in the fami- | |
| 208,752 | Tons. - Carried forward, - - | $163,920.00 |



| | | |
|---|---|---|
| 208,752 | Tons. - Brought forward, - - | $163,920.00 |
| | lies or in manufactories, say, one-third as much as New-York. | |
| 40,000 | Tons of coal, transported a mean distance of 48 miles, at 1 1-4 cents per mile per ton, or 60 cents per 48 miles per ton, - - | 24,000.00 |
| | The valleys of the Musconetcung and Pohatcung furnish an abundance of lime, of which none is to be found east of the summit level: the canal will furnish facilities for transporting this matter, so necessary in agriculture, to the eastern section. | |
| 5,000 | Tons of lime, transported a mean distance of 32 miles, at 1 1-4 cents per ton per mile, or 40 cents for 32 miles per ton, - - | 2,000.00 |
| | At present a great quantity of the productions of the farms and forests of New-Jersey cannot be sent to market, because of the high price of land carriage: the opening of the canal will reduce the transportation so low that we may estimate at least 13,000 tons of this produce as passing along the canal to New-York. | |
| 13,000 | Tons of this produce sent to New-York from a mean distance, along the canal, of 44 miles, at 1 1-4 cents per mile per ton, or 55 cents for 44 miles per ton, - - | 7,150.00 |
| | The commerce between the parts of the state bordering the canal, and the city of New-York, is, on one part, cider, spirits, bricks, rails, &c. and on the other, in salt, gypsum, dry goods, &c.: this may be valued at 10,000 tons. | |
| 10,000 | Tons transported a mean distance of 56 miles, at 1 1-4 cents per mile per ton, or 70 cents per ton for 56 miles, - - - | 7,000.00 |
| | Paterson will use the canal for the conveyance | |
| 276,752 | Tons. - Carried forward, - - | $204,070.00 |

| | | |
|---|---|---|
| 276,752 Tons. | Brought forward, | $204,070.00 |
| | of the raw materials from, and the manufactured articles to, the city of New-York: this is estimated to amount now to 1,950 tons. | |
| 1,950 | Tons, at 30 cents per mile per ton, | 585.00 |
| | The canal will put Easton in communication with the manufactories of Paterson, and the city of New York: the commerce which will result may be estimatod at 9,520 tons. | |
| 9,520 | Tons for a mean distance of 64 miles, at 1 1-4 cents per mile per ton, or 80 cents per ton for 64 miles, | 7,616.00 |
| | The lumber which comes down the Delaware from above Easton is stated at 5,000 tons; half of this may supposed to pass through the canal to New-York. | |
| 2,500 | Tons of lumber, at 80 cents per ton per mile, | 2,000.00 |
| 290,722 Tons. | Total, | $214,271.00 |

As the above estimate gives 290,722 tons of trade, and 214,271 dollars of revenue as a *minimum*, it is believed to be superfluous to enter further into this particular subject. But, before leaving it, we cannot refrain from observing, that all the articles above estimated are susceptible of continual augmentation, and that the day may arrive when the projected canal will, alone, be inadequate to the trade requiring this species of accommodation.

### *Of the proposed manner of Construction.*

To this subject belong, the profile of the canal—the number of locks it will require—the expense of water—the time necessary for the passage from the Delaware to the Passaic, and both the first cost and



that of yearly repairs. The dimensions of a canal, in breadth and depth, are generally determined by the object it is to accomplish: a canal uniting two bays, for example, should permit the passage of the ordinary craft navigating those bays: and so of rivers—but it often happens that a want of water, or a deficiency in capital or the certainty of a small amount of revenue, make it necessary to abandon the above principle, and adopt much smaller dimensions. This reduction, however, has its limits, beyond which stability is compromised, the passage of boats retarded, and animal labour badly applied.

Considered in every point of view, the profile herewith, (*Fig.* 1.) which has been adopted by Mr. Renwick, who, as the principal engineer, has explored the route, located the canal, and made all the plans of construction, is all that can be desired.

1st. The slope of 2 to 1, (*Fig.* 1.) given to the sides, assures a perfect solidity, and, by diminishing the effect of the waves upon the banks, permits to give to the boats a velocity, which would otherwise speedily wear away the banks. In broad canals the slope may be proportionate, inversely, to the tenacity of the soil; but when the banks can be abraded at all, this will not do in narrow ones, in which the preservation of the slopes, and the velocity of the boats, are primary objects. 2d. The breadth at the bottom being 14 feet, two boats of 8 1-2 feet beam (there being one foot water more than their draught) may pass each other without touching. 3d. The depth being at least 4 feet, a boat drawing 3 feet, with 8

feet beam, which gives a profile of about 22 square feet, will occupy but one-fourth of the profile of the canal, which is 88 square feet; a less difference between the two profiles would increase the resistance of the water, and consequently require a greater hauling power for the same velocity. Besides this, the excess of depth over the draught will prevent the boats from injuring the canal, by disturbing the bottom, and it will also permit water to be drawn from any particular level for filling the locks, without requiring recourse to be had, in every case, to the water of the summit level. A depression of one inch, in a level of one mile in length, will fill a lock nearly three times—and in a ten mile level, it will fill twenty-eight locks. 4th. The towing path having 8 feet breadth, 1 1-2 feet elevation above the water, and an exterior slope of 45 degrees, is perfectly adapted to the kind of canal contemplated. And 5th. All the above dimensions being determined with reference to the size of boats, to the best form, as respects the stability of the banks, and to strict economy in the first cost of the canal, they may be regarded as giving a *minimum* quantity of excavation. Supposing the ground to be level, an excavation of three feet deep will suffice, and will give to each running yard 6.66 cubic yards of excavation. The embankment amounts to 6.52 cubic yards.

