

METROPOLITAN SEWERAGE SYSTEM SURROUNDING BOSTON.

BY B. G. UNDERWOOD.

A glance at the map shown on our front page, specially engraved for us by the American Bank Note Company, from data furnished by the Sewerage Commission, shows the magnitude of the work and why it was necessary for the State to appoint a commission to superintend the construction.

The importance of having work of this kind thoroughly done and under an intelligent supervision is very evident, and the cities and towns interested have reasons to congratulate themselves on the high character of the commissioners and the quality of work insisted upon by the chief engineer.

By act of the Massachusetts Legislature, approved June 7, 1889, the governor appointed Hosea Kingman, Tilly Haynes and Robert T. Davis, and later Harvey N. Collison, commissioners to provide for the building, maintenance and operation of a system of sewage disposal for the Mystic and Charles River valleys. Mr. Howard A. Carson, of Malden, was selected chief engineer, and during the past two years the many thousands traveling to and from Boston from the places embraced in the district have been more or less familiar with the methods of sewer construction employed, some of which we illustrate in this connection.

The method recommended by the State Board of Health was that of "discharging crude sewage into a strong tidal current that will convey it to sea, whence it cannot return." After careful examination, Mr. Carson found that the best outlet for the discharge of crude sewage was a little west from the Beacon, which is one-third of a mile south of Deer Island. The outlet at Deer Island Beacon is directly into a tidal current more than fifty feet deep, in which the velocity of more than two and a half miles an hour is much greater than that in the sewer, and the scouring effects of the currents, reversed twice daily, will readily remove everything which the sewer can bring there.

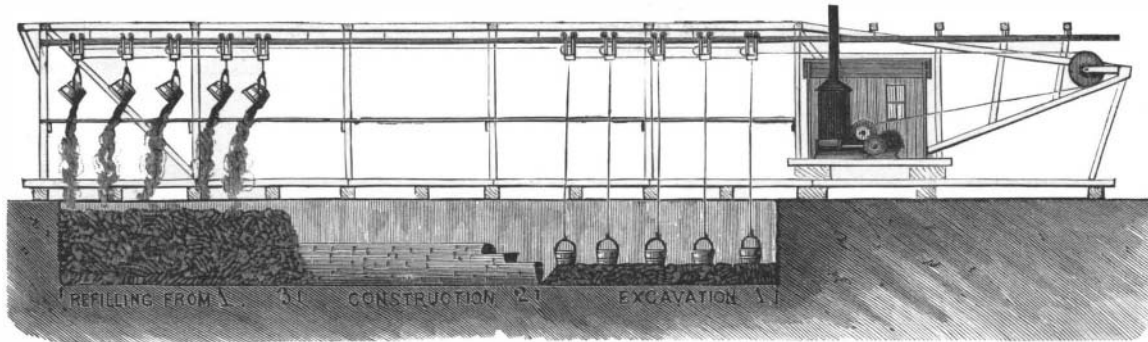
The most distant point is 17½ miles from the outlet, near the line between Stoneham and Woburn. Here the sewer is about 48 feet above low tide and the diameter is 15 inches. The sewer will extend down the valley through East Woburn and Winchester Highlands to the Mystic Valley. Here it will receive two 15 inch branches from Woburn and will continue along the Abbajona River in Winchester to West Medford. The West Medford invert is about 8 feet above low tide and diameter 4 feet 6 inches. Here it will receive sewage from the Alewife Brook branch, and then continue through Medford Center and Wellington to Malden River, with diameters increasing from 4 feet 6 inches to 5 feet. The bottom of the sewer here reaches the level of low tide. Passing under Malden River

pumping station is of a stable character, there is ample frontage on a navigable river, and the surroundings are such that a pumping station would be unobjectionable. The pumping plant may consist at first of three centrifugal pumps and three compound

