

REPORT OF THE COMMISSIONERS

UPON THE

ERECTION

OF THE

NEW HOSPITAL FOR THE INSANE,

IN THE

**NORTH – EASTERN PART**

OF THE

OF THE COMMONWEALTH.

1876

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1876

# REPORT

BOSTON, February 26, 1876.

To the Honorable the Senate and House of Representatives, in General Court assembled:

The Commissioners appointed by His, Excellency Governor Washburn, under the provisions of chapter 239 of the Acts of the year 1873, to establish in the north-eastern part of the Commonwealth an institution for the insane, beg leave to submit the following statement of the progress of the work, the expenditures already incurred therefore, and the estimated amount necessary to complete the same in accordance with the plans approved from time to time by the Governor and Council.

The site selected for the institution on Hathorne Hill, in Danvers, covers an area of 197t acres, and was purchased in the latter part of 1873, for the sum of \$39,724.51. In a report submitted to the Governor and Council on the 8th May last, the place is described as follows: "The location possesses great natural advantages, - First, as regards accessibility from those sections of the State which it is intended to accommodate; second, the adaptation of the ground for the purposes of a public institution; third, the great beauty of the surrounding country. The hospital buildings are being erected on Hathorne Hill, which before grading had an extreme elevation of 257ft. above tide marsh level, being higher than any lands in the vicinity. A station on the Lawrence Branch of the Eastern Railroad is located on the northerly border of the grounds, and it is intended to have a sidetrack laid and a small depot erected within the grounds. Another station, on the Newburyport Branch of the Boston and Maine Railroad, is distant only a mile and a quarter from the hill. From all the principal cities and towns in

the northeastern part of the State, patients can be taken by rail directly to the grounds. The managers of the railroads have shown a disposition to furnish every facility for transacting the business of the institution." "In December, 1873, the Commission appointed Mr. Charles A. Hammond, of Lynn, an able and experienced engineer, to take charge of all engineering works. The plans for the buildings were prepared under the direction of Mr. Nathaniel J. Bradlee, who was appointed consulting architect, and who has made a special study of the subject of providing accommodations for the care and supervision of the insane. The main group is composed of ten buildings, connected by fire-proof corridors, namely, an administration building in the center; a building in rear of the same, devoted to the economic departments of the hospital; and eight wings for the use of patients."

The two extreme wings will provide accommodations for 72 patients in single rooms; the six other wings will accommodate 258 patients in single rooms, and 90 patients in associated rooms. In addition, there will be accommodations in the fourth story of the wings and of the administration building for about 30 patients more, which gives a total of 450 as the capacity of the hospital, exclusive of the attics, which, if necessary, can be finished to accommodate 150 more patients, thereby affording accommodations in the entire building for 600 patients.

The amount named in the original appropriation for the purchase of land and the erection of buildings for this institution, was \$650,000. It was not based upon any detailed estimates, but simply suggested to the committee of the legislature by whom the bill was prepared, as likely to be a sufficient sum for the purpose. As soon as the Commissioners entered upon their work, they discovered that it would be impossible to build a suitable hospital for the sum named, and they lost no time in communicating that fact to the legislature. This was before the details of the plans for grading and building had been worked out, and before any contracts had been entered into. Acting upon the best information available at that time, the opinion was expressed that the sum of \$900,000 would

be sufficient to carryout the plans which had been adopted by the Commission and approved by the Governor and Council. As the work progressed, the Engineer and the Architect found that some things had been overlooked, and that the estimates on others - made somewhat hastily before the details had been fully worked up - were too low. This is fully explained in the reports of those two officers appended hereto.

It appears from these reports that an additional appropriation of about \$600,000 will be required to complete the work, namely: -

To finish the buildings now in process of construction,	\$274,200.00
To erect outbuildings, station house, barn, gas house, and store house,	96,000 00
To complete the work of road building, tile system of sewerage, the laying out of the grounds, the introduction of water from Ipswich River (including a three million gallon reservoir, pumping works, distributing pipes, etc.),	168,796.00
	\$538,996.00
Add for contingencies,	61,004.00
Total additional amount required,	\$600,000.00

The following is a statement of the present condition of the appropriation: -

Amounts heretofore appropriated,	900,000.00
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Expended to January 1, 1876:

For cost of land.	\$39,724.51
"construction of buildings,	410,464.16
"grading of site,	44,317.85

