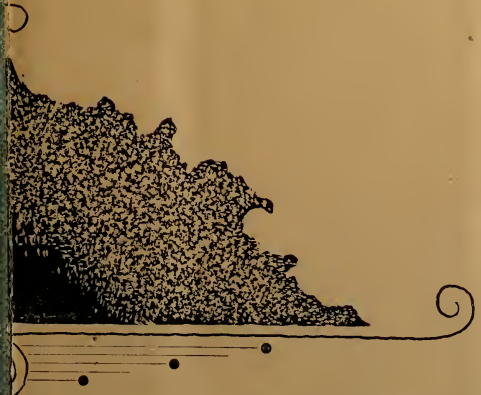
LAKE ERIE AND OHIO RIVER

SHIP CANAL

Pamphlet No 1.

Lake Erie and Ohio River Ship Canal.



Pittsburgh

PROVISIONAL COMMITTEE, LAKE ERIE AND OHIO RIVER SHIP CANAL

GENERAL MAP
PROPOSED
WATER WAY CONNECTIONS
BETWEEN
THE OHIO RIVER & LAKE ERIE
VIA THE BEAVER RIVER

WITHIN THE LIMITS OF THE CIRCLE THERE ARE 37 FURNACES WITH A WEEKLY CAP. OF 73,500 TONS AND MAKING NEARLY ONE THIRD OF ALL THE PIG METAL PRO. DUCED IN THE UNITED STATES FOR A DIST. IN 1890 1,508,564

ILLUSTRATING Areas of bituminous coal available for water supply on the several outlets. The Coal development in SW. Pennsylvania and part of West Va. The Furnace and Iron manufacturing district to be served by the proposed canal &c

SCALE OF MILES.

LAKE ERIE

CHAUTAUQUA

NEW YORK

ALLEGHENY BASIN

3600 SQUARE MILES

ERIE

CONNEAUT HARBOR

ASHTABULA HARBOR

FAIRPORT

ROUTE

FRENCH CREEK BASIN 550 SQUARE MILES

OIL CREEK BASIN 220 SQ. MI.

WARREN

CONNEAUT BASIN 190 SQUARE MILES

MEADVILLE

ASHTABULA

CLEVELAND

GEAUGA

CUYAHOGA

PORTAGE

TUSCARAWAS BASIN 1900 SQ. MILES

FEEDER

SHENANGO

FRANKLIN

VENANGO

TIONESTA BASIN 650 SQ. MI.

FOREST

ELK

PRUMBULL

MERCER

SUMMIT

PORTAGE

WARREN

CLARION

BROOKVILLE

JEFFERSON

MAHONING BASIN 300 SQ. MILES

MAHONING

MAHONING

LAWRENCE

BUTLER

STARK

COLUMBIANA

CANTON

NEW LISBON

ARMSTRONG

KITTANNING

BEAVER

INDIANA

CARROLL

CARROLLTON

ALLEGHENY

PITTSBURG

TUSCARAWAS

HARRISON

CADIZ

WESTMORELAND

WASHINGTON

GUERNSEY

BELMONT

SOMERSET

LIMITS OF PITTSBURGH COAL VEIN

NOBLE

MONROE

GREENE

FAYETTE

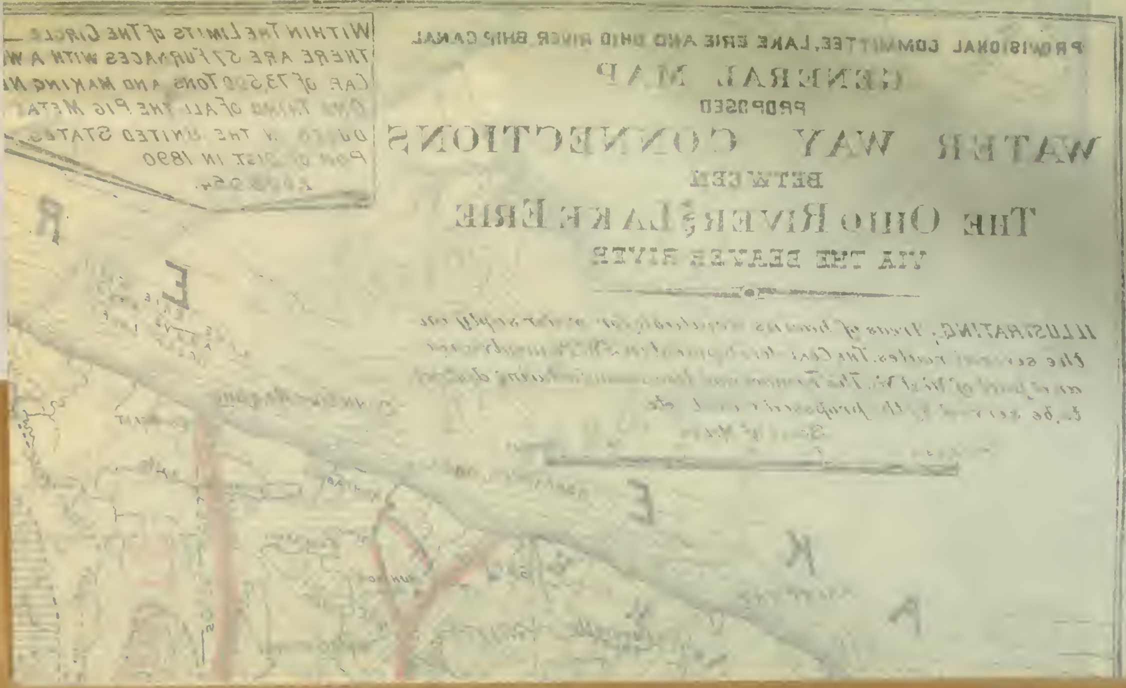
WASHINGTON

WETZEL

MONONGALIA

GARRETT

MARYLAND



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LAKE ERIE AND OHIO RIVER SHIP CANAL.

ORGANIZATION,

REPORTS OF COMMITTEES

AND OTHER PAPERS

APPROVED BY THE

PROVISIONAL COMMITTEE

—OF THE—

CHAMBER OF COMMERCE,

—OF—

PITTSBURGH PA.

ORDERED TO BE PRINTED OCTOBER 9TH, 1894

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Address.

CHAMBER OF COMMERCE ROOMS,
PITTSBURGH, PA.

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Proceedings in the Chamber of Commerce of Pittsburgh, Pa., Organizing the Provisional Committee.

On March 27th, 1893, Col. Thomas P. Roberts read a paper before the Chamber of Commerce, of Pittsburgh, on "The Commercial Outlets of the Great Lakes, with Special Reference to the Lake Erie and Ohio River Ship Canal," including an outline of some of the important facts ascertained by the Penna. Ship Canal Commission, authorized by Act of May 8, 1889.

This paper received the indorsement of the Chamber and was ordered to be printed.

On April 23, 1894, John E. Shaw, Esq., read a paper before the Chamber of Commerce (see page 32) setting forth the great benefits to be secured by the communities in Western Pennsylvania, Eastern Ohio and West Virginia from the construction and operation of a ship canal between Lake Erie and the Ohio River via the Beaver route, and that the time had arrived when there was necessity to put forth an organized effort to secure that desired end, and suggested the building of said ship canal by a corporation backed by private capital and recommended by the Chamber of Commerce appointing a Provisional Committee to investigate the merits of the project, and if approved by them to carry the project forward to the creation of such a corporation and securing the financial support necessary.

At the conclusion of this paper Col. Thomas P. Roberts presented the following resolution to the Chamber:

Resolved, That a committee of five be appointed by the President to take into consideration the advisability of the Chamber of Commerce organizing a Provisional Committee to promote interest in the matter of the construction of the projected Lake Erie and Ohio River Ship Canal.

On motion the resolution was referred to the Committee on Rivers and Harbors.

Provisional Committee Recommended.

At the meeting of the Board of Directors, held May 7, 1894, Captain C. W. Batchelor, of the Committee on Rivers and Harbors, presented the above resolution of Colonel T. P. Roberts with an affirmative recommendation, which, on motion, was adopted.

President George A. Kelly appointed the following named gentlemen on said committee:

C. W. Batchelor, Morrison Foster, John F. Dravo, William P. Herbert and W. Harry Brown.

At the regular meeting of the Board of Directors, held June 11, 1894, Captain C. W. Batchelor, of said committee of five, made a full and exhaustive report, (see page 52), recommending the building of the ship canal, connecting Lake Erie and the Ohio River via the Beaver route, by a corporation backed by private capital, and recommending the appointment of a Provisional Committee of not less than 25 members, to have full charge of promoting and carrying forward the interests of said ship canal, etc., and to carry out the purposes set forth in the report.

On motion of Mr. John F. Dravo it was unanimously agreed that the report be approved and that its recommen-

dations be carried out, and that said Provisional Committee be appointed.

On July 2, 1894, President George A. Kelly appointed the Provisional Committee, consisting of 35 members, four of whom declined to serve, on account of their inability to attend its meetings, but expressed their confidence in and strenuous support for the undertaking.

On July 27, 1894, President George A. Kelly, of the Chamber of Commerce, issued a call for a meeting of the Provisional Committee to be held in the Chamber of Commerce rooms, Pittsburgh, Pa., on Tuesday, August 21, 1894, at 10 o'clock, A. M., for the purpose of effecting a permanent organization.

JOINT REPORT OF EXECUTIVE AND FINANCE COMMITTEES,

OCTOBER 9, 1894.

At a joint meeting of the Executive and Finance Committees, held October 9th, 1894, at 10:30 o'clock, A. M., it was decided to submit to the Provisional Committee the following report with the recommendation therein contained:

WHEREAS, The Engineering Committee has inspected and examined the proposed routes for a ship canal connecting Lake Erie and the Ohio River via the Beaver River, and

WHEREAS, Said committee has reported that upon examination it is in their opinion entirely practicable to build a ship canal by some of the proposed routes connecting Lake Erie and the Ohio River, and

WHEREAS, Said committee also reports having examined the Mahoning-Warren route to Lake Erie, which has never been surveyed, and that said route seems to possess advantages over the Shenango-Conneaut route in that i crosses the lowest possible divide between the Ohio River, at the mouth of the Beaver River, and Lake Erie, thereby involving less lockage and possibly less expense both in the construction and operation of the canal, and increased territory for water supply, and

WHEREAS, Said committee recommend and ask for the expenditure of money in making a preliminary survey of said Mahoning - Warren route, to determine its advantages, before recommending a route for the final approval of the Provisional Committee as the location of said ship canal,

THEREFORE, We deem it advisable at the present time and recommend the creation of a guarantee fund to enable the Provisional Committee to proceed in the promotion of this great enterprise; that the conditions to the subscription to said fund be now fixed and determined; and that said conditions be made as liberal as is consistent with justice and equity to the public, and especially to the residents in the districts to be benefitted by the canal who may appreciate the advantages to them individually and to the communities in which they live, and to the great commercial interests therein representing vested capital, and who may back their faith in the project by subscribing to the guarantee fund; that said fund at the present time be fixed, determined, and limited to a sufficient amount not only to cover the cost of preliminary surveys necessary to determine the final adoption of route, but also the final and detailed surveys necessary on the route adopted, and to cover also the expenses of the Provisional Committee in carrying forward the project to the procuring of the necessary chartered rights, the formation of a legal corporate existence, and to the point where the active work in the construction of the canal may begin, and the procuring of the capital necessary therefor.

THEREFORE, We recommend the creation of a guarantee fund not exceeding One Hundred Thousand Dollars ($100,000), and offering the same to the public for subscription pursuant to the terms and conditions given in the resolution below.

It being understood that, should the whole or any part of said fund be subscribed, the Provisional Committee will only issue calls from time to time upon the subscribers

thereto for amounts sufficient to meet the expenses of the committee as their work progresses.

In recommending the creation of this guarantee fund, we have every confidence in the public generally, and particularly in the people of Western Pennsylvania, Eastern Ohio and West Virginia, giving us not only their moral but financial aid in successfully carrying out this important enterprise.

THEREFORE, We recommend for adoption the following resolution:

Resolved, First, That a Guarantee Fund not exceeding One Hundred Thousand Dollars ($100,000.00) be created for the purpose of meeting the expenses of the work necessary to be done by the Provisional Committee to successfully carry forward and promote the interests of the Lake Erie and Ohio River Ship Canal, by way of thoroughly demonstrating its practicability, utility, cost and profit to the capital invested, and clothe it with the necessary corporate powers, and advance it to the position where its securities offered for capital will command the recognition and confidence of the entire financial world.

And believing that the subscribers to this Guarantee Fund will be the direct instruments in securing the successful promotion and building of the canal, and that the money contributed by the public to this fund will have a more vital relation to its existence, success and ultimate welfare than any money contributed to it in the future, that any preference or advantage that may be legitimately offered the subscribers thereto by way of remuneration for the tangible expression of their confidence and support at this critical period is equitable and just.

Second, That pursuant thereto, said fund be opened to the public for subscription upon the following terms and conditions:

1. When the proposed canal company shall be legally incorporated and legally authorized to issue shares, each subscriber shall receive an allotment of shares full paid and non - assessable, the par value of which shall equal five times the amount of his subscription actually paid in under pro-rata calls of the committee, as compensation for the money contributed, and the use thereof, and the service rendered.

2. Should more than One Hundred Thousand Dollars be subscribed, then the calls shall issue upon all subscribers only pro - rata for the amount needed by the Provisional Committee not exceeding said limit of One Hundred Thousand Dollars, and calls shall not issue until at least Twenty-five Thousand Dollars of said fund is subscribed, and no subscription under Fifty Dollars shall be received, and at any time after the subscription reaches One Hundred Thousand Dollars, the committee reserves the right to close the subscription to the fund by public notice, in three daily papers, of Pittsburgh, Pa.

3. If the necessary chartered powers be obtained, and a company be duly incorporated and the requisite amount of capital be subscribed thereto, the subscriber to be entitled to repayment of his contribution instead of taking shares if he so elects, together with interest thereon.

4. The subscriber's liability to be limited to the amount of his subscription.

5. The agreement to subscribe, and the above conditions shall be deemed a contract with, and be binding upon, the Provisional Committee, notwithstanding any changes in its constitution.

6. The Provisional Committee is to be considered simply as the agents of the subscribers to said fund, and are liable to carry out the conditions of said subscription so far as it lies within their power as agents, but in no case is an individual liability to attach to the several members of said committee.

C. W. Batchelor,
Chairman Executive Committee.

John B. Jackson,
Chairman Finance Committee.

Report of the Committee on Engineering to the Provisional Committee.

OCTOBER 9, 1894.

The Engineering Committee met Thursday, September 20th, 1894, and organized by the election of Thos. P. Roberts, Chairman, and John E. Shaw, Secretary.

Pursuant to instructions given them at the last meeting of the General Committee, held September 4th, 1894, it was decided to begin the inspection and reconnoisance of the various routes for the canal, via the Beaver river, on Monday, September 24th, 1894.

In presenting a report upon our recent examination of the country between Pittsburg and Lake Erie, to determine the feasibility of the several routes which have been proposed for ship canals, connecting the Ohio with the lakes, some explanation concerning the geography and topography of the country traversed, as a prelude, is necessary to a proper understanding of the engineering problems involved in such an important undertaking, and this explanation seems specially desirable for the region in the neighborhood of the summit levels.

The most casual examination of any reliable map discloses the fact that the least distance separating the Ohio river from Lake Erie is to be found near where the Pennsylvania state line crosses the river, from which point to Cleveland, upon

an air line, the distance is only 85 miles. The shortest practicable canal route in the neighborhood of this air line is undoubtedly via the Beaver river and one or the other of its chief tributaries to the summit, or dividing ground, and thence to the nearest available harbor, as, for instance, Conneaut, or Ashtabula, harbors.

The Beaver enters the Ohio 26 miles below Pittsburg, and its general direction seems to be almost a continuation of the northwest course of the Ohio from Pittsburg toward the lake. The Beaver and its main tributaries, viz.: the Shenango and the Mahoning, in respect to directness of valley lines, are, indeed, remarkable as compared with the Monongahela, the Youghiogheny, the Allegheny and other chief valleys of Western Pennsylvania, which, generally speaking, abound with turns and bends.

The engineers of the Pennsylvania Ship Canal Commission report the line recommended by them for a canal from the mouth of the Beaver via the Shenango to Conneaut harbor, Ohio, to be only 105 miles in length, or only four miles longer than an air line between the terminals named. So also by the Beaver and its Mahoning branch, via Warren to Ashtabula, the distance will be found to not be materially, if indeed any longer; and thus it is that these two main prongs of the Beaver afford a choice of routes to the dividing ground, or "lake rim," separating the waters flowing northward to Lake Erie and southward to the Ohio. Upon the elevation of the divides in connection with the available sources of water supply, depends, very largely, their respective merits for consideration as practicable routes for canals.

The lowest summit route, provided an ample water supply can be found for it, requiring as it would the least lockage, and other things equal, the least time lost in navigating a vessel from the lake to the river, or *vice versa*, would be the best from an engineering standpoint. When to the advantage

of least lockage the shortest possible distance is added, a combination is had for which a large additional expense over other routes, in which said combination would be impracticable, would be warranted. Besides the matter of length and lockage, DIRECTNESS of route, that is to say, avoidance of curvature, or its reduction to a minimum, is something to be looked after much more carefully upon a ship canal than it is upon a railroad route, and almost as if nature had this point in view, she has carved from the lake terrace towards Pittsburg—from Sharpsville on the Shenango, and from Warren on the Mahoning (both points about 80 miles distant from Pittsburg)—water courses on very direct lines susceptible of being converted into canals of very noble proportions, leaving only about 50 miles of a country, for the most part nearly level, for art to try its skill in completing its well intended work.

Your committee cannot say that it has made more than a cursory examination of the country between the mouth of the Beaver and Lake Erie. With the aid of the profile and maps of the recent canal surveys via the Shenango to Conneaut, and with data of the old abandoned canal to Erie, railroad, and geological elevations, etc., assisted as we were also by the information imparted by several engineers and surveyors acquainted with the country, the committee did, however, secure a valuable fund of useful information touching upon the topography, water supply, etc.

The Provisional Committee desired, and could only reasonably expect from us at this time, a report embodying recommendations as to what additional surveys, if any, should be made, to demonstrate the facts regarding the several routes, as to water supply, length, lockage and approximate cost in construction. Incidentally, the commercial advantages of the various routes should be set forth, along with the terminal facilities of the several lake harbors, to which proposed lines

may extend, and would necessarily form features of a proper report to be expected from the engineers who made the surveys. This committee cannot more than touch upon such points, but it will commend the wisdom of the Provisional Committee in leaving the determination of routes open beyond the point marked by the junction of the Beaver and the Shenango rivers.

The Region of the Divide.

The mean level of Lake Erie is about 573 feet above mean ocean level. The crest line, or the divide south of the lake, in the district between Ashtabula and Erie, varies in distance from the lake, from more than 30 miles, as at the head of the Grand river; just north of Warren; to about 12 miles, as upon the Pennsylvania–Ohio state line. This so-called "lake rim," or divide, is not, as some suppose, a sharp apex or "backbone," but on the contrary, in some places it is quite flat, covering an extended area of thousands of acres of swampy ground, giving rise occasionally to miniature lakes. It is affirmed that individuals have in wet spring seasons rowed small boats across from the waters of the Mahoning, to the Grand river, in Ohio, and the same thing is at certain seasons almost practicable from the head of the Shenango to Conneaut creek. Separating these low, marshy passes there are extensive hills, sometimes 200 or more feet high, measured from the swamps at their base, along the axis of the divide. The entire divide from near Buffalo, through New York, Pennsylvania and Ohio, has been described by the geologists to be of glacial drift origin, and this formation of sand, clay and gravel is said to cover the pre-existing shale rock formation over a width of from 20, to 75, or more miles, to the depth of from 50 to 300 feet.

In that portion of the divide which we have under consideration, the passes, or lowest points, vary as between 1,129 feet above ocean level (where the Philadelphia and Erie

crosses it), and 936 feet, as near Warren, Ohio. The following summit elevations are reported by various authorities: Warren, Ohio, 936 feet above sea level; Alder Swamp, at the head of the lower Pymatuning creek, 975 feet; the upper Pymatuning Swamp, near the Pennsylvania state line in Ohio; on the line recommended by the Pennsylvania Ship Canal Commission; 1,030 feet—proposed to be reduced by cutting to 1,016 feet to canal surface level; 1,082 feet, as along the old Pennsylvania–Erie canal to the west of Conneaut Lake, and south of Erie, 1,129 feet, as mentioned. It is to be seen, therefore, that these summit heights decrease progressively towards Warren, which is the lowest known pass, for but a short distance to the west of that point the Ohio State Canal crosses the divide at Akron, at an elevation of 1,084 feet above tide. The Warren divide, it is thus evident, offers a route involving the least lockage between the waters of the Ohio and Lake Erie.

The elevation of the Ohio at Pittsburgh is, for low water surface in the river, about 699 feet above the ocean, or 126 feet higher than the mean level of Lake Erie.

Owing to the flatness of the divide or highest summit levels, as just described, it does not on any of them appear to be practicable to resort to deep cuts in order to reduce lockage; nothing, in short, but the actual traversing of the summit levels will probably ever be proposed, or at least only their slight reduction by means of cutting.

Water Supply for the Summit Level.

The most important engineering problem, in the construction of a canal across the dividing ridge between the heads of the Beaver and the lake, is concerned with questions relating to the water supply for the summit level. Your committee, however, proposes to discuss this subject only in general terms. Up to the present time no definite size of canal has been

approved by the Provisional Committee. The size recommended by the Pennsylvania Ship Canal Commission provides a bottom width of 100 feet, and a surface width of 152½ feet, with a depth of 15 feet in the canal prism. The locks were proposed with a length of 315 feet by 45 feet in width, with a maximum lift of 20 feet. Steamers of 2,500 tons actual carrying capacity, and barges of the whaleback pattern of 3,000 or more tons carrying capacity can be constructed to pass through such locks, drawing no more than 13 to 14 feet of water. For the present, we may assume that these dimensions are as large as can be reasonably well provided for in our harbor, and upon the Monongahela river, after certain changes and improvements to accommodate vessels of 14 feet draught are completed in them.

On the canal commission's route, the profile indicates outlet locks from the summit level of 12 feet lift. A lockfull (315x45x12) would, therefore, require 170,100 cubic feet of water. Allowing for the displacement of vessels, which should properly be considered a deduction from the quantity named, it has been found upon an average of several canals, that 1½ lockfulls will pass a vessel into and out of a summit level. For the passage over the summit of each single vessel, therefore, we will assume that 255,150 cubic feet of water will be required. If we assume further that thirty vessels each way, or sixty in all, would daily pass the summit, and making no deduction for vessels passing and entering locks; the emptying of which has been charged against the previous vessel, and should not, therefore, be duplicated; there would be required for lockage alone 15,309,000 cubic feet of water daily. To this must be added an ample allowance for leakage and evaporation. On a well constructed canal of dimensions here proposed, some canal engineers have calculated that a loss of 100 cubic feet per mile per minute would cover this loss; which, if we assume the summit level to be 20

miles in length, would require 2,880,000 cubic feet per diem. Leakage alone from the canal might be more than is here included in evaporation and leakage. Also, there is a further contingency, viz.: where a flight of locks following a summit lock, might involve waiting of vessels occasionally unless an intermediate supply, part ways down the flight, can be secured. A canal of the dimensions proposed should be provided at the outstart of its operations with not less than 25,000,000 cubic feet of water daily, with resources for future development, by enlargement of feeder lines, up to 40,000,000 or 50,000,000 cubic feet daily, in case its business required double locks.

To secure such a volume of water, viz.: 25,000,000 cubic feet daily for the canal during the season of lake navigation, which, as allowed by the underwriters on the great lakes, is 214 days in the year, requires that a considerable area of country be under control.

In this part of America it is shown by discharge records of streams that upon an average 40 per cent. of the total quantity of rainfall actually passes away in the streams, and that the remainder, or 60 per cent., is lost by evaporation. This is the general average, though different localities within a large area may vary considerably as compared with each other. According to the late Charles Ellet, C. E., who conducted a series of gaugings of the Ohio river covering many years at Wheeling, the fact was learned that the upper Ohio, upon an average, discharges about 40 per cent. of the rainfall reaching the tributary country. It is rarely possible, however, in any extensive area to find sites available of capacity sufficient to retain the 40 per cent. of, technically speaking, pondable water. One chief obstacle frequently met with is a financial one, incurred by reason of the extent of necessary land, or overflow, damages.

The basis of calculation by the Pennsylvania Ship Canal

Commission for any given district included above reservoir sites, was as follows: For 40 inches rainfall; first, that 40 per cent., or 16 inches, of the total rainfall was pondable; of this 16 inches the following distribution was made:

	INCHES.
Compensation to riparian owners	6.72
Evaporation from surface of reservoirs, viz.: 4.1 per cent. of rainfall	1.64
Percolation from reservoirs and from feeder line	1.64
Available for canal	6.00
Total	16.00

It will be observed that the allowance to the riparian owners is rather more than is proposed to be drawn from the reservoirs for canal purposes. Reservoir sites were approximately located by the engineers of the canal commission upon this basis in the neighborhood of Conneaut Lake, from which 6 inches of the annual rainfall could be obtained from about 124 square miles. At this rate a square mile of favorably disposed country would yield 13,939,200 cubic feet, and 375 square miles, upon the same basis, would supply 25,000,000 cubic feet daily to the canal for a season's navigation. It is not the purpose here to affirm, or deny, that any such single area exists satisfying the conditions assumed for the water supply.

The committee traversed much of the valley of French Creek and a portion of the Allegheny river valley, and from the elevations reported by railroad engineers and others employed by the U. S. government upon the upper Allegheny river, it has satisfied itself that in all there lies to the east of Conneaut Lake, and at a greater elevation than the surface of said lake, more than 4,500 square miles of country possible to be drawn upon for a water supply, which, by feeders from Conneaut Lake, can be carried, if necessary, to any of the summit levels as far west as the Warren, Ohio, divide. Very careful and detailed examinations would be required to determine the best mode of obtaining the water supply for

any particular route. In any case, it would first be desirable to investigate the possibilities of the immediate summit, and then to make up any deficiency which might be found by means of feeders extending to the large, and higher areas, to the east, referred to.

A remark, by way of illustration, may be made concerning the water supply for the Warren route, the route farthest to the west, but which has not; before the visit of your committee; received any proper attention from canal engineers. The area of the valley of the Mahoning, above the point where the proposed canal line leaves that stream to cross the divide towards Ashtabula, (which is here certainly less than 50 feet above the waters of the Mahoning), is about 500 square miles. It may be found practicable to divert nearly all of the natural low water flow from that territory, reinforced with extra flow of stored surplus of flood waters, from reservoirs constructed with that object in view, into the summit level. From that source, even with only partial control of its flood waters, perhaps one-half, or even more than one-half, the quantity required for the canal could be found. This is a case where the waters so diverted would immediately return through the canal to the Mahoning before reaching Warren, and no just complaints of this use of its waters would likely arise. This place is as convenient as any to remark that if the Mahoning route be adopted, the stream itself would be canalized, from above Warren a short distance to its mouth, it having even perhaps a greater width, and apparently presenting less points requiring correction for alignment, than the Shenango branch to above Sharpsville; also proposed by the canal commission for canalization.

Any shortage of water necessary for the Warren summit level may be obtained from other streams in Ohio, assisted, if needs be, from streams, or reservoirs, in Pennsylvania. And this system of water supply, it appears to your committee,

can be so arranged as to not disturb in the least the normal low water discharge of any of the streams drawn upon either in Ohio or Pennsylvania. The Pennsylvania Ship Canal engineers, as their report shows, never proposed to divert essentially necessary waters from their natural courses. This was provided for by means of the compensation water from reservoirs, as before referred to. This is correct theory, and is practiced in part, we understand, in the State of New York and in France, but was never, we believe, practiced upon the old canals of Pennsylvania, nor in Virginia, as the reports of Mr. W. Milnor Roberts, late Chief Engineer of Canals in the one state, and of Mr. E. Lorraine, Canal Engineer in the other, almost invariably rely on 12 inches, or more, of the annual rain for their reservoirs solely for canal use. It would seem, therefore, to your committee, considering the vast extent of country available, that no alarm need be apprehended in regard to the question of water supply for the canal. There are, it is very true, numerous problems involved in the economies of reservoir location and feeder line construction, which could not be intelligently discussed in the absence of detailed engineering data, not yet produced. The engineers quite recently employed by the City of Philadelphia upon the projected ship canal from the Raritan Bay to near Trenton on the Delaware, report for their 26 feet depth canal for ocean steamers, a territory of only 300 square miles available for the water supply of the summit level. The practicability of the project appears not as yet, on this account, to have been called in question. The Irwell river, which supplies the Manchester canal, has been reported by Mr. T. B. Foster, C. E., to have a minimum flow of only 14,700,000 cubic feet of water daily, or 2,300,000 cubic feet less than the late W. Milnor Roberts and other engineers report as the minimum discharge of French creek at the Bemus dam above Meadville. Nevertheless, by means of a

well-known contrivance, the Manchester canal engineers calculate that this minimum flow would pass daily as follows through the lock:

25	steamers,	2,000	to	5,000	tons	each.
50	"	500	"	2,000	"	"
100	barges,	50	"	150	"	"

Conclusion.

The length of the projected canal from the Davis Island dam via either the Shenango valley to Conneaut harbor, or via the Mahoning valley to Ashtabula, or Geneva harbor, is about 130 miles in all from Pittsburgh. If the canal line should be carried to Fairport via the Grand river valley from the Warren summit, the total length from Pittsburgh would be approximately 145 miles. Fairport harbor has been mentioned as an alternative lake terminal in case it should be found impracticable to carry the line to Ashtabula or Geneva.

On the Shenango-Conneaut route the lockage, as shown by the profile of the canal commission's surveys, is 759 feet, viz.: 316 feet Pittsburgh to the summit level, and 443 feet descent from the summit level to Lake Erie. In all, 50 locks were provided for on this line. On the old Pennsylvania Erie canal, from the mouth of the Beaver to Erie harbor, on a length of 136 miles, there were 133 locks, overcoming a total lift of 921 feet. The Warren route, if we may accept published elevations, would require a lockage from Pittsburgh of only 599 feet; or, perhaps, somewhat less, depending upon the possibility of a reduction of the summit level by means of cutting.

The estimated cost, including locks and dams and excavations in the beds of the Beaver and Shenango rivers and canal construction across the divide, improvement of Conneaut harbor, etc., was $20,500,000, as per the report referred to.

Included in this estimate by the canal commission, was a water supply from reservoirs, etc., near the summit, providing for about 13,000,000 cubic feet of water daily; this without drawing upon French creek. To this estimate of cost was added, for the extension of the canal from the mouth of the Beaver to Pittsburgh, $6,000,000, making a total of $26,-500,000 in round numbers for the canal from Pittsburgh to the lake.

An actual survey must be made, however, before any positive statement as to the cost can be made of the several routes. From Pittsburgh to Erie harbor a line diverging from the Shenango route in the summit region was found by the canal commission which would be 22 miles longer than their Conneaut line, and to construct upon this line it was estimated would involve an additional expense of more than $4,000,000.

Mr. G. L. Moody, C. E., of Erie, explained to members of your committee a project for reducing very materially the distance between Pittsburgh and Erie. His proposed line involved a long level at an elevation of 1,076 feet above ocean datum. This level would start from the lake terrace south of Erie (connected with Erie harbor by a flight of locks with an aggregate lift of 503 feet), thence passing southwestwardly to near Conneaut Lake, and continuing with the same elevation, a total length of more than 80 miles, to the neighborhood of New Castle, where, by a series of locks, he would propose to reach the Shenango river. Mr. Moody has been given some assurance in Erie that means will be provided to test the feasibility of his projected line, and we hope that his expectations will be realized at an early date.