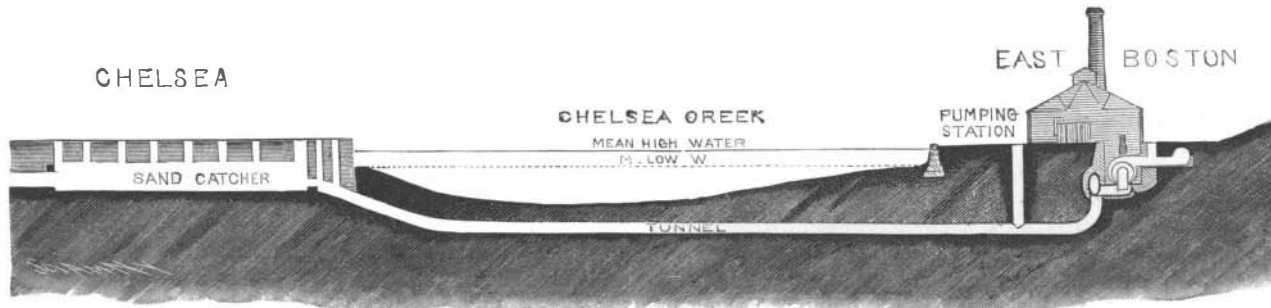
At Deer Island pumping station all of the sewage is to be pumped a height varying with the height of the tide from 10 to 20 feet. It is conveyed along the island 1,000 feet through a sewer 6 feet wide and of varying height, then through two conduits buried in the harbor side of the bar below low water, for 2,000 feet, and rising near the end to about low tide at the outlet. Here, on the north border of the main ship channel, the ends of the conduits will be securely protected from the action of the sea. The bottom rapidly slopes from the ends of the conduits to a depth of more than 50 feet below low tide.

The outlet sewer for the lower valley of Charles River embraces the following places: Waltham, Newton, Watertown, Brighton, Brookline, and a part of Boston. The sewage carried in a similar manner as that of the North Metropolitan District to Moon Island, and there discharged into the sea. The following table gives the estimate of population in 1890 and 1930, the cubic

feet of sewage per head per day and the cubic feet per second in 1930. The estimate which was published in 1889 was based upon the census of 1885 and earlier years, and was about 10 per cent less than the one finally adopted for construction. The sizes of the sewers have been increased accordingly.



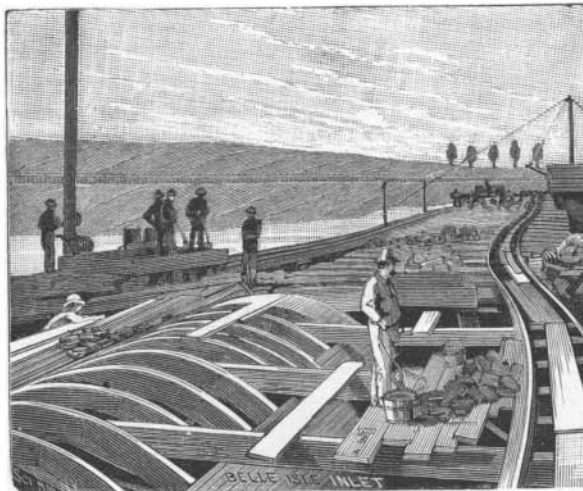
MANNER OF SEWER CONSTRUCTION—CARSON TRENCH MACHINE AT WORK.



SECTIONAL VIEW—CHELSEA AND EAST BOSTON TUNNEL.

condensing engines, capable of lifting 160 cubic feet per second 20 feet, this plant to be increased at a later date.

The type of pumping engines will not be decided until next spring, when tenders will probably be invited for different kinds, for this and three other pumping stations. The brick sewer will continue to



Addison Street, where it will receive the main intercepting sewer of East Boston. The East Boston pumping station is to be situated here.

The sewage of all the towns through which the main sewer has passed, in fact of all the towns north of Mystic River, is brought to East Boston without pumping.