It has been said, that the profile of the canal is calculated for a boat of 8 1-2 feet beam and 3 feet draught. By giving 60 feet length to this boat, its burthen will be 25 tons, which has been found to be



the most advantageous load for a single horse. A boat, on these dimensions, may navigate the Passaic, from the entrance of the canal to its mouth: but it will be too small for the navigation thence to the city of New-York, in rough weather, and too large for the upper Delaware and its tributaries: the Durham boats, on these last, draw but two feet with a full load of 14 tons; and the Periaguas, which run from the Passaic to the city, are about 40 tons. It would be better, no doubt, if the canal could be made to receive such boats as could safely navigate the Bay of New-York, for then the passage through would be more rapid, and cheaper; but the consideration of a much heavier first cost, and of the advantage to the state of New-Jersey of having a place of deposit and transhipment at each extremity of the canal, forbid to hope that dimensions in all respects suitable to the importance of the communication, will be given to it.

The dimensions of the boats being fixed; those of length and breadth determine the horizontal dimensions of the locks: that there may be room for the boat, and for the play of the gates, these should be 9 feet by 64. As to the lift of the locks, it is fixed at 8 feet, being that which is most commonly preferred. A system of locks with less lift, say 4 feet, for the same total rise of suppose 120 feet, will require an expense of construction of about one-half more than locks of 8 feet lift: and while the expense of water will be one-half less, the time required for the passage will be one-third more. For this same total rise of 120 feet, with a system of locks of 12 feet lift, the

expense of construction will be only about one-sixth less than for 8 feet locks; and while the expense of water will be one-half more, the time of the passage will be about one-quarter less. These considerations of cost of construction, expense of water, and consumption of time, have led to the choice of 8 feet lifts, as a sort of mean between the advantages and disadvantages of greater and lesser lifts.

Adopting this fall of 8 feet, the number of locks on the Morris Canal is ascertained by adding the whole rise from the Passaic to the summit level, *viz.* 888 feet to the descent from the summit to the Delaware, to wit, 756 feet, giving a total of 1644 feet: which, divided by 8, the number of feet fall in each lock, gives 205 1-2 locks. This number of locks, compared with the length of the canal, 76 miles, is excessive, and much greater than in any canal hitherto constructed: the Canal of Languedoc is 150 miles long and has 101 locks, and the great western canal in the state of New-York, will have only 80, in its whole length of 360 miles.

The great expense of such a system of locks, in first cost, in water, and in time, would have been fatal to the project; but happily the science and ingenuity of Mr. Renwick, aided by the success of analagous attempts in Europe, have found out an expedient by which this formidable elevation of the summit may be overcome at a comparatively small expense. His idea is, the combination of locks and inclined planes; or rather the use of either, as local circumstances may dictate: the plan of Mr. Ren-



wick, bold, ingenious, and novel, promises such improvement in the mode of passing from one level to another, and indeed such a facility in overcoming obstacles which, in the existing mode, might be regarded as insuperable, that we consider it our duty to enter, with some minuteness, into its details. It will be proper first, however, to examine the consequences which will result from adopting the 206 locks; so that we may know accurately whether the objections to these locks are as great as they at first appear. This examination, as the construction of locks will be much more expensive than the inclined planes of Mr. Renwick, will be attended with the advantage of exhibiting the canal in the MOST UNFAVOURABLE point of view.

In respect to the expense of water, we will observe, that a boat leaving Easton for the Passaic will require two locks full of water for the passage—one on ascending the western, the other in descending the eastern section. But if, on arriving at the summit, this boat meets another just ascended from the eastward, the lock which has been filled for the ascent of that boat, will serve for the descent of this; in this case, the expense will be one lock full. The greatest quantity, therefore, that this boat will require will be two locks full, and the least, one lock full. But it is further to be observed, that from the nature of the trade upon the canal, whether the boats are loaded or empty, the number going one way will be about equal to those going the other; and that the empty boats might be obliged to wait the arrival of loaded

boats from the opposite section, or, which would add to the revenue, to pay as much toll as if loaded, though on this plan one lock full might be taken as the real expense of water in the passage of each boat, we will suppose, for the sake of having the estimate higher than is absolutely necessary, that the expense of water, by each boat, is one lock full and a half. This established, it is easy to estimate the total expense of water. Each lock, being 9 feet broad, 64 feet long, and 8 feet deep will contain 170.66 cubic yards, and one lock and a half 256 cubic yards: this must be reduced to 201 cubic yards, by deducting 55 cubic yards for the water displaced by a loaded boat, (that is, in one lock full the boat displaces 36.66 cubic yards, and in one and a half, 55 cubic yards). The number of tons of trade has been stated at 290,722, and, as each boat is to carry 25 tons, there will be 11,629 boat loads, which, at 201 cubic yards per boat, will give, for the annual expense of water, 2,337.429 cubic yards. It now remains to add to this loss of water that which goes off by evaporation; that which is lost by leakage through the banks and bottom; that which is lost by leakage through the gates, and that required to fill the canal at each annual opening of the navigation.

The evaporation from any given surface of water varies with the temperature, with the force of the winds agitating the surface, and with the elevation above the level of the sea. In warm climates water has a greater tendency to assume the state of vapour than in cold regions, the air in contact being more ra-



rified and opposing less resistance to the disengagement of the vapour: at a high elevation above the level of the sea the atmosphere is less dense, and presses less heavily upon the surface of the water, and, every thing else being equal, resists less the escape of the vaporized particles: and when the atmosphere is agitated by winds, the vapour is carried off with great rapidity by the continual succession of portions of dry air. From these remarks it will appear, that to know with precision what is the evaporation at any particular place, there should be a series of daily observations made upon the spot, and extended through several years; similar observations should be made of the annual quantity of rain; so that there might be a ratio established between the rain and evaporation.

