SOME ENGINEERING FEATURES OF THE OLD NORTHAMPTON CANAL*

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The story of the Northampton Canal is a very important, albeit unwritten, chapter in the history of transportation in New England. The source material, however, apparently is very scanty and widely scattered; this seems particularly true of that phase with which this Society is particularly interested, the engineering. In the following pages is the result of an effort to assemble some of the engineering facts, with an introductory outline of the history of the project, as a necessary background; this limitation accounts for the omission of reference to James Hillhouse, Joseph Sheffield and others whose parts were not in the engineering field.

ACKNOWLEDGMENTS.

Only through the courtesy and assistance of a large number of persons has it been possible to secure access to some of the records, and the author is particularly indebted to The Connecticut Historical Society; Mr. Fred E. Dayton; Professor Henry W. Farnam; The Forbes Library, Northampton; Miss Frances Fowler; Mr. George S. Godard; Professor R. S. Kirby; The New Haven Colony Historical Society; The New Haven Public Library; The New York, New Haven and Hartford Railroad Company; Mr. Russell C. Parsons; The Sterling Library, Yale University; The Village Library, Farmington; and the Yale Art School, and both Society and author are much indebted to the New Haven *Register* for the loan of the majority of the cuts used.

BRIEF OUTLINE OF PROJECT.

The Northampton Canal was one of a number of similar canal projects, which, while of great benefit to the communities they served, were sorry investments for the early stockholders. Unlike many of those other projects, however, it was a wisely conceived scheme to meet a real need; there was every reason to anticipate a successful and profitable outcome, and the failure to realize the expected result was caused by a combination of adverse circumstances which could not have been reasonably foreseen.

Projected to give to the important traffic with the upper Connecticut

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"Public Utility Valuation," Proc. 1923.

"A Modern Power Network," Proc. 1913.

"Boston-Providence R. R. Ex.," Proc. 1905.

Valley a safe and easy route to and from tidewater in place of the passage on the Connecticut River with the difficulties and dangers at Hadley Falls and the Enfield Rapids, and at the same time to furnish better means of transportation between the communities on the route, a company called the "President, Directors and Company of the Farmington Canal" was chartered at the May, 1822, Session of the Connecticut Legislature to construct and operate a canal from New Haven through Farmington to the Massachusetts boundary at Southwick, together with a branch up the Farmington Valley from Farmington through New Hartford to the Massachusetts boundary in Colebrook, looking to an eventual connection with the Erie Canal.

The next year Massachusetts chartered the "Hampshire and Hampden Canal Company" to continue the main line from Southwick to the Connecticut River just above Northampton. Considerably later Massachusetts, Vermont and New Hampshire granted rights to continue north to the Canadian border, where a Canadian group was prepared to build the last section. Had this been done there would have resulted an international waterway from Long Island Sound to the St. Lawrence River. As a matter of fact, however, although steamboat lines were operated on the upper river in connection with it, the canal never was extended above Northampton, nor was the New Hartford branch constructed.

The two original companies were in financial difficulties from the start. Subscriptions to the stock were slow and many of the subscribers failed to pay as the instalments came due, while unprecedented floods and droughts and malicious injuries caused heavy losses both during and after construction. The canal did a good business from the beginning, but both sections were subject to such extraordinary expenses that by 1836 they were hopelessly in debt. As the only means of saving anything a new organization, the "New Haven and Northampton Company" was chartered that year in both Connecticut and Massachusetts to take over the assets and liabilities of the original companies. The old stock was surrendered by the stockholders and the debts were adjusted as best could be done, with a loss to all concerned of roundly $1,039,000.00.

Although the new company did a large and growing business when it was in operation, the extraordinary expenses and interruptions continued, and to these troubles was added the threat of railroad competition. Realizing that the railroad was the coming means of transportation, an amendment to the charter permitting the change was obtained, and in January, 1847, work was begun on a railroad which reached Plainville in January of the next year, and while the section of the canal north of this point was kept open for some time longer, canal operation may be said to have ceased with

the close of the season of 1847. It has been estimated that, giving due credit for the saving to the railroad by use of canal property, and for the land not so used in the City of New Haven, the total loss chargeable against the canal project was $1,089,425.10.

Discussion of the possibility of building the canal was begun at least as early as 1819, but it was January 29, 1822, before definite steps were taken to determine whether or no it would be practicable to construct the waterway, and if practicable if there would be available the necessary water supply at the required elevation. On that date representatives of some seventeen interested communities met at Farmington and authorized a committee to spend one thousand dollars for the necessary investigation.