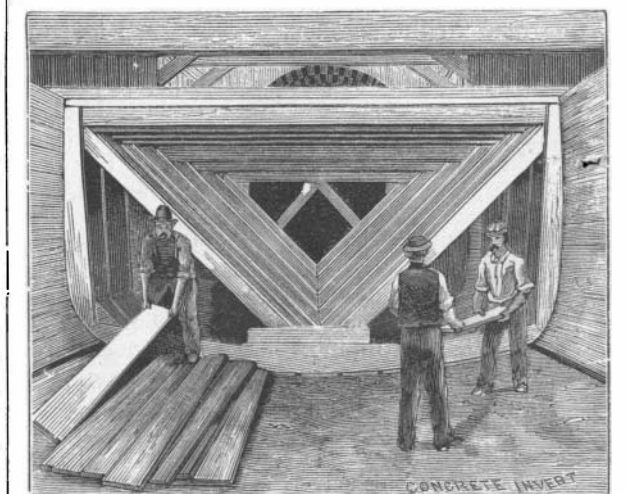
Of the cities and towns south of Mystic River, the sewage of Arlington and Belmont, of the west ends of Cambridge and Somerville, part of Medford is brought by the Alewife Brook branch and will be pumped a height of about 14'6 feet into the main sewer near West Medford. The sewage from Charlestown, most of Cambridge and Somerville and part of Medford will be brought by the Cambridge branch sewer to a pumping station near the middle of the Mystic River, at Malden Bridge. The sewage is here raised by pumping about 12 feet. The sewage will be conveyed under Mystic River by two conduits; after it has passed the pumping station, the sewage will be conveyed in a brick sewer 6 feet 6 inches in diameter to the main sewer in Everett.

At East Boston the sewage of all the towns except Winthrop is pumped to the height of about 15'9 feet and conveyed in a brick sewer 9 feet in diameter, having its invert about 3'1 feet above low water at the upper

	Population according to U.S. Census.		Estimated Population by Sewerage Commission.		Cubic Feet Per head per day.	Sewage Per second.
	1880.	1890.	1890.	1930.		
Arlington....	4,100	5,629	5,000	10,000	30	3'47
Belmont....	1,615	2,098	1,900	4,000	30	1'39
Cambridge....	52,669	70,028	67,000	130,000	35	52'65
Charlestown..	36,760	45,050	40,900	64,100	30	22'24
Chelsea.....	21,782	27,909	27,500	49,100	30	17'01
East Boston..	28,120	35,150	32,100	56,000	30	19'42
Everett.....	4,159	11,068	7,200	29,000	30	10'01
Malden.....	12,017	23,031	17,900	52,000	30	18'05
Medford....	7,573	11,079	10,100	22,000	30	7'63
Melrose....	4,560	8,519	7,000	20,000	30	6'94
Somerville..	24,933	40,152	34,800	82,000	35	33'18
Stoneham...	4,890	6,155	6,700	11,300	30	3'92
Winchester..	3,802	4,861	5,000	10,300	30	3'58
Winthrop....	1,043	2,726	1,900	8,100	30	2'78
Woburn.....	10,931	13,499	13,200	23,500	30	8'16
Totals.....	218,954	306,854	278,600	571,300	—	210'43