We know of no such observations having been made in New Jersey, and as we have not time to obtain the results of those made in other parts of the Union, we find ourselves restricted to very few and partial results, as respects this country, and forced to rely mainly on those belonging to other countries. Though the conclusion will not be rigorously exact, it will nevertheless suffice for the object now in view.

Observations made in this country, and compared with similar ones in Europe, shew that though there are fewer rainy days here, the quantity of rain is greater than in Europe. The comparisons of Dr. Holyoke give 122 rainy days as the mean of twenty years, in twenty cities of Europe, and 88 rainy days per year for Cambridge, Mass. At the same time

that the number of rainy days in Europe exceed those in the United States by 34. the quantity of rain was found to be one-third less there than here. Evaporation is also found to be greater here than on the old continent. Mr. J. Williams gives 56 inches per annum for Cambridge, while the mean for seven German and Italian cities was only 49 inches; and the mean of four observers in England each including at least three years, was 36.45 inches. We have found that 35 inches of rain was observed to fall at Salem, Mass. and supposing the same quantity to fall at Cambridge, the rain there is to the evaporation as 35 to 36, which is a near approximation to the ratio of 3 to 5, (or 30 to 50) given by Halley, and to the mean ratio of 26.87 to 41.52, which we have found from an analysis of the results of seven observers in Great Britain and France. The first ratio above, expressed in simplest terms, is, 1 to 1.60; the second, 1 to 1.66, and the last, 1 to 1.54. The rain at Philadelphia is stated to be 32 inches: applying to this quantity the first ratio above stated, the result is about 51 inches of evaporation per annum; which exceeds the rain upon the surface of the canal by 19 inches, these 19 inches might be considered the real loss of water: but the canal can only be navigated during those eight months of the year (from April to December) when the evaporation will be greatest, and the rain least; and the instruments in use for measuring evaporation must always give results below the truth, from their not being exposed to winds and currents of air: we therefore adopt the whole sum of 51 inches,



as expressing the *maximum* loss of water by evaporation. The canal being 76 miles, or 133,760 yards in length, and 10 yards in breadth on the water line, its surface will be 1,337,600 square yards, which, multiplied by 51 inches or 1.427 yards, will give 1,895,379.2 cubic yards as the whole loss by evaporation.

Filtration through the banks and bottom of a canal causes a loss of water, which is by no means easy to estimate, depending, as it does as to quantity, not only on the manner in which the masonry and the earthen embankments are constructed, but upon the nature of the soil, which can only be known by actual excavation: if the earth is of clay—if the embankments are well shaped, well rammed, and of proper dimensions—if the masonry is executed with care, and on foundations well secured, then the loss of water will be the least possible: but experience has shewn that, with all possible precautions, this loss will be considerable, especially for several of the first years, and, that time alone can put an entire stop to the leakage. From allowances made in France, which seem to have been in accordance with the results, we take, as the least which it will be safe to adopt, 60,000 cubic yards per mile for the annual loss by filtration—and 60,000 multiplied by 76 (the number of miles) gives, 4,560,000 cubic yards.

In the above product is not included the leakage through the gates of the locks, which remains to be calculated. As we are now considering the canal as having a series of locks, we must reckon only the

leakage of the two gates at the extremities of the summit level, because the loss at the inferior gates, on both sections, will be supplied by the loss of these two upper locks. It has been shewn, by the experience of canals in operation, that the loss is about two locks full at each of these gates, making four locks full as the total loss per day. Each lock containing 170.66 cubic yards, this daily loss will amount to 682.64 cubic yards: supposing the navigation to be open for 8 months, or 240 days, if we multiply the 682.64 cubic yards by 240 we obtain 163,833.6 cubic yards for the annual loss by leakage at the gates.

Before we obtain the whole consumption of water by the canal, we have still to consider, that, as the canal will be left dry during the winter, it must annually be filled at the expense of the feeder. The profile of the canal being 88 feet, or 9.777 square yards, and its length 76 miles, or 133,760 yards, the total contents will be (133,760 by 9.777) 1,307,771.5 cubic yards.

*Recapitulation of the quantities of water (in cubic yards) used and lost by the Canal.*

| | |
|---|---|
| 1. For the passage of boats, | 2,337,429 |
| 2. For evaporation, - - | 1,895,379.2 |
| 3. For filtration through the banks and bottom, - - | 4,560,000 |
| 4. For leakage at the gates, - | 163,834.6 |
| 5. For filling the canal every spring, | 1,307,771.5 |
| | 10,264,414.3 |



From measurements made, by Mr. Renwick, of the water passing out of the Great Pond, it seems there is an annual supply of 55,021,991 cubic yards; without reckoning that which passes through its badly constructed dam. By making this dam tight, and raising it three feet, the water in the pond, which has an area of two square miles, or 6,195,200 square yards, will be augmented 6,195,200 cubic yards—which amount, added to the 55,021,991 cubic yards, gives for the supply of the pond, 61,217,191

Deduct the quantity required by the canal, *viz.* - - 10,264 413

And there remains a surplus of, c. yds. 50,952,778

A surplus greatly beyond the present or probable wants of the county.

In calculating the time required to make the passage of the canal, we will neglect the lengths of the locks, which make together 4,394 yards, and consider the length of the canal to be 76 miles, independent of the locks. At the rate of 4 miles per hour, which experience upon the New-York canals has fixed as the *maximum* velocity, this distance will be accomplished in nineteen hours.

As to the time which will be taken to pass the locks, we will assume the *maximum* given by experience, *viz.*

1st Case.—A descending boat, finding the lock full, 6 minutes, *viz.* 1 1-2 to enter, 3 to fill, and 1 1-2 to leave the lock.