The committee is convinced that it is practicable to construct a ship canal from the Ohio river to Lake Erie, but desire further information before deciding as to the most feasible route.

In order that the facts relating to the Warren route, via Youngstown on the Mahoning river, may be positively determined, your committee would recommend that a survey of that route, from the mouth of the Mahoning to the most available lake harbor, be made at as early a date as possible, together with surveys and examinations, to determine the best means of furnishing a canal upon said route with water.

THOS. P. ROBERTS,
MORRISON FOSTER,
W. L. SCAIFE,
E. M. BIGELOW,
J. C. MCDOWELL,
Engineering Committee.

NOTE.—Messrs. Brown and McAfee, of the Engineering Committee, were unable to accompany the committee on its reconnoissance.

The itinerary of the tour of the committee was as follows:—

From Pittsburgh, along the Ohio, Beaver, and Shenango rivers, to the summit level on the Shenango route; thence east, via Conneaut lake, to Meadville, on French creek—looking into the route of the old canal feeder from the Bemus dam, on French creek, above Meadville; thence returning to the Mahoning valley, stopping at Youngstown and Warren; thence via the P. Y. & A. R. R. to Ashtabula harbor on line of proposed Warren route; thence to Conneaut harbor, examining recent improvements in that harbor; thence driving a number of miles to proposed aqueduct over Conneaut creek, (report of Pennsylvania Ship Canal Commission); thence to Erie, Penna., where a day was spent in examining harbor, ore delivery arrangements, etc. Returning to Pittsburgh via the head-waters of French creek, and to the Allegheny river at Tidioute, from which point—and from the Tionesta valley—waters, if needs be, may be made to flow through feeders, to Conneaut lake, the chief distributing point for a water supply on the Shenango route. A stop was made at Oil City, and Franklin, the committee returning to Pittsburgh about 11, P. M., September 27th.

Report of the Committee on Railroad and Canal Statistics and General Information.

OCTOBER 9, 1894.

BUSINESS, COST, PROFITS, ADVANTAGES.

Your committee would respectfully report that it has prepared forms to be sent to all the railroads, manufacturers, mine owners, Chambers of Commerce, and Boards of Trade within the territory that will be tributary to the proposed ship canal, soliciting information and statistics upon which it will be able to base a full report of the business likely to be transacted by the canal, the rates of transportation now prevailing, and the saving that will be effected. The committee also proposes to obtain all essential information in regard to the existing ship canals and those in course of construction or proposed. In addition, it will endeavor to enlist the active co-operation of the public press throughout the whole canal district, and also in the large cities of the country wherein financial support may be expected, and to supply such information to it from time to time as may serve to enlighten the public as to the merits of the project. Your committee has already accumulated considerable matter bearing upon the subject of ship canals in general, and upon the Lake Erie and Ohio River Ship Canal in particular. This embraces valuable pamphlets and newspaper articles from the

city press, and from that of the district traversed by the Engineering Committee on its recent tour over the proposed routes. It is designed to keep a close watch upon all publications concerning the proposed canal, with a view of utilizing such suggestions of value as may be put forth, and of meeting any objections that may be made, and of using favorable utterances to advance the interests of the project.

When the replies to the queries sent out by the committee are received, it proposes to prepare a report for publication embracing their substance and also general information in regard to the advantages and profits of ship canals, the rates charged thereon, their relations to railroads, and expressions of the public press and of competent authorities favorable to the Lake Erie and Ohio River Ship Canal. It will also obtain lists of influential persons throughout the canal country, whom it will see are promptly supplied with literature explaining and commending the project; and it will also see that the latter is properly brought to the attention of the Chambers of Commerce and Boards of Trade of the large cities of the country likely to take an interest in it.

Estimated Business of the Canal.

As the Engineering Committee has pronounced the construction of the canal to be perfectly feasible, and given ample reasons for its conclusion in its full and able report, some remarks in regard to its probable business, profits and advantages may be timely. While all estimates now made are subject to verification as to exactness by the answers to the circulars to be sent out by the committee, the following are believed to be well within the mark. The canal, with due diligence, should be ready for operation within five years. The business which it is likely to do will, therefore, be estimated as of that time, taking into consideration, of course, the facts shown by the business of the past five years.

Keeping these in view, it is safe to say that the furnaces along the proposed canal, or which will be reached by means of it, will, in five years from this time, require, annually, fully 7,000,000 tons of ore from the lake region. The bituminous coal and coke which will go to the lakes annually will be at least 5,000,000 tons. Lumber, grain, sand and other heavy freight suitable for canal transportation will, at the end of five years, equal 2,000,000 tons, to be moved both ways between the lake and the river. Here is a total of 14,000,000 tons to draw from at the outset. Of course, no one anticipates that all this freight will be diverted to the canal at its opening. But before many years from that event, judging from the record of the Sault Ste Marie and Suez canals, practically all such freight, and in greater amounts than the above, will be carried on the projected water way. From 1889 the traffic on the Sault Ste Marie canal has increased at the rate of 1,000,000 tons a year; and the increase on the Suez canal has been nearly as great. The first named canal is now carrying 12,000,000 tons of freight per annum, and the last named one 10,000,000 tons. The territory to be reached by the proposed canal takes 8-10 of the traffic passing through the Sault Ste Marie canal, so it will be seen the figures of the traffic possible in five years are not exaggerated.

Cost and Profits.

The cost of the ship canal to Lake Erie is estimated by the Pennsylvania Ship Canal Commission at $27,000,000, and not to exceed $30,000,000. Taking the latter figure, a dividend of 6 per cent. would require $1,800,000. If the operating and maintenance expenses are placed at $1,000 per mile (a high figure, and much in excess of the experience elsewhere), the amount would be increased to $1,930,000, or say, to be perfectly safe, $2,000,000. A traffic of 14,000,000

tons per annum, at 25 cents a ton, would bring in $3,500,000, while an average traffic of only 8,000,000 tons for the first five years after the opening of the canal would pay all expenses and a 6 per cent. dividend, and doubtless leave a good surplus, as the allowance for expenses has been made more than they are likely to attain unto. It now costs 90 cents a ton on freight to and from the lake, and 14 cents *more* for shipping or unloading at the lake, a total of $1.04. A canal toll of 25 cents a ton to or from the lake, and vessel charges of 20 to 25 cents a ton, would make a difference of more than one-half, as compared with present rates, and would mean a total saving on 14,000,000 tons of freight of from $7,500,000 to $8,250,000 per annum. This estimated saving of more than one-half in freight is less, it may be remarked, than the experience of ship canals and other canals have demonstrated to be the case.

Saving in Freights.

The difference between the amounts paid for freights on railroads now, and on the canal when in operation, is likely to be greater than the above estimate within a few years after the opening of the canal. The experience of canals is that the freight on them can be carried for 37.3 per cent. of the charge on railroads. Those who fear that railroad tolls will be cut down so low as to prevent the canal from doing business are not aware of the fact that the reduction of canal freight charges has kept pace with those on the railroads. Every reduction on the latter which still left a paying return has been met with a similar result by the canals. After a few years the tolls on the proposed ship canal can be placed as low as 15 cents a ton, and leave a good margin of profit. Especially is this likely to be the case in view of a proposed system involving the use of barges and whalebacks.

Will Benefit the Railroads.

Your committee is convinced, from the evidence before it, that the railroads in this country will, before long, perceive, as they have abroad, that the ship canal will prove a benefit instead of an injury to them; and that, instead of entering into competition with the canal, they will rather encourage the extension of its operations. The building and operation of the proposed canal cannot fail to add largely to the business of the railroads. For every ton of heavy, so to speak, non-profitable or expensive freight which the canal will take from the railroads, it will return much more than an equivalent in lighter freight and passenger traffic, arising entirely from the operation of the canal. Actual experience justifies this assertion. The Great Western Railroad of England entered into competition with a canal, but desisted to its great profit, when it found it was using 58 per cent. of its rolling stock to transport heavy freight, which brought in only 14 per cent. of its income. The deepening of the river Main, in Germany, between Frankfort and Mayence, from 6 to 12 feet, was violently resisted by two railroads running along its banks. In two years after the completion of the improvement the traffic on the river had increased 100 per cent., and on the railroads there was an increase of 94 per cent.; and the latter have been urging further deepening of the river since their eyes were opened. In France, railroads only transport passengers and fast freight, leaving the carrying of heavy raw materials to the canals; and French railroads pay better than those of the United States or Great Britain. The New York Central Railroad runs along the Erie Canal, and has constantly paid large dividends. It may be remarked that the building of that canal was at once followed by the city of New York taking the lead of Philadelphia in growth. Properly conducted, canals act as large feeders to railroads by building up the country through which they pass, by

furnishing cheaper raw materials, and thus enabling the establishment of manufactures, and the consequent great increase in passenger, and the lighter, but better paying, freight traffic of the railroads. It has been stated by competent authority that the obtaining of cheaper ore from the lakes by reason of the ship canal will make a material reduction in the price of pig iron, and consequently in the prices which the railroads will have to pay for rails.

General Advantages.

The construction of the Lake Erie and Ohio River Ship Canal will in the estimation of your committee by providing cheaper raw materials (which are now a necessity for our manufacturers if they would continue to compete with other localities to advantage) greatly facilitate manufacturing industries along its line and within the sphere of its influence. The plants of existing industries will be enlarged and their number increased, while new industries, like that of large ship building for the lakes and the Government, will be introduced. Larger markets will be opened up for our coal and coke, and the residents along the canal will be able to get their lumber, grain and many other commodities cheaper. As we have seen, the canal will save freights to the amount of many millions of dollars which can be used by manufacturers to develop their plants. It will increase the population vastly, stimulate the building trades and bring real estate into the market which is now unimproved. It will unite Pittsburgh and its adjacent communities into one great city. It will provide the National Government with an easy way to defend the lakes in case of war. It will, by building up the waste places, increase the revenues of the states it traverses or affects. It will build up a new, large and good paying traffic for the railroads while relieving them of that which is not profitable. The mere work of

building the canal will furnish thousands with employment and the expenditure of its cost will greatly stimulate business. The canal will in short be a vast advantage to all the territory it will reach, which will extend to the interior of West Virginia and to Western Maryland, down the Ohio to Wheeling and beyond to Cincinnati and the Mississippi, and from Pittsburgh to Youngstown, and the lake ports from Erie to the Duluth. It will we believe pay well those who contribute the money for its building and there is every indication that before it has been in operation very long its stock will be held as jealously as that of the Suez Canal, the building of which was pronounced a chimera by English financiers who subsequently paid high figures for it as an investment they had derided a few years before as impossible of ever becoming a paying one.

WILLIAM P. HERBERT,
Chairman.

BURD S. PATTERSON,
Secretary.

REASONS FOR BUILDING

...AND...

PLAN TO BUILD

...THE...

LAKE ERIE AND OHIO RIVER SHIP CANAL.

A PAPER READ BY

JOHN E. SHAW, ESQ.

BEFORE THE

CHAMBER OF COMMERCE, OF PITTSBURGH, PA.

APRIL 23D, 1894.

GENTLEMEN:—In these times in which we live nations are struggling to solve the problem of the amelioration of the condition of the toiling masses who constitute the basis of a nation's strength, from a political, material and social standpoint, and who also constitute the source of a nation's weakness and danger. Cities all over our land are trying to alleviate the condition of the unemployed by furnishing them work upon public improvements, such as parks, improvement of streets, etc., and it seems to be settled and universally agreed upon that the true theory of bettering the condition of the needy is to put them in the condition and way of helping themselves. While all this is good, so far as it goes, the relief afforded is of a somewhat temporary

character, and the question presents itself: Can the resources of our citizens, and the resources and credit of the city itself, be put to a use that will result in a more lasting and permanent benefit to every citizen and taxpayer.

The Basis of Prosperity.

The fundamental basis and substratum of the prosperity of a city or nation lies in the constant and remunerative employment of labor in the natural channels of commercial activity. The pressing need of the hour is, how can we best reach this desired end?

The ship canal recently opened, connecting Manchester, England, with the sea, exhibits a course of wise municipal financiering which our cities at the headwaters of the Ohio would do well to pause and consider at the present time. This canal was completed and opened January 1, 1894, at an expense of about $75,000,000, and $25,000,000 of this amount was raised on the faith and credit of the city of Manchester alone; and, considering her natural resources and previous growth as a manufacturing center, who can measure the impetus she will gain in material wealth by forging the link that connects her previous natural resources and advantages with the rest of the commercial world by a ship waterway, thereby securing and holding for herself the manufacturing supremacy of England?

The completion of the proposed ship canal between Pittsburgh and Lake Erie bears the same relation to the future of Pittsburgh and Allegheny and to the industrial centres in the Beaver, Shenango and Mahoning Valleys.

Note the phenomenal growth of our lake cities in the last 20 years, established through the cheap transportation by the Great Lakes for all commercial products, especially grain, lumber, coal and iron ore. When the whaleback ves-

sels of the lakes, of 2,000 tons capacity, equal to a train of cars almost half a mile long, tie up to the wharf at Pittsburgh, an era of growth in manufacturing and commercial activity will begin in these cities at the headwaters of the Ohio, more rapid, prosperous and permanent than any progress made in the past, and with our present natural advantages of situation as a manufacturing center, with unlimited beds of coal at our very doors, if this link was completed, uniting our coal deposits by a ship waterway with iron ore deposits of the Great Lakes, we could establish and maintain a supremacy in manufacturing and the attendant growth of other commercial industries, against which no other city in the world could compete.

How Pittsburgh Has Been Promoted.

The solid and substantial growth of Pittsburgh in wealth and importance as an industrial center in the past has not been the result of any of the numerous "booming" processes resorted to for the elevation of other cities, but is the result of a combination of unsurpassed natural advantages and resources and Scotch-Irish push and energy. Having already attained the head and front in the production of iron and steel and glass for the continent, there is only one thing needed to make her the center of these and kindred manufacturing industries for the world, and that is to abolish the high rate of freight she now pays to get to and from the lakes, by water transportation.

Pittsburgh, with her productive capacity and attendant natural advantages and resources, has outgrown the facilities of the present day. There is no part of the globe more richly endowed by nature than the hills and valleys of Western Pennsylvania. When she can carry ore from Lake Erie to her furnaces and mills by water, and float her heavy iron

product, and coal, to the Great Lakes by water, she will have command of the situation, and will care little for competition at home or abroad. This water transportation is a present necessity for these cities, and it must come.

Our Magnificent Tonnage.

Pittsburgh's commerce with the lakes in iron ore, coal, lumber, etc., amounts to more than 7,000,000 tons per annum.

Along and near the proposed canal there are 57 furnaces making one-quarter of all the iron produced in the United States. Add to the tonnage of Pittsburgh the tonnage in iron ore, coal, etc., that would be tributary to this canal at Beaver Falls, New Castle, Youngstown, the Mahoning Valley, etc., and the annual tonnage of bulky raw materials that can be transported cheapest and best by a waterway, if the canal but secured the present tonnage in this class of materials, it would annually amount to from 10,000,000 to 12,000,000 tons. The actual operation of this canal would largely increase the present tonnage, between Western Pennsylvania and the lakes, from the increased tonnage of coal and coke that would be diverted to this waterway, from the fact that the market for these products would be broadened and enlarged. This canal will open up the great coal and coke production of Western Pennsylvania to all points reached by the lakes, as far as Duluth, Minn., and that city is destined to become the greatest distributing point in the great Northwest. By rail it is connected with the rapidly growing West, Northwest and British Columbia. The coal of the Monongahela Valley is known everywhere as the best, and the only hindrance in the way of its general use in America is in the matter of cheap transportation rates which this canal will supply.

Allegheny County produces 18 per cent. of the product of pig iron in the United States; 20 per cent. of the output of Great Britain; 33⅓ per cent. of Germany; 80 per cent. of France; one and two-third times the product of Austro-Hungary; two and one-fifth times the product of Belgium; six times the product of Spain; two times the product of Russia; three and one-fourth times the product of Sweden; and 100 times the product of Italy.

Allegheny County produces 35 per cent. of the total product of steel in the United States; 42½ per cent. of the product of Great Britain; 58½ per cent. of the product of Germany; 1¾ times the product of France; 2¾ times that of Austro-Hungary; 5⅔ times that of Belgium; 22 times that of Spain; 5 times that of Russia; 8 times that of Sweden; and 13 times that of Italy. The 26 blast furnaces and 62 rolling mills and steel works in Allegheny County produced in 1892, 1,775,257 tons of pig iron; 55,722 tons of crucible steel ingots; 1,188,727 tons of rails, bars, bolts, rods and skelp iron; and 248,369 tons of sheets and plates. Pennsylvania produced 46 per cent. of the total output of pig iron in the United States in 1892, and Allegheny County made 42 per cent. of all made in the State. Pennsylvania made 57 per cent. of the Bessemer steel made in the United States in 1892; 53½ per cent. of all the rolled iron and steel; 62 per cent. of all the rails; and 68 3–10 per cent. of the total output of plates and sheets.

Can anyone desire any further argument or proof than that presented by the above astounding figures to convince them not only of the present necessity, but of the future profit to the promoters and builders, and the immense advantages to be gained by these two cities and all Western

Pennsylvania, from connecting our coal fields with the ore fields of the lakes by a ship waterway?

The assessed valuation of Allegheny County for taxation purposes is as follows: Pittsburgh, $223,770,787; Allegheny, $81,994,485; McKeesport, $12,906,205; boroughs, $50,642,-832; townships, $66,582,664; total, $435,896,973.

The report of the commission appointed by the Legislature in 1889, and the surveys made by them, demonstrate the practicability of the canal and its estimated cost to be about $27,000,000. This amounts to 6¼ per cent. on the county valuation, and 9 per cent. on the valuation of Pittsburgh and Allegheny alone. Can anyone dispute the assertion that the existence of such a waterway would not benefit the county to the extent of 6¼ per cent. of her taxable valuation, or these two cities alone to the extent of 9 per cent. of their taxable valuation, from the advantages to existing commercial industries here, not taking into account the numerous manufacturing industries and their attendant increase of population that would seek a location at this point on account of cheap raw materials, cheap fuel and cheap transportation?

Manchester's Object Lesson.

The opening of the Manchester, England, Ship Canal is an event of great national importance, and the results, as affecting trade conditions at Manchester, can be studied with profit by the manufacturers, business men and capitalists of Western Pennsylvania. The Manchester Ship Canal transformed a great interior city into a sea-port.

The initial purpose of this canal was to secure to Manchester cheap rates on raw cotton, and direct shipment abroad of manufactured cotton goods, and to cheapen the cost of carriage by bringing large steamers and other vessels from

the sea to Manchester, avoiding the heavy landing and cartage charges at Liverpool, and reducing by one-half the railway and dock rates. This is assured by the adoption of dock rates at Manchester, and rates on ship canal, which are fixed by the act of Parliament at one-half the rates and dues charged on the various descriptions of traffic using the Liverpool docks and the railways to Manchester.

The saving affected in the transport of certain goods between Liverpool and Manchester is seen by the following scale of charges. The rail rate includes dock dues at Liverpool and cartage, and the canal rates include tolls and wharfage.

	Rail.	Canal.
Cotton	11s 5d	5s
Wool	13s 11d	5s
Sugar in casks and bags	10s	4s
Eggs in cases	14s 6d	6s
Butter in casks	13s 4d	5s
Grain and flour	9s	3s
Fruit (oranges)	12s 5d	5s
Iron ore	6s 11d	2s 10d
Pig iron	7s 10d	3s 5d
Scotch iron	12s 11d	6s 5d

Would Benefit in Two Directions.

The effect of this saving on the iron industry is foreshadowed in an item in the *British Board of Trade Journal*, which remarks that "this saving to the iron trade amounts to a release of that industry from a prohibitive tax." The same proposition holds good even in a greater degree to other heavy goods and bulky materials, such as petroleum, lumber, coal, iron ore and machinery.

This demonstrated saving per ton in the cost of iron ore, which saving of cost is still more apparent in the finished product, applies with greater force to Western Pennsylvania.

The blast furnaces reached by the Manchester Canal are so unimportant in number that they form no factor in the production of pig iron in Great Britain, but the blast furnaces reached by the Erie Canal are at present the controlling factors in the pig iron production of America, and the scope of the advantage this iron-producing district would gain in the competition for the world's markets is seen in the fact that the blast furnace industry in England is already located within reach of the ocean, where it can receive its ores to best advantage and economy in the matter of transportation, and as the cheapest freight is always to that port where there is the best chance for a return cargo, the assurance of a return cargo of coal from the Pittsburgh district to the lakes assures also the cheapness of the cost of laying down iron ore at our blast furnaces, and therefore, the benefit to this district will be in two directions, a larger and broader market for our coal production and a marked reduction in the cost of our iron and steel production.

The burning question to-day for the manufacturers and coal producers of Western Pennsylvania is how, and when, can this Erie Canal be built? Shall we wait for the Government to do it through the appropriation of necessary funds, or shall we do it as a private enterprise and with private capital? Government work is always monotonously slow. It took the Government over fifteen years to build a postoffice for Pittsburg, and if we wait for the Government to build the canal, many of us will not live to see it completed, or to enjoy the benefits of the growth of the trade and commerce it will bring to these cities; but taken hold of in the right spirit and in the right manner as a private enterprise, it can be completed in less than five years.

How Difficulties are Surmounted.

The value of waterways and their relation to commercial

progress and municipal aggrandizement is one of the first articles of faith in the creed of Manchester business men, and the business men of Allegheny County need to have the same faith and to be actuated by the same spirit. The difficulties to be overcome at the outset were enough to have appalled the stoutest heart, but these difficulties were met and brushed aside by these Manchester business men, until $75,000,000 was expended in completing the canal, and of this amount $25,000,000 was loaned to the canal company by the municipal corporation of Manchester, and raised upon her faith and credit. Salford and Oldham and neighboring cities followed Manchester with offers of large loans. The city of Liverpool exerted herself to the utmost to prevent the granting of the charter, pointing out the injury to the shipping interests of Liverpool if Manchester was allowed to become a port. The strongest opposition was encountered at the hands of the railway companies that had enjoyed the traffic between Manchester and Liverpool. Several canal companies which lay en route had to be disposed of. Railroad lines were elevated and carried over the new canal on bridges. Intersecting canals were lifted high in the air with extra locks and costly viaducts. All these stupendous difficulties, greater than any that will be encountered in the Erie Canal, were met and overcome; and through all its vicissitudes this great work had constantly the moral support of the Manchester corporation.

The first movement of a public nature toward building the Manchester Canal was owing to the energy and enthusiasm of Mr. Adamson, a practical engineer. He summoned the friends of the enterprise to a meeting at Diddsbury in June, 1882, secured the appointment of a provisional committee, and raised a guarantee fund to apply for a bill. This was followed by a public meeting in Manchester in November, 1882, which appealed to all classes of the community in Manchester and South Lancashire. The proposal was received enthusiastically

by the workingmen of Lancashire, because they saw in the project a prospect of employment and the certainty of the expenditure of a large amount of capital in the district. The opposition encountered in the railway companies and the Liverpool Dock Board in the next three years in procuring the necessary legislation and enabling acts cost the canal company about $75,000, and, it is said, the opposition a much larger amount. All opposition was finally overcome, and a bill at length passed both Houses in 1885. Shortly after this the Mayor of Manchester appointed an independent consultative committee, which, after taking evidence some weeks, reported unanimously in favor of the scheme. London capitalists were consulted, and they naturally asked, "What was Lancashire going to subscribe?"

How Manchester Raised the Cash.

Eventually it was arranged that if Lancashire found half the sum the London financiers would find the other half. Parliamentary powers were obtained to divide the capital into half ordinary and half preference shares, with debentures for $10,000,000. The money for the purchase of the Bridgewater Navigation, $8,550,000, was obtained on the last available day. The first sod was turned November 11, 1887, at Eastham, but the work did not formally begin until January, 1888, when possession of the land was gradually obtained.

As the work progressed, and money was needed, an appeal was made to the Manchester corporation to step in and lend money on the mortgage of the undertaking, and it was promptly and unanimously responded to by the corporation and taxpayers, and powers were obtained for the corporation to loan $15,000,000 by a bill in 1891. In December of that year the conducting of the works to the opening of the canal was placed in the hands of an executive committee, controlled by a majority of the representative members of the

corporation, who were placed on the board under the Act of 1891. In July, 1892, a further estimate of the money needed for the completion of the canal was made, and a further appeal to the corporation was again loyally responded to. The act of 1893 gave power to the corporation to lend an additional $10,000,000, on the condition that the number of directors should be increased to 21, and that the corporation should be represented by 11 members, of whom one should be the deputy chairman, and the corporation was authorized to appoint its engineer, to have joint supervision with the engineer of the canal company, and the money loaned by the corporation was paid out to the company on certificates signed jointly by the engineer of the Manchester corporation and the engineer of the canal company, in respect of works and equipment, and by the secretary and treasurer of the company, in respect of the other purposes authorized by the Acts of Parliament. The power of fixing rates, tolls and rents was given to a committee, composed of five of the sharehold directors and four of the corporation directors.

Capital Powers of the Corporation.

The capital of the company was distributed as follows:

Ordinary shares		£ 4,000,000
Preference		4,000,000
		£ 8,000,000
First mortgage debentures, 1896–1914	£1,812,000	
Second mortgage debentures, 1914	600,000	
New mortgage debentures (Manchester loan)	5,000,000	7,412,000
		£15,412,000

CAPITAL EXPENDITURES.

Purchase Bridgewater Canal	£ 1,782,172
Land purchase, compensation and expenses	1,161,347
Construction of works, including plant	8,861,760
Engineering and surveying	125,432
Interest on share and loan capital, after deducting balance of general interest account	1,038,500

Parliamentary expenses, 1885 to 1893	163,593
Legal charges and disbursements	20,820
Brokerage, advertising and other expenses of issue of debentures	108,833
Expenses incurred by the Manchester corporation in the creation and issue of corporation stock	31,700
Other general expenditures, including directors', auditors' and public accountants' fees, salary of secretary, manager and staff, office expenses and Parliamentary deposit, etc.	176,064
	£13,470,221

According as the corporation of Manchester came nobly to the help of the undertaking, the money was also furnished by other points along its line, and the capitalists of London. We have in the above some pointed suggestions as to how the Erie Canal may be built, within five years. Has it any lessons for the business men of Pittsburgh and Allegheny?

Creation of Corporations.

In the United States corporations are created by the different States, and usually all enabling powers necessary are granted by the State, and it is rare that the necessity arises to have enlarged powers granted by the Federal Government. The power of the Federal Government to create corporations rests upon a basis entirely different from that of the State. With the State it is an incident of sovereignty, and may be exercised for any lawful purpose not repugnant to its Constitution, or the voluntary limitations imposed upon itself by its ratification of the Federal compact. The nature of the Federal Government is, however, different. It possesses no powers save those delegated by the several States uniting to form it, or such incidental powers as may be necessary and proper to carry out the powers thus delegated. It follows, therefore, that whenever there is no express delegation of power in the Constitution to the Federal Congress to create

corporations, there can be no implied power to erect such bodies except as a means or instrument by which to accomplish the objects for which that Government was created.

Until the Fiftieth Congress, the only case in which the general Government has exercised the power to create corporations was the granting of a charter to the Bank of the United States on the ground that the Federal Government could create a corporation as an instrument and an agency, and that the instrumentality must be necessary to that end. Out of this doctrine was evolved the present national banking system, created under the exigencies of the Civil War, as part of the fiscal arm of the Government, and in aid of the regulation of the currency.

Powers of the Federal Government.

The Federal Government also imposed duties and obligations, or conferred powers, upon various State organizations to enable them and others to extend the building of a railroad through the Territories of the United States, from the Missouri river to the California State line, on the ground that Congress had power to build post roads, and therefore to construct a highway within the territory of the United States, it could delegate that power to a corporation for the purpose of performing its own functions. That power has not been seriously questioned.

In the second session of the Fiftieth Congress, that body granted a charter to the Maritime Canal Company, of Nicaragua, which had previously derived an unquestionably constitutional corporate existence from the State of Vermont, from which it had obtained a charter before it sought incorporation at the hands of the Federal Government. This company was organized for the purpose of constructing, equipping and operating a ship canal from the Atlantic to

the Pacific oceans through the Republic of Nicaragua, or in part through that State and the Republic of Costa Rica.

This is the first time in the history of the Constitution that Congress has attempted to grant an act of incorporation for a purpose seemingly foreign to any power expressly delegated to the Federal Government by the States. But the authority of the Federal Government, within its constitutional limitations, to confer such powers on a private corporation erected by the state, seems to be settled in California versus Pacific Railroad, 127 U. S., page 39, where Justice Bradley, referring to the Pacific Railway legislation, said: "It cannot at present be doubted that Congress, under the power to regulate commerce among the several States, as well as to provide for postal accommodations and military exigencies, had authority to pass these laws. The power to construct, or authorize individuals to construct, national highways and bridges from State to State is essential to the complete control and regulation of inter-State commerce."

Federal Assistance Probable.

Pursuant to the above, it would seem that a private corporation, erected under the State law, to build, equip and operate the Erie Canal, would be in a position not only to ask Congress for the enlargement of its chartered and corporate powers by Act of Congress, but to successfully secure from Congress pecuniary assistance in the form of guaranteeing 4 per cent. interest on the bonds of the canal company for a stated period, or until its earnings are sufficient to provide for said interest, on the ground stated in the case above cited, that Congress has the power to regulate commerce among the several States, and to provide for national defense in case of military exigencies, and to facilitate the transportation of military supplies and vessels for national defense.

With the Great Lakes constituting so large an extent of our northern boundary, no one can doubt the great advantages to be gained by our National Government in the matter of national defense from the existence of such a waterway as the Erie Canal.

There being no question as to the existence of such a waterway being a great benefit to these cities in the matter of cheapening the cost of their manufactured products, and in extending the market for coal, there is still another question: Will it pay the builders and promoters as a financial investment? The estimate of traffic on the Manchester Ship Canal, within two years of its completion, founded upon evidence given in 1884, and subsequently by Mr. Marshall Stevens, which stood the test of criticism of railway opposition before Parliamentary committees, and has been corrected after communication with the merchants and traders up to the present time, shows that the revenues of the canal will be sufficient to pay working expenses of $525,000, 4½ per cent. on the loan of the Manchester corporation of $25,000,000, 4 per cent. on debentures, 5 per cent. on preference shares and 3 per cent. on ordinary shares.

The Suez Canal.

The Suez Canal, 100 miles in length, cost $100,000,000. During the first year (1870), 486 ships used it, and the tonnage was 435,911. Ten years later the figures were, 2,026 ships; tonnage, 4,344,519. In 1893, 3,539 ships passed through, and the tonnage (including 189,809 passengers) was 7,712,029. At the annual meeting of the directors, held in Paris, June 6, 1893, a dividend of 20 per cent., free of coupon tax, was declared. On December 30, 1893, the £20 shares were quoted at £107 and £108. Now, if the cost of the Erie Canal is less than one-half the cost of either the Manchester or Suez Canals, and the tonnage on coal, iron ore

and lumber alone from Pittsburgh and points along the line of the canal with the lakes amounts to 10,000,000 tons annually, and the canal can transport this tonnage with a profit to itself at 30, 40 or 50 per cent. below rail rates, it is easy to estimate the amount of business the Erie Canal would start with, and some idea can be formed of the enlargement and growth of the business of such a waterway from the fact that the combined railroad tonnage of the railroads entering this city in 1892 aggregated 37,999,392 tons. Add to this the river tonnage, and the annual tonnage passing in and out of and through Pittsburgh annually exceeds that of any other city in the Union. Opposition may, to some extent, be encountered at the hands of the railways, but the opposing forces here will not be so persistent and hard to overcome as was the case with the Manchester Canal. An analysis of the facts, circumstances and results of the building of such a canal in this country will disclose that the basis of the railways' opposition does not work out to a logical conclusion. They may say that no kind of support should be diverted from the railways because of the vast amount of capital invested in that service. "This," it is said, "is like refusing to go into the country for a beneficial change lest you should thereby affect the income of your town doctor, whose medical education has been costly. The fact is overlooked that you may be able to assist your doctor far more by continuing to live and get better; you will want him occasionally yourself, and will bring others."