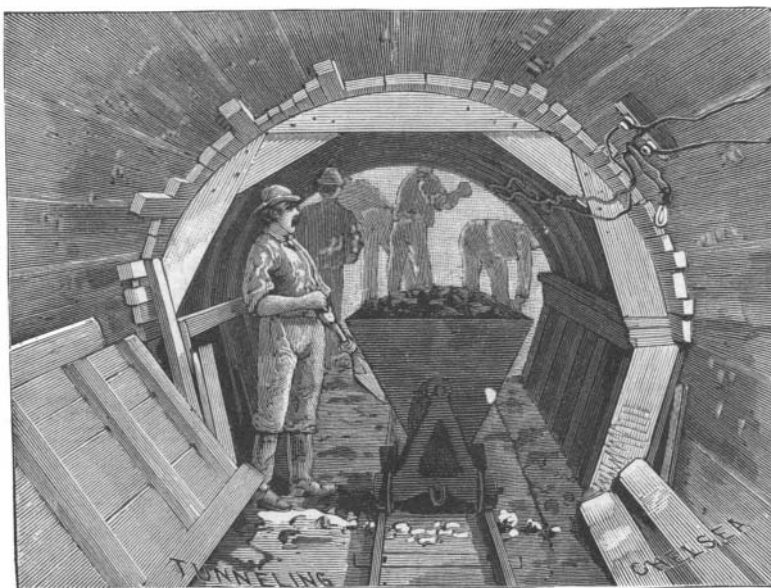
The following is the estimated cost of the North Metropolitan Sewerage System, providing inlets for all towns in previous table and with outlet at Deer Island..... \$4,159,453
 Cost of additions to the work up to 1930..... 234,400
 Total cost of work up to 1930..... \$4,393,853
 The estimated cost of the Charles River Valley System is..... 804,243
 Making a grand total for both systems of..... \$5,198,096
 The amount expended and liabilities incurred by the sewerage commissioners up to September 30, 1892, for both systems, was, in even figures, about.. \$2,600,000

Ground was first broken for the metropolitan sewerage construction in May, 1890. There are now twenty-five gangs at work. Measured by its proportional value, between half and three quarters of the total work has been completed, and about nine per cent more now is under contract. Surveys, studies, and plans have been made for a considerable portion of



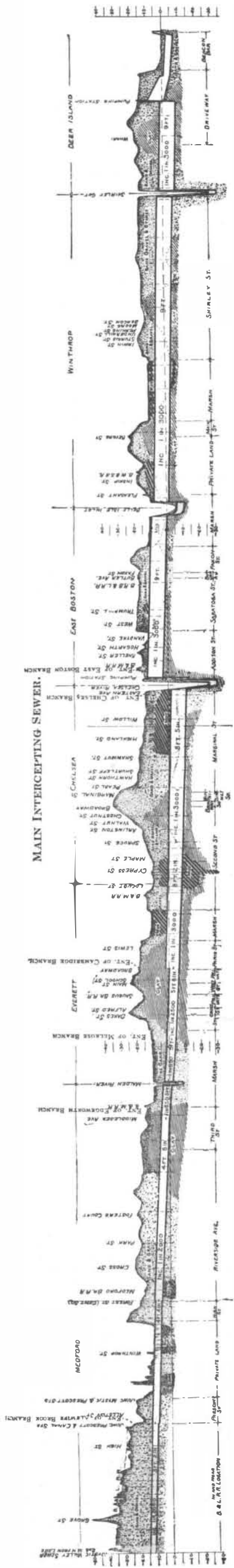
the remainder, and, unless some unforeseen delay occurs, the whole work may be completed in 1894.

The views which we give on our front page, of the actual construction of the sewers, were taken from photographs, and show what thousands of our readers



by two conduits, the route of the sewer can be traced on the map on front page. The Chelsea River is crossed by two conduits. The siphon under Chelsea River is located between the highway and railroad bridges—see diagram drawing. The ground for the

end, passing through Breeds Island and Winthrop to another pumping station in Deer Island, a distance of about 5 miles, where the invert is about 8 feet below low tide. Belle Isle Inlet and Shirley Gut are each crossed by inverted siphons.



have seen in Chelsea, Medford, and Malden, as well as in many other sections of the district. The masonry work, shown at bottom of our front page, will give an idea of the magnitude of the work as well as the concrete invert and the tunneling view on the second page. The view of upper part of centering for sand catcher shows the top of the centers, laggings, etc., and will, perhaps, serve to convey an idea of the immense amount of detail work necessary in a work of this kind. We also give a sketch of the proposed pumping station at East Boston, where the sewer crosses under Chelsea Creek with the sand catcher in position. The diagram as given shows mean high and mean low water levels.