“roads, machinery, etc,	32,650.48	
“drainage and water supply,	10,050.91	
“heating and ventilation,	20,046.38	
“Salaries and expenses,	13,773.84	
“Sundries, including temporary buildings, printing, advertising, and cost of engraving bonds,	4,664.65	
		\$575,692.78
Contracts unfinished,		309,117.60
Total available balance Jan. 1, 1876,		15,189.62
		\$900,000.00

If the whole additional sum required is appropriated this year to be expended subject to the approval of the Governor and Council, the hospital can be completed ready for occupation by the middle of 1877. If half the amount is granted this year and half next year, it will hardly be possible to open the building for use until the summer of 1878.

It is very necessary that a supply of water be secured before the close of the present year for the protection of the buildings against fire, and for all the uses of the hospital when completed. The Commissioners have delayed the taking of water from Ipswich river under the legislative authority granted them, being in hopes that an arrangement favorable to both parties could be made with the authorities of the town of Danvers for a supply of water from Middleton Pond and Swan's pond. But inasmuch as there seems to be no prospect of effecting a satisfactory arrangement with these parties, the Commissioners will proceed at once, subject to the approval of the Governor and Council, to procure an independent supply from Ipswich River should the present legislature appropriate the money required.

While the Commissioners regret that the work was entered upon under a misapprehension as to its ultimate cost, thereby imposing upon themselves the

necessity of making this application for an additional appropriation, they have no cause for regret in the adoption of the plans which they have undertaken to carry out, nor in the character of the work which has been performed. Both the location and the plans have received the unqualified approval of the leading physicians who have charge of similar institutions in this and other States. No unnecessary expense has been incurred either in laying out the grounds and the approaches thereto, or in finishing and ornamenting the buildings. If the Commissioners were to begin the work anew, they are not aware that any changes could be advantageously made, either in the plans or the manner of carrying them out. No mistakes have been made, no losses incurred, no overcharges allowed. All the work has been well done, and for the lowest market rates. It is substantial, enduring work, and the first cost of all such work is large, but in the end it is the cheapest and most economical that can be done for the State. The Commissioners confidently invite comparison as to location, design and cost of construction, between this institution and modern institutions of the same character established in this and other States.

The attention of members of the legislature is asked to the report appended hereto, of Dr. Clement A. Walker, the medical adviser of the Commissioners in matters relating to the construction of the hospital; also to the letters received from Drs. Earle, Godding, and Eastman, superintendents of the several Massachusetts Hospitals; also to the letter of Dr. I. Ray, formerly superintendent of the Butler Hospital for the insane at Providence, R.I.; also to the letter of Dr. Jelly, superintendent of the McLean Asylum at Somerville.

Referring to the accompanying reports for further details as to the purposes for which the additional appropriation is required, the undersigned respectfully submit this request for the consideration of the General Court.

Samuel C. Cobb,

C. C. Esty,  
Edwin Walden,  
Commissioners.

## ENGINEER'S REPORT.

DANVERS, January 1, 1876.

HON. SAMUEL C. COBB, *Chairman of Commissioners for the erection of State Insane Asylum in Danvers.*

SIR, - I have the honor to report the progress of engineering work done at the Asylum site, from December 1, 1873, up to this date, as follows: -

### GENERAL DESCRIPTION.

The site chosen by the Commissioners and purchased by the Commonwealth of Francis Dodge and others, is known as Hathorne or Prospect Hill, situated in the western part of the town of Danvers, about a mile east of Ipswich River. The entire property, containing about 197.28 acres, - about 45 acres woodland, -lies at the junction of Maple Street and the Newburyport Turnpike, fronting on the former 1200 feet, on the latter 2100 feet, and on the line of the Lawrence Branch of the Eastern Railroad 1100 feet, opposite "Swan's Crossing" station, distant from Boston 16 miles by the turnpike and 20 or 23 miles by rail.

Hathorne Hill, the highest in the vicinity, had an original elevation of 257 feet above mean high tide, and presents a graceful outline from the highways, with gentle slopes, but more abrupt on the west and southwest sides. The broad top of the hill was covered with well cleared tillage lots, enclosed by substantial stone walls, while the lower slopes, especially on the northwest side, abounded in boulders of all sizes. Some idea of the abundance of stone found on the premises and the good purpose the same has served, may be gained from the fact that nearly 15,000 cubic yards have thus far been utilized for foundation and other walls, and for road building.