Will Help the Railroads.

Everything that contributes to the general prosperity must help the railroads in their best paying departments, for, and upon that they really exist, namely, the passenger and what may be called the luxury traffic, high-class goods, manufac-

tured articles and perishable freight. This is why the great and numerous railways projected into our lake cities to-day find such an abundant and profitable traffic, and, were these same cities suddenly removed and isolated from their cheap water navigation for raw and bulky materials, which has so largely contributed to their rapid growth and development as commercial centers, it would not only mark the decline of these same cities, but it would also mark the decline of profitable railway traffic in them. One hundred and fifty years ago Franklin said that "fair commerce is where equal values are exchanged for equal, the expense of transport included," and 250 years before that, Francis Bacon had found out that "there be three things which make a nation great and prosperous—a fertile soil, busy workshops and easy conveyance for men and commodities from one place to another."

Now, the Erie Canal will never be built unless the business men of Pittsburgh and Allegheny do something, and, like the business men of Manchester, make a beginning somewhere and somehow. The present seems to be the time when all who have taken a thoughtful and watchful interest in this question, and its wonderful surroundings, should give in their evidence and get a conviction deliberately established, of the beneficent results to be attained from the working out to completion of such an enterprise, and of its feasibility and practicability. John Stuart Mill said, "One man with a conviction is worth one hundred men with only interest." The Manchester Ship Canal has enjoyed the great advantage of scores of such men as leaders, who have from the first stood shoulder to shoulder, facing their work, and high above suspicion of any kind, each taking his turn at carrying conviction to others, and have deserved and secured a great following, who, in their measure, are equally sincere and steadfast.

They not only secured the co-operation of London capitalists, but the free and hearty subscriptions of the toilers and laboring classes of Lancashire, until the shareholders number to-day over 40,000. Let the business men of these cities step to the front, and having become possessed with a like conviction, and inspired with a like courage and faith, promote the building of the Erie Canal, and they will find these two cities in their corporate capacity will come to their aid, as will the other cities along its line. The capitalists, merchants and manufacturers will fall in line with abundant help. The laboring men of Allegheny county, who, as a class, are without peers in this or any other land in industry, thrift and economy, and with a penetrating insight into those conditions which best contribute to their happiness and prosperity, viz: constant and remunerative employment, these will pour the savings from their toil into the coffers of the treasury to help insure the success of the canal. Don't let us look on any obstacle in this matter as too great to be removed. It has been well said "that a three-penny bit placed near enough to the eye is sufficient to blot out a whole sunny heaven," and that is exactly what people do who center their attention on any difficulty, and insist upon isolating it and think that it cannot be surmounted.

How to Begin.

By way of making a beginning, we suggest the appointment of a Provisional Committee, consisting of the members of the Chamber of Commerce, and representatives of the corporations of Pittsburgh and Allegheny, and of districts along the line of the canal to be benefitted by its

construction and operation, that this committee shall have power to raise by subscription a guarantee fund to cover the expense of collecting evidence and data to satisfy said committee and the subscribers to said guarantee fund of the desirability and practicability of proceeding with the undertaking. To facilitate this the said committee to employ a competent engineer, and also a party skilled in financiering and promoting such an important undertaking. The duty of the former, under the supervision of the committee, shall be to collect and present all data relating to surveys that have already been made of said canal, and make such supplementary surveys as may be necessary to demonstrate its feasibility and approximate cost.

The duty of the latter shall be to collect evidence as to the organization, working, and profit of existing ship canals, collect evidence of the traffic and business the Erie Canal would probably secure, and the saving in cost of transportation of freight, and profits to the stockholders of the canal from its successful operation; present a plan of organization and form of charter required to secure a constitutional corporate existence from the State, together with the form of a bill to be presented to Congress to secure the enlarged powers necessary, and the financial aid to be sought from the Government; the legal difficulties to be overcome, and the legislation required to enable the company to proceed.

The above evidence to be collected under the supervision of the Provisional Committee, and when collected to be presented to the Provisional Committee and guarantee subscribers, and they jointly to decide upon proceeding with the undertaking, securing the necessary chartered powers and opening books for the subscription to the stock, etc.

By pursuing the above, or a similar plan, a beginning will be made, and the Provisional Committee, without great

expense, will be able to arrive at an intelligent conclusion, which, if it amounts to a conviction, will spread from them until all the capital required will be subscribed, and the Erie Canal will be in operation in less than five years.

Report of the Committee Appointed by the Chamber of Commerce to Consider the Advisability of Organizing a Provisional Committee, June 11, 1894.

Your committee appointed to take into consideration the advisability of the Chamber of Commerce organizing a provisional Committee to promote interest in the matter of the construction of the projected Lake Erie and Ohio River Ship Canal would respectfully make report as follows:

Suggest a Provisional Committee.

This is a matter which the Chamber of Commerce, of Pittsburgh, has for years past given its unvarying support, and which action has also been concurred in by the Chamber of Commerce, of Cincinnati, and has also been indorsed by other cities in the valley of the Ohio river.

The House Committee on Railways and Canals at Washington has favorably recommended the appropriation of Twenty Thousand ($20,000) Dollars, to be applied in the survey by Government engineers of at least four different routes connecting Lake Erie with the Ohio river, including the Beaver route, and report which route is the most feasible and practicable and can be built with the greatest economy

and secure the greatest advantages to the largest number of commercial enterprises.

We therefore affirm and believe that the building of the ship canal from the Ohio river, at Pittsburgh, via the Beaver route, complies absolutely with all the favorable conditions above stated, and at the same time is the only route which will materially and permanently benefit the manufacturing, coal producing, agricultural and other various commercial industries of the valleys of the Ohio and Mississippi rivers and of their tributaries, and therefore we advocate the building of the ship canal by the Beaver route for the following reasons:

Recommends the Beaver Route.

The commission appointed by the Legislature of Pennsylvania in 1889 (whose report, with maps and profiles, was before us for examination), spent $10,000 in surveying the most feasible and practicable route to connect the Ohio river and Lake Erie by a ship canal, and their report recommends the route via the Beaver river.

In considering a matter of so great importance, and involving such a large expenditure of money as the building of a ship canal from Lake Erie to the Ohio river, the two most important subjects for consideration are its practicability and utility. That it is practicable is beyond all question, as the co-operation of brains and money taking advantage of the facilities Nature has placed within their grasp, will do and accomplish almost anything; and the only points deserving of serious consideration are its location, method of construction and water supply.

The report of the commission above referred to shows the Beaver route to be the shortest possible route between Lake Erie and the Ohio river.

There are four routes to be considered, namely: The Beaver route, from Rochester to Conneaut Harbor or Ashtabula; Muskingum route from Marietta to Cleveland; the Scioto route, from Portsmouth to Cleveland; and the Miami route, from Cincinnati to Toledo.

The distance from Rochester to Conneaut Harbor is 102 miles. The distance from Marietta to Cleveland is about 225 miles. The distance from Portsmouth to Cleveland is 308 miles. The distance from Cincinnati to Toledo is 246 miles.

Nature Has Done Much to Help.

The Ohio River at low water at Rochester is 109 feet higher than the mean level of Lake Erie, and this is about 30 feet below the ship canal level at Rochester. The Ohio river at Marietta is three feet higher than Lake Erie. The Ohio river at Portsmouth is 105 feet lower than Lake Erie. The Ohio river at Cincinnati is 142 feet lower than Lake Erie.

Lockage, up and down, from Pittsburgh to Lake Erie is 759 feet; lockage, up and down, from Marietta to Lake Erie is about 1,017 feet; lockage, up and down, from Portsmouth to Lake Erie is 1,130 feet; lockage, up and down, from Cincinnati to Lake Erie is 882 feet.

The report of said commission also demonstrates an abundant available supply of water for the summit level of the Beaver route, and T. P. Roberts and other engineers of undoubted ability, who have given that subject much thought, assure us that there is no doubt as to a good supply of water for an active business even in seasons of drought.

As to its utility we would say this canal, via the Beaver route, will secure the greatest benefit to the largest number of interests. It will connect the largest possible tonnage that can be secured between the Ohio river and the lakes by the

shortest possible route, and the tonnage along the line of this route, and the industries to be directly benefited by the canal, are infinitely greater along this route than any other that could be selected.

It will also connect the greatest inland navigable waters of the world, where more tonnage passes one point (say Detroit river) in a given time, than passes any place on this or any other continent in the same space of time. With the Mississippi river and its tributaries, containing over 14,000 miles of navigable water, thus connected, the usefulness of the ship canal is too apparent to justify discussion at this time.

Has Long Been Neglected.

We quote from a part of the report of said commission, prepared by T. P. Roberts, which says: "That two such great avenues for cheap transportation in the interior of America, with only 102 miles separating them, as at Beaver and Conneaut Harbor, can exist, with no means of direct connection, evidences the neglect which has been given in this country to advantages which even a colony of Great Britain, not to speak of France, Italy, or Germany, would so eagerly avail themselves of."

This route will be of greater benefit to the National Government than any other, for we believe that vessels for national defense on the lakes could be built and equipped with greater economy at Pittsburgh, and sent out into the lakes in the shortest possible time.

One of the most important arguments that can be made in favor of the ship canal is the great benefit it will be to the railroad transportation companies connecting with, or parallel to, the Ohio and Mississippi rivers and the great lakes. It is safe to say that the population and the business of the region will, in consequence of its operation, be doubled

before many years, and this fact will treble the business of the railroads.

It is an acknowledged fact, the world over, that transportation by water is cheaper than by rail; and all who are experienced in water transportation know that the chief expense in handling freight by vessel is the loading and unloading of cargo. When a vessel is once loaded and starts on her voyage to a destined port, an additional run of 50 or 100 miles adds but little to the running expenses. A steamer leaving Lake Superior for Ashtabula or Conneaut Harbor with a cargo of 2,000 tons of iron ore, the running expenses should be about $200 per day or 10 cents per ton on the ore. Now suppose the ship canal were in existence, and that steamer would continue on to Pittsburgh; and suppose it would take her 36 hours to go from Lake Erie to Pittsburgh, it would add one and one-half days' expenses, or 15 cents per ton to the cost of transportation to Lake Erie ports, to land it in Pittsburgh, and $1 per ton less than is now paid on ore from the lake to Pittsburgh by rail. This rule would apply as well going to, as coming from the lake.

The Most Practicable and Feasible.

In view of the reasons given above, and believing that the public interest has been sufficiently aroused to the great importance of the undertaking to demand that steps be taken to mature plans, and perfect an organization to actively carry forward the project, we therefore approve of the plans proposed of building the ship canal via the Beaver route, by the erection of a corporation, backed by private capital, and clothed with constitutional powers from the State and National Government. We believe that this plan presents the most practical and feasible way of building the canal within a reasonable time, and will also secure, in largest measure, the aid and co-operation of the National Government.

We therefore approve of, and recommend, the appointment of a Provisional Committee of not less than 25 members, the corporations of Pittsburgh and Allegheny, and the principal industries of the two cities and places along the line of the canal, and the Monongahela Valley and West Virginia having a representation on said committee; that said committee shall have full charge of promoting and carrying forward the interests of said ship canal until it obtains a constitutional corporate existence; that said committee shall have power to fill vacancies and to increase its numbers as occasion may require, and shall have power to raise by subscription a guarantee fund to meet the expense of the work to be carried forward by it.

CHAS. W. BATCHELOR,
JOHN F. DRAVO,
MORRISON FOSTER,
WM. P. HERBERT,
W. HARRY BROWN,
Committee.

ADVANTAGES OF WATERWAYS

FOR

CHEAP TRANSPORTATION.

A PAPER READ BY

JOHN E. SHAW, Esq.

BEFORE THE

PROVISIONAL COMMITTEE,

AUGUST 21, 1894.

It has been said "there is no greater national benefactor than the man who makes two blades of corn grow where one grew before."

That is what the Provisional Committee undertake to do in proposing to promote and build the Lake Erie and Ohio River Ship Canal. They propose to carry forward to completion an undertaking which will have for its legitimate and logical result the doubling of the population of the territory adjacent to the canal to twice the present census; doubling the taxable value of the real estate; increasing the mining, manufacturing and other commercial interests to twice their present proportions; take away from the railroads the transportation of bulky raw materials, and reduce the present transportation charges on them by more than one-half; give back to the railroads a doubly compensating advantage, by

creating for them increased traffic and dividends, from the enlargement of their business in the transportation of passengers, manufactured products, high class goods and perishable freight; fill the 2,000 to 2,500 vacant houses in Allegheny County with tenants and create a constantly increasing demand for more houses.

This is the great work the committee will undertake to do, and the results to be attained certainly justify the committee in entering upon the work with a fixed determination and purpose to carry it through to a success if they find it within the limits of human possibility and that the benefits mentioned can be made a reality. As a result, they will not only live to enjoy the fruits of their own real directed efforts, but future generations will rise up and call them blessed.

Its Stimulative Powers.

The carrying out of improvements which increase the facilities for cheap transit cannot fail to stimulate mining, manufacturing and kindred industries, enlarging their productive capacity and earning power, and increase their power to meet competition. In proportion as transport charges are reduced is the field of operations enlarged to markets previously closed against you. Therefore, high transit charges cripple producing power, and place us at a disadvantage as against competitors enjoying cheaper facilities for carriage.

The most progressive and powerful cities of modern times are those which have sprung up on the ocean and great lakes, or on the banks of great navigable rivers, and it is becoming more evident every day that the industrial interests of this country can no longer neglect the cheap transit problem, and that those inland industrial centers denied these advantages by nature, must secure them where possible by art. Splendid examples of such enterprise are Glasgow, Scotland, and Manchester, England, digging out for themselves a road

to the sea. The era of ship canals having only well begun, has come to stay, as they have already solved the problem of cheap inland transportation, for it has already become an established fact that "steam navigation is beyond all controversy the cheapest known mode of inland transit."

A conclusive illustration of the economic operation of this principle is to be found in the declaration of one of the great railway managers, Mr. Moon, Chairman of the London and Northwestern Railway Company, who stated in one of his yearly reports of the road's operations, that "the sea and canals did more for to bring down railway rates than any competition among the railways themselves."

A Most Powerful Lever.

Such admissions, coming from the railway managers, prove that in the development of inland waterways the public have the most powerful lever in maintaining the reduction and equalization of transit charges, and we propose to show that in securing this desired end for the benefit of the public the railways themselves will not be sufferers. Unfortunately for the public, the suitable natural conditions for an inland ship canal are found only at a limited number of points, and where such natural advantages are found to exist, as in the proposed route of the Lake Erie and Ohio River Ship Canal, they should be seized upon with vigor by the public, and promptly utilized and turned to the best account.

An illustration of the effect of transit charges on the heavy trades is seen in the continued movement of many of these industries in England from their inland positions to points of communication with the sea.

A few years ago the *Statist*, a prominent trade journal, pointed out that "owing to the cost of railway transit to shipping ports, the production of Bessemer steel rails had almost been extinguished in some parts of the country," and

the directors of Messrs. Charles Cammell & Co., Lim., manufacturers of steel rails at Sheffield, in one of their annual reports stated "that the high charges of the railway companies have rendered necessary and important changes in the conditions under which the steel rail industry is carried on, and that they have become satisfied that the rail mills must be alongside the blast furnaces, and both must be hard by the sea, and must be in the locality where the ore is found. They will therefore remove their works from Sheffield to the coast of Cumberland and thus avoid the excessive railway charges."

The *Builder*, a journal well known for its clear and pointed articles on questions affecting transit, says: "Some of the principal trades of England are being transferred to Glasgow or to Paisley, owing to the superior cheapness in transport both of raw materials and finished goods afforded by the Clyde."

"Pig iron has long shown this influence. Heavy iron castings from Shropshire and steel rails from Sheffield followed. Now the shoe trade is leaving Stafford and Northampton for the valley of the Clyde, and finally the cotton thread trade is leaving Lancashire for Paisley."

A Question of Taking Chances.

Does this migration of important industies toward the points of advantage of cheapest transit suggest any moral to the great cities and towns in the valleys of Western Pennsylvania? Can we afford to procrastinate and take any chances in this matter, or shall we follow the example of Glasgow and Manchester and build this ship canal and create the conditions which will not only foster and protect the great mining and manufacturing industries upon which we have grown so great and opulent, but encourage like industries to migrate into our midst by reason of the un-

limited natural resources and advantages by which we are surrounded?

We confidently make the assertion that for railroads to grasp for all classes of business, and the carriage of all classes of tonnage, is not an economic principle.

As the result of an exhaustive inquiry by the Government of France into the comparative advantage of water and railway transit, it has become a settled conviction, accepted by the railways themselves, that water communication is a necessity to the economical operation of the railway, and it has resulted in the Government of France appropriating large progressive expenditures for the purpose of extending and improving the inland navigation of that country. This principle was insisted on at the date of the earliest railway concessions, and is lately the object of renewed attention, and in connection with its adoption in France it is interesting to compare the financial results of French railways with those of some other countries.

At the close of 1863 the average cost of a mile of railway in the United Kingdom was £32,000, and in France £32,400. The cost of the former has steadily increased, while that of the latter has diminished since that date, and in 1881, when the cost of each mile of conceded railway of general interest in France had been reduced to £28,773, that of each mile in the United Kingdom had risen to £42,017, and at the present time those of England and Wales have cost £47,700 per mile of line.

Show a Heavy Increase.

Although from 1854 to 1886 the mileage traffic of the English railways increased by 40 per cent., the net percentage on capitalis substantially unchanged. But from 1841 to 1886 the net earnings on capital on the great French railways increased by 70 per cent., rising from 3.11

to 5.56 per cent. on capital—the English returns remaining stationary at 4¼ per cent.

On the English railways the cost per mile is the highest in the world. The freight charges and fares are unusually high, and the working cost is increased from 40 to 52 per cent. by the mixed mode of carrying on traffic. On the other hand the French railways, with charges 15 per cent. lower than the English, pay their security holders 30 per cent. more income on their capital.

In 1877, the gross revenue of the six great French railway systems averaged £2,887 per mile. In the same year the gross revenue of the English railways averaged £2,881 for passengers and high-class goods, to which has to be added £805 for minerals.

Turning from these figures to the consideration of the railways in the United States, we find that in 1891 all railroads in this country made the following showing: Earnings per mile of railroad, gross, $6,852; net, $2,136; expenses to earnings, 68.83 per cent.; interest on bonded debt, 4.25 per cent.; dividends paid on total share capital, 1.85 per cent.; interest paid on stock, bonds and debt, 3.06 per cent.; net earnings on total capital invested, 3.1 per cent.

In view of the figures presented, we look for a logical reason why the French railways can present a better showing than those of either England or the United States, and we find it in the policy adopted in the different countries toward the separate classes of traffic requiring separate rates of speed. In England and the United States the policy of the railroads has been to reach out after all classes of traffic requiring different rates of speed over the same tracks to handle it, which may be divided into three, viz: that of passengers, that of high class or fast freight, and that of minerals. On the other hand, the French railways

have adopted the policy of limiting the rates of speed over their tracks to that required by only two classes of traffic, and only allow the introduction of two rates of running, viz: that required for the transportation of passengers and fast freight, and encouraged both private and Government capital in constructing and improving internal waterways, and have given over to them the transportation of minerals and heavy goods not requiring speed.

Showing the Reverse Side.

The result of this policy is that the mileage capitalization of the French railways is steadily declining, while from a scale of freights and fares considerably lower than that of England, the percentage of earnings on capital invested is steadily on the increase, while on the other hand the mileage capitalization of England and United States railways has steadily increased, and from higher transportation charges the earnings have declined and remain unprofitably low for the capital invested.

In the northern part of France, where canals are most numerous, the railroads are being more extended and prosperous, and show a much greater earning power.

In the last twenty years Germany has paid great attention to the adoption of the cheapest known modes of transit. They have greatly improved the navigation of their great rivers, and have connected them with each other and with the Atlantic ocean and the Baltic sea by canals, and in this connection it is interesting to note that during this period railroads were greatly enlarged in capacity and extended, and during the same period Berlin and Hamburg about doubled not only their population but their tonnage traffic.

The false economy of attempting to make one pair of tracks serve for the conveyance of traffic requiring three rates of speed is shown in the comparative earnings of the locomotives on the railways of France and England.

Thus, in France the gross earning of every locomotive averages £6,069 per annum. In England it only averages £4,385. And as further illustrating the truth of this economic principle in railway traffic, compare the gross annual earnings of the employes of the railway companies, and we have similar results. On lines operated solely with a single speed traffic, each employe of the company can earn from £350 to £400 per annum. On railways confining themselves mainly to two kinds of traffic, each employe earns, on an average £243 per annum, and on the eight principal trunk lines, carrying a mixed traffic, requiring three or more different rates of speed, each employe earned, on the average, only £185 per annum.

A close investigation into the results obtained between land-borne and water-borne traffic discloses a complete series of mechanical reasons for the demonstration not only of the economic traffic principles above set forth, but also the well known fact that while the percentage of earnings of railways on their capital is sharply limited, rarely exceeding 5 per cent., the net earning power of a canal is almost wholly undetermined, and has been known, in favorable instances, to range from 20 per cent. to even higher rates on the original capital. Especially is this true of a ship canal, as illustrated by the Suez Canal declaring a dividend of 20 per cent. in 1893 on a capital of $100,000,000, and upon a traffic that year of 7,712,029 tons.

Speaking of Heavy Matters.

In land traffic the dead weight moved often equals or exceeds the paying weight, and on railways the net or paying weight does not reach to more than a third part of the total weight transported, not including the weight of the locomotives. In water traffic the dead weight is balanced by the water it displaces, and estimates of cost of transportation and earning power are based on the net weight alone. Therefore,

the cost of transportation by a canal is from one-third to a lower proportion of that by land upon equal cargoes, and the average cost of moving a ton of goods a given distance by rail is about three times the cost of performing the same duty on a canal. The capacity of a railway for the moving of traffic is sharply limited, and that limit is narrowed by the variety of speeds required, and a larger capacity for the movement of traffic can only be attained by a proportioned increase of capital.

A canal, however, has almost an unlimited capacity, which reaches to at least ten times that of a pair of railway tracks. On a canal the chief expenses are fixed depending upon time and distance. On a railway they are in proportion to the work done. The cost of operation and maintenance of the Suez Canal remained approximately the same from its opening to date, but the receipts from traffic rose from £206.000 in 1870 to £2,653,000 in 1882, an increase of more than ten-fold, while the cost of maintenance and operation remained stationary.

It has been demonstrated in the case of the Suez Canal and other great waterways that 6 per cent. of the gross earnings will pay the expense of maintenance and operation, but on railways it has also been demonstrated that the working expenses increase in proportion to the gross earnings, and the net earnings on capital invested remain substantially the same. The five great railway lines now carrying the principal traffic between Pittsburgh and the lakes are the Pittsburgh, Ft. Wayne and Chicago, the Cleveland and Pittsburgh, the Erie and Pittsburgh, the Pittsburgh and Lake Erie and the Pittsburgh and Western. Each of these lines in part runs along the line of the proposed route of the ship canal. The total mileage of the five railways is about 1,350 miles, and they represent a total capital stock, funded debt and current account liability of about $110,000,000.

A Pertinent Question Here.

Now, if the ship canal can be built for $30,000,000 or $35,000,000 (the Pennsylvania Canal Commission's estimate being $27,000,000), and can transport a tonnage equal to the capacity of ten such lines of railway at one-third the cost the railways can do it, and can be kept profitably busy carrying the coal, iron ore, and raw and heavy materials, at over one-half less than present cost of transit, and more than compensate the railroads in dividends and earning power from other traffic the operation of the canal will build up for them, is the building of the Lake Erie and Ohio River Ship Canal a plausible and commendable undertaking for the Provisional Committee to take hold of with great zeal and earnestness?

The economic transit principles above set forth have been established by the traffic experience of the last half century.

The introduction of the canal in connecting inland cities with the great water highways of commerce has been the chief factor in solving the cheap transit problem, and we cannot afford to ignore the lessons taught by experience and the practical illustrations of truth.

Two great questions are to be considered by the committee in undertaking such a project:

First—Is the scheme practical as an engineering enterprise, and can it be carried forward to completion, and secure a tonnage and traffic that will insure the attention of capitalists as being a sound and profitable investment?

Second—Will it place the cities and towns touched by the canal, and the immense territory tributary and adjacent thereto, on a better footing as great commercial and industrial centers, and thereby enable their merchants, manufacturers and mine operators to better sustain the competition of the world?

The committee in now undertaking to patiently, exhaustively and impartially investigate the evidence that may be produced both for and against the carrying forward of the project, may

reasonably expect, and undoubtedly will secure, the moral and financial support of all classes of citizens, and all departments of commercial activity representing vested capital, without exception, not only in the preliminary stage of investigation, but in their carrying it forward to successful completion, should they decide it to be a feasible and wise undertaking and for the public good.

Notes Upon The Canal, Etc.

PREPARED BY THOS. P. ROBERTS, C E.

The Harbor of Pittsburgh.

The harbor of Pittsburgh is formed by the dam at Davis Island in the Ohio river, 4½ miles below the city. It affords a depth of nearly 10 feet to the wharves on the Monongahela river. The channel depth might be somewhat improved by means of dredging the shoal near Brunot's Island, half way down to the dam, and at other points. The depth in the first two miles above the dam to the foot of the Island named, is about 14 feet when the dam, which is an adjustable structure, is raised in position. It has been suggested by the writer as one expedient to deepen the harbor, in case of the construction of the canal; to erect a second adjustable dam, abutting against the same lock wall, and two or three hundred feet above the existing structure. The maximum lift of the present lock and dam is about 13½ feet, which is thought to be about the safe limit of the Channoine system of adjustable dam construction. The second dam need have a lift of only five feet to secure, with the aid of a very trifling amount of dredging, a safe navigable depth of 15 feet to the city wharves and up to, and into, the large lock at Dam Number One on the Monongahela river. It will serve to illustrate the area of Pittsburgh's harbor, to state that, during a number of weeks in the fall of 1893, there was at

one time afloat in this pool, or harbor, more than 1,800 loaded coal vessels with more than 50 towing and other steamers awaiting a rise to descend the Ohio. The cargoes of coal by an actual account taken, aggregated a trifle more than 1,000,000 of tons. This great fleet of vessels in close order covered about 110 acres, or about one-eighth only of the harbor between the two dams on the Monongahela and the Ohio referred to. In general, the pool, or harbor, of Pittsburgh ranges from about 800 feet to 1,200 feet in width, with a length of 5½ miles, not including that portion of it extending up the Allegheny. The least height of the bridges crossing it is about 50 feet, with no channel spans less than about 250 feet.

The Ohio River Division.

The Pennsylvania Ship Canal Commission, in 1890, reported in favor of the plan of constructing a canal paralleling the Beaver and Ohio rivers, from New Brighton, on the last named stream, to the Davis Island dam.

At New Brighton there is a water power dam on the Beaver, the level of which is six feet higher than the normal pool elevation of the Pittsburgh harbor. It was proposed to form a continuous canal level, unobstructed with locks, from this New Brighton pool to the Davis Island dam, a distance of 22 miles, at which point a lock of six feet drop would be necessary to connect the canal with the Ohio. The water for the supply of this level would come from the Beaver.

One argument in favor of this parallel canal project was the avoidance it offered of 60 feet of lockage for vessels from Pittsburgh destined for the lakes, viz: 30 feet locking down the Ohio to the mouth of the Beaver, and 30 feet locking up again to the New Brighton pool in the Beaver.

Another important reason urged in favor of the independent canal plan, was the fact that the U. S. Government contem-

plates the improvement of the Ohio by means of adjustable dams providing for only six feet depth on the sills of the locks. Three locks and dams between the Davis Island dam and the Merril dam (now in progress of construction just below the mouth of the Beaver) would be required to complete the river improvement as at present contemplated. As early as 1827, when surveys were in progress, the plans of the State Engineers provided for a separate canal from Beaver to Pittsburgh, and in 1872, the final Act of the State Legislature in the history of that work, provided in distinct terms, authority to construct a separate canal between the same points. It would now, however, require the consent of Congress to construct a canal such as is here suggested for consideration.

The most prominent engineering feature of this division of the canal, is the masonry work involved in the river walls, culverts and arch-ways necessary to pass the waters of the small side streams beneath the canal.

At Rochester, a connection of the canal with the river was proposed by means of locks. Such a connection would be necessary for ore barges, etc., destined for Wheeling, and for the general accommodation of vessels seeking the canal from lower Ohio river ports. The deep water-way from the Pittsburgh harbor to a connection with the Merril dam pool, in the Ohio, could also be taken advantage of by Pittsburgh coal shippers to make up fleets in the Ohio opposite the Beaver river, from which point the opportunities to take advantage of freshets in the Ohio are more frequent than they are at Pittsburgh.

The Beaver River Division.

From the New Brighton dam, to the head, or forks, of the Beaver river, a distance of about 25 miles, it was proposed to canalize the stream; or in other words, convert it into a system of slack water navigation by means of locks and dams.

Soundings taken in the stream indicated that by means of dredging in its bed, and with dams no higher than the old canal dams, the full depth of 15 feet could be had, and for less cost in dredging work than was anticipated before the survey was made. Owing to the lowness of the bottom lands along the Beaver, the Shenango and Mahoning river, (for the same remark will apply to all three valleys), occupied as they are by a succession of towns and villages containing many important manufacturing establishments, it is essential that the height of the flood planes shall in no wise be increased by the canalization of the streams. The writer will not hesitate to assert that with low dams provided with adjustable tops (as was proposed by Mr. E. Sweet, the accomplished New York canal engineer, to meet similar conditions upon the Mohawk river), the height of floods need not be increased; rather to the contrary, it may be safely affirmed that the widening, deepening and straightening of the river channels in the canalization, will so increase their sectional areas that with a less height of flood level, a greater volume of water will pass.

At no point along the Beaver need the railroad tracks be raised on account of the canal, supposing it were constructed. The Canal Commission made no surveys up the valley of the Mahoning, but the same particular care would be observed there, no doubt, to so arrange the canal levels as to not endanger any important vested interest.

Hydraulic Lifts.

There is nothing new in the suggestion to diminish time lost in excessive lockage by means of lifts or inclined planes, and by such means it has been proposed on some canals to economize in the use of water. We have had in this country, however, only the limited experience with their use upon small canals and by primitive methods, such as was practiced with

partial success upon the Chesapeake and Ohio Canal, at Georgetown, and upon the Morris and Essex Canal.

Plans for them in this country, and in Canada, have been produced upon more advanced and modern methods, both upon the mechanical balanced, and upon the vertical balanced, hydraulic principle. They have been recommended by capable engineers to overcome in Canada, upon the Georgian Bay and Lake Ontario Ship Canal, more than 350 feet accumulated difference of elevation; and by American engineers for a proposed ship canal, extending from Lake Erie, along the Niagara terrace, to the neighborhood of Lewistown, thence with a drop of 330 feet to the level of Lake Ontario.