2d Case.—A descending boat, finding the lock empty, 9 minutes, *viz.* 3 to fill, 1 1-2 to enter, 3 to empty, and 1 1-2 to leave the lock.

3d Case.—An ascending boat, finding the lock empty, 6 minutes, *viz.* 1 1-2 to enter, 3 to fill, and 1 1-2 to leave the lock.

4th Case.—An ascending boat, finding the lock full, 9 minutes, *viz.* 3 to empty, 1 1-2 to enter, 3 to fill, and 1 1-2 to leave the lock.

The mean of these 4 cases is 7 1-2 minutes, which being multiplied by 206, the number of locks, gives 25 hours and 45 minutes, for the time required to pass the locks; adding this to 19 hours, we have 44 hours and 45 minutes, or, reckoning 12 hours per day, nearly four days tor the voyage from the Delaware to the Passaic.

Still considering the canal as having locks throughout, it now only remains to examine into its cost. The estimate provided by the engineers, so far as it can be applied to our present supposition, will be given below: and in adopting this estimate we think it important to state explicitly that we believe it to be fully adequate, in all respects, to the construction of the canal. Taking, for example, the excavation and embankments, we find it estimated at $230,184: whereas on the supposition that the ground is level and uniform, the profile (before given) multiplied into the length gives 890,841.6 cubic yards, which at 8 cents per cubic yard (the price of ordinary excava-



tion on the New-York canal) amounts to only $71,-267.33, not quite one-third of the sum allowed by the engineers. The excess of $158,916.67 is undoubtedly ample to meet all expenses of deep and difficult cutting, and of embankments. All the other items of the estimate seem to us equally liberal. The following is a summary of that estimate.

*Excavation and embankment.*

| | | |
|---|---|---|
| For the western section, | $85,258 | |
| For the feeder from Hopat. | 3,500 | |
| For the eastern section, | 141,426 | |
| | | $230,184 |

*Masonry.*

| | | |
|---|---|---|
| For aqueducts and culverts, | $12,287 | |
| For the 206 locks, which our present examination supposes, at the rate of $3,200 each, or $400 a foot lift, | 659,200 | |
| | | 701,487 |
| 150 bridges, at $100, | | 15,000 |
| 76 miles of grubbing, at $200, | | 15,200 |
| 76 miles of fence, at $480, | | 36,480 |
| | | $998,351 |
| Expense of engineers and superintendant, at 5 per cent. | | 49.917.55 |
| Contingent expenses, at 10 per cent. | | 99,835.10 |
| Total expense of the canal with an entire system of locks, | | $1,148,103.65 |

The total expense being on the supposition of the use of locks throughout, must be considered the *maximum;* because we shall soon see, that by substituting the inclined planes invented by Mr. Renwick, and using locks only where the fall is too low to admit inclined planes, there will be a saving of $281,600. The cost of the land is not here estimated, as it is supposed that the owners, sensible of the advantages of having a canal at their doors, will demand little or nothing for it. At any rate, the cost cannot be much; for, taking the breadth occupied by the canal and its embankment at 19 yards, the quantity required will be but 526 acres.

On comparing this *maximum* expense with the *minimum* revenue, which we before obtained, *viz.* $214,275, (see page 14) we find that the investment will yield 18 2-3 per cent. per annum. And on the supposition that the cost of annual repairs and superintendence will amount to $1000 per mile, or $76,000, the net revenue will be $138,271, yielding a little more than 12 per cent. per annum.

From the considerations above stated, we come to the conclusion that, even with an entire system of locks, there are no real difficulties in the way of the proposed canal, whether we regard the cost, the supply of water, or the time required for the passage; and that the profits of such a canal may reasonably be expected to amount to 12 per cent. on the capital. We pass on now to an examination of the proposed canal in the most favourable point of view, that is, as it appears under favour of the ingenious invention of Mr. Renwick.



*Fixed locks* were for a long time the only means in use for getting over the elevations in the route of canals: but although they are certain and safe where there is a sufficiency of water, experience and reflection both shew that they are inapplicable where the quantity of water is small, and inadmissible where the elevations are so considerable as to extend the cost of construction, and the time of making the passage beyond certain limits. Even in cases where they are advantageously applied, there is this inherent objection, that they require more water to pass a boat than is sufficient to float the boat.

In passing, for example, from the level *S* to the level *I*, the quantity *a. b. c. d*, being of equal section with the canal, is sufficient to float the boat; but this must be sustained by the quantity *c, d, e, f*, which is of no other use, and which is lost by being necessarily drawn off by the lower level. Means have been devised for correcting this fault; but as we only advert to this matter with a view of comparing common fixed locks with Mr. Renwick's invention, it is unnecessary to detail them.

Several engineers of reputation have occupied themselves with researches, as to proper substitutes for locks in cases where these can only be applied disadvantageously. Messrs. Fulton, Leach, Reynolds, Deckars, Anderson, Rowland, Pickering, Weldon, and the Duke of Bridgewater, in England, and Solages, Bossut, and Forey, in France, have seve-

rally proposed plans of this nature; and some of them have been carried into successful operation. Reynolds constructed, at Ketley in Shropshire, an inclined plane with two parallel iron rail-ways: a a loaded descending boat, by means of a rope passing round a wheel at the upper end of the plane, drew up a half loaded boat. On the Duke of Bridgewater's canal is an inclined plane, analagous to the above, in full operation.

On the Ellismere canal, in Derbyshire, Rowland and Pickering constructed a moveable lock, with a vertical lift and counterpoise. Mr. Weldon employed nearly similar means in the coal canal near Bath; and lastly, a moveable lock, on similar principles with the last, was successfully applied by Forey, on the plans of Bossut and Solages, to the "Canal du Creusot" in France. The expedients proposed by these engineers are of two kinds—*first*, inclined planes with parallel rail-ways, on which the boats ascend and descend alternately; and *secondly*, vertical lifts, working in a similar manner. Either of these expedients is applied, and sometimes both, as local circumstances may require.