There is quite a number of large elm trees on the upper portion of the hill, also a fine grove of walnuts covering two or three acres of the western brow of the hill, and another of white pine at the foot of the northerly slope, both of which would be much improved by judicious thinning. There are also several large apple orchards in good bearing condition. The character of the ground has been found quite unfavorable for easy digging, being a compact gravelly clay, or hardpan, freely interspersed with boulders. So tenacious and firm is this material, that the sides of cellar excavations, etc., have stood an entire season, without the slightest danger of caving, perfectly vertical.

### **GRADING.**

As soon as the preliminary surveys, begun Dec. 8, 1873, were sufficiently advanced, contour plans were drawn, by means of which the location of the buildings was carefully fixed, and afterward working plans and final estimates of the amount of material to be moved, were made, and contracts and specifications for grading written, providing for 58,000 cubic yards of earthwork in grading, 17,000 yards of cellar excavation, afterward increased, by deepening the cellars, to 20,000 yards, 2,000 cubic yards of stone-wall removal for the foundation walls of the Hospital, in addition to stripping from the area to be graded 38,000 yards of top-soil to be saved in spoil banks for future finishing. About 6000 yards, chiefly grading, around the present farm buildings, were

afterward excepted from the contract, leaving total amount of earth and soil handled, outside of cellar digging, 90,000 yards. The extremes of the building are nearly 1200 feet apart, making it necessary to extend the grading over 33.25 acres in order to overcome the difference in height between the summit of the hill and the ground at the ends of the building, originally about twenty feet, now reduced to six. The greatest depth of grade cutting at the summit was eight feet; the cellars at that point were eight and one-half feet deeper, and excavated uniformly to a level plane 240.50 feet above tide. The contract for grading was awarded April 18, 1874, to Messrs. T. B. Dacey & Co., of Boston, for the sum of \$29,990, afterward increased by extra work to \$33,086.93, which included cost of cellar work and stone hauling, the amount paid for grading proper being \$24,536.93. The work was begun the 4th of May, 1874, and finished on the 6th of October following.

Upon locating the buildings on the ground, it was found necessary, in order to get higher basement windows in the rear, and thereby better light, to reduce the grades on the northerly side of the Hospital, preserving at the same time, as in front, a gradually descending slope of the ground from the buildings. Contractors' prices for doing the work ranging very high, it was concluded to postpone the matter till the season of 1875, and it was recommended that all work yet remaining, - grading, excavation, road-building, drainage, water works, etc., - be done by day-labor under the engineer's supervision. The plan thus far has proved entirely satisfactory, and it is confidently believed that no better results for the money expended can be shown on any public work, the cost, as will be seen, comparing favorably with contract work, while everything has been done to best advantage, with least interference with the building contractors, and any changes or improvements could be made without incurring heavy bills for "extra work."

From careful cross-sections it was ascertained that the entire amount of additional grading would be 25,500 cubic yards. This work was begun April 12, 1875, but on account of stormy weather and frozen ground, was not fairly under

way until the 22d, and completed July 3d, with the exception of 5,530 cubic yards, which we were obliged to leave for another season, on account of the encroachments of the contractors for the buildings. The amount thus far done, therefore, is 19,970 yards, at a cost of \$8,957.16, or at the rate of 44 and 2/3 cents a yard; but this includes \$1,778.15 for the work of slope and terrace finishing, which, deducted, would reduce the cost of grading merely, to about 36 cents a yard. The best prices that could be got from responsible parties to contract for the same work, were 55 and 60 cents a yard.

It was decided to use the material obtained from the rear grading in forming east and west terraces, also a long terrace around the entire northerly side of the hill with a slope of 2 1/2 to 1. Along the brow of this terrace is located the rear portion of the circuit road, above which, at each extreme of the building, rise the upper terraces with varying slopes - steeper as they approach the road and more gradual as they recede, - while between, having a gentle inclination from the buildings to the road, lies a broad area affording ample room for rear-roads, airing-courts, engine-house, etc. The slopes have been carefully and truly made, covered with eight or ten inches of loam, and laid down to grass. The effect is at once striking and pleasing, the entire group of buildings occupying the central and highest portion of an elevated plateau, terraced at the ends and bounded by the circuit drive from which beautiful views are had in every direction of the surrounding country

The entire amount of grading done since the work began, including soil-removal, has been 115,500 cubic yards at an expense of \$33,494.09. This, and the following items of cost, show the amounts paid for labor, equipments and incidental expenses, merely, not including engineering, superintendence, etc.