FIG. 1. BENJAMIN WRIGHT, CONSULTING ENGINEER

The committee very wisely secured the services of Benjamin Wright, then the Chief Engineer of the Erie Canal, and generally considered the leading American canal engineer of the time. Born at Wethersfield, Connecticut, in 1770, he had had a typical farm-boy's education until he was fifteen; then, after three years spent reading law and studying and practising land surveying at his uncle's in Plymouth, Connecticut, he had gone to Fort Stanwix, New York State (now a part of Rome), which then was "out in the far west." Here he made a great reputation as a land surveyor, served a brief term as a county judge, getting the title by which thereafter

he was generally called, and then, becoming interested in canals, his ability and ingenuity had eventually gained him the chief engineership of the Erie Canal. By securing his services the committee was assured both of the best available technical advice and, because of his reputation, of the confidence of the general public in his report.

Survey.

To take the necessary levels Judge Wright employed Eli Whitney Blake, later to become famous, on the one hand, as the inventor of the jaw type stone crusher, on the other, as a great mathematician. The levelling instrument Blake used was one "prepared" by his uncle, Eli Whitney, inventor of the cotton-gin, and a manuscript note in the possession of the New Haven Colony Historical Society would indicate that the levels were taken in feet, inches, and tenths of an inch.

To the committee Judge Wright reported:—

"The result of this examination is a decided opinion that the country is favorably formed for a great work of this kind."

"Comparing the quality of the soil, the convenience of stone for masonry, and the other localities through the route proposed, I think a canal may be formed for a considerable less average expense per mile, than the cost of the canals now making in the state of New York."

And he concluded, in the approved style of the time:—

"Permit me, gentlemen, to express a strong desire to see this first project of the kind in Connecticut carried into effect, and be but the incipient step to works of internal improvement that will be a lasting monument of the enterprise and intelligence of a high-minded people.

"Respectfully, Gentlemen,

"Your obedient Servant,

"Benj. Wright."

Cost.

In view of the quite general belief that the Northampton was a very costly canal it is of interest to try to check Wright's snap judgment with the actual cost, and the latter with that of some of the other canals. The loss at the time of the merger, in 1836, undoubtedly represented much more money than had gone into construction alone, but if we consider it the "original cost" the average per mile was $13,321.00. Sweet, in his "Documentary History of the New York State Canals" gives the average of all the early New York canals as $17,367.57, and that for all New England as $12,838.71, the latter being the only figure lower than that for the Northampton, while Harlow, in his "Old Tow Paths" gives the per mile cost of the Chesapeake and Delaware at $155,000.00!

Detailed Survey and Report.

Judge Wright's first investigation was but little more than a reconnaissance to develop the question of the practicability of the canal in Connecticut, and in view of the complete dependence of each section upon the other it did not seem advisable to take any further steps until the Massachusetts situation was determined. The grant of a charter in that state cleared the way, and August 21, 1823, Judge Wright started a detailed survey of the Connecticut section, with his son Henry Wright in charge in the field. The latter made a report in considerable detail as to physical conditions and construction quantities, but with the exception of "Grubbing" and a few instances where there were boulders to move, made no attempt at pricing. Judge Wright, referring to Henry Wright's report for other details, gave only quantities, which he then priced, extended, and totaled. The estimate was treated in mile long sections, but apparently for contract purposes these later were halved. The report on "Mile 21st" (the numbering being from Massachusetts line south) which is the section containing the big aqueduct over the Farmington River, is, capitals and all, as follows:—

"Mile 21st. From its commencement for 24 Chains is carried along side-lying ground of moderate declivity. At this point the two routes in the vicinity of Farmington and which may be designated as the Eastern and Western routes will diverge—the Eastern crossing Farmington River by an Embankment and Aqueduct and passing through Farmington Village—the Western passing by a Dam at about 3 miles distant—Both routes have been surveyed by the direction of the Board of Commissioners, and an estimate of both, together with a rough draft which will exhibit their general course, is herewith submitted.

