EIGHTY-SECOND LEGISLATURE

SENATE **No. 222**

In Senate, March 10, 1925.

Introduced by Senator Carlton of Sagadahoc under suspension of the rules and on motion by same Senator was laid on the table for printing.

ROYDEN V. BROWN, Secretary.

STATE OF MAINE

IN THE YEAR OF OUR LORD ONE THOUSAND NINE HUNDRED AND TWENTY-FIVE

REPORT of Joint Committee of the Governor and Council and Eighty-second Legislature to the Governor and Council and Eighty-second Legislature of the State of Maine upon the Proposed Locations of a Bridge over the Kennebec River in the Vicinity of Bath and Woolwich.

Pursuant to an order passed by the senate and house of representatives of the Eighty-second Legislature, January 27, 1925, and council order passed by the governor and council under like date, appointing on the part of the senate, Frank W. Carlton, senator from Sagadahoc county, and Clyde H. Smith, senator from Somerset county, and on the part of the house, Harold W. Bishop, representative from Boothbay Harbor, Arthur G. Spear, representative from Portland, and George A. Palmer, representative from Island Falls, and on the part of the governor and council, William S. Linnell of Portland and Guy E. Torrey of Bar Harbor, as a joint committee to investigate the pro-

posed locations of a bridge over the Kennebec river in the vicinity of Bath and Woolwich, and pursuant to further order passed by the senate and house of representatives on February 11, 1925, and order passed by the governor and council under like date, said last named orders requiring said committee to continue their investigations and report their findings on or before March 10, 1925, said joint committee reports that they have attended to their duties, and beg leave further to report as follows:

Pursuant to said orders of January 27, 1925, your committee proceeded to Bath on January 28th, accompanied by Mr. Paul D. Sargent, Chief Engineer of the Highway Commission, and members from the engineering staff of said Commission, and were met by Dr. J. A. L. Waddell of New York, Consulting Engineer, and his associate engineer, Shortridge Hardesty, who had drawn plans for a proposed bridge to extend from a point at or near Broad Street in Bath to Woolwich; also by Major S. C. Godfrey, District Engineer, and Major Charles F. Porter, Assistant Engineer of the United States War Department, and by Mr. G. H. Brazer of J. R. Worcester Company, Engineers, and a preliminary conference took place respecting the various locations, within reasonable distance of Bath, for crossing the Kennebec River. Preliminary information with respect to these various locations was obtained from plans, maps and charts made available for the committee and from testimony of various individuals with particular reference to navigation conditions attendant upon the construction of a bridge at the various locations. The engineers, representing the War Department, indicated that no special plans for defense in time of war or for other utilization of the harbor at Bath, Maine, by the War Department would interfere with the erection of a bridge at any of the proposed locations, but that the sole interest of the War Department would be to preserve freedom of navigation, and, while reserving the right of the War Department to decide definitely upon formal hearing, it was indicated that if testimony such as that presented at this conference should be presented at the time of any formal hearing, the War Department would undoubtedly sanction a bridge with a clearance in the channel of ten feet above high water.

The committee, accompanied by the engineers, then made a superficial survey of several of the locations by the use of the state ferry, going up the river to a point within a short distance of Winslow's Rocks, and returning, discussing en route the possibility of a bridge at Winslow's Rocks, and of a bridge across what appears to be the narrowest part of the river below Winslow's Rocks, about opposite the Texas Company shipyard. Examination of the Woolwich shore was also made. Returning to Bath, investigation was made of the approach to a bridge from the Bath end, with particular attention to the problem of the railroad approach to any bridge built at or near Broad street.

At a later conference, an attempt was made by Dr. Waddell and Mr. Hardesty to plot a railroad approach to a bridge erected further down the stream, about opposite Center street. After the completion of this conference, the entire party, excepting the engineers representing the War Department, and Mr. Brazer, returned to Augusta, where further conferences were held.

As a result of this expedition and the conferences incident thereto, information was obtained leading toward a conclusion that it might be possible to construct a bridge at or near Center street which would accommodate a railroad, that either a highway or a combined highway and railroad bridge might be constructed at or near the Texas Company yard, and that a highway bridge of a single span might be constructed at Telegraph Point, two miles or more outside the city limits of the city of Bath. The information seemed to indicate that a bridge at Winslow's Rocks would not be feasible owing to navigation difficulties. It was known that a highway bridge could be built at Telegraph Point without a draw, and it was deemed probable that such a highway bridge could be erected at or near the shipyard of the Texas Company.

Pursuant to further conferences with the engineers, the committee believed it had not obtained sufficient information to accomplish the purpose intended by the order appointing the committee, or to form a basis for legislative action for construction of a bridge across the Kennebec river. Upon the suggestion of the committee the subsequent orders herein-

before referred to were passed, the order in the house and senate providing that the committee appointed by those bodies should have authority to employ such engineering counsel as they should deem wise to obtain complete information. Pursuant to such authority, the committee of the senate and house obtained from Dr. J. A. L. Waddell a proposition for a more complete investigation and report upon the economics of a proposed crossing of the Kennebec river, which contemplated the investigation of five separate projects, including a highway bridge at Telegraph Point, further examination of the location at Winslow's Rocks, an examination of the location at or near the shipyard of the Texas Company, of a location about three-eighths of a mile below the last named location, and a crossing at or near Broad street, including in the last named project, locations in the vicinity of the railroad yard at Bath.

The committee accepted Dr. Waddell's proposition for this examination and employed him as engineering counsel upon the consideration of payment to him, to cover the services of his office force and his own fee, of $6000, plus the actual cost of his expense connected with the work that should be done outside his New York office.

Dr. Waddell proceeded immediately to his task on February 12th, completed the same as outlined in his proposition and submitted a report under date of February 24, 1925, a copy of which is hereto attached and which, with accompanying plans, is made a part of this report.

