The main sewer is about $3\frac{1}{4}$ miles long, and extends from the pumping-station at Old Harbor Point to the junction of Huntington Avenue and Camden Street. Its inclination throughout its whole extent is 1 foot vertical in 2,500 horizontal. At the pumping-station the water-line of the invert, i.e., its bottom, is about 14 feet below the elevation of mean low tide. From this point, in its course towards the city, the sewer passes for about a mile across the Calf Pasture Marsh, so called. The surface of this marsh is about six inches above mean high water, and, the mean rise and fall of the tide being ten feet, the average depth of excavation required for this section of work was 24 feet. Up to the junction of the South Boston intercepting sewer the main sewer is ten feet six inches in diameter. It was founded sometimes upon clay and sometimes upon sand. Figs. 1 and 2, Plate VI., show the usual methods of construction. Rubble side walls were built for the greater portion of the distance. Fig. 3 shows the bond used in the spandrels.

On this section occurred the only case during the construction of the entire Main Drainage Works in which a sewer was broken so that a portion of it had to be taken down and rebuilt. At one point, for a distance of 150 feet, the marsh mud, which usually was from five to ten feet deep below the surface of the ground, came down below the spring-line of the sewer. Owing to carelessness, on the part of the contractor, in back-filling around the haunches, or in withdrawing the sheet planks, the sewer spread six inches, and sank correspondingly at the crown. Fig. 4 shows the shape assumed at the point of maximum distortion. Although even this portion was probably stable, it was not considered wise to establish a precedent of accepting any imperfect work. Accordingly the trench was reopened, the sewer uncovered, and its arch broken down with sledge hammers.
It was found that the 12-inch Akron drain-pipe built under the sewer, to facilitate drainage of the trench during construction, was broken at this point, and the water from it, accumulated from 4,000 feet of trench, found an outlet and poured over the side walls into the invert. This water was controlled by pumps, but was found to have washed out a quantity of sand, causing a considerable cavity under the sewer platform. The limits of the cavity having been determined, five holes, ten feet apart on centres, were made through the bottom of the sewer and 3-inch wrought-iron gas-pipes were inserted into them. Two of these pipes were about 30 feet long and three others, for vents, were five feet long. Constant streams of grout, made from 47 casks of neat, quick-setting Portland cement, were forced under a 25-foot head, through the long pipes into the cavity until it was filled, as proved by the cement rising in the short pipes. The grout hardened and furnished a secure foundation. Special ribs were cut to fit the invert, which was again arched over and the trench refilled.

Figs. 5 and 6, Plate VI., show methods of connecting manholes with the main sewer. These structures are about 400 feet apart, and are placed alternately on one side of and over the centre of the sewer. At man-holes the arch is supported by cut-granite skewback stones. At the top of the man-holes are cast-iron frames supporting circular iron covers. The covers are perforated for purposes of ventilation. The holes are quite large, so that they are not liable to become stopped up. They also taper considerably, being larger below than they are on top. To prevent road detritus and miscellaneous rubbish from falling into the sewers, catch-pails are suspended below the covers to receive whatever may fall through the holes. The pails are of galvanized iron, well coated with tar. They can be lifted up, emptied, and replaced, as occasion demands. Wrought-iron steps were built into the man-holes during construction. These details are shown on Plate VI., Figs. 7 and 8.

Above the point where the South Boston intercepting sewers join the main sewer the latter is nine feet in diameter. For about half a mile the ground is high, but a location through
it could not be avoided without making a considerable detour. For 1,900 feet, in Mount Vernon Street, the sewer was built by tunnelling through conglomerate rock and coarse sand. The rock, where it surrounded the tunnel, presented no serious obstacle; but the sand tended to run into the excavation, and required close sheeting and heavy bracing to support it. Fig. 9, Plate VI., shows the sewer in tunnel on this section. For several hundred feet the sewer grade was near the surface of the ledge and, the latter being very irregular and covered with boulders, tunnelling operations were attended with much difficulty, and several caves occurred. For a length of 100 feet the ground was opened from the top and the sewer was built in an open trench about 45 feet deep.

The sewer in the tunnel was well built, but after completion, on removing the pumps so that the water table in the vicinity was permitted to rise above the sewer, the latter was found to leak a good deal. The leaks, however, could be successfully caulked. The process consisted in taking out a joint, where a leak occurred, to the full depth of the brick and driving in sheet lead for half the depth, the remainder being filled with cement.

Excepting a section in East Chester Park, from Clapp Street to Magazine Street, the main sewer was built by contract. The laying out as a street of East Chester Park, east of Albany Street, had been contemplated by the authorities for some time, and action to that end was taken in time to permit the sewer being located there. The borings on this line showed that there were beds of marsh mud between Clapp and Magazine Streets which were from 20 to 86 feet deep below the marsh surface. As it would have been difficult to build a stable sewer in such ground, and impossible to prevent one, if built, being destroyed when the street should be filled over and around it, it was decided to fill the street to full lines and grades before attempting to build the sewer.