The East as being the route originally contemplated will be first presented—From the point mentioned the ground rises gradually in 12 Chs to an elevation of 25 feet above the level, but in 5 Chains it will descend again to bottom, where a lock of 10 feet is located, and the Embankment across the Valley of Farmington River will then commence—From this point to the W. Bank of the River the distance is 7 Chains and the Embankment will average 13 44/100 below the Level—The earth for the Embankment can be advantageously obtained from the hill through which the canal is carried, the soil of which consists of sand and light gravel—An aqueduct of 200 feet in length, consisting of stone abutments and piers supporting a wooden Trunk (a plan of which is herewith submitted) will then be required across the Farmington River. From the Eastern extremity of the aqueduct to the commencement of the ascent on the E. side, the distance is 6½ Chains and the Embankment will average 16 75/100 below the Level and 1½ Chains further it will end. On the E. side the material can not be obtained so advantageously and the soil is not so easy of excavation.—For the residue of the distance of gentle declivity, but which presents some irregularities of surface and several chains of hard stony excavation."

The quantities for this mile as given by Henry Wright, with the prices and extensions by Judge Wright are as follows:—

17,925 yds.	Excavation (W. side easy) @	7c.....	$1,254 75
8,213 "	Do (E. side hard)	10c.....	821.30
26,606 "	Embankment (W. side)	14c.....	3,724 84
32,349 "	Do (E. side)	16c.....	5,175.84
Aqueduct over Farmington River.....			10,000.00
1 Road & 1 Farm Bridge.....			250.00
Grubbing (priced by Henry Wright, C.R.H.).....			100.00
			$21,316.73

At some later date it was decided to raise the aqueduct, lengthening it to 280 feet, and do away with the lock of this section. This change resulted in one continuous level from Granby to Southington.

Judge Wright's summation of the estimate figures, a total of $420,698.88, is almost invariably given in accounts of the canal without his highly important and significant statement immediately following his total; "Damages for Lands, Houses, &c., to be added."

Report.

The report was presented at a stockholders' meeting held April 22, 1825, and the recommendation of the Directors that work be started as soon as practicable, was adopted. Whether an attempt was made to secure one of the Wrights as Chief Engineer does not appear; at all events Mr. Davis Hurd was employed as Chief, and his brother Jarvis as Assistant.

Davis Hurd, born April 12, 1788, at Arlington, Vermont, like Benjamin Wright was a farmer's boy, and had only a country school education. When he was twenty-three he moved to Scipioville, New York, and for three years with his brother Marshall had a shoemaking shop, then, shop and stock having been destroyed by fire, he turned to civil engineering and in 1820 was appointed Resident Engineer on the Erie Canal with headquarters at Lockport. It seems probable that Judge Wright, his superior, recommended him to the Farmington Company. Of Jarvis the History and Genealogy of the Hurd family states he was born February 15, 1800, at Arlington, Vermont, and that he was "a successful lumber merchant." His brothers, Davis, Erastus and Isaac, are mentioned as "accomplished civil engineers," but of Jarvis' engineering experience there seems to be no record other than in the canal papers. He must, however, had had some earlier reputation, for he was entrusted with making the locations and estimates of both the section of the Hampshire and Hampden Canal that was built, that from the Connecticut border to Northampton, and of the proposed extension as far as Brattleboro, Vermont.

The records of the early engineering on the Hampshire and Hampden are not clear. Henry Wright made the preliminary survey on which was

based the application for the charter, but other than that he began it October 10, 1822, and that it was quite "thorough and particular", there has been found no record of it. The charter was granted February 4, 1823, but subscriptions to the stock came in very slowly, a fact which probably accounts for the vote of the Stockholders of the Farmington Company at the annual meeting on January 7, 1824, authorizing the Directors to cause an examination to be made of the route of "the contemplated canal between the north line of this state and the Connecticut River at Northampton, with a particular estimate of the expense thereof, and to report at a future meeting of the stockholders."

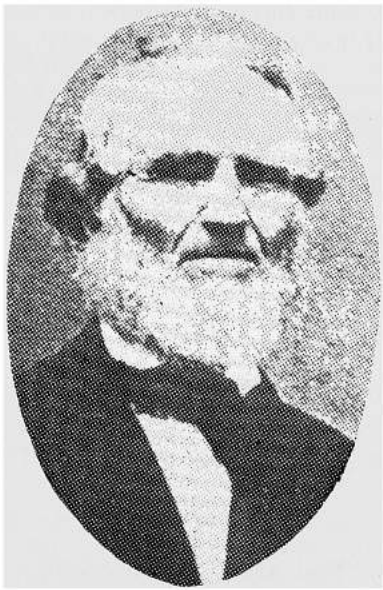

FIG. 2. DAVIS HURD, CHIEF ENGINEER IN 1825.