The report of Dr. Waddell indicates the elimination of Winslow's Rocks as a location, also, in his judgment, the elimination of any location between Broad street and the Bath Iron Works plant, owing to the difficulties attendant upon constructing a suitable railroad bridge. One crossing in this eliminated section is, however, shown on the plans under the title of "Skew Bridge." This bridge would be possible from an engineering standpoint, but for the reasons explained in the report of Dr. Waddell, is not considered a good engineering project.

The report further indicates the possibility of a single span bridge at Telegraph Point for highway only at a cost of $1,066,000; also the possibility of a highway bridge at what is

designated by Dr. Waddell as "The Middle Crossing," located near the yard of the Texas Company. This highway bridge could be constructed at a height sufficient to obviate the necessity for a draw or moveable span, and at a cost estimated at $1,330,000. If a railway bridge is combined with the last mentioned project, the cost is estimated to be $2,850,000. The report further indicates the feasibility of a combined railway and highway bridge crossing from a point at or near the location of the Bath Iron Works and the extreme point of Woolwich peninsular. This bridge is estimated to cost $3,056,000.

As a part of the investigation, Maine Central Railroad was invited to cooperate, with its force of engineers. Subsequent to the report of Dr. Waddell, a copy of which was furnished to Maine Central Railroad, the engineers of that company made an examination of the various locations and the general vicinity to determine where a bridge, which would most advantageously accommodate the railroad, should properly be located, with the result that a new location extending directly from the railroad yards at Bath was determined upon by the railroad engineers as more feasible for a railroad crossing. This location had not been particularly examined by Dr. Waddell for the reasons stated in a supplementary report. Upon this information being obtained, however, Dr. Waddell was again summoned to Bath, and made an examination of the location proposed by the railroad company, with the result detailed in supplementary report of Dr. Waddell, a copy of which is also attached hereto and which, with accompanying plans, is made a part of this report.

This supplemental report indicates the feasibility of a combined railway and highway bridge project from a point in the railroad yards some four hundred feet above the lowest crossing described in the earlier report of Dr. Waddell, and reaching the Woolwich shore at a point considerable above the extreme end of the peninsular, and indicates that such a bridge could be constructed at a cost of approximately $2,954,000.

Subsequent to the receipt of this last named report, conferences took place with President Morris McDonald and the engineers of Maine Central Railroad, with the result, as appears by the supplemental report of Dr. Waddell, and by the

report of the railroad company, a copy of which is hereto attached and made a part of this report, that engineering counsel for the committee and the engineers of the railroad company seemed to agree upon the mutual advantages to the state and the railroad company obtainable by constructing a combined highway and railroad bridge at the location suggested by the railroad company. They believe such a bridge practical and that it can be constructed at a cost estimated not to exceed three million dollars ($3,000,000).

A proposition for financing the cost attributable to that part of such a bridge constructed primarily for the use of the railroad, as distinct from a highway bridge, was evolved and proposed, all as appears in the report of said Maine Central Railroad, a copy of which is hereto attached.

The report of the Maine Central Railroad indicates the approval of the railroad of the location described in the supplemental report of Dr. Waddell. It further indicates a willingness of the railroad company to enter into a contract with the state providing for the payment to the state of a rent for the structure if the initial financing is done by the state, which will be equivalent to four per cent interest on fifty-five per cent of the total cost and the amortization of the sum represented by fifty-five per cent of the total cost, over a period of fifty years, by means of a two per cent sinking fund. This combined sum for interest and amortization would be approximately seventy-six thousand dollars ($76,000). To this is to be added an amount representing the total cost of operation of the draw or moveable span and fifty-five per cent of the annual maintenance expense exclusive of the expense of maintenance of the railroad approaches, ties, and tracks, which is to be assumed by the railroad company, and also exclusive of the concrete highway slab which is to be assumed by the state, but the combined cost of operation of the draw and fifty-five per cent of maintenance cost, except as aforesaid to be paid by the railroad company to the state, shall not be less than fifteen thousand dollars ($15,000) in any year, with suitable provision for equitable credits to the railroad company for amounts by which said fifteen thousand dollars ($15,000) shall exceed actual cost of operation and maintenance in any year.

The combined rental, therefore, would be not less than ninety-one thousand dollars ($91,000) per year for fifty years and fifteen thousand dollars ($15,000) per year thereafter, based upon an estimated cost of three million dollars ($3,000,000). If the cost to the state is less than three million dollars ($3,000,000), that part of the rent applicable to interest and amortization would be accordingly reduced in amount but not in percentage.

Your committee begs leave for further time to supplement this report with a report of the cost of the services of said engineering counsel and such other supplementary matters as may come to its attention growing out of the proceedings in the matter.

Respectfully submitted,
WILLIAM S. LINNELL,
Committee of the Governor and Council.

Committee of the Senate and House of Representatives
F. W. CARLTON,
CLYDE H. SMITH,
Of the Senate.

HAROLD W. BISHOP,
GEORGE A. PALMER,
ARTHUR G. SPEAR,
Of the House of Representatives.
March 10, 1925.

NOTE: Mr. Guy E. Torrey of the committee from governor and council attended all investigations and conferences, examined the reports of Dr. Waddell, is familiar with the information contained in the report of the Maine Central Railroad and of the subject matter of the above committee report and approves the same. Being called suddenly from his duties on the committee and being unavoidably absent at the time of presentation of report, he was unable to sign the same.

REPORT Upon the Economics of a Proposed Crossing of the Kennebec River in the City of Bath, Maine—Prepared for Joint Committee of Governor and Council and Legislature of State of Maine by Dr. J. A. L. Waddell, Consulting Engineer, February 25, 1925.

SYNOPSIS

Six proposed crossings were examined and three of them were rejected because of undue expense and other good and sufficient reasons.

Six layouts, economic studies, and detailed estimates of cost were prepared and are submitted in the report.