### **ROAD-BUILDING.**

The general plan of roads for reaching different parts of the hospital buildings and grounds, is shown on the accompanying topographical sketch.

It is proposed to establish a freight-yard alongside the railroad, near the depot, from which a road ascends by an average grade of 4 in 100, winding up the northeast side of the hill for 2,400 feet, and then, forking, one branch leads to the rear central building (marked E), a distance of 1,400 feet, making total distance from the railroad 3,800 feet, and total rise about 150 feet; the other branch continues on through the walnut grove and along the southwest brow of the hill, and thence around the eastern slope at a distance from the buildings of from 300 to 600 feet, and returning along the summit of the north terrace, again intersects the first-named branch, thus forming an elliptic drive entirely around the hill-top of a little over a mile in length, at the same time enclosing a space of 37 acres for the ornamental grounds, airing-courts, walks, etc., pertaining to the immediate vicinity of the Hospital. Another road, intended for the main public entrance to the grounds of the Institution, giving access also to the tillage fields through which it passes, enters the premises at the square formed by the junction of Maple Street with the turnpike, and unites with the depot road just above the pine grove. The entire length of these roads is about two miles.

The absence of gravel from the premises, the clayey nature of the ground, and the abundance of waste stone, favored the decision to macadamize all roads intended for heavy travel, as a measure of true economy. Accordingly, in the fall of 1874, a stone-crusher and portable engine were purchased of Messrs. Rawson & Hittinger, of Cambridgeport, for the sum of \$2,860.90, and a building was designed and erected for the convenient working of the machinery, at a cost of \$671.24; it was located on the northerly side of the hill at the foot of the upper road slope, very convenient for the delivery and removal of stone. The sum of \$402.10 was paid for a sectional iron roller, also \$570.44 for tools, etc., making total expense of out-fit for road work \$4,504.68.

Work on the depot road was begun October 6, 1874, and about 7,582 cubic yards of earthwork were done before the frost set in, beside slope finishing, formation cutting, and sidewalk grading. The expense was considerably increased on account of the great number of large boulders encountered,

requiring a good deal of drilling and blasting. The stony condition of the ground continuing nearly all the way to the railroad, and the lower portion of the road passing through woodland, necessitated also a large amount of grubbing and stone clearing. The topsoil was generally removed and piled along the line of the road, as well as soft and unsuitable ground in the portions requiring filling. The width of the road was fixed at 35 feet, including gutters and sidewalk. Owing to the side-hill location, the sidewalks, 8 and 1/2 feet wide including border, was put on the outside of the road; and the main gutter, three feet wide and paved, to take the surface water from the ground above the road, was placed on the inside, with silt-basins and drains at proper intervals. There is also a smaller gutter on the inside of the walk, leaving the clear width of carriageway 21 feet.

The method of construction is as follows: After the preliminary work and grading, the formation excavation is done by removing the material in the carriage way to the depth of six inches in the centre, and, with patterns, forming the bottom to the required curve, the earth thus obtained being used in building up the sidewalk and finishing the outer slopes. Upon the foundation thus prepared, is placed the sub-pavement or bottom pitching, composed of large stones taken from the cuttings or from the numerous enclosing walls in the vicinity, averaging, when laid, not more than twelve inches high. If well laid and bedded, a very solid and compact pavement is secured, many of the stone having from one to one and a half square feet of bearing surface. Over this pavement is placed a layer of crushed stone, sometimes with a little blinding of earth, the workmen previously throwing on cobbles, etc., and breaking them on the spot with sledges, thus firmly wedging the bottom stones. About eight inches of crushed stone, or road metal, are put on in three layers, each thoroughly rolled, and the road is finished off with a light covering of gravel.

Up to the present time about a mile of roads has been completed, including the depot road nearly to the rear central building, and the carriage road from the public entrance. These roads have been built on the modified Telford plan, as above described, in the most thorough manner, truly conforming to the

grades established, and are believed to require little repairs for years to come. The crown of the roads has been carefully formed, no where less than five inches, the carriage-way being twenty-one feet wide, and, on the steeper grades, is made so that the inclination from centre to side is barely in excess of that between stations, experience confirming the theory that such a crown will take the water to the gutters in curved lines, at a much less angle than 45 degrees, or increasing the distance over a perpendicular course but one-third, offering at the same time no inconvenience to carriages from excess of curvature.