The invention of Mr. Renwick is of the first kind. It is an inclined plane, on which are fixed two parallel sets of iron rail-ways (see plan, profiles, &c. herewith) each set serving for a lock to ascend and descend. The lock is supported upon, and moves with, a carriage, the top of which is horizontal, the bottom being parallel with the inclined plane: under the bottom of the carriage, and securely fastened to it,



are a number of iron truck wheels in two rows, corresponding with, and revolving along, the rail-way belonging to the lock: two strong chains are secured to, and passed round, a drum at the end of the upper level, the other parts being brought down and fastened, one on each side, to the lower part of the lock: as each of these chains is strong enough to sustain a loaded lock, all danger of accident during the transit is guarded against. The two locks used by Mr. Renwick on his inclined plane are precisely alike, in all respects; but as there are two cases likely to occur in the application of this invention, requiring different methods of giving motion to the locks, it is necessary to describe the method devised for each. 1st. The case when the triangular space between the end of the lower level and the lower part of the inclined plane can be kept dry by draining. On this supposition, it will only be necessary to have a drum at the end of the upper level, extending across both rail-ways: to wind the chains of one lock around this drum, in a different direction from the chains of the other lock, and to have the chains of one lock wound up entirely, and the lock at the top of the plane while the chains of the other are unwound, and the lock at the bottom. Such being the arrangement, it is obvious, that by permitting the escape of a little water from the lower lock, the upper will preponderate, and by descending and turning the drum, wind up the chains of, and, of course, draw up, the lower lock; this will, however, be an accelerating motion, unless water is permitted to escape gradually from

the descending lock, because the lengthening chain in the one lock, and the shortening chain in the other, continually increase the preponderance of the descending lock. 2d. The case when, from there being no lower ground near, the triangular space must be kept full of water. Here the above simple arrangement will not answer, because the moment the descending lock enters the water of the triangular well it loses in relative weight, and soon ceases to preponderate. To surmount this difficulty, Mr. Renwick has introduced the following very ingenious device. Instead of a common drum to both locks, there is one for each lock, and each drum is provided with two spur-wheels of different diameters: the two small wheels of the two drums are, however, alike, as to the diameter and number of teeth, as are the two larger wheels. The intention of this contrivance is, that by gearing the large wheel on the drum of the lock about to descend, with the small wheel on the other, the descent of one lock to the edge of the water will draw up the other the whole length of the plane; because, a given number of revolutions of the larger will produce a greater number of revolutions in the smaller wheel, and, of course, in the drum on which the chains are wound: but the descending lock, after effecting a complete transit of the ascending lock, has still a short descent to make before arriving at the end of the lower level; this is done by ungearing the drums entirely, and letting the lock descend by its own weight, taking care,



however, to check this motion properly, in a way not unlike that of checking the chain cables of ships.

The passage of boats from one level to another, on this plan, is a very simple operation, in either of the cases stated above. A boat, arriving at either end of the inclined plane, passes, at once, into the moveable lock, which, being fastened to the end of the canal level, is, as it were, a prolongation of that level; the gates are then shut, and the transit takes place whether there be a boat in the other lock or not.

Before comparing the expense of these moveable locks with that of fixed locks, we will observe, that the correctness of the principles on which this invention depends, and the success of like contrivances in Europe, leave no reason to doubt of its perfect fitness to the object in view, and of its great utility.

A just comparison of these with ordinary locks requires an examination of the cost of construction, the loss of water, and the consumption of time.

From Mr. Renwick's estimate, it appears that a foot lift of the inclined plane, with its iron rail-ways, and the chains for the locks, costs $133.63.

| | |
|---|---|
| The moveable locks, - - | $824.00 |
| The masonry, wood work, and machinery, at the top and bottom of the inclined planes, - - - | 2,312.00 |
| | $3,136.00 |

The first sum above stated must, in each case, be multiplied into the number of feet lift required for the

inclined plane; the second, being a constant quantity, is to be added to that product for the whole expense. As one of these is a constant, and the other a variable quantity, the price per foot lift will be variable, diminishing continually with the increase of the number of feet in the lift: and, as the constant quantity is considerable, it will be found, that at short lifts the advantage, as to expense, will be in favour of fixed locks; but the inclined plane is inapplicable when the length does not exceed a certain quantity; and it will be found, by consulting the following table, that there will be considerable economy in its use, from the moment the fall is great enough to admit its application. It will also be seen, on reference to the table, that the price of fixed locks per foot rise (with a given lift to each lock) is constant, and that for 48 feet of rise the whole expense is about twice, and for 120 feet about twice and a half as much as that of moveable locks. The table is calculated on the supposition that the inclined plane makes an angle of 14 deg. 28 min. 40 sec. with the horizon, or, in other words, that the vertical rise being one, the length of the inclined plane is four.

[It will be observed that the two first quantities in the last column of the table are in favour of the common fixed lock, all the other being in favour of the inclined plane.]