In the meantime, theory has proceeded into practice in France. At St. Omar, on the Neufosse Canal, in that country, five locks of an aggregate descent of 43 feet, (locks about the size of the New York-Erie Canal, viz: 7 feet depth passing 300 ton boats), where formerly an hour and 20 minutes, and sometimes two hours was lost in passing single vessels, are now, by means of the hydraulic lift in use, passed in 20 minutes. At St. Omar, the weight of one caisson, including water, is 800 tons, and the removal of 40 tons, or 5 per cent. of the weight of one caisson, will elevate the other to the full height. The movement is under perfect control by means of valves, and the caissons can be stopped and started in any part of their course. There seems but little reason to doubt, in view of their success abroad, that by similar means some of the projected ship canals in this country will be able to greatly reduce the time, and consequently the expense, of moving steamers and barges over them. So far as a casual examination of the ground would admit of, the writer is of the opinion, that, by the introduction of several lifts, the locks, or stops, viz: 50 in all, on the proposed Beaver-Conneaut route, can be reduced to about 38; and upon the Warren route, including locks and lifts, to not more than 28 or 30 between Pittsburgh and Lake

Erie. When the comparison is made with the old Pennsylvania-Erie Canal of 65 ton boats compelled to stop at locks 133 times between Rochester and Beaver, and the ship canal for vessels of 2,500 to 3,000 tons compelled to stop at perhaps not more than 28 or 30 places to lock or lift, a realizing sense of the difference between the actual past and possible present can be had.

The Possibilities of the Bituminous Coal Trade, from Pittsburgh, to the Great Lakes.

One of the ablest speakers at the International Waterway Congress, held during the World's Fair, at Chicago, last summer, speaking in behalf of Lake Superior interests, remarked that Lake Superior and the vast, but rapidly developing, region to the west and northwest of it, upon both sides of the international boundary, afforded the most promising field for the development of a great coal trade in America. Not a pound of coal exists in the rock stratification of all that immense district, and yet it is the region of long and severe winters, but which, from its great productiveness, supports, even now, a great and rapidly increasing population. The cities of St. Paul and Minneapolis are included in this coalless district, and now receive much of their fuel supply from Duluth, from which, as the chief distributing point on Lake Superior, about 3,000,000 tons of coal is annually received from Lake Erie ports by steamers and barges. "Twenty-five cents a ton," the speaker said, "of a possible reduction in the price of any fair quality of bituminous coal, would give the shippers who could present such an advantage the practical monopoly of the Lake Superior traffic in this article." Referring more especially to the Monongahela valley coal, with which the speaker displayed a familiarity,

he heartily endorsed the addresses of the representatives of the Pittsburgh Chamber of Commerce, who were present to lay before the Congress the claims to national recognition of the projected Lake Erie and Ohio River Ship Canal, from Pittsburgh, via the Beaver river, to Lake Erie, and asserted, that the desire for cheaper ores in Pittsburgh was fully equalled by the desire for better and cheaper coal upon Lake Superior.

There are some curious anomalies presented in the distribution of coal from the celebrated "Pittsburgh coal vein." This vein is continuous along the Monongahela river, from Pittsburgh, to the sources of the stream in West Virginia, and certainly no other cheap bituminous coal in America is more prized, and more sought after, than the coal from this district. About 4,500,000 tons of it are shipped annually by vessels from Pittsburgh to the lower Ohio and Mississippi river ports. From Cincinnati some of this coal is transshipped by rail to Chicago, Toledo, etc. At New Orleans it is sold to steamers crossing the gulf to Mexican and Cuban ports. From near Pittsburgh it is taken in immense quantities to Erie, Cleveland and other lake ports by rail, to be transferred to steamers on the lakes for more distant lake cities. It may be seen on vessels passing through the Welland Canal, in Canada, to be sold even in Toronto and other Canadian cities; and it is the American coal which meets, and seems to hold in check, at Montreal, the Nova Scotia coals; and this it has been able to do without a tariff protection, and in the face of a heavy, but necessary, transportation tax. So, also, from the neighborhood of Clarksburg and Fairmont, West Virginia, it is shipped eastward over the mountains to Baltimore, there again to be transferred by vessels for New York and Boston, for gas making; and westward, five hundred miles or more, it stands a rail haul, from the Virginia towns named, to Toledo, Chicago and Milwaukee.

In area, assuming only one-half that assigned to it by the reports of the geologists, there is a strip of this coal along the navigable waters of the Monongahela river—the most successful slackwater navigation in America—measuring, say, 100 miles long by 30 miles wide, all of which territory, by short coal mine roads, is directly accessible from the pools of the river named. That is to say, there are 3,000 square miles, much of it really embracing two or three coal veins, equally as prolific as the celebrated vein known as the Pittsburgh vein. The Pittsburgh vein will average more than 5,000 tons to the acre of merchantable coal, and in all there is in the area under consideration, even upon this conservative basis, about 10,000,000,000 tons. At the present rate of mining, there remains enough to last fully 1,000 years.

The eagerness with which the railroad companies are pushing their lines into this golden coal territory, from the North, and from the East and West, entirely reckless, as they appear to be, of the mountain grades, long hauls, etc., affords to the friends of the ship canal the most convincing evidence that it would be highly profitable to ship this coal by vessels to the lake, direct from the pit mouths to the wharves of the countless cities and towns located upon the great lakes, not one of which enjoys the blessed privilege of having a coal mine at its doors, or anywheres in sight of its doors. The present rail tariff on coal from Pittsburgh to lake ports, including transfer to vessels, is about $1.04 per ton. By vessel, including toll on canal and all other charges, this cost to Lake Erie, from the mines, can be reduced to 35 to 40 cents, with a handsome margin for profit.

It is not generally known that work upon the Chicago and Illinois River Ship and Drainage Canal is in active progress. More than $5,000,000 worth of the work (the total estimated cost of which will be over $30,000,000) is now under contract, and the city of Chicago stands pledged to com-

plete the great undertaking—if it must be—without government aid. Within a few years, it now seems certain, there will be a deep waterway, via the Chicago divide and the Illinois river, from Lake Michigan to the Mississippi river, upon which the engineers confidently claim there will be a constant depth of fourteen feet down to the mouth of the Illinois, and not less than nine to ten feet maintained on the Mississippi to St. Louis, Cairo, etc., afforded by the draught the Chicago cut will make upon Lake Michigan waters. Greater depths in the Illinois are possible with a more liberal expenditure upon the Chicago cut.

Branching from the Illinois river toward Rock Island, on the Upper Mississippi, the U. S. Government is now actively engaged in the construction of the Hennepin Canal. Thus it will happen, that about the time of the possible completion of the canal from Pittsburgh to Lake Erie, a way will be open to convey 2,000 to 3,000 ton barges of Pittsburgh coal direct to St. Louis, or to Rock Island, without breaking bulk.

The completion of these canal systems would present a choice of routes to St. Louis for coal from Pittsburgh as follows:

The Lake Route.

Pittsburgh to Lake Erie, 130 miles; still water navigation.
Lake Erie to Chicago, 800 miles; still water navigation.
Chicago to St. Louis, 360 miles; down stream navigation
Total, 1290 miles.

The River Route.

Ohio river to Cairo, 967 miles; down stream navigation
Cairo to St. Louis, difficult up stream navigation (current usually six miles an hour), 180 miles. Total, 1147 miles.

When the great irregularity and risks of the Ohio river navigation are considered, in comparison with the constant.

and reliable canal and lake route to St. Louis, the difference of 143 miles against the lake route is no factor in the problem. It is quite true that the fleet system of barge towing on the Ohio and Mississippi is the cheapest system of transportation known to the world (this statement, no doubt, will create surprise in some quarters, notwithstanding the fact that Pittsburgh has a greater tonnage in vessels engaged in the business than is owned by any city in the world for all purposes of navigation). Notwithstanding its cheapness, it has never been found practicable to ship out, upon the short-lived floods of the upper Ohio, sufficient coal to keep the Mississippi valley markets supplied at a reasonably uniform price. On the contrary, the price of Pittsburgh coal at Cairo, St. Louis, Memphis, etc., fluctuates enormously, doubling and trebling in value, etc. The writer will indulge in no speculations as to what the two canals might do to regulate the markets in the Lower Mississippi country, but from St. Louis, and from Rock Island, consuming and distributing points for a new market would be opened up, second only in importance to what we have every reason to believe Duluth will become, upon the completion of the canal connecting the upper Ohio with Lake Erie. The markets here referred to are beyond, and always will be beyond, the limits of rail haul in great volume from Pittsburgh.

PRESS OPINIONS.

PITTSBURGH "DISPATCH," August 7 and 21, September 3, and October 17, 1894.

The project which brings lake transportation to Pittsburgh will be a universal benefit. It will make Western Pennsylvania the manufacturing center of the world. . . . . No project ever involved greater or more permanent gains to the industrial community. With the canal in operation, nothing short of the deliberate wrecking of the waterway can prevent the permanence of its influence for expansion and wealth. It will mean that so long as that pathway, of the cheapest form of transportation known to man, remains open, Western Pennsylvania can bring its raw material to its manufacturing establishments cheaper, and take its millions of tons of heavy products to market at less cost, than any manufacturing point in the country, if not in the known world; and that implies that men, now living, will see the population of Western Pennsylvania counted by half millions, where it is now counted by hundreds of thousands. . . . . The immense result to the coal industry alone would repay the cost of the canal in five years. Considering that there is an equal or greater gain to be secured for manufacturing establishments, the facts should set Western Pennsylvania at unstinted work to secure the construction of the waterway at once. . . . . Every dollar put into the guarantee fund, or the securities of the future enterprise, is a sound investment by itself but its effect in increasing the wealth of the community will repay it twenty fold.

PITTSBURGH "TIMES," August 24 and 11 and October 10, 1894.

Capitalists will not be lacking who will seek investment in the enterprise when they know the facts. Manchester, a city with a population only equal to that of Pittsburgh and Allegheny combined, loaned the Ship Canal $25,000,000, or only $3,000,000 less than the estimated

cost of the Lake Erie enterprise, after its capitalists and people had raised $25,000,000 in stock subscriptions and borrowed $25,000,000 more from outside London banks. Pittsburgh can certainly do one-third as well as Manchester, especially as the promise for a profitable return is much greater. . . . . The "Times" sees no good reason to doubt from the evidence thus far presented and offered that the Ship Canal is entirely feasible, and that it can and will be built and operated before many years. If the Provisional Committee will, after due investigation, sanction the project. . . . . All that remains is to raise the money required by the work. That ought to be entirely feasible also when capitalists have studied the advantages which the canal will afford Pittsburgh and the country commercially tributary to it, for these can hardly fail to carry conviction that it will be a profitable investment.

PITTSBURGH "LEADER," AUGUST 22 AND OCTOBER 10, 1894.

The Provisional Committee, on the Pittsburgh and Erie Ship Canal, organized yesterday with a full attendance of members, and entered on its preliminary labors with a degree of zest which bodes well for the future. The committee is composed of active, brainy men thoroughly conversant with the commercial advantages and needs of Western Pennsylvania, and having something more than a perfunctory interest in the development of local resources, and the people may accordingly rest satisfied that no stone will be left unturned to push the canal project to an early and successful issue. Of the great benefits that will result from the construction of the canal it is unnecessary to speak. The subject is one with which our citizens are, or ought to be, familiar by this time. All encouragement is due to the canal committeemen in their valuable work. . . . . As it is a visible certainty that the enterprise will be a profitable one, the investment thus thrown open to the people is an attractive one and free from risk.

PITTSBURGH "PRESS," AUGUST 21, 1894.

The Ship Canal project, as it is related to Pittsburgh, has no lack of moral support. What it needs more now than bare, moral support, is the financial support of Pittsburgh's citizens. . . . . There should be no shirking or turning back once the work is begun, and the community will understand that those who constitute the commission at the start are the avowed supporters of the project to the very end. There is, under that conception of the commission, no more vitally important and honorable post in Pittsburgh than to be one of its members.

PITTSBURGH "CHRONICLE-TELEGRAPH," August 22, 1894.

At its meeting yesterday the Chamber of Commerce put the Ohio and Lake Erie Canal project in such shape that its importance must command general recognition. A strong organization was given to the movement by the appointment of committees made up of prominent citizens, and statements were submitted which will convince the public of the feasibility and value of the work.

PITTSBURGH "DAILY FINANCIAL NEWS," October 16, 1894.

There can be no two opinions as to the desirability of a Ship Canal connecting Pittsburgh with the great lakes. The enterprise is national, as well as local, in importance, and, while it would add millions annually to the trade of this section, its benefits would extend to every part of the country in reducing the cost of carriage of freights of all classes. The enterprise should not be allowed to languish, now that it has been fairly discussed and its feasibility demonstrated. Pittsburgh is able and willing to furnish a large share of the money needed to defray its cost, and there ought to be no great difficulty in securing the remainder.

PITTSBURGH "POST," October 17, 1894.

The first step of a practical character to be taken in the matter of the Ship Canal to Lake Erie is to raise the $100,000 necessary for the preliminary work. Subscribers to this fund will not be giving their money away by any means, for when the canal company is incorporated they will receive an allotment of shares equal to five times the amount of the subscription actually paid in. . . . . The necessities of water communication to the lakes, not only to the manufacturing interests of Pittsburgh, but of the contiguous territory as well, come from the sharp competition on the part of the lake industries which have the benefit of cheaper ore. . . . . There seems to be involved in this canal question the other question, whether Pittsburgh will retain its manufacturing supremacy, or stand still, or possibly go back, while our rivals are advancing. This canal enterprise in which Pittsburgh is engaging is not a local matter, by any means, but nearly concerns the welfare and progress of every bit of Pennsylvania west of the Allegheny divide.

PITTSBURGH "COMMERCIAL GAZETTE," October 18, 1894.

The Provisional Committee, having the matter in charge, has completed its arrangements for receiving subscriptions to a guarantee fund

of $100,000 for promoting the construction of the Lake Erie and Ohio River Ship Canal. There is no question as to the commercial benefits which would result from this enterprise. They have been demonstrated beyond cavil or doubt. That it would yield handsome returns to the capitalists of Western Pennsylvania, Eastern Ohio and West Virginia, without regard to dividends on its cost, must be apparent to every intelligent business man within the area named. That the tonnage passing through the canal would pay a handsome percentage of profit on the investment has been satisfactorily demonstrated. . . . . It is gratifying to know that so little doubt is entertained, among many of our prominent citizens, concerning the entire practicability of the project, that they have been tendering subscriptions to the guarantee fund in advance of the readiness of the committee to receive them. . . . . The conditions upon which the subscriptions to this fund are to be made are very favorable, and are surrounded by all needful precautions and safeguards. There is no possibility that the money will be wasted. The preliminary work may necessitate some changes, but no one, whose opinion is worth serious consideration, now believes that the project is not within the engineering and pecuniary ability of its projectors. The completion of the guarantee fund will be the first grand step towards the final consumation of the enterprise. Let the good work go on.

JAMES M'MILLIN, PRINT,
PITTSBURGH, PA.

PAMPHLET No. 2.

LAKE ERIE

AND OHIO RIVER

SHIP CANAL.

SPECIAL EDITION WITHOUT APPENDIX.

PERCY F. SMITH PRINTING AND LITHO. CO.

Herewith find copy of special summary edition of our Report, printed for the promotion of our National and State legislation, and remaining copies distributed to the subscribers to the guarantee fund. A constitutional objection having been raised by the Controller of Pittsburg to the payment of the appropriation of $10,000 for the use of the Committee, leaves the Committee unable to meet obligations incurred which were expected to be paid out of this appropriation, and unable to publish the full and complete report of its work. It is hoped that the objections may be removed and the appropriation be made available, or that an addition subscription to the guarantee fund may be secured that will enable the Committee to proceed in its work of issuing its report without delay and proceed to the organization of a company to construct the canal, as the legislation to accomplish this has now been secured. This is a time when all friends of a ship canal connecting Lake Erie and the Ohio River should rally to its support and provide the Committee with the necessary funds to push its work to completion, as the most favorable conditions are opened up through having obtained the necessary legislation.

George A. Kelly,
President.

John E. Shaw,
Secretary.

LAKE ERIE AND OHIO RIVER

SHIP CANAL.

REPORT

—OF THE—

PROVISIONAL COMMITTEE

—OF THE—

CHAMBER OF COMMERCE,

—OF—

PITTSBURGH, PA.

PROVISIONAL COMMITTEE.

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HON. B. McKENNA, Mayor of Pittsburgh, Pittsburgh, Pa.

HON. WM. M. KENNEDY, Mayor of Allegheny, Allegheny, Pa.

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ADDRESS.

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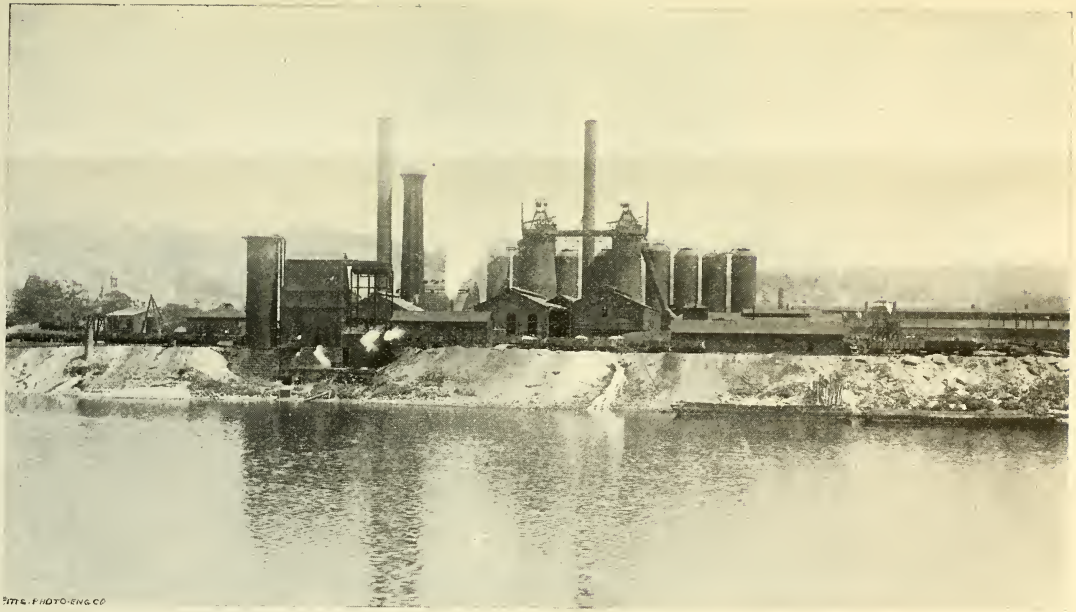

A Specimen Lake Superior Ore Consumer in the Harbor of Pittsburgh.

PREFACE.

The Provisional Committee herewith presents to the public the report of its investigations relating to the practicability and value to commerce of a ship canal connecting Lake Erie and the Ohio River, via the Beaver and Mahoning Rivers.

The report is embodied in the reports to this Committee of the Consulting Board of Engineers, the Engineering Committee, the Committee on Railroad and Canal Statistics, and the Legislative Committee, all of said reports having been presented to the Provisional Committee at a meeting held March 3d, 1896, and duly approved.

At said meeting the following resolution was unanimously adopted:

Resolved, "That the thanks of this Committee is hereby tendered the subscribers to the Guarantee Fund, and the Councils of the City of Pittsburgh for their generous provision of funds which has enabled the Committee to carry the work forward to this point; and to the public press for its valuable co-operation and assistance to the Committee in its work."

It is a matter of congratulation that this project, promising such widespread benefits to commerce and manufactures, has been found practicable, within a reasonable cost, and will prove profitable to the capital invested in it.

THE PROVISIONAL COMMITTEE,

JOHN E. SHAW, *Secretary.* GEO. A. KELLY, *President.*

PITTSBURGH, PA., March 3d, 1896.

PITTSBURGH HARBOR. SAMPLE OF COAL FLEETS AWAITING A RISE IN THE OHIO RIVER.

REPORT

OF THE

CONSULTING BOARD OF ENGINEERS

—TO—

PROVISIONAL COMMITTEE.

REPORT OF CONSULTING BOARD OF ENGINEERS.

BALTIMORE, MARYLAND,
February 18, 1896.

HON. GEORGE A. KELLY,
President Provisional Committee,
LAKE ERIE AND OHIO RIVER SHIP CANAL.

DEAR SIR:

The undersigned Board of Consulting Engineers has the honor to submit the following report on the project for a ship canal to connect the waters of the Ohio River and Lake Erie.

In company with the Chairman of your Engineering Committee, (Colonel T. P. Roberts), the Board made a thorough examination of the country traversed by the lines of survey for the canal, reservoirs and feeders, and have carefully and thoroughly investigated the plans and estimates for the work, which, it is pleased to say, exhibit to a remarkable degree the skill, intelligence and painstaking care put into the development of the project by Colonel Roberts and his Principal Assistant Engineer, Mr. George M. Lehman.

The Board is of opinion that the project is feasible and financially practicable. The details of the subject will be discussed under the following heads:

(1) Commercial Demand for a Canal.
(2) Best Route for the Canal.
(3) Topography of the Region Traversed.
(4) Ohio River Traffic and the Canal.
(5) Dimensions of the Canal.
(6) Available Water Supply.
(7) Location and Dimensions of the Feeder Lines.
(8) Bridges over the Canal.
(9) Estimates of Cost.

COMMERCIAL DEMAND FOR A CANAL.

Unless it can be established beyond a doubt that there is a sufficient tonnage to warrant the large outlay required to build this canal, and that its economies would be far-reaching, there is no necessity of proceeding further in the premises. Hence a few statistics as to its utilities are submitted to demonstrate the great need existing at the present time for its early completion.

The rich and extensive deposits of the Gogebic, Messaba and Vermilion ranges bordering Lake Superior are being rapidly developed, but their conversion into mercantile products requires fuel, and the nearest extensive veins of coal are located on the tributaries of the Ohio, in Pennsylvania and West Virginia.

Again: The manufacturers and miners of these latter districts require the agricultural products of the great grain fields of the Northwest, in exchange for the fuels which do not exist in those sections.

The population of the Pittsburgh district within a radius of 60 miles was 1,608,000 in 1890.

This interchange of commerce is now accomplished through the instrumentality of ten (10) lines of railway between Pittsburgh and the Lakes, requiring several trans-shipments and an additional overland movement from the head of Lake Superior. The total cost of these roads, with their equipment, with one exception, is said to be $172,141,738, while the average ton mile rate on all freight on said lines is about 6.7 mills, which is below the ton mile rate on the ore (8.85) and coal (8.00) to and from the Pittsburgh district, including transfer, and yet some of these roads are being operated almost continuously at a net loss on their capital invested.*

The total commerce on the Great Lakes for the year ending Dec. 31, 1889, was ..... 53 424,432 tons,
while that of the Atlantic Coast was ..... 77 597,626 "
and the Pacific Coast ..... 8,818,262 "
and Gulf of Mexico ..... 2,864,956 "

Of the lake traffic 54.22 per cent. consisted of mineral products, 24.97 per cent. was lumber, and 16.41 per cent. agricultural, while 5.9 per cent. was miscellaneous. The average distance

*For details see Report of the Statistical Committee by John E. Shaw.

carried was 566 miles, and the total ton mileage was 15,518,360,000, while that for all the railroads of the United States was 68,727,223,146, so that the business of transportation on the Great Lakes was 22.6 of that of all the railways for 1889.

Carefully checked statistics of the traffic over this portage between Lake Erie and the Ohio River indicate a tonnage at present not less than :

7,000,000 tons of iron ore,
7,000,000 tons of coal,
2,000,000 tons of coke,
1,000,000 tons of heavy manufactured products,
1,500,000 tons of limestone, lumber and general merchandise,

making a grand total of 18,500,000 tons; so that it would be safe to base an estimate on 13,000,000 as the probable tonnage over this much cheaper water route immediately after its completion, and this will form the basis of our estimate of revenue for the canal.

The present cost of ore from Lake Superior to Ashtabula per ton is $0.80
From Ashtabula to Pittsburgh, including transfer and dockage charges 1.15

Total $1.95

By canal the charges would be:
Ashtabula to Pittsburgh, via canal $0.13
Canal toll per ton (old rate by Pittsburgh and Erie Canal) ..... .25

Total $0.38
Saving, $1.15 less $0.38 ..... 0.77

In the same manner the tariff on coal may be reduced from the present charge of $1.05 to $0.33, a saving of 72 cents per ton. Thus coal can be delivered at Chicago for $1.67, at Duluth for $1.50 per ton, at New York for $1.75, and at Montreal for $1.60, with corresponding reductions for all points reached by the lake connections.

Applying these economies to the existing traffic and omitting the inevitable increase resulting from reduced cost, there would result on the ore now used in the Pittsburgh, Mahoning and Shenango districts and the Ohio Valley from Beaver to Bellaire, a saving of $4,496,082, and on the return cargoes of coal $4,868,561, and of coke $1,414,044, or a total reduction on the price of

coke, coal and iron ore of $10,778,687. In addition, the canal would earn in carrying the ore for these districts, at 25 and 15 cents respectively, $1,515,014; on the coal at 20 cents, $1,352,378, and on coke $301,657, a total revenue from these few items alone of $3,169,049, being 9.6 per cent. on $33,000,000. Hence we believe there is an ample margin for large returns from investments in this project, and there is abundant reason, and, in fact, urgent necessity, for its early completion in order that the entire lake region and its dependent territory may receive the benefits accruing from cheaper transportation, and maintain the large plants now in competition with more favored localities.

The economy in 6 lake cities in coal* alone would be		$11,852,876
" " " canal district in ore	" "	4,496 082
" " " the lake district in coke	" "	1,414,044
		$17,763,002

Thus the annual economy resulting from the construction of this commercial highway would be more than half the estimated cost of the canal from these few items alone. For the revenues and expenses we respectfully refer to the close of this report, under the head of ESTIMATES.

THE BEST ROUTE FOR THE CANAL.

In projecting every line of transportation it is fundamental that the physical obstructions should be reduced to a minimum. Hence it becomes necessary that the district through which the line is to pass should be thoroughly examined as to its topography and resources, that the most economical, useful and profitable route may be secured.

For a waterway this route should occupy the lowest points in divides, both to avoid unnecessary lockages and to increase the area of the tributary water-shed for the summit level, as well as to accommodate the largest traffic.

For this particular project, whereby it is proposed to connect the waters of the Ohio River with those of Lake Erie, it is neces-

*See Report of Statistical Committee.

sary so to locate the channel as to afford the greatest facility to commerce, especially with reference to the time required to traverse it, the elevations to be surmounted, and the supply of water available for the maximum tonnage.

Several possible routes present themselves, to wit:

(1) That of the old State work known as the Beaver and Erie, or the Erie Extension Canal, connecting these terminals, via the Beaver and Shenango Rivers and Conneaut Lake, having a length of 136½ miles, with 926 feet of total lockage. There were 133 locks, having an average lift of about 7 feet per lock.

(2) That from Portsmouth to Cleveland, via the Sciota, Tuscarawas and Cuyahoga valleys, covering 321 miles, although this distance might be materially reduced by the construction of a short link from Zanesville to the Muskingum, following the latter river to Marietta, on the Ohio, where the elevation is 570 feet above tide. From the Marietta terminus to Cleveland the total distance would then be 246 miles, of which 136.8 would be canal proper and the balance slackwater navigation. There would be required 70 locks on the canal, and 15 locks and dams on the river portion, or 85 in all, having a total lockage of 793 feet, and an average lift of 9.3 feet.

(3) A third route is that via Sandusky and ~~Portland~~ Portsmouth, covering 228.3 miles and crossing the divide at an elevation of 315 feet above Lake Erie and 412 feet above the Ohio River. Total lockage 727 feet, overcome by 82 locks and 20 dams. Average lift about 7 feet.

(4) Still a fourth route is practicable via Toledo and Cincinnati, following the valleys of the Maumee and Miami Rivers for a distance of 249 miles and crossing the divide at an elevation of 374 feet above Lake Erie and of 516 feet above the Ohio River, thus requiring a total lockage of 890 feet, distributed through 98 locks with an average lift of 9.08 feet. The summit levels on these two latter routes would each be 24.2 miles in length, but in none of them is the trunk of the canal adapted to the transit of lake vessels, while the estimated traffic is limited to from two and a half to three millions of tons, so that they do not enter as important factors in a trunk line waterway between the central basin and the seaboard.*

*For more detailed statistics in relation to these routes see Report of Capt. Hiram M. Chittenden, U. S. Engineer.

The route which, in our opinion, best fulfills the above conditions is that following the valley of the Ohio River from the Davis Island Dam, 5.25 miles below the Smithfield Street Bridge, Pittsburgh (699.2 feet above tide low water, and 702.86 pool level), to the slackwater of the Beaver River, 23.26 miles; thence up the Beaver and Mahoning Rivers by a slackwater system of pools and dams 46.26 miles to Niles; thence by canal 8.74 miles to the plateau, 900 feet above tide; thence 31.35 miles across this summit; thence descending to the level of the lake (572.86 feet above tide) in a distance of 12.55 miles.

Thus the total distance from the entrance to the slackwater system at Guard Lock No. 4, on the Beaver, to Lake Erie, at Ashtabula, is only 98.9 miles, while the total lockage is but 548 feet.

As the shortest air line distance between the Ohio River and Lake Erie at any point is about 84.3 miles, it will be seen that the route proposed is but 17 per cent. longer, and that it is practically the only one possible for a canal of the proposed dimensions necessary to accommodate the large tonnage now in sight.

Thus it appears that the route is 37 miles shorter than the old State Canal, that it has 100 less locks and a summit level 182.5 feet lower, thus giving a much larger drainage area for water supply and requiring much less time in transit. With suitable deductions for lockages, detentions, and reduced speed in canal portion (52.64 miles), the passage should be made in 40 hours, as against 71 by the Erie line, or 80 by the Central Ohio route, even if it were practicable to construct so large a trunk on the latter route.

Turning now to the question of the traffic to be served, it is found that the tonnage of the Monongahela River is within 50,000 tons of the aggregate of all the remaining tributaries of the Ohio River, and this fact alone would indicate that the largest interests would be accommodated by the shortest connection from this tributary to the Lakes; but when it is remembered that the largest mills and furnaces lie on or near the path of this projected canal, and that their tonnage aggregates many millions, it leaves no doubt as to this location being the proper one, both from the physical and commercial standpoint.

THE TOPOGRAPHY OF THE REGION TRAVERSED.

For the purpose of this report it is only necessary to consider those tributaries of the Ohio River which lie between it and the Lake, and it is the topography of this district that must determine the feasibility of the canal. If there be no point in the divide between the lake and the river which can be fed from the drainage of more elevated territory, with sufficient water to provide for the contemplated tonnage, then the canal must be pronounced impracticable; hence the consideration of the topographical features becomes fundamental and has justified the large expense and time devoted to the collection of all available data from surveys and records, and the construction of a relief map of the entire district, to determine the most feasible route.

The elevation of the summit level is but 900 feet above tide, while many points in the possible available drainage district reach an elevation of 2,000 feet or over. The catchment basins available for water supply are large and numerous, and will be treated under the sub-division of water supply.

It is a peculiar fact that the divide between the lake escarpment and the Allegheny and Ohio Basins lies very near the lake shore, giving but a short base to the drainage in that direction, and turning most of the precipitation of this district into the tributaries of the Ohio, which have a comparatively slight fall. The broad flat plateau lying in Ashtabula and Trumbull Counties, Ohio, and Crawford and Warren Counties, in Pennsylvania, comprising a portion of the lands known as the Western Reserve, renders it practicable to construct a summit level of 31.25 miles, including a reservoir or lake in the bed of the canal eight miles in length. This great plain lies in the direct path of the canal, and is also the key-point of the divide. It is flanked on the west by the hills enclosing the Mahoning Basin of 500 square miles, and on the east by Pymatuning, Mill, Conneaut and Watson's Basins of 199 square miles, succeeded by that of French Creek at a still higher level and enclosing 775 square miles, while still further to the east lie the Oil Creek and Allegheny Basins at sufficient altitude to be available for water supply by gravity, should it be required to meet the future demands of commerce.