It is thought that, when fully completed and the slopes (never less than 2 to 1) protected and adorned with a thrifty growth of grass, these roads will form a beautiful, as well as useful and permanent feature of the premises. Especially satisfactory are the results in sidewalk construction, both in appearance and cost, and prove highly creditable to the workmen employed. The formation is made with broken bricks, small rubble, coarse gravel, etc., above which are placed three or four inches of stone screenings from the crusher; the color, a light blue-gray, blending well with the green sod-borders. The walk, thus made, is never either dusty or muddy, being thoroughly hand-rolled and absorbing moisture, while the porous bottom, resting on clay, allows the rain to keep the inside border, formed with rich loam placed in a trench and covered with sod, in a moist and flourishing condition.

Six silt-basins have been built, receiving water through gratings directly from the main, or inside gutter, with inlet pipes from the sidewalk gutters, and discharge drains to the foot of the outside slopes. Their inside dimensions are 5 by 6 and 1/2 feet, with a depth of 4 to 8 feet below the outlets. The walls are of rubble stone laid in cement with brick bottom. They are covered in with vaulted 8 - inch brick - work, the arches keyed by the granite curbstones whose top faces are cut to conform to the hollow of the gutters. The sidewalk gutters are provided with smaller curbs, each connected, by funnel-shaped openings in concrete, to the top of the inlet pipe leading to the basin opposite. The cost of each basin, complete, has been 11 little over \$200.

The detailed cost of such items of road construction as could be readily measured, is given as follows: - Sub-pavement, "Telford," 15,656 square yards, averaging 13 cents a yard, including gathering, hauling and laying. Gutter paving, including getting, hauling, sledging, and lying 3,410 square yards, at 76 cents a yard. Sidewalks, 4,875 lineal feet, at 23 and 1/2 cents a foot. Sodding - cutting, hauling and laying - 1,845 square yards, at 13 cents a yard, or 1 and 1/2 cents a square foot. For rolling, \$544.28 has been expended, which includes cost of extra wheels, of the larger size, for cast-iron sectional roller, thus making all the sections of uniform diameter instead of alternating with smaller wheels. The change was found to be a great improvement in rolling broken stone; as before, the stone, being worn round by the rutting and grinding of the roller, failed to pack properly, although the evil was in a measure remedied by a slight blinding between the layers. The entire cost of crushing stone, including repairs and improvements in machinery, coal, etc., also drilling, blasting, sledging and hauling, has been \$7,403.74; and the quantity of stone crushed, 3,100 cubic yards, of which 16 percent is screenings, making the cost of per yard of stone and screenings, \$2.39; for clean stone, \$2.84.

The total expenditure for road building, not including outfit, since the work began, is \$25,145.80, a considerable item, not so much due, however, to the cost of macadamizing, as to the unfavorable nature of the ground. It is estimated that, outside of the first cost of machinery, etc.; not more than six or seven thousand dollars could have been saved, even had a gravel road been built instead of one of stone. But it would seem a wise policy, in designing important works of this nature for the public use for all time, to take into account the expense of future repairs and maintenance, the reduction of which to a minimum through a long period of time, ought to warrant some increase in first cost. A gravel road used for heavy teaming, would soon be deeply rutted and broken up, entailing a large expense each year to keep it in order, while a good macadamized road built on a firm sub-pavement, will require but little mending for years.

## WORK ON BUILDING ACCOUNT.

The cost of such work pertaining to building construction as has been done under the engineer's supervision, has been kept separate from other items, in order that it might be read in connection with the architect's report. The work has consisted chiefly of excavations for cellars and foundations, and for the under-ground air ducts connecting the fan chambers with the hospital wings, also hauling stone for the rubble masonry.