TABLE shewing the comparative expense (in dollars) of moveable and fixed locks, from 8 to 152 feet rise.

| | Vertical heights of incl'd plane. | Length of the inclined plane. | Price per ft. lift of incld. plane with mov. locks. | Total price of the whole lift with mov. locks. | Price per ft. lift of com. locks. | Total price of the whole lift with com. locks. | Difference in total cost between fixed and moveable locks. |
|---|---|---|---|---|---|---|---|
| 1 | 8 | 80 | 525.50 | 4205.04 | 400 | 3,200 | 1,005.04 |
| 2 | 10 | 96 | 447.23 | 4472.30 | | 4,000 | 472.30 |
| 3 | 12 | 112 | 394.96 | 4739.56 | | 4,800 | 60.44 |
| 4 | 16 | 128 | 329.63 | 5274.08 | | 6,400 | 1,125.92 |
| 5 | 20 | 144 | 290.43 | 5808.60 | | 8,000 | 2,191.40 |
| 6 | 24 | 160 | 264.30 | 6343.12 | | 9,600 | 3,256.88 |
| 7 | 28 | 176 | 245.63 | 6877.64 | | 11,200 | 4,322.36 |
| 8 | 32 | 192 | 231.63 | 7412.16 | | 12,800 | 5,387.84 |
| 9 | 36 | 208 | 220.74 | 7946.68 | | 14,400 | 6,453.32 |
| 10 | 40 | 224 | 212.03 | 8481.20 | | 16,000 | 7,518.80 |
| 11 | 44 | 240 | 204.90 | 9015.72 | | 17,600 | 8,584.28 |
| 12 | 48 | 256 | 198.96 | 9550.24 | | 19,200 | 9,649.76 |
| 13 | 52 | 272 | 193.93 | 10084.76 | | 20,800 | 10,715.24 |
| 14 | 56 | 288 | 189.63 | 10619.28 | | 22,400 | 11,780.72 |
| 15 | 60 | 304 | 185.89 | 11153.80 | | 24,000 | 12,846.20 |
| 16 | 64 | 320 | 182.63 | 11688.32 | | 25,600 | 13,911.68 |
| 17 | 68 | 336 | 179.75 | 12222.84 | | 27,200 | 14,977.16 |
| 18 | 72 | 352 | 177.04 | 12757.36 | | 28,800 | 16,042.64 |
| 19 | 76 | 368 | 174.89 | 13291.88 | | 30,400 | 17,108.12 |
| 20 | 80 | 384 | 172.83 | 13826.40 | | 32,000 | 18,173.60 |
| 21 | 84 | 400 | 170.96 | 14360.92 | | 33,600 | 19,239.08 |
| 22 | 88 | 416 | 169.25 | 14895.44 | | 35,200 | 20,304.56 |
| 23 | 92 | 432 | 167.71 | 15429.96 | | 36,800 | 21,370.04 |
| 24 | 96 | 448 | 166.29 | 15964.48 | | 38,400 | 22,435.52 |
| 25 | 100 | 464 | 164.99 | 16499.00 | | 40,000 | 23,501.00 |
| 26 | 104 | 480 | 163.78 | 17033.52 | | 41,600 | 24,566.48 |
| 27 | 108 | 496 | 162.66 | 17568.04 | | 43,200 | 25,631,96 |
| 28 | 112 | 512 | 161.63 | 18102.56 | | 44,800 | 26,697.44 |
| 29 | 116 | 528 | 160.66 | 18637.08 | | 46,400 | 27,762.92 |
| 30 | 120 | 544 | 159.76 | 19171.60 | | 48,000 | 28,828.40 |
| 31 | 124 | 560 | 158.92 | 19706.12 | | 49,600 | 29,993.88 |
| 32 | 128 | 576 | 158.12 | 20200.64 | | 51,200 | 30,959.36 |
| 33 | 132 | 592 | 157.40 | 20775.16 | | 52,800 | 31,024.84 |
| 34 | 136 | 608 | 156.68 | 21309.68 | | 54,400 | 32,090.32 |
| 35 | 140 | 624 | 156.03 | 21844.20 | | 56,000 | 34,155.80 |
| 36 | 144 | 640 | 155.40 | 22378.72 | | 57,600 | 35,221.28 |
| 37 | 148 | 656 | 154.82 | 22913.24 | | 59,200 | 36,286.76 |
| 38 | 152 | 672 | 154.26 | 23447.76 | | 60,800 | 37,352.24 |

What has been said is sufficient to shew the great advantage, as to economy, which these moveable locks have over the common fixed locks; but in relation to comparative expense, it only remains to add, that this advantage will increase with the sines of the angles of elevation of the inclined planes, up to that degree of elevation which experience shall shew it will be hazardous to exceed.

The quantity of water used by these moveable locks is the least possible, since they contain no more than is sufficient to float the boat, which, as has been said, is far from being the case with fixed locks. It is true, that if a moveable lock, having descended without a boat, receives a boat at the lower level to carry up, it will lose part of the water brought down; but this is compensated when the case is the reverse—that is, when the lock, having brought down a boat, is to ascend without one; for then the lock receives water from the lower, to carry back to the upper level. The absolute loss for each transit being always only that which is permitted to escape from the lock at the bottom, that the lock at the top may preponderate sufficiently to overcome the friction of the truck wheels.

As the moveable locks contain no more water than is necessary to float the boat, no time is lost, as is the case in fixed locks, in emptying and filling them. On the entrance of a boat, the water which is displaced passes into the canal, and, on its exit, water rushes into the lock to fill the space it occupied, the trifling deficiency of water in the ascending boat mak-



ing no sensible difference. The time employed by a boat, therefore, in making a transit from one level to another, is consumed—1st, in entering a lock; 2d, in moving along the inclined plane, and 3d, in passing out of a lock. Supposing the lifts to be 64 feet, and the inclination of the plane 14 deg. 28 min. 40 sec. the length to be moved over by the boat will be 250 feet: this might be passed very rapidly; but, with a view to save the machinery and to guard against accidents, and also to allow for the time required to adjust the locks to the end of the canal, and to regulate the preponderance of the upper boat, we take 20 feet per minute as the velocity of the locks; in these suppositions the time consumed will be as follows:

| | |
|---|---|
| To enter the lock, - - - | 1 1-2 |
| To move over the inclined plane - | 12 1-2 |
| To leave the lock, - - - | 1 1-2 |
| Total, 15 1-2 minutes to rise 64 feet. | 15 1-2 |

For the same height of 64 feet, with 8 common locks, at 7 1-2 minutes each, the time would be 60 minutes, or four times that required by moveable locks.

