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SEWER OUTLETS AT NIAGARA FALLS, ONT.

By Chas. H. Mitchell, Town Engineer.

The sewerage works now under construction at Niagara Falls, Canada, present several novel features which are worthy of description. The system generally differs little from modern sewer construction, but the outlets through which the sewage is discharged are peculiar and have received considerable attention.

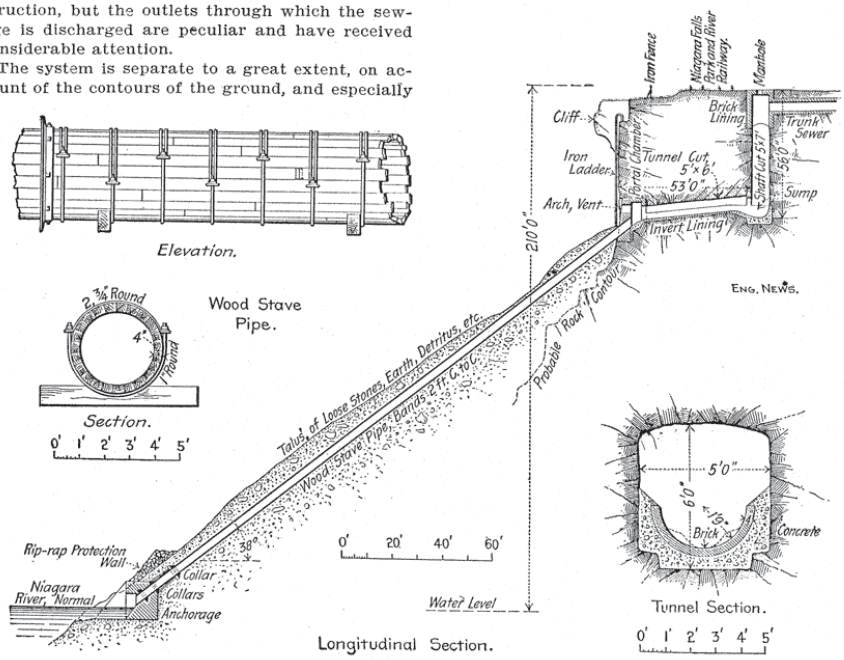
The system is separate to a great extent, on account of the contours of the ground, and especially as a creek flows through the chief portion of the city, toward which for many blocks there is a distinct fall, thus permitting of the ready disposal of surface water. The lower quarter-mile of this water course is covered in by a substantial stone culvert, 6 × 7 ft., and the city is now continuing this work up to a point such that danger from flood and overflow is minimized. Besides this, the present sewer construction provides for a relief overflow during time of freshet by an inlet at a point further up the creek into a trunk sewer, which here changes from an 18-in. pipe to a 36 × 48-in. egg-shaped brick conduit. This trunk sewer continues with the latter section for a half mile, where it empties into the river gorge immediately south of the cantilever bridge. There are two other drainage areas, the upper outlet being near the upper suspension bridge and another midway between the two.

The system when completed will embrace ten miles of sewers, of which at this date nearly half has been completed, including two of the outlets. In the construction, a large amount of rock is encountered, especially in those portions near the river. This rock is a limestone, not difficult to work, and has been taken out of sewer trenches during the past year at a price of about $2.20 per cu. yd.

The 38 × 48-in. brick trunk sewer previously mentioned consists of two rings of brickwork, the inner being complete, while the outer ring was replaced in the bottom by a hollow invert tile. The intention of this was to get the advantages of the invert block for foundation and drainage, and at the same time obviate the disadvantages which are usual with a construction wherein the invert block itself forms the invert of the sewer. There were nine special bricks, forming the lower portion of the invert, burned specially hard, while in the whole there were about 150 bricks per ft. This sewer cost about $4.50 per lin. ft., figured on an all-earth basis, the average cut to grade line being 11.2 ft.

The outlet works demanded entirely original designs, it being necessary to get sewage from the surface, over the cliff and down to the water's edge of the Niagara River, a fall of over 200 ft. The accompanying illustrations and the following description apply generally to the three outlets, the distances and dimensions of course varying somewhat with circumstances.