Railroad surveys, with cross-sections, were made and the locations determined by contour lines for three approaches, the total length of line thus surveyed being nearly three miles.

A landing plaza in Bath for the entrance to the highway approach to the suggested bridge at the Middle crossing was laid out, and a contour map thereof was plotted, so as to compute its cost and show its connection to Washington street.

An accurate triangulation was made of the river between the Middle crossing and the Lowest crossing; for the reason that no reliable maps of that area were obtainable.

Some solid-rod borings were put down in an unsuccessful attempt to determine the locations of bed-rock and to obtain some idea of where it pitches off suddenly, as shown by the profile of the wash borings made in 1923 by another engineer for the proposed crossing at Broad street.

A careful valuation was made of the property damages and the right-of-way for the railway approach through the residence district of Bath to the bridge at the Middle crossing, the amount, with a liberal allowance for contingencies, being $25,000.

Ten sheets of drawings were prepared to record the findings of this economic investigation and to illustrate the report.

The cost estimates of the four layouts worthy of serious consideration are as follows:

Location	Character of Bridge.	Cost of Bridge Proper	Cost of Entire Project
Telegraph Point.	Highway Bridge.	$916.000	$1,066,000
Middle Crossing.	Highway Bridge	1,275,000	1,330,000
Middle Crossing.	Combined-Railway-and-Highway Bridge	2,420.000	2,850,000
Lowest Crossing.	Combined-Railway-and-Highway Bridge	2,944.000	3,056,000

A comparison is made of the two proposed highway crossings, and a recommendation is offered in favor of the one at the Middle Crossing, because of the superior service it would afford to the citizens of the City of Bath and those of the Town of Woolwich.

A comparison is made of the combined-railway-and-highway bridges at the Middle Crossing and the Lowest Crossing, and all the pros and cons are stated; but no recommendation as to selection of site is offered, as that is a matter to be determined by conference between the State and the Railway Company.

No suggestion is offered as to the policy of building a combined-railway-and-highway bridge or a highway bridge pure and simple; because that is a question to be settled by the Governor and the Legislature.

Under the assumption that a combined-railway-and-highway bridge is to be built, operated, and maintained by the State and used by the Maine Central Railway Company, a computation is given as to what, in equity, the said Company should pay the State anually for the use of the structure, the amounts found being $73,000 for the Middle Crossing and $109,000 for the Lowest Crossing.

A suggestion is offered in respect to an improvement in the type of bridge originally selected, viz., the substitution of concrete footwalks for the plank ones, at an additional expenditure of $70,000.

Respectfully submitted,

J. A. L. WADDELL,
Consulting Engineer.

J. A. L. WADDELL, D.E., LL.D.
CONSULTING ENGINEER
150 BROADWAY
NEW YORK

THE HON. R. O. BREWSTER,
GOVERNOR OE MAINE,
Augusta, Maine.
Sir:

Bath, Maine
February 24, 1925.

In accordance with your instructions, given me by Long Distance Telephone on the 11th inst., I proceeded immediately with my Resident Engineer, Mr. R. S. Moore, to Bath, and early on the morning of the 12th we started work by looking over the ground, arranging for a launch and skiff with the paraphernalia required therefor, outfitting an office in the King Tavern, and making other necessary arrangements.

Two of my engineering force arrived that evening; and the next morning we obtained another man, as general helper, and made the survey for the West Railway Approach to the Middle Crossing. (See Sheet No. 1.)

That evening I telephoned Mr. P. D. Sargent, State Highway Engineer, and obtained from him the services of two experienced fiield engineers, who arrived on the night of Sunday, the 15th inst.

On Saturday forenoon I made a reconnaissance of the river by launch as far up as Telegraph Point, and examined both banks at all proposed crossings. This trip convinced me of the futility of considering the building of a bridge at Winslow's Rocks, my reasons for that conclusion being as follows:

A. Owing to the swiftness of the current in the channel at this place, a movable span would be dangerous for navigation, as vessels could not readily stop and cast anchor, in case the said movable span should fail to function on time.

B. On this account a combined-railway-and-highway bridge could not be built there, as the high climb would be uneconomic for the railroad, in respect to both first cost and expense of operation.

C. Owing to the great width of the river at that place, a high-level highway-bridge would be altogether too expensive,

notwithstanding the possibility of utilizing some of the "Rocks" for pier foundations.

On the afternoon of the 15th, my party triangulated the River at Telegraph Point and started the survey for the approaches, which work was finished next day by the augmented party.

On the 16th I telephoned Mr. Sargent, asking for an experienced draughtsman, who arrived that night. That day the party triangulated the river at the Middle Crossing; and the next forenoon they did some work on the survey for the railroad line thereto on the East side of the river. In the afternoon a triangulation of the River in the City of Bath between the Middle Crossing and the Lowest Crossing was begun. This proved to be necessary, because I could find no reliable map, on a sufficiently large scale, showing both sides of the river with banks, streets, and wharf lines. The small contour maps of the Federal Government proved to be absolutely unreliable.

On the 18th the party resumed work on the survey for the East railroad approach at the Middle Crossing; but on plotting the records that night I found the land to be much higher than I expected; and, by means of two lines of levels that had been run and plotted, I indicated a variation of the route and its continuation to grade at a point on the existing railway.

This day's work convinced me of the futility of a project that I had had in mind for two and a half years, viz., running the western railroad approach by means of a rather sharp curve from the end of the west main span of the Middle Crossing down along and close to the bluff, so as to join the existing railway track on Front Street, and by it to reach, via Commercial Street, the depot of the Maine Central Railroad. Of course, it would be feasible to make such a connection; but it would involve, with standard compensation, a grade of fully two per cent. This would undoubtedly be objectionable to the Railroad Company, because it would probably necessitate the use of pusher engines for trains of ordinary length.