We might shew, in addition to the above striking general advantages, the great superiority of the moveable lock in case of a great and sudden descent where common locks must necessarily be contiguous or near to each other; but we consider all further comparisons of this sort superfluous.

It has been before stated, that the whole ascent and descent of the Morris Canal is 1644 feet, and that to pass the 206 fixed locks which that number of feet requires, would take 25 hours and 46 minutes, which, added to the 19 hours required to pass along the levels, gives a total of 44 hours and 45 minutes, or at 12 hours a-day, 3 2-3 days. But by combining the system of fixed locks with inclined planes as Mr. Renwick proposes, the whole passage will be made in 28 hours and 33 1-2 minutes, or in 2 1-3 days, as will be seen below. Along the route of the canal there are several small depressions of level, in which fixed locks alone can be used; and the whole amount of these is 244 feet, leaving 1400 feet for the inclined planes. Giving 8 feet lift to the locks, and 64 feet to the planes, the time occupied in the passage will be as follows:

| | | | |
|---|---|---|---|
| For 244 feet lift with locks, requiring 31 locks, at 7 1-2 minutes each, | 3 | 52 | 1-2 |
| For 1400 feet lift with planes, requiring 22 planes, at 15 1-2 minutes each, | 5 | 41 | |
| For passing along the levels, (as before stated) - - - | 19 | 00 | |
| Total time in hours and minutes, | 28 | 33 | 1-2 |

The gain will therefore be 1 1-3 days in each passage.

We will now see what this will amount to as regards economy of transportation, both with respect to the boats and to the men, &c. employed with them.

Supposing 291,000 tons are to be transported from



the Delaware to the Passaic in 8 months, or 240 days, there will be 1212.5 tons per day; which, at 25 tons a boat, will require 48 boats to leave the Delaware daily. With a system of locks 3 2-3 days will be consumed in reaching the Passaic, 1 day in unloading, 3 2-3 days in returning, and 1 day in taking in a new cargo, making 9 1-3 days: it will be necessary, therefore, if 48 boats are to leave the Delaware every day, to employ 9 times 48 boats, or in the whole 432 boats. But with the system of inclined planes, combined with locks, 2 1-3 days will be consumed in the passage, 1 day in unloading, 2 1-3 days in returning, and 1 day in taking in a new cargo, making only 6 2-3 days: on the 7th day the boats might begin the second voyage; but we will suppose that they do not till the 8th, which will require seven times 48 boats, or in the whole 336 boats. Now as 336 is about the four-fifths of 432, it follows that there will result a saving of about 20 per cent. on the charter of the boats. A like economy will result in regard to the men employed with the boat: for in one case 864 men must be employed during 8 months, and in the other only 672, to transport the 291,000 tons, giving a saving of about 20 per cent. in the number of men. The consequence will be the same also, as regards animal labour: and it is scarcely necessary to remark, that all these savings must diminish the price of freight in the same proportion. It is proper, in this place, to ascertain what is the total amount of trade, in tons, which can be passed through the canal in a year. Taking the day at 12 hours, and

the number of days at 240—we will suppose that the first boat entering the canal finds the river-lock full, (4th case, page 26) which will require 9 minutes for the passage; the second boat, supposing an equal number of boats to pass each way, being obliged to wait 6 minutes for the descent of the boat coming from the opposite direction, (1st case, p. 25) and requiring 6 minutes for its own passage, (3d case, p. 26) will consume 12 min. in getting through the first lock; the third boat will also consume 12 minutes; the fourth the same, and so on. Reckoning from the moment the first boat is ready to enter, the following times will respectively elapse between that moment and the complete transit of the several successive boats.

1 boat 9 minutes,
2 do. 9 *plus* 12 minutes,
3 do. 9 *plus* twice 12 minutes,
4 do. 9 *plus* thrice 12 do. and so on.

Continuing the series, we find that the sixtieth boat will have completed her passage only after 9 minutes *plus* 59 times 12 minutes have elapsed, making 717 minutes, or 11 hours, 57 minutes. Sixty boats may therefore enter the canal in one day, at the same time permitting an equal number to leave the canal. Sixty, the number of boats passing each day, multiplied into 240, the number of days, gives 14,400 boat loads, which multiplied by 25 tons, the weight of each load, gives, as the amount of trade, 360,000 tons per annum. This trade, from what has been said before, will require, with a system of locks,



the employment of 9 times 60, or 540 boats. Applying the same sort of calculation to inclined planes, we find, that as a boat requires 15 1-2 minutes (according to our previous estimate p. 37) to pass the average lift of 64 feet, only 46 boats can pass in a day of 12 hours (12 hours, or 720 minutes divided by 15 1-2 gives 46.4); and, each, being loaded with 25 tons, the whole amount of trade passed along the canal, will be 276,000 tons. Although this amount of 276 000 tons is less than that which might be passed through a canal with locks, and less than the estimate of the anticipated trade, which we made, 291,-000 tons (see p. 14) the canal with inclined planes may still be considered as fully adequate to this, and even a greater activity of transportation; because in the above calculation we assumed the day as of 12 hours length, whereas in summer they extend to 14 and 16 hours. The transportation of the 291,000 tons will employ 336 boats, 672 horses, supposing a relief of horses at one end of the canal, and 672 men and boys.