We also show a profile diagram of the main intercepting sewer, showing approximate mean low water of the sea, character of the ground in profile section as judged by soundings and surface indications, and indications of the size and grade of sewer. This diagram is taken from a preliminary report made to the Legislature in 1889. Most of the sewers have been built larger than originally designed, to correspond with the increased population as determined by the census of 1890.

It will be noticed that the Carson trench machine is largely used in the construction of these sewers. A detailed view of the operations of this machine is given on page 390, from which will be seen the comparatively small area of street disturbed during progress of sewer construction when it is used. This machine or one like it is a necessity for many portions of the work, such as crossing the marsh, as shown in view in Malden on front page, where teams could not be used. The detail drawing, supplemented by the other views, explains the system so clearly that we do not think a detailed description necessary.

During the past year about 13,000 tests have been made to aid in selecting such kinds of cement as are best adapted to this work, and pains have been taken to make these tests of a practical character. Greater

Our thanks are due to the commissioners and chief engineer of the Metropolitan Sewerage Commission for the many facilities granted us in the preparation of this article.

The Astounding Military Force of Europe.

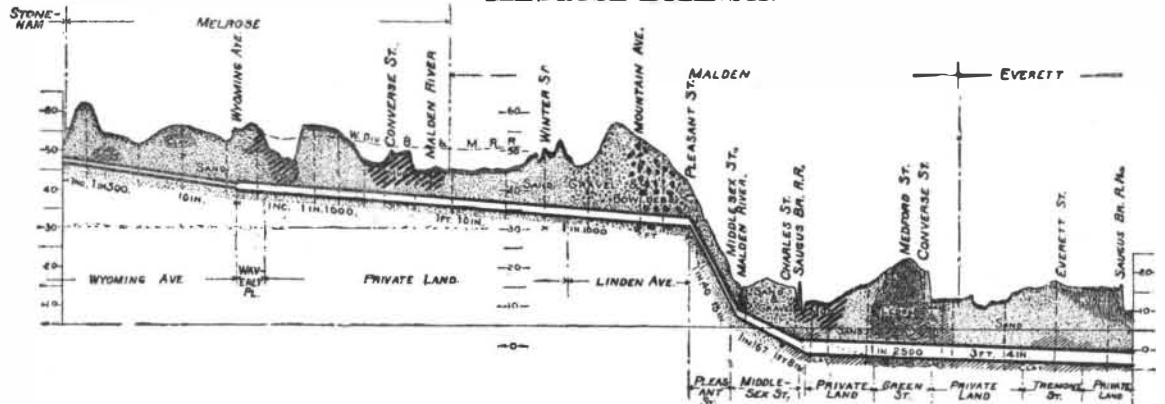
The official data relating to the growth of European armies are set forth in a pamphlet which has just been published in Paris by Captain Molard, of the Military School of St. Cyr.

It appears that in 1870 the soldiers and militia of France nominally amounted to 1,330,000 men, but as is well known, only a fraction of these could be promptly mobilized and turned to account against the Germans. On paper Germany had a slightly smaller force, namely, 1,300,000, but proportionally a much larger could be at once placed in the field. At the same epoch the military establishment of Russia comprised 1,000,000 soldiers, that of Austria 750,000, that of Italy 570,000. Switzerland had 150,000, and Belgium 95,000. Including England, Spain, Portugal, Denmark, Sweden, Norway, and the Balkan States, for which details are not given, the whole of Europe in 1870 could, at the utmost, put 7,000,000 men in active service.

What is the situation to-day? This year the French army has risen to 2,500,000, the Russian to 2,451,000, the German to 2,417,000; the Italian, which now occupies the fourth place, to 1,514,000; the Austrian to 1,050,000; the Swiss to 212,000 and the Belgian to 128,000. In most of these countries the expenditure for military purposes has more than doubled since 1869, and in Switzerland the increase has been much greater. Viewed collectively, Europe now spends more than a thousand millions of dollars annually on her fighting force, which already amounts to 12,500,000.

