Concrete and Concrete Block Sewers in St. Joseph, Mo.

St. Joseph, Mo., is in the northwest corner of the State and covers an area of 9.73 square miles, with a 3.5-mile frontage on the east bank of the Missouri River. The central business portion of the city is built on comparatively level ground, but back of and to the north of this district is a series of steep bluffs, which are cut through by narrow valleys leading to the river. The storm water run-off from these bluffs is heavy and follows suddenly after a rainfall. The sewerage system of St. Joseph is built to carry the combined domestic and storm-water flow, which is discharged into the Missouri River. The original sewer system was begun 25 years ago and from that time until 1902 the main sewers were with very few exceptions built entirely of brick; the few exceptions are those built of native limestone. The later, or district sewers, which include all sizes from 8 to 30 in. in diameter, have been built of vitrified sewer pipe. The main sewers are paid for by the city out of the general fund raised by taxation and have been extended each year as much as the funds available for this purpose, would allow. The lateral or district sewers are paid for by the property owners.

The main sewers were mostly built up the valleys between the bluffs and served the developed portion of the city. The recent rapid growth and extension inland, of the residential districts has required the extension of the main sewers and the building of lateral systems for the recently developed areas. The requirements for the extension of the main sewers being greatly in excess of the available funds the city issued bonds for this special purpose; the amount realized from the sale of these bonds being $225,500. This amount was apportioned and appropriated for the extension of 6 of the main sewers which would serve the greatest extent of the newly developed area. Work on two of the extensions has already been completed and on three others is nearing completion, while on the remaining one, the work has just fairly begun. The capacity of the old main sewers, with two or perhaps three, exceptions, is thought to be entirely adequate to carry any flow that will ever reach them, even after most of the areas tributary to the various mains have been entirely built up and paved. For that reason no new main sewers have been built at this time in the area covered by the city proper.

The extensions have all been built of plain concrete, reinforced concrete or concrete blocks. The larger reinforced-concrete sewers were built according to the system controlled by Mr. W. C. Parmley, and the concrete block sewers were built according to designs also controlled by Mr. Parmley. The largest sewer to which an extension has been built is known as the Blacksnake Creek sewer. This sewer has a somewhat elliptical or oval shape, and at its mouth has a diameter of 17.5 ft. vertical by 14.5 ft. horizontal. In 1903 this sewer was extended for a distance of 114 ft. toward the river, under the tracks of the Chicago, Burlington & Quincy and the Chicago Great Western Railways in order that the old creek bed might be filled and the bridges then in use abandoned. This extension was built of concrete. The Blacksnake Creek sewer extends from the Missouri River up the valley of a stream called Blacksnake Creek. This creek has a drainage area of about 8 square miles of rough country between two rows of bluffs, one to two miles apart. Although the storm water flow from this area is heavy, the stream during certain seasons is nearly dry, and the domestic sewage that reached the creek above
The steel reinforcement consists of transverse bars and longitudinal rods, placed as shown in the cross-section. The transverse bars are \( \frac{3}{16} \times \frac{3}{4} \) in. in section. The bars near the intrados of the sewer arch are placed 2 ft. on centers; those near the extrados are also 2 ft. on centers. The longitudinal rods are \( \frac{3}{16} \) in. in diameter and are interlaced between the transverse bars.

The sewer barrel is first built up to the springing line of the arch; pieces of the transverse bars long enough to extend 1 ft. 6 in. above that line being placed in the haunches of the arch. After the forms and lagging have been placed for the upper half of the sewer the arch bars are carefully placed and fastened to the side bars with clamps, the detail of which is shown in one of the illustrations. The longitudinal rods are next wired to the arch bars and the work is then ready to receive the concrete, which is mixed very wet in order to permit it to flow completely under and around the steel bars.