On the 19th inst., the party started *de novo* from the river bank on the survey for the before-mentioned railway approach,

and finished it on the 21st. On the same day the triangulation of the river also was completed.

On the 20th I took on another field engineer to relieve one of the members of the party for the purpose of having him aid in the drafting.

On the 22nd I made a valuation of property damages and right-of-way cost in Bath for the Railway Approach to the Middle Crossing. Senator Carlton went with me; and I was fortunate enough to secure the aid of Mr. Albert L. Strout, a citizen of Bath who was born and has spent all his life there. He is well posted on both land and building values; and I was able to make, with his aid, an authentic, but liberal, estimate of cost for this item of expense.

On that day the party completed the survey for the new line of railroad to pass around Woolwich, excepting only the making of a few cross-sections by hand-level for the plotting of contour lines. These were finished the next forenoon.

The 23rd was spent by the field party in attempting to make rod-borings to bed-rock near the two ends of the Lower Crossing, in order to determine how far out into the stream the shallow ledges thereof extend, but in this they were unsuccessful, as the rock was too far down to be reached by this method of boring; the draftsmen practically completed all the drawings; and I put the finishing touches on this report, enabling the party to disband on the 24th inst., and me to go to Augusta to have the said report type-written, and its accompanying blue prints made for presentation on the 25th—just two weeks after I was retained to do the work.

The fact that this job was finished in such an unprecedentedly short time must not be taken by anyone as an indication that the work was slighted, or that any needed investigation was omitted. There were three main causes for the work's being done so expeditiously, viz.

First. Exceptionally good weather after the 12th inst., until the last day of the fieldwork, when it rained.

Second. An unusually fine body of young, intelligent, and energetic engineers serving under a first-class Chief of Party.

Third. Continuous work, not only by myself but by all the others, from the morning of the 13th until noon of the 24th,

from 7.15 A. M., till 10.30 or 11 P. M., the fieldmen working in the evenings on the plotting of survey notes taken during the day.

While the field-work was being done I spent most of my time, day and night, working on economic studies and estimates for the various crossings; but reserving enough of it to locate on the ground the highway and railway approaches in Bath for the Lower Crossing, and a Plaza for the highway entrance to either the Highway Bridge or the Combined-Railway-and-Highway Bridge near the West end of the structure at the Middle Crossing. This Plaza, which occupies some vacant ground, fans out into Washington Street between Edward and Beacon Streets, its elevation being about that of the grade of Washington Street near its junction with Beacon Street, where there is a level stretch about eighty-six feet above High Water. I had this vacant ground laid out into twenty-five-foot squares, and elevations taken at the corners thereof, so as to prepare the accompanying contour map and to compute the amounts of excavation and fill. This design will necessitate a small stiffening of the grade on Washington Street in the vicinity of Edward Street, and will involve the removal of a very small and inexpensive dwelling. There would be no other property damages involved by this Plaza; but, of course, the vacant lot would have to be purchased.

All told, I have determined the economic layouts and have estimated the costs for six bridges, viz:

No. 1. Highway Arch Bridge at Telegraph Point.

No. 2. Highway Cantilever Bridge at the Middle Crossing.

No. 3. Combined-Railway-and-Highway Bridge at the Middle Crossing.

No. 4. Combined-Railway-and-Highway Bridge close to the site chosen by Senator Carlton near Broad Street.

No. 5. Combined-Railway-and-Highway Bridge on a decided skew passing from a point on the Woolwich shore just below the State Ferry-Slip, and joining one of the curved tracks of the Maine Central Railway at a point a little above its Ferry-Slip on the Bath shore.

No. 6. Combined-Railway-and-Highway Bridge running from the extreme southerly point of the peninsula on the East

shore to a point between the northern end of the main shop of the Bath Iron Works and the slip occupied by the spare ferry boat of the Maine Central Railway Company. This crossing was suggested to me by Mr. W. H. Norris, the Bridge Engineer of that system, who selected it two years or more ago.

Accompanying this report are ten blue-print sheets, as follows:

Sheet No. 1. Map of the Kennebec River showing all the Proposed Locations for the Bridge.

Sheet No. 2. Layout for a Highway Arch-Bridge and its Trestle Approaches at Telegraph Point.

Sheet No. 3. Layout for a Cantilever Highway Bridge and its Trestle Approaches at the Middle Crossing.

Sheet No. 4. Layout for a Combined-Railway-and-Highway Bridge with a Vertical-Lift Span at the Middle Crossing.

Sheet No. 5. Layout for a Combined-Railway-and-Highway Low-Level Bridge with a Vertical-Lift Span at the Lowest Crossing.

Sheet No. 6. Triangulation Map of the Kennebec River at Bath, showing Pier Locations for the Carlton, Skew, and Lowest Crossings, also Streets and Wharves on both sides of the River.

Sheet No. 7. Plan and Profile of Approaches to a Combined-Railway-and-Highway Bridge at the Middle Crossing.

Sheet No. 8. Plan and Profile of East Approach to the Combined-Railway-and-Highway Bridge at the Lowest Crossing.

Sheet No. 9. Contour Map of Plaza for a Highway Landing in the City of Bath at the Middle Crossing.

Sheet No. 10. Cross-Sections of Bridge Floors for various Types of Span.

In preparing my estimates of cost, I assumed the following governing conditions:

Live Load for Railway, Class 60 of my "Bridge Engineering".

Live Load for Highway, Class B of the same.

Intensities of Working Stresses, as given in the Specifications of that treatise, excepting that for the silicon steel, to be used in the trusses, I have stressed the metal about fifty

per cent higher than indicated therein for ordinary carbon steel.