There is also an area on the south of the Pymatuning Basin

that can be reached by a short feeder of only 13 miles in length, including the drainage of the Sandy Creek and the Little Shenango, and enclosing an area of about 138 square miles, which can be used for additional supply in case of necessity.

OHIO RIVER TRAFFIC AND THE CANAL.

From Pittsburgh, Smithfield Street Bridge, to Davis Island Dam the distance is 5.25 miles, and thence to the point of entering the Beaver River, 23.26 miles. Throughout this entire distance the route closely follows the river, and it has been suggested that the traffic might best be accommodated by a single system of improvement which would reduce the cost and unite the interests of the canal and river trade. To properly decide this question a definite understanding of the latter is necessary.

The commerce which goes down the Ohio River from Pittsburgh consists chiefly of coal. It is carried on "boats" or "barges." The former average 170 feet in length, 26 feet in breadth, and 9.5 feet in depth. Their maximum draft is 8 feet, and they carry about 1,100 tons. The barges average 130 feet in length and 24 feet in breadth. They draw from 6 to 7 feet, and carry from 450 to 500 tons. The freight tonnage of the river is divided nearly equally between these two classes of carriers. Of late years single vessels are always rafted together in large numbers, and towed by powerful tugs to New Orleans or points above, as required, and when empty are towed back. The large fleets are finally made up below the Falls at Louisville, and often carry 30,000 tons. This business is remunerative at the very low cost of about one-third of a mill per ton per mile. The volume for the entire river is enormous, amounting in 1894 to 7.8 million tons. The part contributed by Pittsburgh is shown by the records at the Davis Island Dam. In 1894 46,414 tons of freight passed up, and 3,099,389 tons passed down.

But the great volume of this commerce is not the only matter which demands attention when considering the question of using

a common route for river and lake traffic. Although the General Government has expended over twelve million dollars in improving the river above Cincinnati, there are long intervals of time during which low water prevents navigation. In 1895 this was exceptionally true, the river being closed from April until November. At one time there were about 2,500 loaded vessels afloat, aggregating 200 acres in area, and carrying 1.2 millions of tons of coal at a loss estimated at about $3,000 per day. The pool above the Davis Island Dam affords a commodious harbor for lying in wait, and as soon as the needful rise occurs the entire fleet usually starts down the river to take advantage of it. To accommodate such movements the Davis Island Lock was made 600 feet long and 110 feet wide, having in view to pass one tug and 14 barges at once.

This river commerce is therefore not only very extensive, but is also subject to great interruption, and it is easy to foresee the confusion which would result in a canal of any reasonable dimensions when a long line of lake steamers, moving in one direction, encountered a coal boat fleet hastening in the other, to take advantage of a rise in the river below.

Moreover, the plan of improvement of the river is in charge of the General Government, and the work is done at its expense. In this vicinity it contemplates a series of locks and movable dams, affording only such depth as will accommodate the river craft engaged in the navigation. To increase this depth to that demanded by the canal traffic would wholly change the character of the constructions, and even if successful, the channel would still be subject to the interference just noted.

In fine, the nature of the traffic in river and canal is so different that different means of accommodating it are demanded by economical considerations, and the Board of Consulting Engineers is of opinion that it would be a mistake to adopt a common route. The only matters, therefore, to be considered here are suitable arrangements for admitting up-river craft bound for the Lakes into the canal at or near the mouth of the Beaver River, and the question of providing good navigation for larger vessels from Davis Island Dam to the city. Here some dredging will be necessary unless the Government plan can be modified by raising the level of the pool about 5 feet. Throughout a large portion of the harbor the depth is already sufficient, but certain shoals will

have to be dredged unless the level of the pool can be raised above its present height. Such a rise in water surface would be of great benefit to river navigation, and is well worthy of consideration by the Government engineers, to whose wise plans the existence of the present harbor is due.

Convenient admission to the canal should be provided for such craft ascending the river as may desire to pass to the Lake. This object may most readily be accomplished by locking down about 12 feet near the mouth of the Beaver, and thus facilitating a separate entrance. Such a reduction of level in the canal will materially reduce the cost of the high river wall in this vicinity, and will be advantageous in connection with the matter of railway crossings. The difference of level between the pool of Dam No. 6 on the Ohio River, now under construction by the Government, and the lowest level in the canal, near the mouth of the Beaver River, is about 22 feet, and a connection by a single lock having this lift is provided for in the estimates.

DIMENSIONS OF THE CANAL.

The dimensions most suitable for a new canal should be determined from a study of the nature and extent of the commerce to be accommodated, the water supply available for lockage and waste, and the conditions existing at crossings, especially railroad crossings, where the traffic is so extensive as to make bridges with draws highly objectionable.

For the canal proper the controlling dimension is the depth, the others resulting from it with but little latitude for choice; but for the locks, length and width must also be considered.

THE DEPTH.

The volume of the commerce to be accommodated has much to do with the size of the vessels to be employed, and consequently with the depth of the canal.

As already stated, an analysis of the data contained in the Report of the Committee on Railroad and Canal Statistics justifies the belief that the annual traffic awaiting the canal is not over-

estimated at 18,500,000 tons. Adopting, however, a grand total of only 13,000,000 tons as a conservative basis in estimating the canal capacity required, and assuming that operations will be restricted by ice to 225 days annually, it is clear that each and every lock must pass hourly an average of 2,407 tons, working continuously day and night. With a 7 foot canal and barges of 250 tons burden, this would imply arrangements for passing 10 boats hourly, and with a 9 foot canal and barges of 500 tons, half that number. As over 30 locks, disposed at irregular intervals, will be required, it is apparent that with so many boats the canal would be overtaxed and blockades would occur, unless the expense of locks large enough to pass several boats collectively were incurred. But if so large locks are necessary, why not make them about 15 feet deep at once, and thus accommodate ordinary lake steamers, carrying cargoes of 1,200 to 2,000 tons? Such steamers would reduce the lockages to less than two per hour, and they could be easily and safely handled. Experience has shown that on the Welland Canal the average time of lockage is 19.2 minutes, at the Sault Ste. Marie Canal about 20 minutes for single boats, on the Manchester Ship Canal, 9 minutes, and on the Monongahela River, slack water navigation, five minutes for single steamers.

Considered, therefore, simply as a matter of easy and certain canal operation and administration, the capacity afforded by a 15 foot depth would be sufficient, but by no means excessive, to meet the demands of the traffic in sight.

The same conclusion is reached by a line of reasoning quite different. The ruling freights from Pittsburgh will call for distribution over the entire region bordering the Great Lakes, and the chief return freight (iron ore) will all come from Lake Superior. How short-sighted then would be the policy of limiting the size of the canal to boats unsuited for long voyages and rough water, and of thus incurring the expense and delay of transferring cargoes when the lake is reached, to say nothing of the expense of constructing a special class of boats for use in the canal. It is emphatically the opinion of the Board of Consulting Engineers that the canal will fail to meet the just expectations of its promoters unless it be constructed to accommodate vessels large enough to navigate the Great Lakes with profit. What is this size, therefore, becomes the next subject for consideration.

The lake harbors generally have been improved to a ruling depth of 16 feet at mean lake level, but by reason of the frequent fluctuations in water surface, most of the commerce has been actually carried in vessels loaded to a draft not exceeding 13 or 14 feet. But very few vessels built before the year 1893 were over 325 feet in length, with 42 or 43 feet beam, and 2,000 net tons capacity; but since that date the new 20–21 foot channel under construction by the General Government has induced a considerable increase. Next season will probably see at work nearly a dozen steamers 400 feet or more in length, and capable of carrying 6,000 net tons on 18 feet draft. It should be noted, however, that such vessels are to a certain extent experimental, their economy resulting largely from their increased speed; and that it is claimed by some experts that even with a 20–foot channel equal cargoes may be carried more cheaply by smaller steamers towing consorts. However this may be, it seems certain that for many years the ordinary type of lake vessel will be able to make use profitably of existing depths, and that a canal adapted thereto will find no lack of shipping for its trade. Ultimately, no doubt, its immense commerce will produce a special type, designed to take full advantage of the dimensions adopted for the canal, whatever they may be.

In fine, then, a depth of 15 feet is believed to be the minimum which will meet the needs of this canal, and that it will suffice. What should be the corresponding length and width of locks?

LOCK DIMENSIONS.

In the enlarged Canadian system the length between quoins is 270 feet, the width between walls 45 feet, and the depth on mitre sills 14 feet. A special class of whaleback vessels has been designed for lake navigation and for these canals, but as their length would exclude the larger and more profitable of the lake carriers of ordinary types, such locks are deemed too small for the Lake Erie and Pittsburgh Canal traffic.

In deciding upon the precise dimensions of the locks, a compromise is necessary to avoid, on the one hand, needless waste of water in lockages, and on the other, the exclusion of desirable freighters navigating the Lakes. A length between quoins of 340 feet, and a width between walls of 45 feet, with a depth on mitre sills of 15 feet, will accommodate nearly all the steamers now in

the trade, except the new 20-21 foot channel class, which only began to make its appearance in 1893, and which is not well suited to inland canal navigation. The dimensions of the different vessels vary greatly among themselves, and in order to fix ideas as to the commercial capacity of such locks it will be well to select a special type. Of the thirty-five whalebacks on the Lakes in 1895 about half were intended to accommodate the new Canadian canals, being 262 feet long, 36 feet beam and 22 feet depth of hold. The others were larger, ranging from 300 to 340 feet in length. With the latter class, a steamer 320 feet long and 42 feet beam will carry 2,200 long tons on 14 feet draft, and consorts of the same size will carry 2,500 tons. A steamer towing two consorts will make the round trip from Duluth to Ashtabula in about twelve days, carrying 7,200 long tons on 14 feet draft. There can be no question that locks which, like those above described, will accommodate such a class of vessels, will meet all commercial demands, and it only remains to consider whether the available water supply is sufficient, and whether the grades at critical railroad crossings conform, or can be adjusted to conform to the requirements of vessels of so large dimensions.

The volume of water required for lockage, evaporation and leakage will be discussed under its appropriate heading. The following figures are based upon an annual traffic requiring the passage over the summit level of 48 steamers daily for 225 days, carrying cargoes ranging from 1,200 tons to 2,500 tons, corresponding to a commercial demand of say twenty million tons.

48 lockages (24 vessels each way) daily	22,000,000	cu. ft.
Evaporation, filtration and leakage daily	18,000,000	" "
Total, daily	40,000,000	" "

This estimate of the volume required is believed by the Board of Consulting Engineers to be a liberal one, sufficient to supply all immediate needs of the canal, and the amount called for may confidently be expected from the reservoir system recommended without exhausting the full available capacity.

Accepting then the conclusion that a canal of the size stated is demanded by the commercial interests of the district, and that its water supply may be provided at reasonable cost, it remains to

consider whether its construction would cause such interference with vested interests as to be inadmissible. The minimum clear headway necessary at fixed bridges first calls for attention.

CLEAR HEADWAY AT BRIDGES.

For the whaleback type, which has been shown above to be admirably adapted to the commercial needs of the canal, definite information has been furnished by its designer, Mr. Alexander McDougall. The dimensions affecting bridge problems are about the same for both of the standard sizes, viz: Depth of hold, 22 feet; height of the two turrets above deck, 16 feet; height of smoke stack above deck, 38 feet; height of mast (for carrying light) above deck, 43 feet; draft of consort, light, 3.5 feet and of steamer 5 feet; both can load to 18 feet draft. Hence when loaded to 14 feet draft a clear headway of, say, 46 feet will be required to pass the smoke stack, and of 24 feet to pass the turrets. The mast for lights can easily carry an adjustable top; and the smoke stack can probably be arranged for lowering, as is now often done on the Great Lakes.

For the ordinary class of lake steamers, the ruling height is that of the pilot house, since the smoke stacks can be arranged for dropping and the spars for lowering. The height of the pilot house above the light water line for the larger class of steamers which will use the canal is about 44 feet, and as these vessels light draw on an even keel about 6 feet, the minimum clearance for them when loaded to a 14 foot draft is about 36 feet.

These figures indicate that a clear headway of about 45 feet is the least that will admit vessels of the desired class at bridges where the traffic would be so seriously interrupted as to forbid the use of draw openings. Where the latter are admissible, and the exceptions are few, they will naturally be preferred.

To perfectly meet the objects proposed, it must be practicable for the ore vessels to deliver their freights without trans-shipment at the furnaces, most of which are situated near the water level in the valleys of the Monongahela and Allegheny Rivers, and near the route of the canal itself. The bridge question, therefore, must be considered for existing as well as for new structures.

Upon the Monongahela River, within a distance of 31 miles above its mouth, there are 14 bridges, six being railroad and eight highway. The least clear headway above the level of full pool

at low water is 51 feet, but this may be reduced to about 42 feet during the frequent short rises. The conditions here then are satisfactory.

Upon the Allegheny River, within the corporate limits of the City of Pittsburgh, there are nine bridges, of which two are railway and seven highway. The clearances range between 33 feet and 41 feet at low pool level, the former being reduced to 24 feet in frequent rises. These bridges are not well suited for conversion into draw structures, and are generally adjusted to meet street grades in Pittsburgh and Allegheny. They must be accepted as definitely limiting the size of boats which can enter the Allegheny River, but with the whaleback type, dropping smoke stacks to the level of the turrets, even these difficult conditions may be met.

In fine, the Board of Consulting Engineers considers that a clear height of 45 feet under fixed bridges is the least which will permit the passage of such lake craft as should be accommodated by the Canal. How the topographical features of the route can be adjusted to this standard will be considered below under a suitable heading.

Hence, to sum up the conclusions already reached, the Board is of opinion that 15 feet should be adopted as the depth most suitable to meet the requirements of this Canal; that the locks should be 340 feet long, measured between quoins, 45 feet wide measured between walls, and 15 feet deep on mitre sills ; also that the clear headway at fixed bridges should not be less than 45 feet above the normal water surface. The cross section of the Canal next claims attention.

THE CROSS SECTION.

The resistance to motion, and consequently the speed attainable, is greatly dependent on the cross section of waterway adopted. In order that this resistance shall not be materially greater than in a large expanse of water, many engineers, among them Professor Rankine, have considered that the width at the bottom of the Canal should be at least twice the greatest width of the vessel; the depth 1.5 feet more than the draft; and the sectional area of waterway six times the greatest midship section.

The International Inland Navigation Congress of Engineers, held at Vienna in 1886, considered that for principal canals of large

traffic the normal transverse section of the waterway should be at least four times that of the largest immersed transverse section of the vessel, and that an increase to five times this section would be economically advantageous, both in respect to capital invested and to expenses of operation and maintenance. These views were reaffirmed at the session of this Congress held at The Hague in 1894, where it was also urged that, to favor rapid working, the passing of boats should be facilitated by giving for vessels of 300 tons a width of waterway at the bottom of 16.2 feet more than twice the beam, with an increase of 1.6 feet for each additional 100 tons burden. Also that for screw steamers the least depth between the keel and the bottom of the canal should be 1.3 feet for 200-ton vessels, and 2.6 feet for 1,000-ton vessels. Also that for quick working the curvature in new canals should be limited to a radius of not less than 1,640 feet.

These rules for dimensions of cross section conform in general to the best practice in ship canals abroad.

Thus on the Terneuzen Canal, regularly used by sea-going steamers between Ghent and the Scheldt below Antwerp, the transverse section of the waterway is by regulation 2,085 square feet, and actually is 2,420 square feet; the submerged midship section of the largest vessels is by regulation 659 square feet, and in practice 538 square feet; hence the ratio between these quantities is by regulation 3.17 and in practice 4.5. The speed of transit, both authorized and actual, is limited to 5.4 miles per hour.

The enlarged Suez Canal (bottom width 107 feet, top width 420 feet, depth 31 feet) has a transverse section of 8,240 square feet. For the largest vessels which traverse it, this allows a ratio of about 4.5 between the wet cross sections. When first constructed this canal had a bottom width of 72 feet, a top width of 190 feet and a depth of 26 feet; giving a wet cross section of 4,170 square feet. Vessels drawing 24.6 feet were allowed to pass, having a midship section of say 1,000 square feet. The ratio between the wet sections was thus about 4.2. The maximum speed allowed was six miles per hour, but the average actually attained was much less.

The Manchester Ship Canal has a bottom width of 120 feet, a top width of 172 feet, and a depth of 26 feet, giving a wet cross section of 3,796 square feet, which in rock cutting is reduced to 3,250 square feet. For the larger class of vessels navigating this

canal these figures indicate a ratio between the wet cross sections not varying greatly from 4.0. The limit of speed is about 7 miles per hour.

It is to be borne in mind that about half the route of the Lake Erie and Ohio River Canal lies through canalized river beds where the waterway will be ample to admit of considerable speed. In the canal proper the passage of bridges and other steamers will probably reduce the practicable rate to not exceeding about four miles per hour, and a moderate ratio between wet sections will therefore meet all needs. The immersed midship section of the larger class of vessels which will navigate the canal will rarely exceed about 500 square feet. Adopting a ratio of 4.0 as sufficient to meet commercial requirements, the wet cross section of the canal proper becomes 2,000 square feet. With a depth of 15 feet, this corresponds nearly to a bottom width of 107 feet, a top width of 160 feet, and side slopes of about one on one and a half —dimensions which conform well to the soil and other local conditions, and to the cross section favored by the Engineering Committee (depth 15.5 feet, bottom width 102 feet, and top width 156.25 feet), which are accordingly recommended.

WATER SUPPLY.

This vital point in any project for a canal having a summit level to be supplied with water, has been investigated with a view to insure an ample supply under the most unfavorable conditions.

As the flow of the stream draining the areas from which the water for the canal is proposed to be obtained, has not been measured by gaugings, it has been necessary, in order to ascertain their value and capacity for canal purposes, to determine the relation between the rainfall on these areas and that portion of it which may be safely estimated as flowing off into the water courses; which, with a proper allowance for maintaining the stream flow below the dams, represents the quantity which can be impounded in reservoirs and applied to the operation of the canal. It is, moreover, necessary for safety that such estimates should be based on the lowest, or least, recorded annual rainfall on the areas under consideration.

The recent very thorough and able investigation of these relations by Mr. C. C. Vermeule, C. E. (Vol. 3, Geological Survey of New Jersey) affords all the data required for a safe conclusion in this case; indeed for a more reliable conclusion than could be otherwise obtained, unless the volume of flow of all the water courses draining these areas had been measured during a long series of years and with the utmost precision.

The areas depended upon to furnish water for the summit level of the canal embrace the drainage of French and Cussewago Creeks, Watson's Run, Conneaut Lake, Mill Creek and Pymatuning Swamps, covering altogether not less than 974 square miles.

It is proposed to draw from the stream flow of this area about one-half its estimated amount between November 1st and May 1st (the season of greatest precipitation and least evaporation), leaving the summer flow undiminished, and improving rather than injuring the regimen of these streams below the dams during the winter and spring. The water thus drawn off will be stored in reservoirs in the Pymatuning and Mill Creek basins, and delivered to the canal as required during the season of navigation, which is estimated to cover 225 days, or from April 15th to November 25th.

In order to determine the amount of water to be obtained under these conditions, *at all times*, it is necessary to ascertain the lowest recorded rainfall in these drainage areas, the proportion of the annual rainfall precipitated between November 1st and May 1st, and the proportion of this precipitation flowing off into the streams during the same period.

The investigations of Mr. Vermeule (before referred to) show that for very similar drainage areas (drift-covered, with moderate slopes) having about the same elevation and latitude, at least seven-tenths (7-10) of the rainfall during these months passes off as stream flow.

The lowest recorded rainfall at the following stations surrounding the district covered by the drainage areas under discussion, was as follows:

Erie, Pa.,	for 19 years.....	31.94 inches.
Franklin, Pa.,	" 10 "	33.97 "
Freeport, Pa.,	" 13 "	30.66 "

Warren, Pa.,	"	8	for	32.54 inches.
Oil City, Pa.,	"	14	"	22.80 "
Pittsburgh, Pa.,	"	24	"	28.17 "
Canton, Ohio,	"	12	"	31.29 "
Warren, Ohio,	"	5	"	33.21 "
Wooster, Ohio,	"	10	"	31.32 "
Youngstown, Ohio,	"	9	"	26.20 "
	Mean			30.21 "

The Board has based this investigation on the lowest of these records, that of Oil City for 1888, giving a precipitation of 22 80 inches only, the average at that station for 14 years being 40 inches.

It may be well also to state that the past year (1895) was considered throughout all this region of country an extremely dry season, yet the total rainfall at Oil City was 28.82 inches, or 26 per cent. greater than during 1888.

Under these circumstances the conclusions as to the quantity of water available would surely seem to be very far on the safe side.

The precipitation as recorded at Oil City from November 1st, 1887, to May 1st, 1888, was 15.22 inches, of which 0.70, or 10.65 inches, may safely be estimated as passing off in stream flow. Assuming that less than one-half this amount, or five (5) inches in depth, is drawn off into the storage reservoirs, it will furnish for canal uses 11,314 million cubic feet of water.

The estimated requirement for the canal, season of navigation, including liberal allowances for evaporation, filtration and waste, in canal, feeders and reservoirs, is 9,189 million cubic feet, which leaves a surplus of 2,125 million cubic feet.

The estimate of the quantity of water required is based on the following daily consumption:

24 vessels each way or 48 in all, averaging 1,500 tons cargo	22,000,000 cu. ft.
Evaporation, filtration, waste on canal, reservoirs, feeders, etc., per day	18,000,000 cu. ft.
Total amount required per day	40,000,000 "

It will thus appear that without resort to any of the other readily accessible drainage basins referred to in this report, an ample supply can be had for at least 16 million tons of commerce

per annum, and in point of fact, as it is more than probable that the summit level will receive water from the drainage of adjacent flat lands rather than lose any by filtration, the amount of water provided will suffice for a trade of 20 million tons per annum.

Within not unreasonable distances, as heretofore stated, additional supplies of water can be had sufficient for any probable extension of the canal commerce in the future.

LOCATION AND DIMENSIONS OF THE FEEDER LINES.

The volume of water to be delivered, per unit of time being fixed by the requirements of the Canal, and the grade of descent being determined within narrow limits by the topography of the region to be traversed, it remains to choose such a form and such dimensions of cross section as shall give the desired discharge with a velocity not too great for the soil forming the bed. Adopting 2.0 feet per second as the maximum admissible velocity, and side slopes of one on one and a half, as appropriate to the soil of the region in question, the remaining variables, the channel width at bottom and the depth, must be determined by computation.

Three feeder lines are to be considered. The first extends from Bemus Dam to Pymatuning Reservoir A, a distance of 20.3 miles, of which the last mile is constructed with three masonry steps to absorb an excess of 42 feet in the fall. In passing through Kerrtown, opposite Meadville, the water is led for a distance of 6,700 feet through a double masonry conduit, as being the most economical construction. In the rest of the artificial waterway the slope of the surface is so adjusted, by the location of the line, as to utilize the surplus volume of Conneant Lake to the extent of about two feet. The surveys have demonstrated that a uniform fall of 0.6 of a foot per mile is practicable throughout the entire distance, and as this grade is well suited to the requirements, it has been adopted. The service imposed on this feeder is to convey 40 million cubic feet per day, or 463 cubic feet per second.

The second feeder line leaves Pymatuning Reservoir D, and conducts the flow to the valley of Mill Creek; it discharges into

that stream where the slope is ample to carry it forward. The artificial length is 11.6 miles, and the service is to convey forty million cubic feet per day, or 463 cubic feet per second. Here, too, the topographical conditions permit a uniform slope of 0.6 of a foot per mile throughout the greater part of the distance, but a tunnel is necessary through a hill composed of stratified slate and shale, with sandstone in seams. The length of the tunnel will be 22,000 feet, and the estimates contemplate a brick lining throughout, although experience may prove this to be needless. At the point of discharge into Mill Creek, an excess of fall of 22 feet is absorbed by two masonry steps.

After following the bed of Mill Creek for 4.4 miles, and passing en route two dams, forming small service reservoirs of great value for regulating the flow, the water enters the third feeder. This conducts it, still with the uniform fall of 0.6 of a foot per mile, to the summit level of the canal, a distance of 3.8 miles. The service imposed is forty million cubic feet per day, or 463 cubic feet per second.

Summing up, then, it appears that the natural topographical features of the route throughout the entire length of the artificial channel, 35.7 miles, are favorable, permitting the use of one and the same gradient, except at the tunnel and for a short distance near Meadville, where for local reasons a conduit is more economical. At only one point will a very heavy cut (63 feet) be necessary; this occurs between Bemus Dam and the Pymatuning Reservoirs. The total distance traversed, including the feeder lines and reservoirs, is 54.2 miles.

It remains to determine the most suitable cross section of the waterway to give the discharge demanded by the needs of the canal, under a slope of 0.000114 (fall of 0 6 of a foot per mile).

From the geometrical form of cross section above indicated (bottom horizontal, with side slopes of one on one and a half) the following equations may be derived, in which A denotes the area of the actual water cross section; W, the horizontal bottom width; D, the channel depth, and R the mean radius or quotient of the area by the wetted perimeter, the foot in all cases being the unit:

$$(1)\quad A = WD + 1.5\,D^2$$

$$(2)\quad R = \frac{WD + 1.5\,D^2}{W + 3.6\,D}$$

Determining the numerical value of A by dividing the given discharge of the desired velocity, and computing the value of R by any standard formula which may be preferred, these expressions enable the exact corresponding depth and bottom width to be found ; or if for special reasons it be desired to assume either a depth or bottom width, they give, by the method of successive approximation, the corresponding values of the other, and of the area of cross section.

For determining the quantity R for small streams like these feeders, the Ganguiller and Kutter formula is generally preferred by engineers, as being based on the largest collection of actual observations. The Board has checked its indications by those

ERRATA—Page 30.

First line, second paragraph, 4.4 should read 7.9.

Last line, third paragraph, 54.2 should read 55.6.

radius. Solving formulas (1) and (2) with these values of A and R, an imaginery value of D indicates that no dimensions can be given to a channel of the adopted form which will enable it to carry the water with the desired velocity, but that it will so nearly accomplish the result that an increase of 2.5 feet in the area of cross section only is required. Making this change, the depth called for is 10.5 feet, and the bottom width 6.6 feet, dimensions corresponding to the minimum excavation possible with the slope and form of cross section adopted. Further details are given in the table below, which also contains the figures computed for an assumed depth of 6.5 feet, often used in such cases. Other solutions may be multiplied indefinitely, by assuming the discharge and any desired depth, or the discharge and any desired

that stream where the slope is ample to carry it forward. The artificial length is 11.6 miles, and the service is to convey forty million cubic feet per day, or 463 cubic feet per second. Here, too, the topographical conditions permit a uniform slope of 0.6 of a foot per mile throughout the greater part of the distance, but a tunnel is necessary through a hill composed of stratified slate and shale, with sandstone in seams. The length of the tunnel will be 22,000 feet, and the estimates contemplate a brick lining throughout, although experience may prove this to be needless. At the point of discharge into Mill Creek, an excess of fall of 22 feet is absorbed by two masonry steps.

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For determining the quantity R for small streams like these feeders, the Ganguiller and Kutter formula is generally preferred by engineers, as being based on the largest collection of actual observations. The Board has checked its indications by those given by other formulas of good repute, and believe that any errors in the figures adopted lie upon the safe side.

The feeders excavated in earth between the Bemus Dam, the Pymatuning Reservoirs and the summit level will first be considered. Here, as above stated, the required discharge is estimated at 40,000,000 cubic feet per day, or 463 cubic feet per second, the uniform slope being 0.000114. Economy of construction calls for the largest admissible velocity, as this corresponds to the smallest area of cross section. Adopting 2.0 feet per second as the maximum which can safely be permitted in a geological formation like that traversed here, the corresponding area of cross section becomes 231.5 square feet. With the given slope, a velocity of two feet, and N assumed at 0.025, the Ganguiller and Kutter formula indicates 5.3 as the value of the mean radius. Solving formulas (1) and (2) with these values of A and R, an imaginery value of D indicates that no dimensions can be given to a channel of the adopted form which will enable it to carry the water with the desired velocity, but that it will so nearly accomplish the result that an increase of 2.5 feet in the area of cross section only is required. Making this change, the depth called for is 10.5 feet, and the bottom width 6.6 feet, dimensions corresponding to the minimum excavation possible with the slope and form of cross section adopted. Further details are given in the table below, which also contains the figures computed for an assumed depth of 6.5 feet, often used in such cases. Other solutions may be multiplied indefinitely, by assuming the discharge and any desired depth, or the discharge and any desired

bottom width, and computing the corresponding values of the other variables.

The following table contains the detailed results of the computations indicated above, the slope being in all cases 0.000114, and the quantity N being 0.025 :

	CONDITIONS, FEEDERS IN EARTH.	
	V—2.0 AV=463	D—6.5 AV=463
Area cross section, Sq. ft	234.7	252.0
Depth, feet	10.5	6.5
Width at bottom, feet	6.6	29.0
Width at top, feet	31.5	48.5
Wet perimeter, feet	44.4	52.4
Mean velocity, ft. sec	2.0	1.85
Discharge, ft. sec	469.0	466.0

These figures make it apparent that there is a wide latitude for choice in determining the dimensions of cross section. Where the needful area is secured by depth rather than by width, the advantages of minimum excavation and minimum loss by evaporation result; and the former becomes highly important in deep cuts. On the other hand, where embankments are necessary the head of water will be more dangerous in deep than in shallow channels. As the cross sections are equivalent, from a merely hydraulic point of view, there is no reason why the one best suited to each locality on the route should not be chosen. It should be borne in mind that the dimensions are those of the water cross section, and hence that the depth of excavation will be always greater than the figures in the table.

In practical construction the dimensions of the deeper channel may, with advantage, be somewhat varied from the minimum given in the table. Thus :

The area of cross section may be taken at 235 square feet, the depth at 10 feet, the horizontal bottom width at 8.5 feet, the width at top at 38.5 feet and the wetted perimeter at 44.5, giving a

mean velocity of 1.98 feet per second and a discharge of 465 cubic feet.

Where a more shallow channel is preferable, the figures given in the second column of the table may be adopted to advantage.

Whichever section be used, any desired safety co-efficient may be applied by slightly increasing the bottom width; but for the reasons above stated, such a co-efficient is believed to be unnecessary in the present case.

As already stated, it has been found expedient to replace the open feeder by a covered conduit for a distance of 6,700 feet nearly opposite Meadville. The water will flow through two equal channels, each 8 feet wide by 6.6 feet deep, measured to the springing lines of the arches. A fall of 4.752 feet per mile has been allowed, which will give to a volume of water filling the dimensions above indicated a velocity of 4.75 feet per second. The joint discharge will thus be 502 feet per second, N in the formula being assumed at 0.015. As the normal flow will be only 463 feet, this provision is considered ample.

At the tunnel between the Pymatuning Reservoirs and Mill Creek, the water will flow through a channel, lined with brick, 12 feet wide at bottom and 8.75 feet deep, measured from the springing line of a flat arch at top. If a lining be found unnecessary, the excavation left in rough will be not less than 14 feet wide and 10 feet deep. The slope will be 4.752 feet per mile, or 0.0009. The lined tunnel below the springing lines when full will have an area of cross section of 105 square feet, and the computed velocity of flow (N being 0.017) will be 6.11 feet per second, giving a discharge of 641 cubic feet. The service demanded being 463 cubic feet, this will give a large safety co-efficient, but under the circumstances it is not deemed excessive.

The topography of the district near the summit level favors the most advantageous delivery of water to the canal. The natural inflow has place at the northern terminus, near the head of the flight of locks conducting to Lake Erie, where the demand will be greatest, and where a sensible lowering of the canal surface would occur if the volume had to be drawn from a point further south. The three lower reservoirs on Mill Creek also assist at this critical locality by affording a reserve supply at an intermediate point of the flight.

Similar favorable conditions exist at the southern terminus of

the summit level, where the lake formed by the dam near the mouth of Mosquito Creek tends to maintain the level when drawn upon by the locks below.