We have now to compare the expense of the two systems. The first amounts, according to the estimate given, (p. 27) to $1,148,103.65. To obtain the other, we suppose that an inclined plane of 64 feet lift will answer as the mean of the whole: and we might take the sum of $182.63 (found in the table) as the proper price, but with a view of being above, rather than under the cost, we shall assume $200, as the price per foot lift. On this assumption, the cost of the Morris Canal, with both locks and inclined planes, ac-

cording to the plan of Mr. Renwick, will be as follows:

| | | |
|---|---|---|
| *Excavations and embankments.* | | |
| *Of the western section, | $85,258 | |
| *Of the feeder and dam at Brookland, - | 3,500 | |
| *Of the eastern section, | 141,426 | |
| | | $230,184.00 |
| *Masonry.* | | |
| *Of the culverts and aqueducts, - - | $12,287 | |
| Of 244 feet lift of locks, at $400 per foot, - | 97,600 | |
| | | 139,887.00 |
| *1400 feet lift of inclined planes, with moveable locks, at $200 per foot, | | 280,000.00 |
| *150 bridges, at $100 each, - | | 15,000.00 |
| *76 miles of grubbing, at $200 per mile, | | 15,200.00 |
| *76 miles of fence, at $480 per mile, | | 36,480.00 |
| Engineering and superintendence, say 5 per cent. - - | | 35,837.55 |
| Contingent expenses, say 10 per cent. | | 71,675.10 |
| Total expense of proposed canal, | | $824,263.65 |

[*Note.*—The items marked thus (*) are common to both estimates.]

| | |
|---|---|
| Total expense, with an entire system of locks, - - | $1,148,103.65 |
| Total expense, with locks and inclined planes, - - - | 824,263.65 |
| Difference in favour of Mr. Renwick's plan, | $323,840.00 |



By comparing the cost of $824,263.65, with the *minimum* net revenue of $138,271, (see p. 28) we find that an interest will accrue from the whole investment of 16.77 per cent., while that accruing on the supposition of a system of locks was found to be 12.04 per cent., giving a difference of interest in favour of Mr. Renwick's project of 4.73 per cent.

We here terminate our report on the projected Morris Canal; having gone into the extended and minute examination which we thought due to a project so important in its local and general relations. This examination shews that the project, under any point of view, is practicable as to cost, and promising as to revenue; but that in both these respects there is a decided preference to be given to a system of inclined planes combined with fixed locks, as proposed by Mr. Renwick. It is greatly to be desired, therefore, that the invention of this gentleman may be sanctioned by experience, because not only will the execution of the design, as it slowly progresses, enable him to mature and perfect its details; but it is experience alone which can effectually remove the fears and doubts with which inventions the most useful are at first regarded. To us, however, whether we consider the economy, the utility, or the durability of these inclined planes, ALL IS CERTAIN; and we look confidently forward to the day when their introduction will be regarded as a most important era in the history of canal navigation, and especially in this country, to which they are so peculiarly adapted.

We connect, with this report, a "Map exhibiting the route of the proposed canal from the tide water of the Passaic river to the Delaware river; with the adjacent country"—a "Map shewing the relation of the proposed canal with the upper basins of the Delaware and Susquehannah rivers"—and a sheet containing a plan, profile and elevation of Mr. Renwick's inclined plane.—All which is most respectfully submitted.

S. BERNARD,
*Brig. Gen.*

JOS: G. TOTTEN,
*Major Engineers, Brevet Lieut. Col.*



PROFILE OF A CANAL.

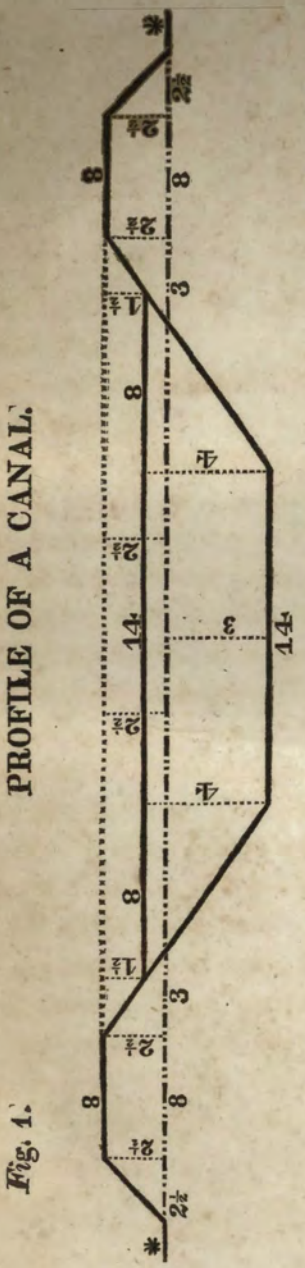


Fig. 1.

* Natural Surface.

A LOCK.

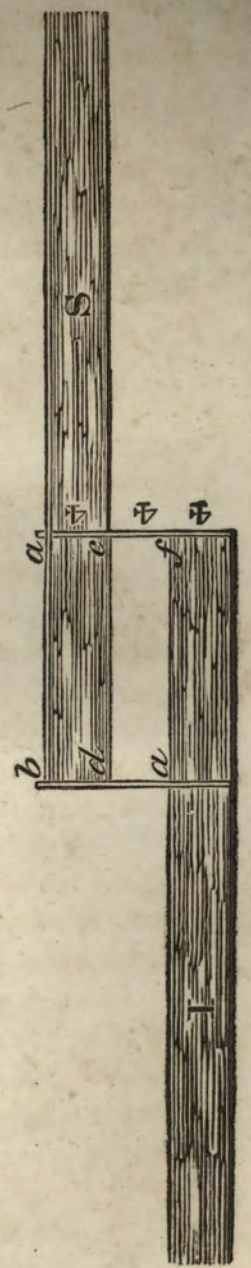


Fig. 2.