The amount thus expended in 1874, was \$9,980.55, as follows: - For digging the cellars of the ten hospital buildings, under the Dacey contract, \$7,750.00; extra cellar excavation and trenching, \$1,205.55; cellar drainage (pipe), \$225 00; hauling stone for foundation, \$800.00. On the 2d of June, 1874, the first stone in the foundation walls was laid at the easterly corner of the building, and the entire job was completed about the 20th of November, 1874. The walls (about one mile in length) measured 27,863 superficial feet, and were laid by masons employed by the State under the general charge of Mr. R. Raymond. Further measurements are given as follows: -

1874	Perches.	Cu. Yards.	Tons (net).
Granite caps and quoins,	658	603	1,417
Rubble wall,	3,355	3,075	6,859
Total,	4,013	3,678	8,276

During the season or 1875, the sum or \$13,370.95 was expended on the above account as follows: - For excavation of engine and boiler house cellar, begun June 30, 1875, and finished about the 1st of September, during which time 5,766 cubic yards of earth were removed, \$2,980.20, at 51 and 1/2 cents a

yard; for air-duct excavation, begun Aug. 19, 1875, and suspended about the 1st of December, during which time 9,773 cubic yards were taken out, \$7,116.50, at 62 and 1/2 cents a yard for excavation merely, increased however, by expense of back-filling, to 72 and 1/2 cents per yard of cutting; for hauling stone for foundations and walls, in all 3,147 cubic yards - 836 yards for boiler-house cellar, and 2,311 yards for ducts, etc. - \$2,096.50, at an average of 66 and 2/3 cents a yard; for draining cellars, \$459.25; for removing waste earth and rubbish from cellars, \$544.00; and for covering and protecting the masonry of the coal-bunkers, \$174.50. The amount of material yet to be removed to complete the digging of the air ducts, is 3,443 cubic yards.

The ducts rise from the fan chamber toward the buildings by a straight grade of 2 in 100, except the extreme ducts, 1 in 100, and the middle duct, 4 in 100. The width of main duct excavation is 12 feet, and of the branch ducts, 10 feet. The average depth of digging has been 14 feet, about 9 feet of which is occupied by the ducts themselves; the walls, built of stone, 2 feet thick, being 7 feet high, and the crown of the brick covering-arch 2 feet more, This necessitated hauling away, or "wasting," the quantity of material answering to the space occupied by the ducts, equal to 5,127 cubic yards, which was usually done first with carts, and the balance afterward cast out from the bottom and left along the sides of the trenches to be used in back-filling, upon the completion of the masonry. This waste material, together with that from the engine-house cellar, amounting in all to 10,893 cubic yards, was not provided for in the general plans for grading, and has therefore been used in slightly raising the grades of the front lawn, and in forming slopes, 4 to 1, on the front circuit road, a portion being piled in a waste-bank, to be used in completing that portion of the road now obstructed by the front, or No. 2, soil-bank.

The following is given as the measurement of stone laid in 1875, by the masons in the employ of the State, under Mr. J. S. Scott, consisting of cellar and step foundations, walls of air chambers and ducts, and underpinning rear walls of hospital buildings at entrances of the ducts: -

1875	Perches.	Cu. Yards.	Tons (net).
Granite caps and quoins,	11.6	102.0	238.14
Rubble wall,	3,436.9	3,147.6	7,171.29
Total,	3,547.5	3,249.6	7,409.43

Superficial feet in air-duct walls, 24,533; in engine-house foundations, 9,093; total, 33,626.

The total cost, up to the present time, of work to be charged to the building account, is \$23,351.50.

### **WATER WORKS.**

In the latter part of the year 1874, surveys were made with reference to a system of water supply for the Hospital, and early in January, 1875, plans and preliminary estimates were submitted. Ipswich River, about a mile west of the Hospital Hill, was found to be the nearest available source of supply, and legislative authority has been granted to use the same. Analysis proved the water to be of desirable purity, and an approximate gauging of the stream in time of drought, showed a daily flow of some four million gallons, due to a water-shed of five and one-half square miles lying below the paper-mill dam in Middleton, three miles above the point of supply. It is not considered probable that more than 100,000 gallons a day can ever be needed by the institution, although there will be facilities for using, in dry weather, two or three times that amount, should it be needed in sprinkling roads, watering lawns, shrubbery, gardens, etc. Additional surveys were made with reference to bringing water from Middleton Pond, about two and one-half miles distant from the Hospital, in event of the town of Danvers, which has the right to take water from Middleton and Swan's Ponds, co-operating with the State Commissioners in building works to be used in common by both parties.