At first sight, the long tunnel through the rocky hill near Pymatuning Reservoir D might seem to be a serious drawback; but when it is remembered that a large supply of rip-rap will be required at the reservoir dams in the close vicinity, even this considerable outlay is seen to involve compensating advantages.

In fine, there is every reason for congratulation that the natural supply of water, including the feeder connections, conforms so well to the demands of the canal.

BRIDGES OVER THE CANAL.

The region between the Ohio River and Lake Erie, traversed by the projected canal, forms part of the broad belt through which passes much of the enormous passenger travel and freight traffic carried by rail between the East and the West. The engineers of the canal have been alive to the importance of avoiding interference with these interests, and have adjusted the water levels and located the line with a view to dispense with draw openings wherever practicable. Indeed, the estimates have been increased more than one and a half million dollars to accomplish this object; and, as will appear below, remarkable success has been attained.

The line of the canal between the Ohio River and Lake Erie is crossed by 80 bridges, of which 59 are highway and 21 are railway. Adopting 45 feet as the minimum clear headway needful to avoid a draw opening, 41 highway and 12 railway bridges are carried overhead, and thus in no way interfere with the traffic by rail, leaving only 18 highway and 9 railway bridges where draws are probably unavoidable.

There can be little objection to a draw on any of the 18 highway bridges under consideration, leaving only 9 railway draw crossings to be considered. Of these, only 3 are of serious im-

portance, and one or two of them may perhaps be eliminated, as will appear from the following analysis of the traffic concerned.

Thirteen railroads operate in the region in question, but as one of them, the Erie & Pittsburgh, only uses the tracks of another road from Pittsburgh to New Castle, and then diverges from the route of the canal, it may be disregarded. The remaining twelve are the following:

(1) The Pittsburgh, Fort Wayne & Chicago.
(2) The Pittsburgh, Youngstown & Ashtabula.
(3) The Cleveland & Pittsburgh.
(4) The Lake Shore & Michigan Southern.
(5) The Pittsburgh & Lake Erie.
(6) The New York, Chicago & St. Louis (Nickel Plate).
(7) The Pittsburgh & Western.
(8) The New York, Pennsylvania & Ohio.
(9) The Niles & New Lisbon.
(10) The Trumbull & Mahoning.
(11) The New Castle & Beaver Valley.
(12) The Beaver & Ellwood.

Of these railroads, the four last named are short and have only a limited traffic. Two of them, (9) and (10), cross the canal by draws at Niles and Haselton respectively, where no serious interruption of business can result, as no high speed can be used in this vicinity.

The main line of (4) is fortunately free from interruption, but a local branch track in Ashtabula Harbor must be crossed by a draw.

One local branch of (5) is crossed by a draw at Lowellville, and another at Struthers, but no interruption of business need be feared at either locality.

A similar unimportant crossing of a local branch of (8) occurs at Youngstown.

Thus six of the nine railroad draw crossings are of no serious importance; it remains to consider the other three.

One of them is at Rochester where the low grade of (3) at present forbids any attempt at dispensing with a draw. Possibly in the future this grade may be raised, but in any event it should

be noted that the Pennsylvania System to which (3) belongs, controls another route to Alliance, crossing the canal by a high bridge, and thus has one unobstructed line for its Pittsburgh and Western traffic.

The other two important draws are at Niles, where (2) and (7) are thus crossed. This locality is extremely difficult, and has received the most careful study. It is not impossible that the crossing of (7) may be avoided either by raising the present bridge and changing the grade of the road accordingly, or by raising the grade and using the existing high bridge of (8); but as such changes would involve the co-operation of the railroad companies, it has been deemed proper to include the cost of a draw in the estimates.

Summing up this review of the canal and railway crossings, it is a matter for congratulation that so difficult a problem has received so good a solution. The great through routes of the Pittsburgh, Fort Wayne & Chicago Railroad, the Lake Shore & Michigan Southern Railroad, the New York, Chicago & St. Louis Railroad (Nickel Plate) and the New York, Pennsylvania & Ohio Railroad are none of them interrupted by even a single draw crossing; and the interference with other important lines has either been avoided or reduced to a minimum by the careful studies of the engineers of the Provisional Committee. Their recommendations are heartily endorsed by the Board of Consulting Engineers.

ESTIMATES OF COST.

The estimates of cost of this work as presented by the Engineering Committee, amounting in round numbers to $33,000,000, includir g the cost of electric lighting, have been carefully investigated in detail by the Board, and are believed to be sufficient to accomplish the building of the canal and its accessories.

Special attention has been given to the designs for the side walls on the Ohio Division, and to those of the dams for storage reservoirs, to render them secure against any possible danger of failure.

As has been already stated, the earnings of the canal for tolls on coal, coke and iron ore would amount to $3,169,046 per annum. Deducting from this sum the cost of maintenance and operation as shown in detail in the report of the Engineering Committee, and amounting to $250,000 per annum, there is left a net annual revenue of $2,919,046, which represents on the estimated capital required a return of 8.9 per cent.

In conclusion we desire to express our appreciation of the valuable aid afforded us by your very able and energetic Secretary, Mr. John E. Shaw, as well as by the members of the Engineering Committee.

Respectfully submitted:

THE BOARD OF CONSULTING ENGINEERS.

HENRY L. ABBOT,
Colonel Corps of Engineers, Retired Bvt. Brig. General, U. S. A.

LEWIS M. HAUPT,
Consulting Engineer.

N. H. HUTTON, C. E.
Engineer Harbor Board of Baltimore.

PITTSBURGH HARBOR—NOVEMBER, 1895. 1,200,000 TONS COAL LOADED ON 2,500 VESSELS.

REPORT

OF THE

ENGINEERING COMMITTEE

— TO —

PROVISIONAL COMMITTEE

REPORT OF ENGINEERING COMMITTEE.*

The growth in recent years of commerce between Lake Erie and the upper Ohio Valley district, which includes Eastern Ohio, West Virginia and Western Pennsylvania, is without a precedent in America, if not indeed in the world. The great staple products of this district and of articles of consumption, viz: coal, coke, iron ore and limestone, are all exceedingly low-priced commodities, and are peculiarly sensitive to the influences of freight rates. A few cents a ton in these rates decides whether certain coal mines can be successfully operated or not, while sometimes it has been the case that a few cents a ton in the price of coke has determined the matter of the closing down or continuation in operation of great furnaces and steel mills, furnishing employment to many thousands of men, and involving the use of many millions of capital. As it is now, coal, transported only one hundred miles at the lowest practicable rail rates from the Ohio Valley, suffers a tax equaling more than its original cost loaded in the cars. With coke this tax is about one-half, and with iron ore about one-third of the cost value, at the distance of 100 miles from the shipping point.

Realizing the situation in which such vast mining and manufacturing interests are involved in Western Pennsylvania demanding some improved means of transportation which could afford it rates cheaper than would be possible by railroads, on a route to connect the upper Ohio River with Lake Erie, where there is now an interchange of commerce amounting to fully 20,000,000 tons per annum, the Pennsylvania Legislature in 1889 authorized the appointment of a commission to make a survey for a ship canal to connect the two systems of navigation, and appropriated the sum of $10,000 for said purpose.†

During 1890 these surveys were made, and the commission reported that a route for a canal of fifteen feet depth was practicable by way of the Beaver and Shenango Rivers to Conneaut Harbor, Ohio. The route from the Beaver via the Mahoning

*For a more detailed report upon Engineering operations see Appendix page —.

†For Historical Sketch see Appendix, page —.

River to Ashtabula Harbor was even then known to be practicable, but as no actual survey of it was made at this time, its superior topographical advantages remained unknown.

It is at the mouth of the Beaver River, twenty-five miles below Pittsburgh, that the Ohio River approaches Lake Erie at the nearest point, and it so happens that the comparatively narrow neck of land here separating the river from the lake can be crossed with a fewer number of locks, involving 180 feet less lockage than any route to the West, through either Ohio or Indiana. It is along this line, also, that the greatest water supply is to be found, and here, too, on the shortest and cheapest route to construct upon, is located the greatest freight producing region in America, more densely populated, also, than any similar sized area in the country west of the Allegheny mountains.

Impressed with the necessity which here exists for a betterment in transportation facilities, in the fall of 1894, the Chamber of Commerce, of Pittsburgh, authorized the appointment of a Provisional Committee to make further surveys to demonstrate the most advantageous route for a canal of a size adequate to meet the enormous demands of the traffic in readiness to take advantage of its construction. The Provisional Committee was authorized to raise a fund limited to $100,000, if so much should be found necessary for the purpose; and in March, 1895, the Committee placed a number of engineering parties in the field, having at that time a fund of $28,000 in hand, and to date, (Feb., 1896), of this amount about $25,000 has been actually expended in engineering operations, and in the gathering of accurate statistics. In addition to the sum here mentioned, the City of Pittsburgh, by unanimous vote of both branches of its Councils, has appropriated $10,000 to assist the Committee in the furtherance of its plans, which now contemplate the organization of a corporation to undertake the work of actual construction. In furtherance of this object, the proposed form of a national charter, vesting the control of tariff rates on the proposed canal in the National Inter-State Commerce Commission, is now in the hands of a Committee in Congress.

The Provisional Committee, in addition to its own expenditures for surveys, as above recited, is in possession of the maps, plans, and field books of the Pennsylvania State Canal Commission, as well also of the engineering data of the small canals which

formerly extended via the Beaver River to Lake Erie at Erie, Pa., and to Cleveland, Ohio. To this fund of information there has also been added the results of a number of railroad surveys, upon lines paralleling the canal line, all the way from Pittsburgh to Lake Erie, and of other railroad surveys crossing the canal district in various directions; while from the reports of the Pennsylvania and Ohio State geological surveys, a multitude of elevations of known points above tide were obtained, and which assisted materially in the production of an accurate relief map which has been made of the entire country from Lake Erie, between the limits of New York State line, nearly to Cleveland, to the rivers from McKeesport, Pa., nearly to Wheeling, West Virginia. The actual mileage of accurate surveys undertaken by the Provisional Committee was upward of 600 miles, while the aggregate mileage of surveyed lines represented on the maps of the Committee are not less than fifteen hundred miles.

As a result of its labors, the Provisional Committee believes that it is in possession of all the data necessary to a clear understanding of the engineering difficulties to be encountered in the construction of a canal of any prescribed size which may be proposed, to connect the Upper Ohio with Lake Erie. These surveys were conducted under Mr. Thomas P. Roberts, Chairman of the Engineering Sub-Committee, Mr. Roberts in former years having been engaged as an Assistant U. S. Engineer on various river and harbor improvements; member of the Pennsylvania Ship Canal Commission, and is now Chief Engineer Monongahela Navigation Company and in charge of the locks and dams on that river. As chief assistant in the conduct of its surveys, the Committee appointed Mr. Geo. M. Lehman, C. E., late Principal Assistant of the Delaware River and Raritan Bay Coastwise Ship Canal Surveys, and formerly connected with the geological surveys of Pennsylvania.

Upon the completion of the field work last fall, an Advisory Board of Consulting Engineers was organized by the Provisional Committee and fully authorized to examine the country and report upon the physical and commercial merits of the project, in the light of the surveys which had then been made. The membership of this Board is as follows:

General H. L. Abbot, Corps of Engineers, U. S. A., retired;

Professor Lewis M. Haupt, C. E., of Philadelphia, and N. H. Hutton, C. E., of Baltimore.

During the fall the Advisory Board traversed the country along the line of the canal, as projected, examined into the question of water supply, the loading and harbor facilities, both upon the Ohio and at the Lake end; and has since that time held a number of meetings in Pittsburgh, going over the details of estimates, especially as these applied to the arrangements of bridges crossing the canal; water supply, etc.; every one of its suggestions having been adopted without disagreement among the engineers in any important particulars.

Appended to this statement, or resume, is the summary of the estimate, as finally prepared, of the cost of a canal extending from the Davis Island, or U. S. Government, Dam in the Ohio River, five and a half miles below the Pittsburgh wharves, to Ashtabula Harbor, Ohio, a distance of 122.16 miles. A more detailed estimate, covering every feature of the work on the several divisions of the canal, will be found in the appendix to this report.

The final summary of the estimate in grand divisions is based upon dimensions of canal prism as follows:—Width at surface of water, 156¼ feet; width at bottom, 102 feet; depth, 15½ feet, making a wet section of 2,001.44 square feet. The dimensions of locks are as follows:—Length between gate quoins, 340 feet; width between walls, 45 feet; depth provided for on mitre sills in lock chambers, 15 feet.

Ohio River Division	$ 8,139,379
Beaver and Mahoning River Division	8,092,762
Mosquito Creek, Summit and Lake Erie Divisions	10,689,242
Feeders, Reservoirs, etc	3,033,713
	$29,955,096
Adding 10 per cent. for contingencies	2,995,509
Grand total	$32,950,605

Included in the estimate is a system of arc light illumination of the entire length of the canal, buildings for employees, etc.

THE OHIO RIVER TERMINAL.

The Harbor of Pittsburgh, between dams on the Allegheny and Monongahela Rivers respectively, to the Government Dam at Davis Island, is about six and a half miles in length, averaging more than 1,100 feet wide, and includes an area of more than 2,000 acres. In this extensive harbor, and in the pools above it on the Monongahela River, as many as 2,500 loaded craft have been accumulated at one time. The creation of this magnificent harbor by the construction by the Government of the Davis Island Dam, which maintains perennial navigation on this portion of the Ohio, has furnished the chief incentive for the extension of a navigable outlet to the Lakes. Belonging to the Port of Pittsburgh there is a greater tonnage in vessels, very largely coal flats, boats and barges, than is registered at any port or harbor in the world.

A description of the navigable waters of the Monongahela River, through the heart of the coal fields of Southwestern Pennsylvania to the even more extensive coal fields of West Virginia, will be found in the Appendix.

DESCRIPTION OF CANAL BY DIVISIONS.

First. Ohio River Division: Davis Island Dam to the Beaver River at New Brighton. Length of division, 23.26 miles.*

The canal as projected will follow the right bank of the Ohio 20 miles to the mouth of the Beaver, thence three miles along the left bank of the Beaver, entering that stream at New Brighton where the canalized river section of the canal begins. From the pool of the Pittsburgh Harbor at Davis Island Dam, the canal is entered through a guard lock. Elevation of Harbor pool and canal level, 703 feet above mean tide. Thence to the mouth of the Beaver the canal prism is separated from the Ohio River by a wall aggregating in length about two-thirds of the distance, and

* For further details of this division, see Appendix, page —.

upon the remaining third the canal is carried through bottom lands The general course of the canal along the Ohio River is between the tracks of the Pittsburgh, Fort Wayne & Chicago R.R. and the river. A canal separate from the river is recommended because of the serious difficulties which would be met with in the attempt to maintain on the Ohio a system of dams affording the depth recommended for the canal.

Near the town of Freedom, two miles above Rochester at the mouth of the Beaver, the first lift lock occurs, involving a descent of 12 feet (for vessels bound toward Lake Erie). While it was found to be possible to maintain the Pittsburgh Harbor level in the canal through to the Beaver at New Brighton, but owing to the arrangement of the railroad bridge at the mouth of the Beaver, and the low elevation of certain streets in Rochester, it was finally determined to include in the estimate a lock at Freedom, which in turn involves the necessity for another lock, also estimated for, ascending of the same lift, and which second lock is located some distance above the aforesaid low streets and railroad bridge.

At the mouth of the Beaver a connection with the Ohio River Pool No. 6 (of the series of dams now under construction on the Ohio River) is provided for by means of a special lock, the canal level at this point being 22 feet above said river pool level. With this arrangement it will not be necessary for vessels seeking the canal from lower river ports to go to Pittsburgh to enter it. In the first five miles of the canal in the Beaver valley, there is a population of 40,000, centered in a number of manufacturing towns, chief of which are Beaver Falls, Rochester and New Brighton.

Beaver and Mahoning River Division: Length 46.26 miles.*

This division consists of a series of pools or levels maintained in the Beaver and Mahoning Rivers by means of dams provided with locks of various lifts best adapted to the varying height of the river banks. It is not contemplated to construct any dams raising the surface of the streams materially higher than the elevation of the pools of the dams now existing in the stream. Regulating devices are provided for by which the pools can be partially lowered in times of freshets, which are usually

* For further details of this division see Appendix, page —.

short-lived in these streams. Where the dams fail to furnish the requisite depth, the estimates provide for excavation of a channel width at bottom of 150 feet on the Beaver, and the same on the Mahoning. The Beaver River averages fully 450 to 500 feet in width ; the Mahoning about 300 feet, so that a greater speed can be maintained on this extensive division of the canal than elsewhere.

With four exceptions, all the railroad bridges crossing these streams can be raised to afford a clearance of 45 feet, which is recommended for fixed structures over the canal. At only one point in the entire canal, viz: at Niles, Ohio, will any important railroads cross the canal by means of drawbridges. The addition to the estimate to avoid the necessity of drawbridges over the canal is considerably more than $1,500,000, and, considering the labyrinth of railroad tracks about the various mills and manufacturing towns where connecting railroad bridges are in existence, it is remarkable that so little interference with the usual operations over these structures was found to be necessary.

The profiles and appendix of this report may be referred to for the location and lift of the various locks, and the location and clearances of bridges over the proposed canal.

Steam whaleback barges having a capacity of 2,000 tons, of 22 feet moulded depth and with 16 feet turrets (with smoke stacks hinged to turn back at the height of the turrets), when loaded to even the medium draught of ten feet, require only 28 feet clearance. As this type of vessel is eminently well adapted to the requirements of a combined lake, river and canal system of navigation, they will likely be numerous on the canal, and thus the maneuvering of drawbridges having a clearance of 30 feet over the canal will be an unusual occurrence. The clearance of 45 feet for fixed bridges is recommended to meet important occasional demands, and for the movement of certain kinds of war vessels. When it is borne in mind that with the early completion of the St. Lawrence Ship Canal this canal will furnish access from the sea coast to the great interior coal fields, the importance of adapting it to the occasional use of other types of vessels than whaleback barges manifests itself. That the height of 45 feet, all things considered, is the best to adopt for fixed bridges, was agreed upon by the engineers of the canal in consultation with the Advisory Board, after the most careful consideration. In this investigation the

Advisory Board was placed in possession of heights to various fixtures of lake vessels of the latest types. It must remain, however, that any vessels which cannot, by removal of top masts or other fixtures, pass beneath a bridge of 45 feet clearance, could not take advantage of this canal.

Mosquito Creek, Summit Level and Lake Erie Divisions. Length, 52.64 miles.*

That it is possible to extend a slackwater system of navigation so near to the summit level as to involve only three locks with an aggregate lift of 55 feet to reach it from the Mahoning River, is a fact strikingly illustrative of the natural advantages of the Beaver and Mahoning River route to Lake Erie. The old Pennsylvania fifty ton boat canal, which formerly extended via the Beaver and Shenango Rivers and Conneaut Lake to Erie, Pennsylvania, required 133 lift locks, whereas, by the Mosquito Creek route to Ashtabula, only 33 lift locks will be required, none of which will exceed 20 feet lift.

The summit level is reached after passing up the wide, flat valley of Mosquito Creek, from Niles on the Mahoning, a distance of nine miles, one lock only occurring in this distance; two locks, however, being required at the end of the level to lift up into the proposed Mosquito Lake, which for nearly eight miles forms a wide place in the navigation of the summit level. The entire length of the summit level is 31.35 miles, including the lake, and it terminates near the town of Jefferson, Ohio. The general district of country traversed by the summit level appears to the unaided eye to be for the most part an absolute plain; it is only sparsely settled. The formation is soft glacial drift, superimposed over rock, to be found at depths varying from ten to fifty feet or more. In places extensive swamps exist. The water supply for this level will enter near its northern end, where the water is most needed to meet the demands of the flight of locks descending to Lake Erie. The elevation of water surface in the canal on this level is 900 feet above mean tide, 197 feet above river level at Pittsburgh, and 327 feet above the mean level of Lake Erie. (572.82′ A. T.)

*For details of this division see Appendix, page —.

The descent from the summit level to Lake Erie, it so happens, is precisely the same that is found on the Welland Canal in reaching Lake Ontario from its summit, and in about the same distance, viz., eleven miles. On the Welland, however, 25 locks are employed, while on this canal, to overcome the same descent, only 17 locks are proposed.

The series of locks here required may be briefly described as follows: From the outlet lock the first level (880 A. T.) extends 1.1 miles to the next of the series; thence a level of nearly four miles extends to the next; thence follows a two mile stretch on the "Plymouth level" (840′ A. T.). Following this in the next two miles eleven locks occur, ten of them being in connected pairs laid tandem with levels of 700 feet intervening between pairs. The last, a single lock, or 14th from the summit level, reaching the waters of the Ashtabula River at elevation 620′ A. T., and at a distance of about two miles from the harbor entrance and nine miles from the northern end of the summit level. In the next half mile in the Ashtabula River, as it is proposed to be canalized, three locks occur, the final one located about 1½ miles from the harbor entrance and well above existing railroad yards, docks, etc.

Water Supply, Feeder Lines, Etc *

To meet the requirements of the canal so far as regards the water supply the present calculations provide enough for the accommodation of 16,000,000 tons of freight moved over the summit level in 225 days of a canal season. This volume of business would require the passage of a vessel hourly in each direction over the summit, or 48 vessels daily, of an average cargo capacity of 1,500 tons each. This is about the average of coal and iron ore cargoes leaving and arriving at Ashtabula, but as it includes at Ashtabula a number of cargoes of sailing vessels, carrying less than 1,000 tons each, and as such sailing vessels are not well adapted for inland canals, the probabilities are that the actual cargoes of vessels, at least in the coal and ore trade, will considerably exceed 1,500 tons, and that a fewer number of lockages over the summit would suffice to do the business above assumed. It might happen, however, that vessels of less capacity in other

*More detailed reference to questions relating to water supply will be found in the Appendix, page —.

lines of business might seek the canal, and thus sustain this daily average of vessels, or even cause the number of lockages here estimated for to be exceeded.

For lockage purposes at the rate of 48 vessels daily, each vessel requiring two lockfuls; less displacement of vessels; in locks of the dimensions as hereinbefore given, it is estimated that 22,032,000 cubic feet of water would be daily required; and inclusive of lockages, and to provide for evaporation and leakage on the canal summit division, or entirely through from the Mahoning River to Lake Erie, 52.80 miles, and for the same kind of losses on the feeders, reservoirs, etc., a total daily supply of 40,000,000 cubic feet in the outstart of the operations of the canal is provided for. That is to say, a total of 9,000 millions of cubic feet for the canal season of 225 days.

To the east of the canal line, and mostly within the limits of the State of Pennsylvania, there is an area of approximately 5,000 square miles of territory higher—most of it hundreds of feet higher, and some of it as much as a thousand or more feet higher—from which, by a gravity system, water can be made to flow to the summit level. Of this area a portion, embracing about 1,075 square miles, is recommended to be actually drawn upon for water, and over which the annual average precipitation is about 40 inches.

The least known rainfall over this district, if the mean record of ten U. S. and State weather stations surrounding it be taken, is 30.21 inches. One of these stations, however, viz: Oil City, reported in 1888 a rainfall of only 22.80 inches; but the probabilities are, when considering so extensive an area as 1,075 square miles, that the average least rainfalls of ten surrounding stations is nearer the truth than the least of any one of the ten. However, as the tax upon this territory will be small, as will presently be shown, even 22 inches of rainfall would be enough.

It is proposed to store approximately four inches of the annual precipitation over this 1,075 square miles, which includes 975 square miles of the valley of French Creek, in reservoirs. French Creek is noted as the largest low-water tributary of the Allegheny River. From observations and gauge records, commencing as early as March, and measurements of this stream at intervals during the unprecedented drouth of 1895, the engineers of the Provisional Committee are clearly of the opinion that

French Creek, in the very worst conceivable year discharges fully 10 inches, or one-third of the water falling in its basin. It is proposed to draw upon the streams in this district chiefly during the winter and early spring months, when they have invariably an abundant supply. That this draft upon them can be made without impairing their usual summer discharge, which should not be diverted under any circumstances, admits of no serious argument.

Careful surveys were made to obtain the storage capacity of certain reservoir sites, which are now for the most part nearly worthless swamps, and it was learned that the necessary capacity was available. Contoured maps of these reservoir sites have been prepared and their capacity calculated for different depths. In no instance are dams proposed higher than would be necessary to sustain a head of 20 feet. The estimates for their construction are ample to provide for selected material, well rolled in layers, furnished with central walls of puddled clay, and with their slopes liberally covered with broken stone, which would be at hand in great quantity from a feeder tunnel, which must be driven through rock in the neighborhood.

The length of feeder line from the selected point on French Creek to the Pymatuning Swamps, where the principal reservoirs would be located, is 20.3 miles. While from these main reservoirs to the canal line near Jefferson, the distance is 19.8 miles. The principal reservoirs are about 120 feet in elevation above the canal summit level. The dimensions of feeders, tunnels, etc., are given in detail in the Appendix Report of Engineering Committee.

COST OF MAINTENANCE OF THE CANAL.

Careful consideration was given the subject of the cost of maintenance of the canal, and the conclusion was finally reached that for salaries of collectors, night and day forces at the locks, repairmen, maintenance of dredges, renewals of lock gates, etc., supervision of reservoirs, division and chief engineers, with necessary assistants, lighting, administration, legal and clerical, printing, and other expenses, including taxes, would not for a

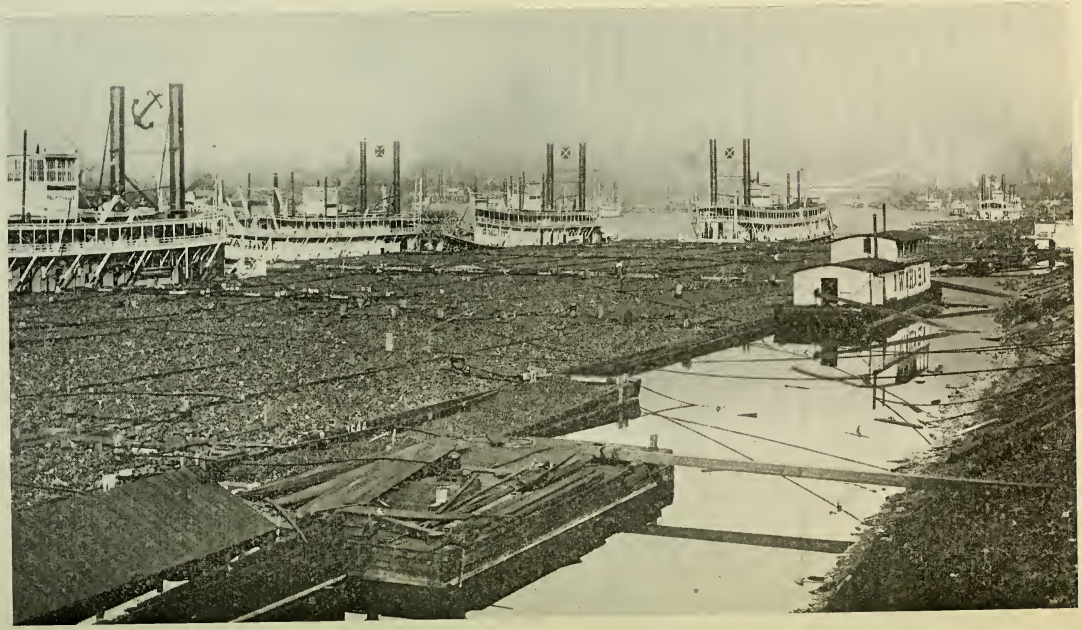
number of years to come exceed in the aggregate the sum of $250,000 per annum.

It is the fact that on canals and river improvements the cost of maintenance remains practically the same no matter how great the increase in the business, while upon railroads maintenance charges generally keep pace with the increase in the business; as a rule amounting to 66 per cent. of the gross receipts. On this canal the cost of administration and maintenance, including all fixed charges, would not be more than eight per cent. of the gross annual receipts on the estimated volume of business the canal would serve, based upon receipts from ore, coal and coke alone.

That the traffic upon this canal, if ever it be constructed, would, with even very low toll rates established, provide ample interest upon the cost of its construction, will scarcely be questioned by any who will take the trouble to investigate the figures upon which the assumption is based, and which figures are set forth quite fully in the Report of the Statistical Committee.

THOMAS P. ROBERTS,
Chairman.

JOHN E. SHAW,
Secretary.



Lower Pittsburgh Harbor—Ohio River. Coal Fleets Awaiting an Outlet to Market.

SUMMARY OF ESTIMATE.

Lake Erie and Ohio River Ship Canal.

February 17th, 1896.

SUMMARY OF ESTIMATE.

OHIO RIVER DIVISION.

Davis Island Dam to New Brighton. 23.26 Miles.

EXCAVATION, including side cuts, wall sections and over river flats.

	CU. YDS.		PRICE.		
Earth	6,105,600	at	$ 0.20	$1,221,120	
Rock	114,440	"	1.00	114,440	
					$1,335,560
WALL, CONCRETE	1,018,660	"	5.00		5,093,300
LOCKS (5), 1, 2, 2A, B, 3. (Excavation included above.)					
MASONRY.	CU. YDS.		PRICE.		
Coping stone	3,805	at	$12.00	$ 45,660	
Facing, Ashlar	15,507	"	10.00	155,070	
Backing, etc., concrete	56,377	"	6.00	338,262	
Timber per M.B.M.	1,912,890	"	30.00	57,387	
Gates, wood, iron braced				53,254	
Machinery for operation				59,000	
Buildings				10,000	
					718,633
CULVERTS (17)					225,000
BRIDGES:					
Railroad, draw 1				$ 37,660	
Highway, " 5, Overhead 2				133,226	
					170,886
RIGHT OF WAY, includes 350 acres at $700 and damages					550,000
ELECTRIC LIGHT PLANT					46,000
TOTAL					$8,139,379

BEAVER RIVER AND MAHONING RIVER DIVISIONS.

New Brighton, Pa., to Niles, Ohio, 46.26 Miles.

(SLACKWATER).

EXCAVATION AND DREDGING in river channel and across bends, locks included.

	CU. YDS.	PRICE		
Earth	18,374,900	at $ 0.20	$3,674,980	
Rock	856,380	" 1.00	856,380	
				$4,531,360

LOCKS, (11) 4 to 14 inclusive. New Brighton to Niles.

MASONRY.	CU. YDS.	PRICE		
Coping stone	9,377	at $12.00	$ 112,524	
Facing, Ashlar	36,608	" 10.00	366,080	
Backing, etc., concrete	129,014	" 6.00	774,084	
Timber, per M.B.M.	4,181,980	" 30.00	125,460	
Gates			95,531	
Machinery for operation			138,000	
Buildings			27,500	
				1,639,179

DAMS (11) crib, stone filled 508,000

BRIDGES { Railroad, draw 5, overhead 7 $ 615,954
Highway, " 10, " 11 503,229

1,119,183

RIGHT OF WAY. 1,620 acres at $125.00 202,500

ELECTRIC LIGHT PLANT 92,540

TOTAL $8,092,762

MOSQUITO CREEK, SUMMIT AND LAKE ERIE DIVISIONS.

Niles, Ohio, to Ashtabula, Ohio, 52.64 Miles.

EXCAVATION, CANAL PRISM.

	CU. YDS.		PRICE.	
Earth, sand, drift gravel	15,708,025	at $	0.18	$2,827,445
Rock, shales	1,484,000	"	0.65	964,600

EXCAVATION, for levels between locks. Lake escarpment.

	CU. YDS.		PRICE.	
Earth	799,200	at $	0.18	$ 143,856
Rock	382,450	"	0.65	248,593

EXCAVATION for locks.