A contract was accordingly concluded by which the street was filled with gravel brought by the N.Y. and N.E. Railroad. So great was the settlement of this filling into the mud that over 106,000 cubic yards of gravel were required. The marsh
level for 100, or more, feet on either side of the filled street was pushed up by the filling from 8 to 14 feet high. A surcharge, 20 feet wide on top and eight feet high, was put upon the street, west of the N.Y. & N.E. Railroad, where the mud was deepest, to insure prompt settlement.

Building a stable sewer in a street so recently filled being a difficult operation, requiring methods of treatment which cannot be determined upon beforehand, it was thought best to build this section by day’s labor.

As a masonry structure would have been broken when the trench was refilled, a wooden sewer was adopted (Fig. 10, Plate VI.). This consisted of an external wooden shell, formed of 4-inch spruce plank, ten inches wide, every fourth plank being wedge-shaped; the whole securely spiked and trenched together and finally lined with four inches of brick or concrete masonry.

The depth of excavation for this sewer was from 32 to 36 feet, and the pressures were so great as to require very heavy bracing. As many as 60 braces of 8 inch X 8 inch, or heavier timber, were sometimes used for a length of 18 lineal feet of trench; and these, when taken out, were all found to be either broken or so crippled as to be unfit to use again. Frequently the earth on one side of the trench was found to be different from that on the other, which caused very unequal pressures, so that internal bracing was necessary to maintain the sewer in its proper shape until the trench had been back-filled. It was found necessary to build the shell with a vertical diameter four inches greater than was required for the masonry lining, to allow for settlement, change of shape, and compression of the timber. The vertical diameter inside of the lining was also increased, so that, if in places the sewer should settle as a whole, the bottom could be brought to the true grade, and still leave the established sectional area.

The length of this section was 1,894 feet. Ground was first broken in August, 1879, and the work was completed in October, 1880. For excavating and back-filling the trench, machinery designed by the Superintendent, Mr. H. A. Carson, was used. The average cost per lineal foot of the completed sewer
was $56. For several hundred feet, where the mud had been deepest, a continual slight shrinkage and settlement of the gravel filling under the sewer occurred for a year or more. The sewer itself, also, settled in a long curve, whose greatest depth below the original grade line was about 18 inches. A masonry sewer would have been broken by such movement, but the wooden one having considerable flexibility was apparently uninjured. At present (1885) the street seems to have assumed a condition of permanent stability.

In East Chester Park, from Magazine Street to Albany Street, clay was chiefly encountered, and the sewer generally consisted of a simple ring of brick-work without side walls, and its construction presented few features of special interest. As a precaution in passing within 35 feet of a large gas-holder, tongued and grooved 4-inch sheet planks were driven, and the trench was back-filled with concrete to the crown of the sewer arch (Fig. 11). In passing across the old Roxbury Canal, which had been recently filled by the city, an influx of tide-water along the loose walls of the canal and through the filling occasioned some delay and expense. The water was finally kept out by double rows of tongued and grooved sheet-piling. A side entrance and boat-chamber (Fig. 12), were built on this section, at the corner of Swett Street. The latter structure resembled a very large man-hole, with a rectangular opening from the street, 11 × 4 feet in dimensions. This was built to allow the lowering of boats into the sewer.

At Albany Street the east-side intercepting sewer joins the main, and above this point the latter is again reduced in size, to eight feet three inches wide by eight feet five inches high. The extra horizontal course was put in at the spring line because it was supposed to facilitate dropping and moving the centres. In East Chester Park, and Washington Street from Albany to Camden Street, the sewer was built chiefly in clay, and consisted of a ring of brick-work. For about 300 feet, however, near Albany Street, mud was found, and a foundation, consisting of a timber platform supported on piles, became necessary (Fig. 13, Plate VI.).

In Camden Street, from Washington Street to Tremont
Street, a distance of 1,391 feet, the depth of trench required would have been 26 feet. Camden Street is rather narrow, and contains sewer, gas, and water-pipes. As good clay was found at a depth five or more feet above the top of the sewer, it was thought that it would be as cheap to the city, and decidedly less annoying to residents on the street, to build the sewer by tunnelling beneath the surface (Fig. 14). Working shafts were sunk about 250 feet apart, and headings in each direction driven from them. At one or two points the miners permitted the roof of the tunnel to settle slightly, by which the common sewer above was cracked, and some trouble caused by the sewage leaking into the tunnel. The main sewer was back-filled above the arch with clay, packed in under the lagging as firmly as possible. On the whole the method of construction was successful, and a well-built sewer was obtained. Its cost was $22.52 per lineal foot.

At Tremont Street, the Stony-Brook intercepting sewer is taken in. At this point, as at all other places where intercepting sewers join the main sewer, the grade of the latter rises abruptly somewhat less than a foot, or enough to maintain the established inclination on the surface of the sewage at the time of maximum flow. From Tremont Street to the present end of the main sewer, at Huntington Avenue, the sewer was built in open cut (Fig. 15), and for a large part of the distance needed side walls and piling for its support. Just west of the B. & P. R.R. another bent-chamber and side entrance (Fig. 16) were built, and a third side entrance, reached by a stone stairway leading from the sidewalk, was constructed at Huntington Avenue.

The total cost of the 3.2 miles of main sewer was $606,031 being an average of $36.09 per lineal foot.