A 3-ft. sewer, 902 ft. long, built of Parmley concrete blocks connects with this 8-ft. sewer. The cross-section of this 3-ft. sewer is shown in one of the accompanying illustrations. The sewer barrel is built in four sections, an invert, two side sections and a closing section at the top. These sections are made 1 ft. wide and are cast in specially designed forms. One side of each of the sections, except the invert section, is cast with a projection \( \frac{3}{4} \) in. wide and 1 in. thick, which has its inner face flush with the inner face of the sewer barrel. The sewer barrel is built in 1-ft. lengths, the projections on one side of one set of 4 sections abutting against the straight side of the adjoining set. A \( 1\frac{1}{16} \times \frac{3}{4} \)-in. bar is warped around the upper 3 of each set of 4 sections, as shown in the cross-section, in the outside groove formed in the joint between the two sets of sections by the projections on one set of blocks. The remaining space in this groove is then filled with cement grout.

Another of the main sewers known as the Mitchell Ave. sewer has a diameter at the river of 14 ft. vertical by 12 ft. horizontal, and was built entirely of brick for a distance of 8,175 ft. Where the brick sewer ends, the size had been...
reduced to a diameter of 10 ft. vertical by 8.5 ft. horizontal. This sewer has been extended 1,752 ft. by the construction of a plain concrete sewer circular in section and 9 ft. in diameter. From the end of this 9-ft. sewer, there are two branches, one an 8-ft. plain concrete sewer, which has already been built for a distance of 650 ft., and the other a 6-ft. plain concrete sewer of which 700 ft. has been built. Work is now in progress on both of these branches, and it is expected that they will be completed within the next 60 or 90 days.

A cross-section of the 8-ft. sewer is shown in one of the accompanying illustrations in which the full lines show the general, or regular, section, and the dotted lines, the section used under special conditions. The general section required 1.15 cu. yd. of concrete per linear foot as compared with 0.63 of a cu. yd. per linear foot required in the reinforced-concrete sewer of the same section. The contract price for the 8-ft. sewer built of plain concrete complete, without the cost of excavation or back-fill, was $6.90 per linear foot on the Mitchell Ave. sewer. The contract price for the 8-ft. reinforced concrete sewer, complete without cost of excavation or back-fill was $6.30 per linear foot on the Grand Ave. sewer. The comparatively low price of concrete materials in St. Joseph and the extra cost of placing the steel and concrete in the reinforced sections makes the actual cost of plain and reinforced-concrete sections about the same, with the difference, if any, in favor of the plain concrete, according to Mr. William H. Floyd, Jr., city engineer of St. Joseph.

Included in the work to be done with the $255,500 appropriation is the provision for the partial construction of a system of sewers for a newly developed territory around the packing house district in the southern part of the city. This district is largely at the foot of high bluffs, ½ to 1 mile from the river. Between these bluffs and the river is a low, flat bottom that is just above extreme high water in the river. The heavy storm-water run-off from these bluffs frequently floods the land around the packing houses and stock yards in the low area before it reaches the river. In order to carry this flood flow immediately to the river and to provide an outlet for a sewerage system for the district near the bluffs, an 8-ft. reinforced-concrete sewer is being built across this area. This sewer is 3,900 ft. long, and as it is built according to the Parmley design it is similar in construction to the Grand Ave. sewer. A system of 3½ to 5-ft. sub-mains, of either concrete blocks, or plain concrete will be constructed in connection with this main outfall.

The 8-ft. sewer after crossing the low, flat bottom will have to pass under 19 railroad tracks. Where it passes under these tracks, a special form of section will be used which will require 1.21 cu. yd. concrete and 17.3 lb. of steel per linear foot; the thickness of the concrete at

the crown of the arch being 9 in.; at the springing line of the arch and at the invert, 10 in.

The extensions of the main sewers and the new sewers that have been built were designed and are being constructed under the direction of Mr. William H. Floyd, Jr., city engineer, of St. Joseph.
Mouth of 13 by 15 Foot Blacksnake Creek Sewer at St. Joseph, Mo.

Types of Sewers at St. Joseph, Mo.