	CU. YDS.		PRICE.		
Earth	1,319,675	at $	0.18	$ 237,541	
Rock	483,500	"	0.65	314,275	
					4,736,310

	CU. YDS.			
PUDDLING	30,000	at $	0.50	15,000

LOCKS (22), 15 to 36 inclusive, Niles to Ashtabula.

MASONRY	CU. YDS.		PRICE.	
Coping stone	15,127	at $	12.00	$ 181,524
Facing, Ashlar	82,318	"	10.00	823,180
Backing, etc., concrete	304,779	"	6.00	1,828,674
Brick arching	3,892	"	7.00	27,244
Timber, per M. B. M.	8,043,976	"	30.00	241,320
Gates				201,891
Operating machinery				271,000
Buildings				21,500
				$3,596,333

Brought forward,			$8,347,643
DAMS.			
Mosquito Lake, Rock Fill Dam		$ 99,752	
Ashtabula River, crib, stone filled		28,041	
			127,793
	CU. YDS.	PRICE.	
BANK PROTECTION	350,000 at	$ 2.00	700,000
BRIDGES { Railroad, draw 3, overhead 3			$249,758
BRIDGES { Highway, " 2, " 26			766,138
			1,015,896
CULVERTS, 3,200 lin. ft. at $20.00			64,000
RIGHT OF WAY:			
800 ft. wide, 4,300 acres, at $35.00			$150,500
Mosquito Lake, 5,090 acres, at 35.00			178,150
			328,650
ELECTRIC LIGHT PLANT			105,260
TOTAL			$10,689,242

FEEDER FROM BEMUS DAM, PA., TO CANAL AT JEFFERSON, OHIO. 55.62 MILES.*

EASTERN DIVISION.

FEEDER CHANNEL, Bemus Dam to Pymatuning Reservoir, including conduit . . 20.32 miles
DISTANCE THROUGH PYMATUNING RESERVOIR . . . . . 12.00 "

LENGTH OF DIVISION . . . . . 32.32 "

EXCAVATION.	CU. YDS.	PRICE.	
Earth (feeder prism)	2,926,800 at	$0.18	$526,824
Rock " "	38,221 "	0.65	24,844
			$551,668

*NOTE Feeder proper, including culvert and tunnel, 35.72 miles.

Brought forward				$551,668
BEMUS DAM				14,722
CULVERT, KERRTOWN.				
Concrete	28,000 "	$5.00	$140,000	
Brick arching	2,830 "	7.00	19,810	
				159,810
MASONRY, GUARD GATES, ETC., descent to Pymatuning Reservoir				1,500
PYMATUNING RESERVOIRS:				
Dam A			$346,841	
" B			124,371	
" C			202,967	
" D			62,399	
				736,578
E. & P. R. R. CROSSING—Pool of Dam B				34,550
ROAD EAST TO LINESVILLE:	CU. YDS.	PRICE.		
Embankment	297,740 at	$ 0.20		59,550
MASONRY AND GUARD GATES where feeder leaves Section D				1,620
BRIDGES { Highway, 12 at $2,500			30,000	
BRIDGES { Railroad, 2 " 4,150			8,300	
				38,300
RIGHT OF WAY.	ACRES.			
Bemus Dam			14,000	
Bemus Dam to Reservoirs	255 at	$35.00	8,925	
Pymatuning Reservoirs	15,126 "	$10.00	151,260	
				$174,185
TOTAL				$1,772,483

WESTERN DIVISION.

FEEDER CHANNEL, including tunnel, Pymatuning Reservoir to Mill Creek Reservoir No. 1	11.55 miles.			
DISTANCE THROUGH RESERVOIRS No. 1 and 2	7.90 "			
FEEDER CHANNEL, MILL CREEK RESERVOIR No. 2 to Canal	3.85 "			
LENGTH OF DIVISION	23.30 "			
EXCAVATION:	CU. YDS.	PRICE.		
Earth, feeder prism	1,217,980	at $0.18	$219,236	
Rock, " "	92,550	" 0.65	60,157	
				$279,393
TUNNEL.	CU. YDS.	PRICE.		
Rock excavation	124,740	at $4.00	$ 498,960	
Brick lining	34,205	" 7.00	239,435	
				738,395
MILL CREEK RESERVOIRS:				
Dam No. 1			$ 23,010	
" " 2			69,677	
				92,687
MASONRY AND GUARD GATES, descent to Mill Creek Dam No. 1				2,500
MASONRY AND GUARD GATES. Feeder entrance to Canal				2,000
BRIDGES:				
Highway, 9, at $2,500				22,500
RIGHT OF WAY:	ACRES.	PRICE.		
Feeder channel	140	at $35.00	$ 4,900	
Dam No. 1 and 2	680	" 15.00	10,200	
				$ 15,100
TOTAL				$1,152,575

AUXILIARY RESERVOIRS.

MILL CREEK RESERVOIRS.		
Dam No. 3	$ 25,084	
" " 4	44,144	
" " 5	20,027	
		$ 89,255
FEEDER CONNECTION WITH CANAL, 1.9 miles		$ 12,000
RIGHT OF WAY.		
Reservoirs No. 3, 4 and 5. 370 acres at $20.00		$ 7,400
TOTAL		$ 108,655

FINAL SUMMARY.

Ohio River Division	$ 8,139,379	
Beaver River and Mahoning River Divisions	8,092,762	
Mosquito Creek, Summit and Lake Erie Divisions	10,689,242	
Feeder, Reservoirs, etc	3,033,713	
		$29,955,096
Adding ten per cent. for contingencies		2,995,509
GRAND TOTAL		$32,950,605

REPORT

OF THE

Committee on Railroad and Canal Statistics

—TO—

PROVISIONAL COMMITTEE.

A 2,000 Ton Whaleback Steamer and 2,500 Ton Consort Adapted for Canal Navigation.

REPORT OF THE COMMITTEE ON RAILROAD AND CANAL STATISTICS.

The Committee's investigations have been confined to ascertaining:

FIRST: The volume and character of tonnage of the districts reached by the canal.

SECOND: The volume and character of tonnage of the Great Lakes.

THIRD: The volume and character of tonnage movement from the Great Lake district to the canal districts.

FOURTH: The volume and character of tonnage movement from the canal districts to the Great Lake district.

The canal districts, relating to their manufacturing industries, are divided as follows:

1. Allegheny County, Pennsylvania.
2. Shenango Valley, Pennsylvania.
3. Mahoning Valley, Ohio.
4. Ohio Valley (mouth of Beaver River to Bellaire).
5. Western Pennsylvania (whose tonnage movement to and from the Lakes passes through Pittsburgh).

The canal district, relating to the production and movement of coal and coke, is confined to the counties bordering on the Monongahela River, and mainly the four counties, Allegheny, Westmoreland, Fayette and Washington, bordering on the Monongahela River from the FIRST to the FOURTH Pool

The industries of districts (1) and (3) are located directly on the main canal, Pittsburgh Harbor and canalized Monongahela River, and can be reached by any vessel that can navigate the canal.

The industries of district (4) will be located on navigable water, for vessels drawing 8 feet, passing through the main canal and lakes without breaking cargo, when the slack water system of the Upper Ohio, now being carried forward by the Government, is extended to Bellaire, and district (2) for vessels that can navigate the full depth of the canal when a branch canal is extended up the Shenango River from its mouth to the industries in that valley. Until these improvements are made, the main

canal will establish a lake port for district (2) at the mouth of the Shenango River, about 65 miles nearer than at present, and for district (4) at mouth of Beaver River, about 100 miles nearer than at present, and for district (5) at Pittsburgh Harbor, about 130 miles nearer than at present.

The estimate in this report of tonnage for the canal, saving on commerce and earnings on cost from tolls, is based on the tonnage movement of ORE, COAL and COKE alone, the movement of which is best adapted to a waterway, and which always seeks a waterway when it is provided, leaving the vast tonnage of manufactured products, limestone, building stone, lumber, food products and general merchandise to draw upon for additional tonnage and revenue for the canal, and also the tonnage which will seek this route for interchange between the Great Lake district and tributary waterways, and the districts reached by the navigable waters of the Ohio and Mississippi Rivers.

Population of the Canal District.

Within a circle of 60 miles radius, with a point a few miles north of Pittsburgh as the centre, in 1890 the population was 1,608,964 (increase in 1896 about 10 per cent.), which is a larger population than exists within the limits of a similar circle drawn around Chicago, Cleveland, Buffalo, Detroit, St. Paul, Milwaukee, St. Louis or Cincinnati.

There are fourteen counties reached by the canal, the Ohio River to Wheeling and the Monongahela River to Lock No. 4. The population of these counties by the census of 1890 was approximately 1,300,000, and the average increase to 1896 would probably exceed 10 per cent. Their commerce is created, and the population supported mainly in the manufacture of iron and steel, and their products, and in the production of coal and coke.

Iron Ore.

The following are the ore shipments from Lake Superior and receipts at Lake Erie ports for the year 1895:*

*For detail reports of receipts and shipments see Appendix, page .

Shipments, Lake Superior ports..... 10,233,910 tons
Receipts, Lake Erie ports..... 8,112,228 "

The five Lake Erie ports from which the furnaces in Allegheny County, Pa., and the Mahoning and Shenango Valley districts on the canal, and the Ohio Valley district from the Beaver River to Bellaire, and the Western Pennsylvania furnaces receiving the ore via Pittsburgh, are Cleveland, Fairport, Ashtabula, Conneaut and Erie.

Receipts said five ports, 1895..... 6,758,734 tons
Reduction stock, said five ports, 1895..... 459,730 "

Sent to furnaces..... 7,218,464 tons

Iron Ore Consumption and Pig Iron Production.

The following table gives the pig iron produced in the canal district in 1895, from the report of Mr. J. M. Swank, Secretary of the American Iron and Steel Association, and as it requires one and six-tenths tons of ore, one ton of coke and one-third ton of limestone to make a ton of pig iron, the following will give the crude materials required:

Districts.	Furnaces and Product.		Crude Materials. Tons.			
	Number Furnaces 1895.	Pig Iron.	Ore.	Coke.	Limestone.	Total.
1. Allegheny County, Pa.	27	2,054,585	3,287,336	2,054,585	684,862	6,026,783
2. Shenango Valley, Pa.	21	820,037	1,302,059	820,037	273,346	2,395,442
3. Mahoning Valley, Ohio.	14	620,526	992,841	620,526	206,842	1,820,209
4. Ohio Valley, Beaver to Bellaire	10	417,591	668,145	417,591	139,197	1,224,933
5. Western Pa., through Pittsburgh	*11	454,773	727,636	454,773	151,591	1,334,000
Total	83	4,367,512	6,978,017	4,367,512	1,455,838	12,801,367

*Johnstown, 6; Dunbar, 2; Scottdale, 1; Emporium, 1; Kittanning, 1.

The above does not include four new furnaces in Allegheny County building by the Carnegie Steel Company, which will be put in operation this year. Their annual capacity will be about 700,000 tons of pig iron, and will require annually about 1,120,000 tons of ore, 700,000 tons of coke, and 233,000 tons of limestone additional. When these new furnaces are in operation the ore requirements in these districts for a year like 1895 would exceed 8,000,000 tons, and therefore their average annual requirements for a period of years, even under present conditions of transportation, would be not less than 7,000 000 tons. The ore required is based upon the ores used in this district, which yield not less than 60 per cent. metallic iron.

The above eighty-three furnaces in the canal district are all within the limits of the circle above referred to, having its centre a few miles north of Pittsburgh, and a radius of sixty miles. Seventy-two of the above eighty-three furnaces will be located on the water, and can be served direct with water transportation through the canal, and the other eleven furnaces will all receive their ores through the canal, with possibly one exception.

In 1895 Allegheny County made 47 per cent. of all the pig iron made in the five districts, and the first three districts together made 80 per cent of the total for said districts.

Allegheny County made 52.9 per cent. in 1894, and 43.8 per cent. in 1895, of all the pig iron made in Pennsylvania, and in 1894 26.8 per cent., and in 1895 21.8 per cent. of all made in the United States. The first three districts together made 39 per cent. in 1894, and 37 per cent. in 1895, of all made in the United States, and the five districts together made 46.9 per cent. in 1894, and 46 2 per cent. in 1895, of the total product of the United States, and in 1894 made 12.3 per cent. of the total product of the world, and in 1895 made 17.2 per cent. of the world's product in 1894.

The production of Allegheny County, Pa., in 1895 was 590,796 tons more than the entire production of the State of Ohio, and more than double the entire production of the State of Illinois, and almost equalled the entire production of both States.

Coke Consumption—Lake District.

The following are the coke furnaces located on the shores of the Great Lakes, now receiving their coke mainly from the Con-

nellsville district, near Pittsburgh, by rail; and the canal would supply all water transportion at a great saving in cost, as will be seen below, in chapter relating to Effect of Canal on Commerce. The production of pig iron and coke required is for the year 1895. Authority, Mr. J. M. Swank.

DISTRICTS.	NO. FURNACES.	PIG IRON PRODUCED.
Illinois	17	1,006,091
Wisconsin	4	102,443
Minnesota	1	
Ohio	5	286,861
New York	2	112,891
Total	29	1,508,286

Coke required ..... 1,508,286 tons.

Of the 17 Illinois furnaces, 8 are located at South Chicago; 5 at Chicago, 3 at Joliet and 1 at Cummins. The five in Ohio are located at Cleveland, and of the two in New York, one is located at Buffalo and one at Tonawanda.

Coke Production.

The following table, compiled from the weekly reports published in the *American Manufacturer*, shows the number of cars and tons of coke shipped from the Connellsville region, (1) to points west of Pittsburgh; (2) to points east of Pittsburgh; (3) to Pittsburgh, for the year 1895. The tonnage is estimated on the basis of each car averaging 18.2 tons:

SHIPMENTS—1895.	NUMBER OF CARS.	TONS OF COKE.
To points west of Pittsburgh	221,169	4,025,275
To points east of Pittsburgh	85,149	1,549,711
To Pittsburgh	127,322	2,317,260
Total	433,640	7,892,246

There were 4,025,275 tons shipped west of Pittsburgh; of this amount the requirements of districts 2, 3, and 4 were 1,858,-154 tons, leaving 2,167,121 tons to go beyond these districts.

As shown above, the requirements of the 29 coke furnaces on the lakes was 1,508,286 tons. As district (4) uses a small proportion of coke from the upper Monongahela district in West Virginia, it would leave a larger amount of Connellsville coke to go to the lake district. The total production of the upper Monongahela district in West Virginia in 1894 was 158,623 net tons, and the output for the entire State of West Virginia was 1,639,687 tons. As a large amount of coke is used for other than blast furnace uses (viz: In making finished iron and steel from pig iron), for foundry, domestic and other purposes, it is safe to estimate the annual tonnage of coke that would seek transportation through the canal for lake points at 2,000,000 tons.

The ore fields supplying the furnaces in the canal district are located on Lake Superior and Lake Michigan.

The coal fields, supplying not only the furnaces of the canal district with coke but the above coke furnaces on the Great Lakes, are located about forty miles southeast of Pittsburgh and about ten miles from Pool No. 4 on the Monongahela River.*

Prolific beds of limestone and building stone, now used in Allegheny County, Shenango and Mahoning Valley districts, are located along and near the line of the canal, in Beaver and Lawrence Counties, Pa., and in Mahoning County, Ohio.

The coal fields, sending nearly all the coal from Western Pennsylvania to both Lake and Ohio and Mississippi River markets, are located in the four counties bordering on the Monongahela River from Pool No. 1 to Pool No. 4. These counties are Allegheny, Westmoreland, Washington and Fayette. The Pittsburgh coal bed lies on both sides of the Monongahela River from Pool No. 1 to its headwaters in West Virginia. A more detailed description of the coal areas reached by the canal will be found in the Appendix, pages—

Rolling Mills and Steel Works in the Canal District.

The following represents the number of rolling mills and steel works in the canal district and their annual capacity in gross tons of product. All of these are located on the canal or the rivers reached through the canal, except twenty:

*For detail description of coke fields see Appendix, page—

District.	Number.	Annual Capacity—Gro. Tons.
Allegheny County, Pa.	63	5,226,440
Beaver & Shenango Valleys, Pa.	18	572,900
Mahoning Valley, Ohio.	18	984,800
Ohio River, (Beaver to Bellaire.)	17	1,142,414
Western Penna., outside above	20	1,323,350
Total.	136	9,249,904

The above information was furnished partly from direct reports of the firms to the Statistical Committee (about fifty per cent of said firms having so reported), and the others were taken from their reports to the American Iron and Steel Association.

For details relating to the production of iron and steel in the canal district, see Appendix to the report of this Committee, page —.

Manufacturing Industries in the Canal District.

The manufacturing industries reporting to the eleventh census of the United States in cities on the line of the canal and adjacent thereto, containing a population of 20,000 and upwards:

1.	Total number reporting	2,989
2.	Capital { Value of hired property	$ 12,354,330
	{ Direct investment	$170,919,561
3.	Miscellaneous expenses	$ 12,485,391
4.	Average number employees	94,131
5.	Total wages	$ 54,193,107
6.	Cost of materials	$124,641,491
7.	Value of product	$217,284,195

Coal Tonnage From Canal District to Lake Erie Ports.

According to the report of the Ohio Mine Inspector, in 1894 there were received at Lake Erie ports 5,452,029 tons of bitumi-

nous coal for transhipment by lake, of which 3,593,805 tons came from Pennsylvania, 1,568,912 tons came from Ohio, and 289,312 tons came from West Virginia. This is what passed through Lake Erie ports for transportation by vessel to upper lake and Canadian ports.

The receipts of bituminous coal at Lake Erie ports for 1894, including what passed through for vessel shipment, as given in "Coal Trade," amount to 10,245,289 tons as the total bituminous coal received at Lake Erie ports in 1894. Taking the total receipts of bituminous coal at Buffalo, Cleveland and Toledo in 1893, as given in the "Mineral Resources of the United States," and adding the bituminous coal passing through Ashtabula, Lorain, Fairport and Conneaut for 1893, as given in "Coal Trade," we have 10,394,356 tons as the total bituminous coal received at Lake Erie ports for 1893.

Deducting the bituminous coal which was forwarded by vessel from Lake Erie ports in 1894, viz: 5,452,029 tons, from the bituminous coal received at said ports in 1894, viz: 10,245,289 tons, the balance, 4,793,260 tons, would approximately represent the bituminous coal consumed at Lake Erie ports in 1894.

As shown by the report of the Ohio Mine Inspector, of the total bituminous coal forwarded by vessel from Lake Erie ports in 1894, 66 per cent. came from Pennsylvania, 29 per cent. from Ohio, and 5 per cent. from West Virginia. It is reasonable, therefore, to assume that of the total of said coal received at said ports in 1894, each of the above States would furnish a proportionate amount of same; in that event, the amount going from said States would be as follows:

Pennsylvania	6,761,891	tons
Ohio	2,971,134	"
West Virginia	512,264	"
Total	10,245,289	"

Coal Production in Canal District.

The total production of bituminous coal in the United States in 1893 was 128,385,231 tons,* in Pennsylvania 44,070,724 tons and in West Virginia 10,708,578 tons.

*Mineral Resources of the United States.

The production in the Monongahela River counties was as follows:

PENNSYLVANIA.	TONS.	
Allegheny County	6,663,095	
Washington County	3,315,146	
Westmoreland County	7,439,760	
Fayette County	6,261,146	
Total		23,679,147
WEST VIRGINIA.	TONS.	
Monongalia County	38,600	
Marion County	1,062,334	
Total		1,100,934
GRAND TOTAL		24,780;081

Of the production in the above four Pennsylvania counties there were:

Loaded at mines for shipment	15,538,193	tons.
Made into coke	7,275,825	"
Used locally at mines	865,129	"
TOTAL	23,679,147	"

The four Pennsylvania counties produced 53.7 per cent. of the total production of Pennsylvania. The two West Virginia counties produced 10.3 per cent. of the total production of West Virginia, and the six counties together produced 19.3 per cent. of the total production of the United States.

That this estimate of coal going from the canal district in Western Pennsylvania to Lake Erie is amply conservative is indicated from the amount of coal carried in 1894 by the railroads terminating at Lake Erie ports, from Cleveland to Buffalo, carrying through traffic between Pittsburgh and said ports or connecting with other main lines from Pittsburgh, which latter are not included to avoid duplication. The total ~~ton~~ coal tonnage of said railroads in 1894 was 8,129,266 tons.* It is safe, therefore, to estimate the existing coal tonnage going to the lakes from Western Pennsylvania would annually average 7,000,000 tons, without allowing for the increased tonnage that would result from reduced cost of transportation by having all water route to these markets.

*Page —.

Consumption of Bituminous Coal on the Great Lakes.

"Mineral Resources of the United States" gives the total receipts and shipments of coal by lake and rail for the year 1893 at six lake cities, viz: Buffalo, Cleveland, Toledo, Milwaukee, Chicago and Duluth, as follows:

Receipts	25,144,493 tons.
Shipments	6,000,992 "

Deducting shipments from receipts gives consumption at said points and sent inland from said points:

For consumption, viz:	19,143,501 tons.
Deduct anthracite coal from Buffalo	2,681,173 "
Bituminous coal consumed	16,462,328 "

The above is the natural market for Monongahela River coal and Connellsville coke, and all that is needed to cheapen their cost in these markets is the water route which the proposed canal will supply.

The relation of the proposed ship canal to this coal field is apparent. When it connects with the present canalized Monongahela River at Pittsburgh, it will admit vessels to penetrate the very heart of the Pittsburgh coal measures, and without breaking bulk, transport this coal and coke, the best in the world, to every lake port, and when the Erie-Hudson Canal is deepened, to the cities on the Atlantic Coast, and so reduce the cost of bituminous fuel at all these points reached by it, through all water transportation, that it will contribute to their greater prosperity in commercial and manufacturing interests, which a cheap fuel supply is a potent factor in building up and maintaining. This illustrates not only the present, but the future possibilities of tonnage traffic for the canal from the coal fields, and the enlarged markets that can be reached by this coal. When it is considered that the product of the mines and quarries make up 54.22 per cent. of the entire traffic of the Great Lakes, and that coal and iron ore largely make up the products of the mines and quarries, and that this iron ore is at present largely meeting the coal and coke along the proposed pathway of this canal in Allegheny County, Ohio River, Mahoning and Shenango Valleys, to be manufactured into the

finished product by a dual and costly method of transportation, the widespread commercial benefits of such a waterway must become apparent to any intelligent mind.*

Coal Markets Reached through the Canal.

The following table compiled from "Mineral Resources of the United States," "Coal Trade" and "Coal Statistics," gives estimates of the coal annually consumed and passing through the markets mentioned below to other points for consumption, that could be reached by all water transportation without change of bulk by Pittsburgh coal and coke, through the proposed ship canal and the Erie-Hudson Canal, when improved and deepened to nine feet.

MARKETS.	ANTHRACITE FUEL—TONS.	BITUMINOUS FUEL—TONS.	TOTAL FUEL—TONS.
Great Lake Cities, U. S.	4,750,000	16,462,328	21,212,328
Canada	† 1,550,000	† 1,500,000	† 3,050,000
New England		6,000,000	‡ 6,000,000
New York	10,000,000	5,000,000	15,000,000
Philadelphia	5,500,000	2,500,000	8,000,000
Baltimore	400,000	2,400,000	2,800,000
Total	22,200,000	33,862,328	56,062,328

See page 88 for price of Pittsburgh coal at these points through the proposed canal.

Commerce of Monongahela River.

In 1894 the coal tonnage alone passing out of the Monongahela River was 4,417,132 tons, which does not include the rail-

*For details of coal fields, production and tonnage in canal district see Appendix, page —.

†Imported only. Total consumption of Canada about 6,000,000.

‡Bituminous consumption only.

road tonnage in coal from the valley. The shipments from the several pools were as follows in bushels:

Pool No. 1	11,677,915	bushels.
" " 2	25,086,000	"
" " 3	20,735,500	"
" " 4	58,457,000	"
" " 5	283,900	"
Total	116,240,315	"

In 1893 the record for the Monongahela River was 4,275,504 tons of freight, and the same year the combined tonnage of all the other tributaries of the Ohio River from Pittsburgh to Cairo was 4,258,904 tons; in other words, the traffic of the Monongahela in that year exceeded that of all the other tributaries of the Ohio River combined.

In June, 1895, there were collected in the Pittsburgh harbor 1,200,000 tons of coal loaded on about 2,500 vessels awaiting water to move down the Ohio River. The largest tonnage ever assembled in any harbor in the world at one time. The rise did not come until November 27th.

The cost of freight and vessels engaged in the service may be summarized as follows, according to the statement of the Secretary of the Pittsburgh Coal Exchange:

2,500 vessels, average cost $900	$2,250,000
Cost of coal in vessels in Pittsburgh harbor	1,260,000
80 registered towing steamers in this port, average value $30,000	2,400,000
20 passenger and other steamers in this port, average value $20,000	400,000
	$6,310,000

It cost $2,000 per day to keep the tonnage afloat, and $1,000 per day interest on the investment—total, $3,000 per day. This tonnage was kept waiting in the Pittsburgh harbor for water in the Ohio River an average time of five months, or 150 days, at a loss of $450,000, which is five per cent. on $9,000,000. That is what this one item of commerce lost in five months in Western Pennsylvania in not having the economy of transportation that results from continuous water movement, and this loss was suffered

not only by the producers in Pennsylvania, but by the consumers in Southern markets where the product is needed.

On May 6th, 1895, Mr. Richard A. Roberts, assisted by Major Thomas McGowan, submitted a statement carefully prepared of the population and industries in the territory proposed to be formed into a new county on the Monongahela River, extending from Pool No. 2, a short distance above McKeesport, to and including Luzerne Township in Fayette County, and to and including East Bethlehem Township in Washington County, near Lock No. 6 in the Monongahela River.

The report states that in 1895 the population was estimated at 73,885. Fifty-eight mines, shipping by river only, put out in 1894, 104,785,000 bushels of coal, and twenty-eight mines shipping by railroad put out about 23,000,000 bushels, making a total output for the district of 127,785,000 bushels, equal 4,914,807 tons of coal. In 1895 there was a total of forty-eight manufacturing industries, and taking the mining and manufacturing interests together, there is an aggregate of 129 interests in the territory which support more than 10,000 families, and on an invested capital of about $50,000,000.

Notwithstanding the building of railroads on both sides of the river into the coal fields of the Monongahela Valley in the last fifteen years, the coal shipments by the Monongahela River have continuously increased, the tonnage of 1894 being the largest in its history, and the railroads along its banks are among the best paying railroads in Western Pennsylvania; which goes to show that water and rail transportation are not hostile to each other, but each is a necessary complement to the success of the other, and in further proof of this fact comparison is invited to the financial returns of the railroads on each side of the Allegheny River, which is not an improved navigable stream.

Allegheny River Commerce.

The United States Engineers Report for 1894 gives the commercial movement in the Allegheny harbor at Pittsburgh for the year 1892 as 953,406 tons.

In January, 1896, Mr. T. P. Fleeson of Tarentum, Secretary of the Allegheny River Improvement Association, presented a statement before the River and Harbor Committee, showing that

the annual shipment of coal from this valley was over 1,000,000 tons; that the raw material delivered to manufacturers along the Allegheny River aggregated annually 3,242,748 tons, and the amount of finished product shipped out of the valley was 2,968,705 tons, the value of the annual output along the valley was $150,000,000, and 46,475 men were employed.

Commerce of Ohio River.

In 1894 the commerce passing Davis Island Dam, four miles below Pittsburgh, was:

Number of vessels..... ~~7,535~~ 14,120

Freight, tons..... 3,145,803

By census of 1890 the commerce of the Ohio and Mississippi Rivers and tributaries is set forth as follows:

	Number of Vessels.	Freight—Tons.
Ohio River and tributaries. . .	6,255	15,600,439
Upper Mississippi, Missouri and tributaries.	631	6,373,448
Lower Mississippi and tributaries	554	9,080,525

The tonnage of the Ohio River and tributaries exceeds the combined tonnage of the upper and lower Mississippi and Missouri Rivers and tributaries.

At the Ohio River Improvement Convention, held at Cincinnati, Oct. 8th and 9th, 1895, a paper read by Col. Amos Stickney, U. S. Engineer, in charge of the Ohio River, states as follows:

"The commerce of the river during the year ending December 31st, 1894, as ascertained in my office, amounted in round numbers to 7,800,000 tons, which is much greater than that of any other inland waterway in this country except two, one of which is the pathway of the Great Lake commerce and the other is the Hudson River."*

*For further details on Ohio River commerce see Appendix, page —

Volume of Tonnage in Canal District as Shown From Railroad Tonnage.

The following statement compiled from the quarterly reports of the National Association of Car Service Managers, shows the movement of railroad cars at the most important commercial centres of the United States for the year 1895, which includes only cars receiving and discharging cargo in the territory of the association, and as a rule, only cars having full cargo are reported—less car loads and mixed shipments are not reported to the association. This report shows that the Pittsburg district exceeds that of any other commercial centre, and the tonnage of the district being largely of a character best adapted to a waterway, it illustrates not only the magnitude of the tonnage in the districts reached by the canal, but the volume of the tonnage available and that the waterway would have to draw upon for transportation.

NAME OF ASSOCIATION.	NO. CARS, YEAR ENDING DEC. 31ST, 1895.
Pittsburgh	1,504,036
Philadelphia	1,233,985
New York and New Jersey	595,483
Western New York (Buffalo)	559,311
Chicago	514,769
Mahoning and Shenango Valleys	485,200

The Pittsburgh and Mahoning and Shenango Valley Associations are the districts which the canal would provide with direct water transportation.

Considering the character of the tonnage in the canal district being so largely made up of crude materials and other heavy freight, and that the estimate is from full carloads, we believe twenty tons per car would average the total freight moved, and therefore the tonnage from full carloads in these districts together would be as follows:

Number of cars 1,989,236
Tons of freight moved 39,784,720

The tons of freight at fifteen tons per car would be 29,838,540. It has been estimated that the railroad tonnage entering and leaving Pittsburgh in 1892 aggregated 37,999,392 tons. In no period of the world's history has capital been invested in an artificial waterway that could reach such a colossal and magnificent tonnage of a character best suited to a waterway, and which would bring such vast and widespread commercial benefit as the proposed canal connecting Lake Erie and the Ohio River.

Railroads Operating Between Pittsburgh and the Lakes.

The following are the main line and branch railroads operating wholly or in part between Pittsburgh, the Mahoning and Shenango Valleys and the lakes:

1. Pittsburgh, Fort Wayne & Chicago R. R.
2. Pittsburgh & Western R. R.
3. Erie & Pittsburgh R. R.
4. Cleveland & Pittsburgh R. R.
5. Pittsburgh, Youngstown & Ashtabula R. R.
6. Pittsburgh & Lake Erie R. R.
7. Pittsburgh, Shenango & Lake Erie R. R.
8. Allegheny Valley R. R.
9. Lake Shore & Michigan Southern R. R. (Branches to Mahoning and Shenango Valleys.)
10. Pittsburgh, Painesville & Fairport R. R.

Taking the report of railroads (1) to (8) inclusive to the Secretary of Internal Affairs for the year ending June 30th, 1892, and including the ore and coal tonnage only of (9) for 1892, (excluding (10) from which there was no report), the following is the combined tonnage of (1) to (8) including ore and coal tonnage of (9) for that year:

Products of agriculture	1,234,031	tons.
" " animals	441,734	"
" " mines	24,517,039	"
" " forests	1,469,149	"
" " manufacture	6,559,961	"
Merchandise and miscellaneous	2,476,903	"
Total	36,698,817	"

The combined cost of road and equipment of railroads (1) to (9) inclusive is $172,141,738; the average expenses to earnings is 68 per cent., and the average rate on freight per ton per mile is 6.7 mills.