There is no record of such report, but the New Haven *Register* of February 4, 1826, states that the survey from the Connecticut line to Northampton was completed on "Friday of last week" (presumably January 29th) and as of April 3 of that year Jarvis Hurd, then apparently employed by the Hampshire and Hampden Canal Company, made a detailed report of the location and estimate to Messrs. Thomas Shepherd, Elijah Bates, Augustus Collins and John Mills, the Executive Committee of that company.

The facts are set up in the same general form used by the Wrights in their report on the Farmington Canal. Unlike the latter report, however, which appeared only on the company records, the Hurd report and estimate

was printed as a pamphlet and distributed and there are at least several copies in existence.

Hurd divides his route into sections "most of which are 42 chains," and did his own pricing. His figures were based on going west of the Congamond Ponds and dropping to the level of Westfield by seventy-eight feet of double lockage, but he suggests the desirability of further investigation with a view to a possible shift to the east and the use of the ponds as part of the canal. Later, Davis Hurd having been "authorized to leave the service of the company to lay out the Hampshire and Hampden Canal from its southern extremity to Westfield," a joint committee of the two companies decided on the route through the ponds, on his recommendation.

Jarvis Hurd says of his Section XIX:

> Passes along just back of, and nearly parallel with the principal street, in the beautiful and flourishing village of Westfield. It has a very eligible location for the convenience of the town, and will furnish one or two fine natural basins, at points that will best accommodate the business of the place. It has from two to six feet depth of cutting. The soil is sandy loam. It has:—
>
13,690 cubic y'ds of excavation at 4 cts	$547.60
1 road bridge	85.00
1 farm bridge	60.00
Grubbing and clearing	10.00
	$702.60

His total of $290,000 makes no mention of land damages, nor is there anything regarding such expenses anywhere in his report.

Jarvis was in no ways behind Wright in Victorian English. He concludes:—

> This result, Gentlemen, not only shows the amount of the probable expense, but the quality, quantity and prices, of the many articles to be removed on, or used in constructing the canal, which prices are equal to the object to be affected, and with strict economy in the charge of its construction, I think must fall within the amount. My entire confidence in the scheme, need not be mentioned; nor that I retain the most sanguine opinion of its utility and productiveness, which are based upon never failing principles. But confident as I am, Gentlemen, of the great importance of so valuable a work, and the flattering prospects of profit from an ever-increasing revenue, I wish you all the success, so laudable an undertaking merits, and hope for its speedy completion, and shall ever be happy in rendering you any service hereafter, that shall tend to further the project, which health will permit.
>
> Respectfully yours, &c.,
>
> JARVIS HURD.
>
> Northampton, April 3, 1826.

The two estimates, shown in some detail in the comparative table, are particularly interesting for the elaborate classification of excavation and embankment, and the low prices.

Work Starts.

Work on the Farmington Canal was formally begun on July 4th, 1825, when "two or three thousand people, among them several gentlemen of distinction from Massachusetts," after a prayer, a reading of the Declaration of Independence and an "able oration" marched, in a procession two miles

Fig. 3. Section of Canal near Granby, Connecticut.

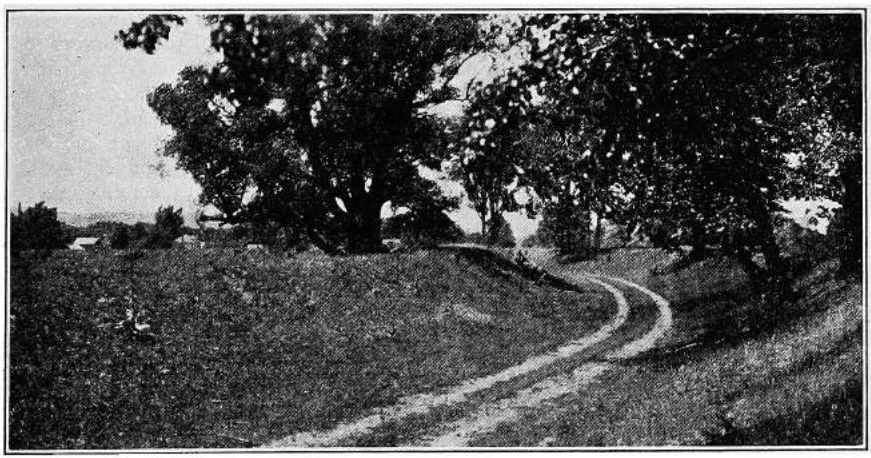

Fig. 4. Canal at Ten Mile River, Milldale, Connecticut.

long to the north line of the state, where Governor Oliver Wolcott, of Connecticut, after an address, turned the first sod, and, incidentally, broke the spade. Another address, the parade back, and a dinner to the invited

guests under what Deacon Hooker of Farmington called a "bouerie" on Granby Green ended the ceremony.