The general design for independent works for the Hospital may be thus described: a pumping station will be located at the river, from which a force main

of 8-inch cast-iron pipe, will ascend to a reservoir, or storage basin, to be built on the western slope of the hill, just above the depot road, as shown on plan, having a capacity of three million gallons, and affording ample facilities for storage, irrigation, ice-cutting and protection against fire. The mean height, above tide, of the river at the point of supply, is 36 feet; height of water in reservoir when full, 230 feet. Pumping capacity of about half-a-million gallons in twenty-four hours will be provided and the lift, including friction, when pumping from the river into the reservoir, is 210 feet; when pumping into the attic tanks, 275 feet. Since no natural elevation, commanding the hospital buildings can be had, these tanks, connected with each other by 4-inch pipes, will serve as a distributing reservoir; they will be circular, built of cedar plank, strongly bound with iron hoops, and lined with pure Portland cement, their diameter being 12 and 1/2 feet, and height 5 and 1/2 feet, each holding about 5,000 gallons. It is intended to have nine in all, resting on the corridor and partition walls, one in each of the eight wings, and one in the rear centre building, the latter being the receiving tank from which an 8-inch overflow pipe leads to the reservoir. It is further proposed to place in the engine-house in rear of the hospital, containing the boilers for steam-heating, a large fire-pump, drafting through a conduit from the reservoir of 12-inch iron pipe, and connecting with an 8-inch fire-main 2,600 feet in length, with hydrants both in the front and rear of the hospital, and also with the attic tanks, so as to be independent of the river pump in case of accident, or to co-operate with it in case of necessity. As the reservoir will store from one to two months' supply, the above arrangement virtually duplicates the pumping service.

The expense thus far incurred for work on account of water, amounts to \$804.66, including cost of iron pipe, cut granite, etc., being for pump-well and about 60 feet of the conduit within the walls of the engine-house, made necessary by the erection of the building. The well is rectangular, 6 by 8 feet, and 26 feet in depth below the cellar floor, or 5 feet below the level of the reservoir bottom, giving sufficient fall to take all the water in tile reservoir when pumping at full capacity of 1,000 gallons per minute.

## RAINWATER DRAINAGE.

The disposal of the water from the roofs is effected by a system of drains, by which the water is gathered at convenient points into catch basins, or cisterns, the over-flow from which finally enters the sewers. There are on the hospital buildings about 130 copper conductors, from which short branch drains of 4-inch pipe lead to the 6-inch main drains, running length wise with each wing, parallel to the same, and distant 18 or 20 feet from the main body of the building. The main drains lead directly to the cisterns, which are connected by 8 and 10-inch pipes. There are eight cisterns in all, four in front and four in rear of the buildings, located as shown on the accompanying plan of the drainage system, etc., built of brick, their inside diameter being 11 and 1/3 feet, depth 10 feet below inlet and outlet pipes, and capacity 7,500 gallons each.

The sizes and grades of pipes were calculated to take care of a maximum rainfall of two inches per hour; in carrying out the work, however, the grades were made sufficient to provide for three inches per hour. The roof surface of the hospital building is estimated at 78,000 square feet.

This work was begun the 20th of October, 1875, and finished before cold weather, except one cistern, the outlets to sewers, and the drains for the centre buildings, which are not yet erected. The entire length of trenching completed, averaging five feet in depth, is 5,493 feet, costing, including refilling, \$1,742.30, or 31 cents a foot. The seven cisterns were built at a cost of \$1,792.50, - a little more than \$256 apiece, or at \$24 and 1/3 per thousand bricks laid. The cost of stoneware drainpipe and laying the same, has been \$2,031.39; but this includes all the pipe necessary to complete the work.

The total expense for rainwater drainage, thus far, is \$5,608.69, and there remain about 2,285 feet of trenching and one cistern to complete the whole work, making the total estimated cost when finished, \$6,673.16.

## **SEWERAGE.**

The location and grades of the air ducts are such that the sewers must pass under them some four feet, making the average depth of these drains beneath the present surface of the ground about 18 feet, except the main sewer, which, starting below the ducts about half way between the engine - house and the extreme west wing, descends the north-westerly slope of the hill, and need not be put more than six or seven feet under ground. The sewers might have been located nearer the surface on the top of the hill, crossing the ducts by twelve inverted siphons, but it would so complicate the system and increase the care of the same as to be impracticable.