Roadway twenty (20) feet wide in the clear, and two sidewalks each five (5) feet wide in the clear. Roadway to be covered with either concrete or bitulithic pavement resting on a reinforced-concrete slab. Sidewalks to be of reinforced concrete in the case of a highway bridge, or of planks in the case of a combined-railway-and-highway bridge. This plank flooring for the foot-walks was prescribed over two years ago by Senator Carlton when my office made the preliminary study and estimate of cost for him, based upon the borings at the Broad Street Crossing. I would greatly prefer to make these footwalks of reinforced concrete; and, if it be decided to build a combined-railway-and-highway bridge, and if I be retained as your engineer to design it and supervise its construction, I shall advise your giving serious consideration to the making of this change. It would involve an additional expenditure of some $70,000; but the improvement would be well worth the money. One great advantage that it possesses is that it would do away with the necessity of insuring the structure against injury by fire, for the reason that there would be nothing in it that could burn. This alone would be worth the $70,000. expenditure; because it is not likely that any insurance company would insure the bridge having wooden sidewalks for as small a premium as $3,500. per annum.

All piers to be of plain concrete, properly protected by granite facing where subject to erosion from ice.

Unit prices for all materials in place are those governing today, excepting that in certain cases an additional allowance for a prospective rise has been made.

Limiting grade for railways, one and a half per cent.

Ditto for highway trestles and spans, five per cent.

Ditto for highways on ground, seven per cent.

Limiting curves for railway, eight degrees.

All curves on steep grades to be compensated on the basis of 0.04 per cent for each degree of curvature, so that after

adding the correction to the rate of grade the sum shall never exceed one and a half per cent.

My estimates of cost for the six suggested layouts are as follows:

ARCH HIGHWAY BRIDGE
TELEGRAPH POINT CROSSING.

Arch Span and its Pedestals,	$520,000
Steel Trestle, 2000 ft at $145,	290,000
Buried Piers, 2 at $5,000	10,000
Rock Fill, 3,000 cu. yds. at $3.00	9,000
Pavement on embankment, 1,200 sq. yds at $3.30	4,000
Summation,	$833,000
Engineering and Contingencies, 10%	83,000
Total Cost of Bridge and Trestles,	$916,000
Highways to Connect with main routes of travel	150,000
Grand Total Cost of Project	$1,066,000

CANTILEVER HIGHWAY BRIDGE
FOR
MIDDLE CROSSING.

Three River Spans, complete,	$533,000
Main Piers, 2 at $194,000	388,000
Anchorages, 2 at $40,000	80,000
West Trestle Approache,	102,000
East Trestle Approach,	47,000
Retaining Walls,	4,000
Embankments,	5,000
Summation,	$1,159,000
Engineering and Contingencies, 10%,	116,000
Total Cost of Bridge Proper,	$1,275,000
Plaza and Land therefor,	20,000
traveled route,	35,000
Grand Total Cost of Project,	$1,330,000

Highway at East end to connect with main

N. B. Owing to the uncertainty regarding the location of bed-rock at this crossing there will be a possible plus or minus variation of $70,000 in the grand total cost.

COMBINED-RAILWAY-AND-HIGHWAY BRIDGE
FOR
MIDDLE CROSSING.

Superstructure of Main Spans, complete with Vertical-Lift Span, its Machinery and Accessories,	$1,102,000
Main Piers, 3 at $231,000 (average)	693,000
Side Piers,	25,000
Trestle Approaches,	360,000
Buried Piers and Embankments,	20,000
Summation,	$2,200,000
Engineering and Contingencies, 10%,	220,000
Total Cost of Bridge Proper,	$2,420,000
Western Railway Approach,	105,000
Eastern Railway Approach,	190,000
New Depot on the Bath Side,	25,000
Plaza,	20,000
Extras for Tunnel under Plaza and Washington St.,	30,000
Highway Connection for main route of travel,	35,000
Bath Property damages by railway and right-of-way therefor,	25,000
Grand Total Cost of Project,	$2,850,000

N. B. As this estimate is based upon an assumed elevation of bed-rock there will be a possible plus or minus variation of about $100,000 in the grand total cost.

COMBINED-RAILWAY-AND-HIGHWAY BRIDGE
FOR THE
CARLTON CROSSING.

Superstructure of Main Spans, complete, with Vertical-Lift Span, its Machinery and Accessories,	$1,462,000
Main Piers, 6 at $203,000,	1,218,000

Eight Small Piers,	192,000
U-Abutments and Filling,	10,000
Property Damages,	40,000
Summation,	$2,922,000
Engineering and Contingencies, 10%,	292,000
Total Cost of Bridge Proper,	$3,214,000
New Railway Track,	9,000
Excavation in Woolwich,	18,000
Highway in Woolwich,	4,000
Grand Total Cost of Project,	$3,245,000

Strictly speaking, there should be an additional item to cover the three hundred feet of wharf space ruined by the curved approach in the river; but I understand that this property is owned by the City and the Railroad Company, and that, consequently, there would be no damages claimed thereon.

COMBINED-RAILWAY-AND-HIGHWAY BRIDGE
FOR THE
SKEWED CROSSING.

Superstructure of Main Spans, complete, with Vertical-Lift Span, its Machinery and Accessories,	$1,431,000
Substructure of Main Bridge,	1,390,000
Trestle Approaches,	91,000
U-Abutments and Filling,	10,000
Property Damages,	20,000
Summation,	$2,942,000
Engineering and Contingencies, 10%,	294,000
Total Cost of Bridge Proper,	$3,236,000
New Railway Track,	9,000
Excavating in Woolwich,	18,000
New Highway in Woolwich,	4,000
	$3,267,000

If the piers be placed parallel to the current, there will be

involved thereby an additional cost of $125,000, making the Grand Total Cost of Project, $3,392,000.

COMBINED-RAILWAY-AND-HIGHWAY BRIDGE
FOR THE
LOWEST CROSSING.