Massachusetts evidently considered this her official opening also, although there was a little celebration at Southwick, when on November 1, 1826, Sheldon and Hurd began actual work on the Hampshire and Hampden Canal.

In Connecticut the work was let out to a number of contractors, the more important masonry structures apparently being let individually. The first award was on August 5, 1825, and by December 5 of that year contracts had been made for the Farmington River aqueduct, all the culverts, and all other work beginning with Section No. 1 at the Massachusetts line through No. 68 in Cheshire.

In Massachusetts there were but two contracts, one with Sheldon and Hurd, from the Connecticut line to the Westfield River, later taken over by Sheldon alone, and the other with Thomas Shepherd, from the south side of the Westfield River to the Connecticut River above Northampton. As yet, no details of any of the Connecticut contracts have come to light, but the original Massachusetts contracts are in existence. They both are lump sum agreements, the price being for the section complete, including also:—

> "All damages which shall be assessed on the whole of said canal from the north line of Connecticut, to the entrance of the same into the Connecticut River in Northampton in the County of Hampshire in the State of Massachusetts for lands, mills, water privileges and for every other injury which may arise from the making and constructing said canal, and the necessary feeders, all the compensation or wages of Superintendent, President and Directors and engineers, and all others necessarily employed in the business of said canal, all the preliminary expenses which have been incurred by said Hampshire & Hampden Canal Company in the survey of said Canal or otherwise, all the necessary alterations in public or private ways, all Waste Weirs and Fences and all other contingent and incidental expenses which may in any way accrue in the business of making said canal."

Sheldon and Hurd were to receive 731 shares of stock and $138,968.52, while Shepherd, who had no obligations as to damages, etc., was to receive 269 shares and $51,030.48. Each contract has attached two exhibits, one being a printed specification sheet used on the Farmington Canal, with the word "Farmington" scratched out, and "Hampshire and Hampden" written in; the other a pen and ink sketch with long-hand bills of material for road bridges, 42 feet long, 14 feet wide, and having truss timbers 8″ x 10″, and for farm bridges, 42 feet long, 12 feet wide, and having truss timbers 7″ x 9″. The contract refers to lock and aqueduct plans drawn for the Farmington Canal by Davis Hurd, and deposited with the Hampden Bank of Westfield "for safe keeping and for the use of each party," but although

President Little of the successor "Hampden National Bank and Trust Company," who was greatly interested, had a careful search made, no trace or record of the plans could be found.

A number of the contractors failed, necessitating reletting their sections. At first thought it might well be questioned if the apparently low prices were not the chief cause of the trouble, but the fact that in each case of default the Directors authorized the reletting only on condition the original prices were not exceeded, and that in no case is there record of any difficulty on this score, would seem to indicate some other reason.

There were two factors which undoubtedly played important parts. All contracts were let on the basis of the contractor accepting in payment as much stock as possible, but practically nothing could be realized on this in the market. When the company had funds it made various advances to the contractors, but much of the time it was hard put to meet its own obligations, including the cash payments to the contractors, so that those of the latter who had not reserve funds to fall back on were in a bad way.

The other important element was the fact that many of the contractors had had little or no experience with work of any extent. The Erie Canal was almost the only large project up to this time, and while some of the contractors on the Farmington Canal came from the work on the Erie others were local men entirely unaccustomed to work more extensive than the excavation of a large cellar.

Canal Design.

The canal section was fixed at a bottom width of 20 feet, a width at water surface of from 34 to 36 feet, and a depth of water of 4 feet, the towing path and the berm bank or opposite side to be not less than two feet above the water surface, nor, in the case of the towing path, more than 5 feet above. In cuts a shelf was made for the towing path, which in all cases was at least 10 feet wide. In the Congamond Ponds the towing path was carried as a fill across some of the shallow sections; where the water was deep close to the shore the natural bank was benched; while across one stretch of 700 feet there was anchored a floating towing path which had been built on shore, launched, and towed about a mile to its destination. Later this possible mobility was taken advantage of by some enemy or enemies of the canal, and on at least one occasion it was cut loose and allowed to drift away, luckily without receiving serious damage.

As will be seen by the specifications—Appendix A—the treatment of the earthwork was in accordance with the best practice of today except as to the employment of rolled layers, and it is quite probable that few if any of the contractors had ever seen a roller of any size. It is questionable, how-