At points in the river road, which skirts the Canadian bank of the river, vertical shafts 5 × 7 ft., as shown in the longitudinal section, are sunk to a depth equal to the height of the cliff. These are lined at the top by 12-in. brick walls, backed by concrete, and supported by four-course arches set in the rock. The trunk sewers and such other drains as were necessary are securely built into this lining, also iron steps and platforms for purposes of inspection. The covering consists of I-beams and buckle plates, filled in with concrete and macadam pavement, a cast iron manhole top and cover of standard design being set in on one side of the same. The main parts of the shafts are unlined, but at the bottom are solid constructions of paving brick set in concrete backing, with such curves as to form a sump and water cushion from 2 to 3 ft. deep, as the case demands. On the river side of each shaft is a heavy brick wall, with an arch to hold the overhanging rock wall.



DETAILS OF OUTLET SEWERS AT NIAGARA FALLS, ONT.
Chas. H. Mitchell, Town Engineer.

From the base of the cliff a tunnel 5 × 6 ft. in section was driven to the bottom of each shaft, and on a grade of 10%. This was lined on the bottom, only, by an invert consisting of one ring of paving brick laid as stretchers and set in concrete, as shown in the cross-section. In the case of the two smaller trunk sewers, a smaller invert is formed by concrete. At the portal of each tunnel a chamber is built, having in front a heavy stone retaining wall, 4½ ft. thick at the toe, and built into the rock face of the cliff so as to securely support the hanging wall. The interior part is built of brick, backed with concrete, and has steps and supports for a platform. An arch opening, 3½ × 4 ft., is made in the retaining wall to afford ventilation, means of overflow, and access to the interior. This is covered by a grating on the river side. For purposes of inspection, an iron ladder is built down the cliff at each outlet.

One of the most novel features of these outlets is the means of getting down the slope or talus of the river gorge. The materials composing the slope have assumed an angle of repose of about 38°. From examinations which have been made at places in the gorge, it appears that the solid rock shows some such profile as is indicated, and that the regular slope is formed over this, consisting of loose stones, detritus and earth. Percolating through this loose material is a considerable amount of water, arising from springs in the cliffs and rocks, all of which is impregnated with lime. In view of these difficulties, the design of a substantial and economical conduit down the talus demanded careful attention. Masonry, either brick or stone, was out of the question, unless it were possible to excavate through the loose slope to the stable rock foundation beneath, a work of uncertain and very costly extent. Cast iron pipes of a sufficiently large size were not considered practicable, on account of their weight and inflexibility in an unstable ground, they being very liable to part at the joints. Riveted plate pipe would, it was considered, be quickly attacked by the quantities of lime water coming through the slope, and would very soon become disjointed and collapse. The design as now constructed is of wood stave pipe, built of first quality pine, of staves 4 ins. thick, the whole banded every 2 ft. with round iron, as shown in the illustration.

In two of the outlets the interior size of this pipe is 2 ft. (the sewers being 18-in. pipe and 24 × 36-in. brick) and in the third, 3 ft. (the sewer here being 36 × 48-in. brick). Theoretically these outlet pipes are larger than required, but experience with other small pipes down these slopes has shown that gorging frequently occurs, and when such is the case the matter is serious under such velocity. It is claimed for this design that the pipe is very strong, is comparatively light, is durable, being preserved rather than attacked by the water and moisture, is flexible throughout, and is perfectly smooth, offering but little resistance to the passage of water. The wearing action of the sewage is reduced to a minimum in these outlets on account of the extreme angle of the grade and the fact that the system, being separate, carries but little sand or silt, and that only occasionally.

In the construction it was necessary to excavate from the top of the talus downward and construct the pipe from the bottom. A firm foundation for the anchorage at the water's edge was obtained upon a bed of boulders in shale and gravel. The anchorage consists in each case of 70 cu. yds. of stone masonry, and the pipe is firmly embedded in the main portion and anchored by two cast-iron collars. Another collar is placed above each anchorage at a distance of 14 ft. and supported by posts from the face of the masonry. A water cushion 4 ft. deep was obtained at the foot of the pipe.

The lengths of the staves in the pipe varied from 14 to 16 ft., and they were cut to a width of 5½ ins. on the outside face. The staves were painted on all surfaces with two coats of carbolineum, and joints were made in white lead, end joints being secured by a steel tongue. The staves were lowered over the cliff and built into the work singly, as the pipe could not be built in sections. The inclination at which the work required to be carried on rendered it doubly difficult, especially in the unstable material. The mud sills, 10 ft. apart, were first set to grade, the bottom section laid thereon, and templets placed, when the upper staves were put in place, the last ones requiring to be driven home beneath the loosened bands. When the staves in a section were all in, they were driven to their true position from the interior and the bands tightened, after which the back filling was proceeded with, from the bottom upward.

The two outlets now built under this design have cost about $3,600 each. The sewerage system has been carried out under the direction of the writer as chief engineer.