Superstructure of Main Spans complete, with Vertical-Lift Span, its Machinery and Accessories,	$1,279,000
Piers 2 at $15,000,	30,000
Piers 1 at $5,000,	5,000
Piers 1 at $180,000,	180,000
Piers 5 at $208,000, (average)	1,040,000
Trestle Approaches,	117,000
U-Abutment and Filling,	5,000
Property Damages,	20,000
Summation,	$2,676,000
Engineering and Contingencies, 10%,	268,000
Total Cost of Bridge Proper,	$2,944,000
Highway Construction on Woolwich Side,	17,000
Railway Approach on same,	75,000
New Railway Track and Rock Fill in Bath,	20,000
Grand Total Cost of Project,	$3,056,000

It is possible, of course, that there is a greatly different bed-rock-profile at this crossing from that found near the line of Broad Street; but I doubt that the variation of cost, either up or down, due to that difference would amount to as much as $25,000; and it is my opinion that the expense for piers would be reduced rather than augmented.

CONCLUSIONS FROM RESULTS OF COMPUTATIONS.

Comparing the two highway-bridge projects, the total expenditure for the arch structure at Telegraph Point, is $1,066,000 as against from $1,260,000 to $1,400,000 for the cantilever structure at the Middle Crossing. In respect to æsthetics, there is not much choice between the two layouts, for either structure would have an exceedingly fine appearance;

and from this standpoint many more people would be likely to see the one in Bath than the one two miles further upstream.

In my opinion, the difference of approximately a quarter of a million dollars in the costs of these two structures is more than offset by the greater convenience to the citizens of Bath and Woolwich. In fact, with the bridge located at Telegraph Point and the State Ferry abandoned, the only means for crossing the River for the people of Woolwich would be the irregularly-run ferry of the Maine Central Railway.

Comparing the four layouts for combined-railway-and-highway structures, the choice would be between the Middle Crossing and the Lower Crossing; because the other two are not only more expensive but are seriously objectionable. The Carlton Crossing involves a small skew, and an eleven-and-a-half-degree curve out in the river, reversing without any intermediate tangent to a twelve-and-a-half-degree curve on the shore. Such a combination of curvature would be likely to cause derailments and would necessitate at all times very slow speed over the structure. Again, the total destruction of 300 feet of wharfage, which it involves, might be considered a rather serious matter.

The skew crossing is objectionable, primarily on account of its length and cost; but, as stated over a quarter of a century ago in the chapter on "First Principles of Designing" in my little treatise "De Pontibus", "The Building of a Skew-Bridge Should Always be Avoided When it is Practicable."

In my opinion, the War Department would not permit the piers of this structure to be constructed at right angles to the bridge tangent, but would require them to be placed as nearly as may be, parallel to the current of the river. This, as previously indicated, would involve an additional expenditure of about $125,000.

Again, the approaches to this crossing are not as easy in operation as those of the Lowest Crossing.

There is a matter of some import in comparing the two intermediate crossings with those immediately above and below, viz., that during the construction of either of the former bridges, the railway ferry-boats would have to cross a number of times per day the new bridge tangent, thus causing trouble to both the ferry operators and the bridge builders. This is a

more serious matter than, at first thought, one is liable to deem it.

Comparing finally the combined-railway-and-highway-bridge layouts for the Middle Crossing and the Lowest Crossing, there is not much to choose from, as far as first cost is concerned. The difference of some $200,000 in my estimates is not as certain as it would be, were borings to bed-rock made at both crossings; moreover, the possible variation I have indicated might cut this difference down to $100,000.

The Middle Crossing possesses the following advantages over the Lowest Crossing:

A. A comparatively small saving in the total first cost of structure and approaches.

B. A location above nearly all the shipping in the harbor of Bath.

C. A vertical clearance when the lift-span is down, sufficient to pass all river craft, so that the said span would have to be raised only for ocean-going vessels, thus interfering very little with the passage of trains, vehicles, and pedestrians.

D. The affording of a detour around the business centre of Bath for tourist travel. At present the people of that city seem to consider this feature as a detriment; but experience in the Middle West and on the Pacific Coast has shown that the running of tourist automobiles and freight trucks over the main streets of a city is an unmitigated nuisance, as well as a source of danger to the inhabitants, a vexation to the drivers, and an added expense for city government, by reason of increased wear on the pavements and extra policing, in order to ensure against vehicles exceeding the safe speed-limit.

On the other hand, there are the following detriments:

a. Injury to the best residential property of the City of Bath because of the noise and smoke of railroad trains.

b. Climbing by each railroad train and descending an additional vertical distance of forty (40) feet, thus increasing for all time the cost of operating the railway.

c. Transfering the railway station fully a mile from the business centre of the city.

d. Necessitating the delivery of all freight to the business

centre of Bath by means of a branch road instead of from the main line as at present.

e. Causing the people of Woolwich to travel an extra two miles in going to Bath and in returning therefrom.

f. The immediate expenditure by the Maine Central Railroad Company of a large amount of cash (some $375,000) for the building of its approaches, while by the Lowest Crossing the amount would be only $100,000. Considering the present financial condition of the said railroad company, this item might have an important bearing upon the selection of the bridge location.

The preceding pros and cons should be given due consideration by both the State and the Railway Company, and then a decision should be reached by mutual agreement.

There is an economic question still to be settled, that might be thought by some people as not coming within the scope of my duty when making this report; but I have given the matter serious consideration and have reached the conclusion that it does pertain to my province. I refer to the question of how the cost of a combined structure should be divided between the State of Maine and the Maine Central Railroad Company.

