by 1¼ inches will be inserted to act as a water-stop, and prevent leakage at these joints.

It will be noted in the cross-sections of the aqueduct that in each case there is a central wooden box drain and a platform consisting of two thicknesses of 1-inch boards, the upper one being fluted on the under side to furnish channels in which the water may flow from the side to the drain. This arrangement is shown in Fig. 3. The platform furnishes a dry bottom upon which the concrete bottom of the aqueduct will be built and kept dry until it has had time to set. Although the drawing shows a double platform, a single board with grooves in each edge may be used where there is but little water to be taken care of. The boards are to be bedded in sand.

The Steel Pipe Line.—From the end of the concrete aqueduct, near Transcona, a 5-foot pipe line 43,200 feet in length, will convey the supply as far as Red River. This pipe will be of rivetted steel, ⅜ of an inch in thickness. At its upper end a valve it to be provided for shutting off the supply, while above and below this valve there will be branches, each provided with a valve to be used in the future in connection with the reservoir and

The remaining 12,000 feet of pipe to McPhillips Street reservoir is to be laid for almost the entire length in the city streets, and a 48-in. cast-iron pipe has been adopted. This for the reason that steel is less desirable in city streets than cast-iron pipe, and that a pipe larger than 4 feet in diameter interferes too seriously with other structures. The pipes which are to be laid in the streets will be laid to such a depth as to permit a 4-foot covering of earth.

East of Transcona, where the aqueduct will not follow the streets, but will be laid through the open country, a cheaper and more expeditious plan will be adopted of building it in a shallow trench from 3 to 4 feet deep, where practicable, and covering it to a depth of 4 feet with an earthen banking, the top width of which will be at least 8 feet, and nowhere less than the inside width of the aqueduct, so as to make the slopes of the embankment 2 horizontal to 1 vertical.

Gradients.—For a distance of 33,000 feet (6.26 miles) from Indian Bay, the gradient of the aqueduct has been made so low that is falls only .11 of a foot in 1,000. This low gradient was adopted for this distance to diminish

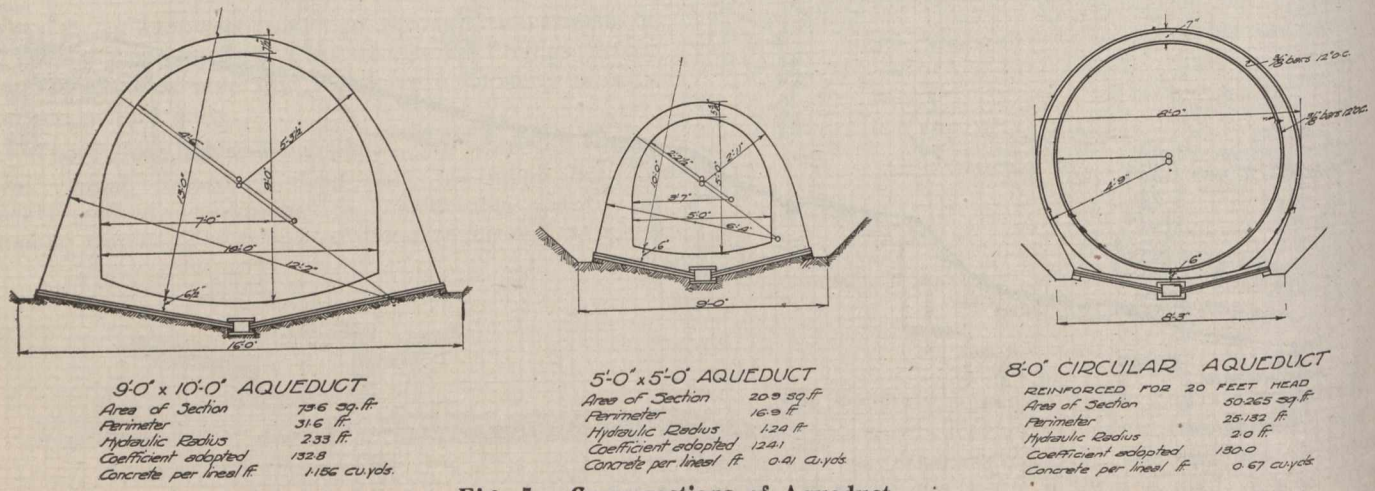

Fig. 5.—Cross-sections of Aqueduct.

pumping station to be installed when the 25,000,000-gallon supply to the city becomes inadequate.

Where the pipe crosses the Seine River, a new street has been projected, the design of which provides for the erection of a 30-foot arched culvert, filling over it with earth, and it is intended to lay the steel pipe in this earth.

The Cast-iron Pipe Section.—Reaching the Red River, a tunnel extending about 900 feet horizontally across the river from a shaft in Victoria Park to a corresponding shaft in the opposite side, each 75 feet in depth, will carry the supply in a 60-inch cast-iron pipe, 1.9 inches thick, and provided with a special bell about 15 inches long, so designed as to permit the joints between the pipe lengths to be caulked from the inside with lead wool. The tunnel is to be of only sufficient diameter to permit the placing of the pipe. This provides a minimum of 6 ft. 3 in., although the average diameter, owing to the irregularities in blasting, will be considerably more.

All spaces between the pipe and the sides of the tunnel are to be filled with concrete, as far as it is practicable to place concrete, and the remaining space is to be filled by pumping in cement grout, the aim in using such thick pipe and in filling all spaces with concrete or cement grout being to make absolutely secure this portion of the pipe line which will be inaccessible unless the water is shut off, and the pipe is emptied by pumping.

the depth of the summit cut and is the most economical gradient, all things considered. As stated, the aqueduct through this section is 9 feet high and 10 feet wide.

For the next 25,000 feet (4.74 miles), the fall per 1,000 is .25 of a foot. The large sized aqueduct, 9 feet high and 10 feet wide, is continued for 15,000 feet of this distance and a smaller aqueduct, 8 feet high and 9 feet wide, for the remainder of the distance. This design is the result of hydraulic computations, which show that with these sections of the aqueduct as planned 85,000,000 gallons daily will flow through the aqueduct when the water in the bay is 3.75 feet below high-water level, provided the water has such a free entrance through the intake and gate and screen chamber that it does not fall more than .25 of a foot in passing through them.

Beyond the three portions of aqueduct above described, the gradient of the aqueduct has been made to follow approximately parallel with the surface of the ground all the way to its end near Transcona, and a size has been adopted for each gradient, with a few exceptions which would give the aqueduct the standard capacity of 85,000,000 gallons per day.

The quantity of water which will flow through the reinforced section of aqueduct, used for the last 26,000 feet, will not depend upon the gradient of the aqueduct