Three things were constantly borne in mind in designing the work, namely, - simplicity, perfect means of inspection, and economy in construction. The first was obtained by making each drain take the most direct course to the sub-sewers, and the latter to the main sewer, and by making the lines of location and grade perfectly straight, thus helping to secure the second advantage of providing easy inspection, which is completely gained by placing at each point of intersection or change of course a man-hole to be built of brick, two feet in diameter at the top and five feet at the bottom, so that an inspector in one may be able to see a lighted lamp in the next through the entire length of the sewer between, and any damage or obstruction be very closely located, - an important matter, considering the depth necessary to dig to remove a length of pipe. Furthermore, as the distance between these inspection holes will rarely exceed 150 feet, generally less, it is evident that by using proper tools, with fifteen or twenty rods each five feet long forming jointed handles, the entire system of sewers is under complete control. Economy in construction is next attained by using pipes no larger than necessary to do their work effectively. Nothing smaller than 6-inch pipe is used nor larger than 10-inch, except the main sewer, for which, on account of the rapid fall available, a 12-inch pipe is ample. The chief consideration, of course, is to provide for the maximum amount of rainwater, which will materially aid in cleansing the pipes, the sewage proper being

comparatively small in amount. None but the best hard-burned, vitrified stoneware pipe will be used, each piece before using tested to sustain a certain pressure. It will be seen by the plans that no sewer drains are allowed within the buildings, the cast-iron soil pipes being continued horizontally below the cellar and through the outside walls.

The ventilation of the main sewer will be effected by air shafts at frequent intervals, but as no traps are to be used at the water-closet bowls, the house drains will be ventilated by special pipes of the same material as the sewers, running directly to the steam chimney in the boiler-house, the powerful draft inducing a constant current of air downwards from the closet bowls. Traps at the man-holes just below, the ventilating pipes, and so arranged as not to interfere with a straight line from the man-hole outside the building to the inspection hole at the foot of the vertical soil pipes, serve to cut off the house drains from the sewers below them, and to render the downward air current more effectual.

The plan contemplates carrying the sewage directly to Ipswich River, at a point about one mile below the pumping station, as the quickest and safest way of getting rid of it. It may, however, be deemed advisable to build a cess-pool in the lower part of the premises, nearly half a mile away from the buildings, from which the sewage, if not needed on the farm lands, might be sold to neighboring proprietors. It is not recommended that any doubtful experiment in the way of sewage-irrigation or purifying, be attempted, the objections of climate and unceasing attention required being too great.

Nothing has yet been done in the execution of the above described work, except constructing seven culverts under the air-ducts, made necessary by the progress of the latter, at a cost of \$451.43. These culverts, of which there will be twelve in all, are simply brick walls covered with flagging, the drain pipes having been carefully laid to the proper grade; the culverts are then filled over with earth to the grade of the duct bottoms. Their object is to protect the pipes and afford

ready access for inspection or repairs, and their exact location will be marked for future reference on the face of the duct walls.

### **MISCELLANEOUS WORK.**

There has been paid for labor and expenses under this head, the sum of \$4,310, for care of tools, water, carpenter work, stable repairs, drainage, grubbing and clearing, and, sundry work, including \$1,381.75 for replacing about 4890 cubic yards of top soil, at a cost of 28 cents a yard.

### **CONCLUSION.**

The duties of the engineer corps have been very creditably performed by the assistants employed. Beside making a complete topographical survey of the premises, a large amount of work has been done in laying out the buildings, giving various measurements and heights required, in addition to designing laying out and supervising work belonging specially to the Engineer's department, including detailed estimates and measurements of work done each month.

At the beginning of last season the Commissioners authorized the Engineer to act as paymaster for all labor performed under his supervision, thereby somewhat increasing the responsibility and care, although aided by our superintendent of labor, Mr. Conrad Juul, whose energy and diligence have been very commendable. It is recommended, however, that a suitable person be employed as clerk of the works and book-keeper, whose duty shall be to take the time of the laborers according to the work on which they are engaged, to keep all the accounts and records of expenditures, make up the monthly payrolls, and assist in the disbursement of wages.

The total amount of money expended up to date for work under the Engineer's charge, including what has been done on the building construction account, also engineering and superintendence, is \$113,147.90.

Estimates of the sums required to complete the entire work in this department are herewith presented. All of which is respectfully submitted.

GRAS. A. HAMMOND,

*Engineer.*

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