Comparing the cost of the highway bridge at the Middle Crossing with that of the combined bridge at the Lower Crossing, we have, respectively, $1,330,000 and $3,056,000. To the latter, however, must be added the equalized first cost of annual expense due to operation of the movable span and the repairs to its operating machinery, which would not be less than $6,000 per annum. For this, at five per cent. the equivalent investment is $120,000. Adding this to the $3,056,000 makes $3,167,000. One half of this is $1,588,000 as against the cost of a highway bridge alone, viz., $1,330,000. It is evident, therefore, that, in equity, the Railroad Company ought to pay somewhat more than one-half the cost of the combined bridge. It may be more equitable to throw out of consideration all costs other than those of the "Bridges Proper", i. e., letting the State pay for the highway approaches, property damages, etc., and the Railway Company take care of the costs of its approaches, property damages, etc. In that case the comparing figures would be $1,275,000 and $3,042,000. It is evident that either set of figures may be used in making the comparison without

involving an error of any magnitude, and that the proportionate cost-figures are 42 and 58.

Comparing the costs of the highway bridge and the combined bridge at the Middle Crossing, we have the following figures: $1,330,000 and $2,850,000 to which must be added, as before, $120,000, making $2,970,000. The reduced comparing figures in this case are $1,275,000 and $2,540,000. For this the proportionate cost-figures are 45 and 55 on the first basis and 50 and 50 on the second basis.

In case the Lowest Crossing be adopted for a combined bridge, the Railway Company's annual payment to the State if the latter furnishes the money for building, should be figured thus:

Five per cent. interest on $3,000,000	$150,000
Annual cost of operation, maintenance, repairs, and minor replacements,	21,000
Annual cost of administration, say,	9,000
Total Annual Expense	$180,000

Of this the Railroad Company, as before indicated, should pay 58 per cent. or $104,500.

In case the Middle Crossing be adopted for a combined bridge, the corresponding figures are as follows:

Five per cent. interest on $2,400,000	$120,000
Other annual charges, as before,	30,000
Total Annual Expense,	$150,000

Of this the Railroad Company, as previously indicated, should pay 50 per cent. or $75,000.

There is an item of expense, that hitherto has very properly been omitted from consideration in these estimates, viz., "Interest during Construction"; because, on Government work, that item is not usually considered. For the Lowest Crossing its amount would be $150,000 and for the Middle Crossing $120,000. The interest on these sums are $7,500 and $6,000. The Railroad Company's share of these charges would be, respectively, $4,500 and $3,000. Adding these to the previous figures gives $109,000 for the Lowest Crossing and $78,000 for the Middle Crossing.

Please note that I have not dealt herein with the question

of retirement of the bonds by either the State or the State and the Railway Company jointly.

Trusting that this report will meet with your approval and will serve the purpose intended,

I remain, with great respect

Yours faithfully,

J. A. L. WADDELL,
Consulting Engineer.

SUPPLEMENTARY REPORT
UPON THE
ECONOMICS
OF A
PROPOSED CROSSING
OF THE
KENNEBEC RIVER
IN THE
CITY OF BATH, MAINE.

PREPARED FOR
JOINT COMMITTEE OF
GOVERNOR AND COUNCIL
AND LEGISLATURE
STATE OF MAINE
BY

DR. J. A. L. WADDELL
CONSULTING ENGINEER

Mar. 5, 1925.

J. A. L. WADDELL, D.E., LL.D.
CONSULTING ENGINEER
150 BROADWAY
NEW YORK

The HON. R. O. BREWSTER,
GOVERNOR OE MAINE,
Augusta, Maine.

Bath, Maine,
March 5, 1925.

Sir:

In accordance with your instructions, telegraphed me by Mr. Linnell on the morning of the 2nd inst., I proceeded that evening to Bath with my former Chief of Party, Mr. Moore, and met there early the next morning Mr. Morrill and a party of six surveyors from the Maine Central Railway, also Mr. Metcalf of the State Highway Department, who had aided me previously with the preparation of the plans that accompanied my Report.

The object of this meeting was to survey a site for the proposed combined-railway-and-highway bridge, suggested by the Railroad Company, located on the Bath side some four hundred feet above my Lowest Crossing. As this line cuts the existing yards longitudinally into two parts by an embankment, I had not considered such a possibility; but had skirted around the said yards with both the railway and the highway approaches to the Lowest Crossing.

After determining the location of the new bridge-tangent, we proceeded to tie it onto our old triangulation system, and to make a survey for a railway line to cut through the peninsula on the Woolwich side and tie onto the line that we had previously surveyed around the periphery of the said peninsula. We also made a survey in Bath for the line of the highway approach.

At first it was my intention to have a plaza with ticket-selling booths at each end of the bridge; and I had laid out the one for the Bath end by means of contour lines. Mr. Morrill, however, assures me that several important toll bridges in New England are operated satisfactorily by collecting tolls at one end only; hence I have decided to put a plaza at the Woolwich end, where the construction is cheap, and omit the ex-

pensive one in Bath. Moreover, the latter, sooner or later, would have proved to be a nuisance to both the city and the tourists, by causing stoppage of traffic whilst fares were being collected—and that in the very heart of the city.

My estimate of cost is as follows:

Superstructure of Maine Spans, complete, with Vertical-Lift Span, its Machinery, and Accessories, also Lighting and Signals,	$1,320,000
Substructure,	1,051,000
Trestle Approaches,	142,000
Retaining Walls and Fills,	10,000
Woolwich Plaza and Toll Booths,	5,000
Summation	$2,528,000
Engineering and Contingencies, 10%,	253,000
Total Cost of Bridge Proper,	$2,781,000
Highway Construction on Woolwich side,	15,000
Railway on Woolwich side,	127,000
Modification of the Bath Railway Terminal,	31,000
Grand Total Cost of Project,	$2,954,000

As the total cost of the bridge proper is well below the limit of three millions of dollars, I have taken the liberty of including in this estimate the $70,000 which I advocated in my Report to be spent for the substitution of reinforced-concrete sidewalks for the plank ones originally contemplated.