Such figures, however, give but an imperfect idea of the state of things which will presently exist as soon as the new military laws shall have come into full effect. Then the German army will comprise 5,000,000 men; the French, 4,350,000; the Russian, 4,000,000;

MELROSE BRANCH.



reliance was placed on those in which sand and cement were mixed in the same proportions as used on the work than on those made with neat cement. All of the briquettes for testing are now placed in tanks where the water is continuously renewed. In addition to tests for indicating the strength of the different kinds of cement, other tests of various kinds have been made, including some to indicate changes in volume which take place under different conditions while crystallization is going on.

The interior cross sections of the metropolitan sewers have not usually differed very much from a circular shape. In the deviation most extensively used the horizontal diameter is about 6 per cent less than the vertical and the invert is flatter than a semicircle. In this shape the area, perimeter and the theoretical velocity, when flowing more than one-sixth full, differ but little from the corresponding elements in a circle having the same height. In actual construction under the conditions that usually obtain on our work this shape is more stable when entirely completed than a circular shape, but more care is required during construction to prevent injury to the invert.

In a number of places the normal shape of the sewer has been considerably and abruptly widened and flattened to pass under culverts, sewers, and other objects whose positions could not be very much changed. These widened and flattened sections may act to some extent as sand catchers. Those that occur on the North Metropolitan system will aid the sand catchers which are required at the siphons. The work is making good progress, and when the extent of ground covered is considered, and the many difficulties encountered, such as crossing railroads, creeks, marshes, etc., etc., we think the residents of the district have good reason to congratulate themselves on the near completion of this system, which will add so much to the comfort and healthfulness of this section.

There are five pumping stations required to lift the sewage so it will flow to the outlets. They are located near West Medford, Somerville, Chelsea, and on Deer Island in the North Metropolitan District, and near Savin Hill in the Charles River Valley District. These stations are all plainly marked on map on front page.

the Italian, 2,236,000; the Austrian, 1,900,000; the Swiss, 489,000; and the Belgian 258,000. Altogether, Europe will be able to dispose of not less than 22,000,000 soldiers, or 15,000,000 more than she had in 1869. Such is the price which she has to pay for Germany's seizure of Alsace-Lorraine. It is at least possible that her fighting force might be cut down by two-thirds tomorrow were those provinces restored to France.—*N. Y. Sun.*

An Eye-Opener on Coinage.

Superintendent Allen, of the Butte and Boston Mining Company, of Montana, has sent a letter to the Secretary of the Treasury offering to make any amount of much better silver dollars for ninety cents apiece than are at present in use. Mr. Allen takes the position that counting silver at 85 cents per ounce, the intrinsic value of a silver dollar is only 65.71 cents. He would put in each dollar 400 grains of pure silver, whereas the present dollar only contains 371 1/4 grains, and he would number and letter each coin, so that the government would not be compelled to redeem duplicates, a safeguard now neglected. Mr. Allen says he would reap a profit in coining while the price of silver was anywhere under 129.29. The letter adds:

"While it has always been possible to recognize counterfeit paper money, the present silver coin can be produced at a profit of 53 per cent, and a coin that cannot be detected. This is true of silver money, whether foreign or American. Now, my proposition is either to withdraw the present silver money before the excess becomes so large that it will bankrupt the government to redeem it, or combine with foreign powers who are equally in danger and make the old standard of value, \$1.2929, which will make a coin which cannot be counterfeited without the use of base metal alloy, which is easily detected, and for which the government will never have to pay a face value."

THE conditions required for the profitable feeding of swine are (1) clean, dry, warm quarters, protected from wind and draughts, (2) as much wholesome feed—if grain, preferably *ground* fine—as they will eat clean, three times a day, and (3) free access to a mixture of salt and ashes, to sods or to soil.—*Can. Farm Bull.*