From reliable reports received covering all roads obtainable, we give below the tonnage in items given of roads only having terminus at Lake Erie ports from Cleveland to Buffalo, carrying their traffic through from Pittsburgh, Mahoning and Shenango Valleys to said lake ports, or received from lines not included, and receiving freight at said lake ports for said points, or delivered to other roads for through shipment to said points, for the year 1894:

Iron ore	6,913,489	tons.
Coal	8,129,266	"
Coke (5 roads)	2,335,677	"
Manufactured iron and steel (5 roads)	3,041,466	"
	20,419,898	"

The total tonnage of said roads in 1894 was about 25,000,000 tons.

The coal, ore and coke traffic of the above named railroads averages over 50 per cent. of their entire business, and the ton mile rate on their raw materials is above the average of the ton mile rate of all freight carried, and yet some of these roads are being operated almost continually at a net loss on capital invested. As the lowest class traffic which properly belongs to a waterway has required a ton mile rate above that of total freight carried, it is not hard to see that it would have been business economy for these railroads to have put a sufficient amount of the enormous cost of their roads into a ship canal, and had it relieve them of this low class freight and develop the growth and prosperity of the manufacturing communities on which they are dependent for business, through a reduced cost on materials entering into manufactured products, and thereby creating a higher class and more suitable and profitable traffic for railroads to carry.*

*For further details of railroads tonnage, operation, etc, in canal district see Appendix, page —.

Commerce of St. Mary's Falls Canal for the Year 1895.

Iron ore, net tons	8,062,209
Coal, net tons	2,574,362
Other freight, net tons	4,426,009
Total	15,062,580

The ore used in the canal district in 1895 was 6,978,017 tons, and the bituminous coal going to Lake Superior ports in 1894 was 1,509,543 tons from Pennsylvania, and assuming the same amount came from Pennsylvania in 1895, the coal and ore traffic of the canal district in 1895 would be 56 3-10 per cent. of the total traffic of the St. Mary's Falls Canal.*

Commerce of Detroit River for the Year 1894.

Iron ore and finished iron,	tons	6,448,445
Coal,	"	6,264,590
Lumber,	"	2,150,000
Flour and grain,	"	5,586,848
Total freight	"	24,263,868
Number vessels		34,800
Registered tonnage		26,120,000

The coal, ore and lumber tonnage of the canal district passing through Detroit River amounts to over one-third of the entire commerce passing that point.†

The lumber coming from the lakes to the Pittsburgh district approximates annually 500,000 tons.‡

Total Tonnage Movement of Points Connected by the Canal.

LAKE DISTRICT.—By the Census Bulletin, April 26th, 1892, the freight movement on the Great Lakes by all classes of United States commercial craft operating during the year ending December 31st, 1889, was as follows:

*See Appendix, page —.
†See Appendix, page —.
‡See Appendix, page —.

Steamers	20,181,483 tons.
Sailing vessels	19,302,949 "
Unrigged craft	13,940,000 "
Total	*53,424,432 "

OHIO RIVER DISTRICT.—By the report of Col Amos Stickney, U. S. Engineer in charge of the Ohio River, and the census of 1890, the tonnage of the district was as follows:

Ohio River (1894)	7,800,000 tons.
Ohio River and tributaries (1889)	15,600,439 "

CANAL DISTRICT.—For the purpose of this estimate we include all the territory reached through the canal and Ohio River, covered by statistical information relating to manufacturing industries, and call it the "Pittsburgh District." By considering the volume of tonnage carried to and from this district by railroads extending east, south and southwest, and considering the less car load and mixed car load tonnage, a conservative estimate of the entire rail and water tonnage movement of the canal district would be as follows:

Pittsburgh District	50,000,000 tons.
Mahoning and Shenango Valleys	10,000,000 "
Total	60,000,000 "

This union of waters and districts creating and moving such vast tonnage, affording the cheapest method of intercommunication by water, would ensure widespread commercial benefits and a commerce for this waterway which the present can hardly accurately measure.

Effect of Canal Rates on Existing Commerce and Earnings for the Canal on Capital Invested.

Before entering upon a discussion of this subject, we give below a comparative table of existing rail and water rates, which will be referred to in connection with the conclusions reached upon this subject.

*NOTE.—Atlantic Coast, 77,597,626 tons; Pacific, 8,818,363 tons; Gulf of Mexico, 2,864,976 tons.

The rates here given are compiled from the years 1894 and 1895.

FROM	TO	ROUTE	ARTICLES.	RATE PER TON.	DISTANCE IN MILES.	TON MILE RATE M'LLS.
Duluth	Ashtabula ..	Lake	Ore.	$0.80	890	0.89
Ashtabula...	Duluth	Lake	Coal.	0.36½	890	0.41
Buffalo	Duluth	Lake	Coal.	0.25	1,000	0.25
Duluth	Buffalo	Lake	Wheat.	0.66	1,000	0.66
		Erie				
Buffalo	New York..	Canal	Wheat.	0.62	500	1.24
		Erie				
Buffalo	New York..	Canal	Coal.	0.60	500	1.20
		Erie	Up freight			
New York...	Buffalo	Canal	Mdse.	0.60	500	1.20
Pittsburgh ..	New Orleans	River	Coal.	0.70	2,000	0.35
Ashtabula...	Pittsburgh .	Rail	Ore.	*1.15	130	8.85
Pittsburgh ..	Ashtabula..	"	Coal.	†1.05	130	8.00
Ashtabula...	Youngstown	"	Ore.	*0.67½	62	7.66
Pittsburgh ..	Youngstown	"	Coal.	0.60	65	9.23
Connellsville.	Youngstown	"	Coke.	1.20	121	9.92
"	Braddock ..	"	"	0.50	46	10.87
"	Pittsburgh .	"	"	0.65	56	11.60
"	Cleveland ..	"	"	1.55	206	7.52
"	Chicago....	"	"	2.65	524	5.06
"	Wheeling ..	"	"	1.20	122	9.84
Pittsburgh ..	Chicago....	"	Coal.	2.25	468	4.80
"	New York..	"	Pig iron.	2.40	440	5.45
Ashtabula...	Wheeling ..	"	Ore.	*1.15	140	8.22
Connellsville.	Buffalo	"	Coke.	2.00	334	6.17

*Including transfer charges at lake.

†Including transfer charges at lake, 15c.; freight charges, 90c.=6.92 mills

Davis Island Dam, Forming Harbor of Pittsburgh. Lock 600 Ft. Long 110 Ft. Wide.

Average freight rates, iron ore, from ports named to Lake Erie ports, for following years, as given in Marine Review:

	ESCANABA.		MARQUETTE.		ASHLAND AND OTHER PORTS AT HEAD OF LAKE SUPERIOR.	
Year.	Wild or Daily Rate.	Contract Rate.	Wild or Daily Rate.	Contract Rate.	Wild or Daily Rate.	Contract Rate
1893 . . .	$0.56	$0.85	$0.71	$1.00	$0.77	$1.00
1894 . . .	0.46	0.60	0.60	0.80	0.78	0.80
1895 . . .	0.73	0.55	0.92	0.75	1.13	0.80

Charges to vessel for trimming and unloading, 18c. per ton.

Average daily wild rates, soft coal, from Lake Erie ports to ports named, for following years, as given in Marine Review:

YEAR	MILWAUKEE	ESCANABA	DULUTH	GREEN BAY	MANITOWOC
1893 . . .	$0.48	$0.40	$0.38	$0.50	$0.41
1894 . . .	0 48½	0.39	0.37½	0.49½	0.48
1895 . . .	0.54	0.39	0.36½	0.50	0.51

Coal of all kinds shipped in net tons and handled without charge to vessel.

Chicago rate on soft coal practically same as Milwaukee.

In 1894 rates on hard coal from Buffalo were as follows:

To Duluth, 25c; to Chicago, 46c; to Milwaukee, 46c.

Average rates on grain from Chicago to Buffalo were 1.3 cents in 1894, and 1.9 cents in 1895; and charges to vessel for shoveling, trimming and weighing grain foot up about $4.75 per 1,000 bushels.

A study of the above tables ought to be sufficient in itself to require no further argument as to the necessity and advantages

of the ship canal. A ton of ore is carried nearly 1,000 miles by lake for 80 cents, and is subjected to a tax of $1.15 for transfer and freight charges for overland carriage 130 miles to its destination, to which the ship canal will enable the same vessel to come and unload its cargo without transfer. A ton of coal is carried overland 130 miles at a cost of $1.05 for freight and transfer charges to a lake vessel, and then proceeds to its destination almost 1,000 miles by vessel, at a cost of 25 to 37 cents. Ought such a tax and wasteful expense be allowed to exist on such a colossal commerce, by the communities interchanging these commodities in a volume of such vast magnitude, when Nature has provided the way to introduce a water route with the tremendous saving indicated in the above table?

The average ton mile rate on all the railroads in the United States is about nine mills. The lowest rate effected by any single road in the United States is about four mills. As the largest amount of freight is carried by the roads having the lowest ton mile rate, it is presumable that the average rate paid on freight on all railroads would be from 6 to 6½ mills.

So far as rail and water borne commerce are concerned, it is therefore manifest that these two systems can never encroach the one upon the territory of the other, nor can they ever hope to compete in rates, nor are they hostile to each other's interests, as any one may learn who will examine the value of the securities and earnings of railroads the world over, which are paralleled by waterways, as compared with railways not so situated.*

Rates and Tolls Through the Canal.

An examination of the above table of rates shows that ore is transported on the lakes at 8-10 of one mill per ton per mile. Coal at 1-4 to 2-5 of one mill; wheat 6-10 of one mill; coal on Ohio and Mississippi Rivers 3-10 of one mill; coal and up freights on the present Erie-Hudson Canal (6 feet depth) 1.20 mills.

By the introduction of the mineral train boat system on the Aire and Calder Canal in England (9 feet depth) the cost per ton mile has been reduced to the level of cost of an ocean steamer.

Therefore a vessel rate of one mill per ton per mile for ore, coal and coke, through a canal of the dimensions proposed for

*This subject treated more fully in Appendix, page —

canal prism and locks, is a vessel rate that will be profitable where the way is open for ninety-five per cent of the steam vessels and barges now on the lakes to come through the canal and secure the movement by water of the great tonnage of the canal districts, which is best adapted to water transportation.

The assumed toll rate on ore is 25 cents from Lake Erie to the districts on the Ohio River, and on coal 20 cents from the Pittsburgh harbor to Lake Erie. These were the rates established on the old Pittsburgh-Erie Canal on coal and ore passing between Lake Erie and the Ohio River.

The assumed rate on ore to the Mahoning and Shenango Valleys is 15 cents, as the majority of the locks in the canal are passed in reaching those points. The assumed rate on coke through to lake points is the same as for coal, viz: 20 cents.

On the above vessel rate of one mill per ton per mile and the above toll rates, the estimates of saving on commerce and earnings for the canal from ore, coal and coke tonnage are calculated by deducting them from existing rates of overland carriage and transfer.*

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*For furnaces in Western Pennsylvania that would receive their ore through Pittsburgh we have used the Pittsburgh rate and the distance which the canal would reduce the water transportation; the actual rate would exceed the Pittsburgh rate, and as their ore would have to be transferred to cars at Pittsburgh, we have allowed 20 cents in cost by canal, the usual transfer cost at Lake Erie ports.

Saved on Ore and Coal.

Districts.	Distance to Lake Erie via Canal	Rail.	Canal.				
		Rail Rate, Including Transfers...	Rate 1 Mill...	Tolls.	Transfer....	Total	Total Saved per Ton.....
Mahoning & Shenango Valley—ore	62	0.67½	$1.06	$0.15		$0.21	$0.46
Allegheny County, Pa.,—ore.....	130	1.15	0.13	0.25		0.38	0.77
Ohio Valley, Beaver to Bellaire—ore..	160	1.15	0.16	0.25		0.41	0.74
*West Penna, outside above—ore	130	1.15	0.13	0.25	0.20	0.58	0.57
Pittsburgh coal on board at Lake Erie	130	1.05	0.13	0.20		0.33	0.72

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*For type of vessel adapted to canal traffic and earnings of same see Appendix, page —.

ORE.—Applying this saving and the above toll rates to the tonnage movement in 1895 in ore, without taking into account the natural and inevitable increase which would follow from the reduced cost above given, affected by such a waterway, the following will represent the saving on the cost of ore and the earnings for the canal on the ore traffic of 1895:

DISTRICTS.	ORE REQ IRED.	SAVED ON COST OF ORE.	EARNED FOR CANAL.
Allegheny County, Pa.	3,287,336	$2,531,248.72	$ 821,834.00
Shenango Valley, Pa.	1,302,059	598,947.14	195,308.85
Mahoning Valley, Ohio	992,841	456,706.86	148,926.15
Ohio Valley, Beaver to Bellaire	668,145	494,427.30	167,036.25
West. Penna., outside above	727,636	414,752.52	181,909.00
Total	6,978,017	$4,496,082.54	$1,515,014.25

$1,515,014.25 is 4.60 per cent. on $33,000,000.

COAL.—The total coal tonnage for the year 1894 of the railroads having terminals at Lake Erie ports from Buffalo to Cleveland, whose lines extend to Pittsburgh or connected with main lines from Pittsburgh, was 8,129,266 tons. (Page 72).

As previously shown (page 71), from the reports of the Ohio Mine Inspector and "Coal Trade," the bituminous coal going to Lake Erie ports from Western Pennsylvania in 1894 for consumption and trans-shipment was 6,761,891 tons.

As also shown (page 73), from the United States Engineer's Report, the consumption of bituminous coal at six lake cities in 1893 was 16,462,328 tons. As Pittsburgh coal, which is now so prominent a factor in lake consumption, could reach those markets at a reduced cost of 72 cents per ton, all bituminous coal consumed would necessarily come to the level of this coal in said markets. Therefore the saving on the cost of coal and earnings for the

canal at 20 cents per ton toll on the amount going to Lake Erie in 1894 would be as follows:

Saved on cost of coal from Pennsylvania	$ 4,868,561
Total amount saved on fuel account, six lake cities	11,852,876*
Earned for canal on above coal from Pennsylvania	1,352,378
Per cent. earned on $33,000,000	4.09 per cent.

In an able paper read recently by Mr. Geo. E. Tener before the Engineers' Society of Western Pennsylvania, showing exhaustive study into the amount of waste in the transportation of coal by rail and transfer to lake vessel, it was shown that there was a loss of ten per cent. in the value of coal from the carriage by rail to lake ports and from the handling occasioned by transferring to and from lake vessels, and the saving of one transfer through the canal, and saving in loss in vessel over rail carriage would easily exceed five per cent.

As the value of coal going from Western Pennsylvania for trans-shipment at lake ports by vessel would amount to over $3,000,000 a year, there would be a saving of over $150,000 a year in carrying this coal through without change by lake vessel from the Pittsburgh district.

Price of Coal at Tipples to Vessels on Monongahela River.

The thin coal veins are located in the Chartiers district and in the First, Second and Third Pools of the Monongahela River. The thick coal veins are located in the Fourth Pool, Monongahela River, and south of Port Royal on the Youghiogheny River.

At the present mining rate of 64 cents for the thin coal and 51 cents for the thick coal, the following is the selling price per ton of the various grades at the tipples:

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*The above estimate of a saving of 72 cents per ton on fuel in lake markets is based upon the coal going out of the Monongahela River free from tolls on that river. Proceedings are now pending either for the purchase or condemnation by the Government of the corporate rights held by the Monongahela Navigation Company, and opening the same as a free Federal waterway, which it is expected will soon be accomplished.

Thin coal run of mine	65 cents.
" " lump ¾ in. screen	75 "
" " " 1½ " "	85 "
Thick " run of mine	55 to 60 "
" " lump ¾ in. screen	65 to 70 "
" " " 1½ " "	75 to 80 "

Allowing 80 cents as the price of the coal at the tipples, 20 cents tolls through the canal, and one mill per ton per mile through the canal, and lake rates given on coal from Ashtabula to all upper lake ports, and one mill per ton per mile through to all Lake Erie ports, and all points reached through the Canadian and Erie-Hudson Canals, the following will represent the distance by water from Pittsburgh to the points named and the price at which Pittsburgh lump coal could be sold alongside at said ports, covering the cost of the coal, cost of transportation and toll charges:

Distance from Pittsburgh by Water to Following Points, and Estimated Price of Bituminous Coal Per Ton.

CITIES.	CANAL. MILES.	LAKE. MILES.	RIVER. MILSE.	TOTAL MILES.	PRICE OF COAL PER TON.
Ashtabula	128	.....	.....	128	$1.13
Buffalo	128	116	.....	244	1.24
Cleveland	128	56	.....	184	1.18
Toledo	128	146	.....	274	1.27
Detroit	128	147	.....	275	1.27
Chicago	128	781	.....	909	1.67
Milwaukee	128	716	.....	844	1.67
Marquette	128	651	.....	779	1.65
Duluth	128	889	.....	1,017	1.50
Albany	*480	116	.....	596	1.60
New York	*480	116	150	746	1.75
New Haven	*480	†190	150	820	1.82
Providence	*480	†305	150	935	1.94
Toronto	155	132	.....	287	1.29
Montreal	198	272	125	595	1.60

For distance by water from Cincinnati to above points add 443 miles for Ohio River from mouth of Beaver River to Cincinnati, allowing only 100 miles for the Lake Erie and Ohio River Canal, as the distance from Pittsburgh to the mouth of Beaver River would be saved. Wheeling on the Ohio River is 65 miles below the mouth of the Beaver River.

When the Coastwise Canal is completed, distance New York to Philadelphia and Baltimore, as follows:

*Lake Erie and Ohio River and Erie-Hudson Canals.

†Lake and Long Island Sound.

	Canal.	River and Bay.	Total.
New York to Philadelphia.....	31	59	90
Philadelphia to Baltimore.....	14	126	140

If the Coastwise Canal is completed and made a Federal waterway, free of tolls, the price at Philadelphia would be about 10 cents above New York, and Baltimore about 25 cents above New York. A comparison of existing prices of bituminous coal in the above markets will indicate the reduction in the cost of bituminous fuel at these points, from having access by water to the coal and coke fields of Western Pennsylvania.

It is apparent also that pig iron could pay a higher toll rate and a higher ton mile rate and reach New York at about $1.00 per ton less than rail rates; and in like manner all heavy products of iron and steel, such as billets, rails, merchant and armor plate, could reach tidewater with a great saving in cost over present facilities.

Rates and Tolls Monongahela River.

Monongahela River toll charges and towing rates for boats averaging 950 tons coal, from the several pools named into the Pittsburgh harbor:

Pools.	Tolls per ton Cents.	Towing Rate per ton Cents.	Total Cents.
First.....	2.37	1.05	3.42
Second.....	4.74	2.10	6.84
Third.....	6.45	3.15	9.60
Fourth.....	7.00	4.20	11.20

Barges of 500 tons, loaded, towing rates one-half of above each pool.

Boats of 950 tons up the river, empty, towing rates $6.00 each pool and tolls $1.00 each lock.

Barges of 500 tons up the river, empty, towing rates $4.00 each pool and $1.00 each lock.

Until the Monongahela River is made a Federal waterway and free of tolls, the above should be added to costs of coal by water, or an average of about 7¾ cents per ton to the prices given for Pittsburgh coal at the points named.

Coke.

As previously shown, page —, in 1895 the 29 coke furnaces on the lakes produced 1,508,286 tons of pig iron, requiring an equal number of tons of coke, as follows:

LOCATION OF FURNACES.	NUMBER.	TONS COKE REQUIRED
Chicago, Ill	17	1,006,091
Milwaukee, Wis	4	102,443
Duluth, Minn	1	
Cleveland, Ohio	5	286,861
Buffalo & Tonawanda, N. Y	2	112,891
Total	29	1,508,286

Allowing the rail freight to Braddock 50 cents per ton, and 15 cents per ton for transfer to deck of steamer at that point, and *6 cents per ton through one lock on Monongahela River, one mill per ton per mile for the distance by water through the canal to Cleveland and Buffalo; and for Chicago and Milwaukee one mill per ton per mile to Ashtabula; and then same rate by lake as

*Actual rate through one lock 3¾c per ton.

on coal to said points, and 20 cents per ton toll through the canal, the saving in cost of transportation of coke to said points will be as follows:

Furnaces	Rail Rate.	Water Rate.	Saved Per Ton.	Saved on Coke Used in 1895.
Illinois....	$2.65	$1.58	$1.07	$1,076,517.37
Wisconsin.	2.65	1.58	1.07	109,614.01
Ohio.....	1.55	1.09	0.46	131,956.06
New York.	2.00	1.15	0.85	95.957.35
Total				$1,414,044.79

Ten cents per ton may be added to the water rate to cover cost of transfer from vessel to stock pile at furnaces, and still the saving over existing rates will be apparent.* The 20 cents per ton toll charges on all of the above coke going to lake furnaces in 1895, 1,508,286 tons, would earn for the canal $301,657.20.

Saved on cost of coke.....$1,414,044.79
Earned for canal 301,657.20
Per cent. earned on $33,000,000....91-100 of 1 per cent.

Recapitulation.

On the basis of the existing ore tonnage coming to the above districts, and the existing coal tonnage going from Western Pennsylvania to the lakes for consumption, and the existing coke requirements of the twenty-nine lake furnaces, the following will represent the commerce in these three articles for the canal and the saving in cost of transportation of same and earnings for the canal, were this waterway open for their through transportation :

*Transfer charges at lake ports more fully discussed in Appendix, page. —

ARTICLES.	TONNAGE.	SAVED ON COST.	EARNED FOR CANAL	PER CENT ON $33,000,000
Ore	6,978,017	$4,496,082	$1,515,014	4.60%
Coke	1,508,286	1,414,044	301,657	0.91%
Coal transported from Penna...	6,761,891	4,868,561	1,352,378	4.09%
Coal (cost other bitm. coal lake ports)		6,984,315		
Total	15,248,194	17,763,002	3,169,049	9.60%

The above calculations (except as to coke) are based on the Monongahela River being made free from tolls, and it will be seen from the rates on said river that the charges of coal and ore required to go through would make a very small reduction on above saving in cost.

The saving on the cost of the above items of commerce would be sufficient in about two years to cover the entire cost of building the canal, and the gross earnings on the capital invested would amount to 9.60 per cent. The above estimate of earnings is based exclusively on tolls from above items of freight carried ; tolls from vessels running light through the canal are not included, which would be a legitimate source of additional revenue.

No allowance is made in above estimate for the earnings from passenger traffic, the inland commerce of the canal between the populous points located on it, the coal and coke that would go by water from the Monongahela Valley to the Mahoning and Shenango Valleys. No allowance is also made for the lumber traffic nor the traffic in limestone and building stone, of which vast beds are located along the line of the canal, and in stone and lumber the annual traffic would exceed 1,000,000 tons.

No allowance is made for the traffic in manufactured products and other heavy freight. It will be seen, (page —), that the railroads having terminals at Lake Erie ports, from Cleveland to Buffalo, carried in 1894 over 3,000,000 tons, not including the

main lines* extending to Chicago and other lake ports west of Cleveland; and it would be safe to assume that the canal would carry at least 1,000,000 tons annually of heavy manufactured products for lake ports and for tidewater points, through the deepened Erie-Hudson Canal.

No allowance is made for the commerce seeking a water route through the canal from lower Ohio and Mississippi river points destined for lake points and tidewater points, through the Erie-Hudson Canal; nor for the commerce that will seek this water route from tidewater and lake points destined for Ohio and Mississippi River points.

*For details of tonnage of lines of railroads connecting the canal districts with the northwest and lake ports, see Appendix.

The earnings from these items of commerce not entering into the above calculations ought certainly to increase the earnings to a sufficient amount to cover cost of maintenance and operation and leave ten per cent. net profit annually on the cost of building the canal.

The cost of maintenance and operation is estimated at $250,000 per annum, as will appear from the report of the Engineering Committee and Consulting Board, which is only about 8 per cent. of above earnings. The ore, coal and coke traffic therefore would earn 5 per cent. on the cost of the canal, pay operation and maintenance and put over $1,000,000 annually into the sinking fund.

From the data given, which has been collected from the most reliable sources and which is set forth more fully in the Appendix, the existing traffic that would seek the canal at its opening for transportation annually may conservatively be summarized as follows:

7,000,000 tons of iron ore.

7,000,000 tons of coal.

2,000,000 tons of coke.

1,000,000 tons of heavy manufactured products.

1,500,000 tons of limestone, lumber, building stone and general merchandise.

National and Local Advantages of the Canal.

FIRST. It will furnish cheaper ores and cheaper food products to the great manufacturing districts reached by the canal.

SECOND. It will furnish cheaper fuel, and thereby cause cheaper cost of living and manufacturing in all the Great Lake district, and in the districts connected with the Great Lakes by waterways.

THIRD. It will afford a cheaper avenue of commercial communication and interchange of products between the Great Lake district and the great States reached by the Ohio and Mississippi Rivers and the seaboard cities.

FOURTH. It will provide water communication for the fuel deposits of Western Pennsylvania to reach the Great Lake cities, and districts reached through tributary waterways, which are the natural markets for coal and coke located in the Pittsburgh district and the Monongahela River, and leave the lower Ohio and Mississippi River coal markets for the Kanawha River, Tennessee, Kentucky and Alabama coal producers.

FIFTH. It will provide the means for national defense in time of war, as the mills making plate and angle iron and armor plate for steel merchant and naval vessels are now located on the canal and in the Pittsburgh harbor, and therefore they could be built more cheaply alongside these mills than any point in the country, and put out into the lakes in a few hours when needed, without violating any existing treaty relating to the number of war vessels permitted on the Great Lakes.

SIXTH. The canal will make Pittsburgh a lake port, with its tremendous natural resources, ponderous manufacturing industries originating a magnificent tonnage, now so prominent a feature of lake traffic, and vastly increase and expand this traffic to the advantage of all points provided with and connected by water through the canal, by reason of the cheaper transportation afforded ; and the dimensions adopted for the canal and locks will permit 95 out of every 100 steam vessels and barges* now carrying traffic on the lakes to directly reach this great tonnage-producing district.

James Fisher, Q. C. M. P. P., of Winnipeg, speaking in the Cleveland Deep Waterways Convention in relation to the value to commerce of enlarged waterway systems, said:

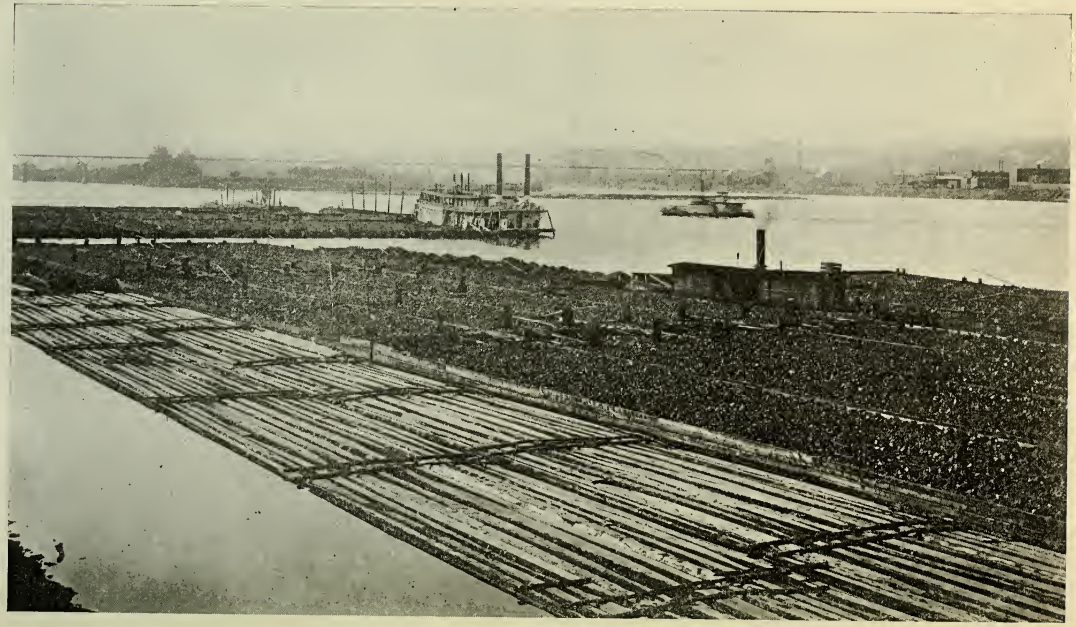
"Do we realize how trade would be increased and the prosperity of the two countries promoted if canal systems connecting

*For particulars as to size, draft and carrying capacity, see Appendix, pages—

with the Great Lakes were extended in other directions? Looking at the vast movement of coal and ore, for instance, between the lakes and the Pittsburgh district, what a stimulus would be given to that trade by the opening of a water channel in that direction. What sum expended in such an enterprise would be too great to be justified by the commercial advantages it would bring and the actual saving in dollars and cents in the cost of transportation? In the American Union, apart from New York and Pennsylvania, there are sixteen great States that are to a large extent dependent on the lake route for transportation of their products. They are all States in which population is increasing and industries extending from year to year."

JOHN E. SHAW,
Secretary.

WILLIAM P. HERBERT,
Chairman.



PITTSBURGH HARBOR—OHIO RIVER LOOKING TOWARD DAVIS ISLAND DAM

REPORT

OF THE

LEGISLATIVE COMMITTEE

TO THE

PROVISIONAL COMMITTEE.

REPORT OF THE LEGISLATIVE COMMITTEE.

Your Committee respectfully reports that it has secured by unanimous vote the passage in the Legislature of Pennsylvania of an act entitled, "An Act to provide for the incorporation and regulation of ship canal companies to connect the Great Lakes with points on navigable rivers of this Commonwealth." Approved the 24th day of June, 1895.

Said act provides that companies organized thereunder may connect their canals and works at the State line with those of similar companies organized in other states, and permitting the consolidation of their franchises so as to form a continuous line of canal, connecting the waters aforesaid through one or more states.

The Committee has also introduced in the present session of the Legislature of Ohio, a bill conferring similar powers on ship canal companies organized in that state, and hopes to secure its passage, thereby providing the necessary legislation whereby, under powers conferred by the States of Pennsylvania and Ohio, a canal such as is recommended in the report of the Engineering Committee and approved by the Consulting Board can be constructed on the route proposed.

The Committee further reports that on January 13th, 1896, through Hon. John Dalzell, a Bill was presented in Congress, asking for the Government incorporation of a company to construct a ship canal, connecting Lake Erie and the Ohio River, on the route recommended through the States of Pennsylvania and Ohio.

Said Bill was referred to the House Committee on Railways and Canals, and is now pending before said Committee.

The Bill provides for the Government indorsement of a limited number of bonds, Government representation on its Board of Directors, Government approval of its plans of construction through the Secretary of War, control of its tolls through the Inter-State Commerce Commission, with limitations as to the disposition of its earnings, and providing for the Government assuming absolute control and declaring it a free Federal waterway.

WILLIAM FLINN,
Chairman.

GEO. H. ANDERSON,
Secretary.

CITIES	CANAL MILES	LAKE MILES	RIVER MILES	TOTAL MILES
ASHTABULA	128			128
BUFFALO	128	116		244
CLEVELAND	128	56		184
TOLEDO	128	146		274
DETROIT	128	147		275
CHICAGO	128	783		909
MILWAUKEE	128	116		244
MARQUETTE	128	462		590
DULUTH	128	889		1017
ALBANY	*480	120		600
NEW YORK	*480	120	100	700
NEW HAVEN	*480	190	150	820
PROVIDENCE	*480	950	100	930
TORONTO	455	120		987
MONTREAL	198	979	135	806

*Lake Erie and Ohio River and Hudson Canals.
(Lake and Long Island Sound).
Actual Distance Canal, Davis Is. Dam to Ambridge (Light House), 125.78 Miles.
From Pittsburgh (Smithfield St. Bridge), 127.98 Miles.