In comparing the cost of this proposed crossing with that of my Lowest Crossing, it will be necessary therefore, to add $70,000 to the latter. This indicates a saving of $172,000 on the entire project by the new layout, and one of $233,000 on the bridge proper.

An additional advantage (or, possibly, a future disadvantage) of the said new layout is that it brings all travel closer to the heart of the city.

Accompanying this Report are three blue-print sheets, numbered 11, 12 and 13, delineating, respectively, the new layout of spans and piers, the plan and profile of the railway approaches, and a plan of the highway approach in Bath. After

Sheet No. 11 was prepared, it was found necessary to carry a one-per-cent grade over the entire structure, in order to reduce to a minimum the yardage of rock-cutting in the railway approach on the Woolwich side. This grade is not indicated on the drawing.

In making a new estimated division of expense between the State and the Railway Company, I have inserted a modification that is in the line of greater exactness. It is this—while the minimum figure of annual cost of operating the vertical-lift span that I used previously, viz., $6,000 would apply properly to the Middle Crossing, where one attendant would suffice at all times, and where there would be no moving of the span during the winter season, it would require about twice that amount for either the new crossing or the Lowest Crossing, owing to the necessity for at least two sets of attendants per day.

Again, in making the comparison, I have added to the first costs of both the highway bridge and the combined bridge the proper amounts for "Interest During Construction".

Upon this basis I figured the comparing equivalent total costs to be $1,400,000 and $3,170,000, of which the ratio is 0.442, showing that the rate of division should be 44.2 per cent and 55.8 per cent.

Assuming that the bond issue would be $3,000,000, in order to take care of interest during construction, the annual expense, as before, would be as follows:

Interest,	$150,000
Operation, Maintenance, Repairs, etc.,	21,000
Administration,	9,000
Total,	$180,000

Fifty-five and eight tenths per cent of this is $100,400, or, say, an even $100,000 per annum.

Please note that the $9,000 per annum allowed for administration does not cover the cost of collecting the tolls, as this is a matter in which the Railway Company is not concerned.

Let me again call attention to the fact that, in neither this Report nor its predecessor, have I dealt with the question of

the retiring of the bonds by either the State or the State and the Railway Company jointly. That is a matter to be taken up and settled by the two interested parties.

In respect to the correctness of the bed-rock profile that I have used, I would say that I do not believe the depths to bed-rock at this crossing can vary materially from those found by the borings located only a short distance up-stream—in fact, from all that I could see and learn, the conditions in this particular are likely to prove somewhat better than those found above.

In conclusion, I would state that I am well pleased that the feasibility of adopting this new crossing was indicated by the Railway Company; for, without the initiative coming from it, I never could have suggested such a drastic division of its terminal yards as is now contemplated. The new line is an improvement on the old one in regard to both railway and highway traffic, is exactly at right angles to the channel of the river, saves some five hundred feet of railway line, is somewhat cheaper in respect to first cost, and causes the least possible interference with the ferry-boat navigation during the construction of the bridge.

Very respectfully yours,
J. A. L. WADDELL,
Consulting Engineer.

MAINE CENTRAL RAILROAD COMPANY
OFFICE OF THE PRESIDENT

Portland, Maine,
March 10, 1925.

To the Special Joint Committee of the
Legislature and Executive Council of
the State of Maine:

In accordance with your request, the representatives of this Company have examined the several suggested locations for a combination highway and railway bridge across the Kennebec River between Bath and Woolwich and are of the opinion that the location described in the supplemental report of your engineer, Mr. J. A. L. Waddell, dated March 5, 1925, is the one best suited for this purpose.

In reply to your further oral request that this Company state the terms and conditions upon which it would participate in the

expense of construction and use of a bridge erected at this point, the following proposal is respectfully submitted.

If the State of Maine shall decide to construct a combination bridge at this location for highway and railroad uses, at a cost not exceeding $3,000,000 including both highway and railway approaches, substantially in accordance with the plan and design of Mr. Waddell, accompanying his said supplemental report, the Maine Central Railroad Company would be willing to acquire an interest in such bridge and share the cost of construction in the proportion of 55% to the Maine Central Railroad Company and 45% to the State of Maine, substantially as recommended by your engineer. The payment of its proportion of such cost would be made by the Railroad Company to the State in semiannual installments as hereinafter set forth, and the expenses of operation and maintenance of such bridge would be apportioned and paid in the following manner:

The Railroad Company would pay its proportion of the cost of the bridge, namely $1,650,000, by making semiannual payments over a period of fifty years, after the bridge shall be open and ready for use, it being assumed that the State would provide for the construction of the bridge by an issue of bonds, with suitable callable provisions, to be retired through the operation of a sinking fund. The payments proposed to be made by the Railroad Company have been computed to produce an amount which would discharge the debt of $1,650,000 and interest thereon at the rate of 4% per annum, in one hundred equal payments during a period of fifty years. This semiannual payment would be $38,284.95 or, $1,650,000 multiplied by .023203.

The cost of maintenance to be apportioned as follows:

The Railroad to maintain ties and track structure, also its own approaches;

The State to maintain concrete slab and highway approaches. The maintenance repairs to main steel and masonry structures and draw operating machinery to be divided between the Railroad and the State on the same basis as the cost of bridge;

The Railroad to pay the wages of draw tenders, cost of electric current, and other incidental expenses of operating the draw;

The Railroad to make an annual payment of $15,000 from which the cost of operating the draw is to be deducted and the accumulated balances of such payments applied to its proportion of the cost of maintenance as aforesaid.

If the final cost of the bridge, when completed, is less than the estimate of $3,000,000, the amount to be paid by the Railroad Company toward the cost of the structure is to be proportionately reduced.

The foregoing terms and conditions, with necessary details and such additions and modifications as may be mutually agreed upon, are to be embodied in a contract between the Railroad Company and the State to be executed prior to the construction of the bridge.

Respectfully,

MORRIS McDONALD,

President.