KARST TOPOGRAPHY AND SANITARY ENGINEERING AT ALTON, ILL.*

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In 1926, the City of Alton had a rapidly growing subdivision so located topographically that it was impossible to connect it with any of the existing city sewers without the expenditure of a considerable sum of money for the construction of a pumping station, tunnel or siphon. Therefore, inasmuch as the subdivision is located on the margin of an area of Karst or sink hole topography, it was proposed to dispose of the sewage by running it into a conveniently located sink which was at the time carrying off the surface drainage of the area. The Division of Sanitary Engineering of the State Department of Public Health raised the question whether or not the sewage discharged into this sink would enter Mississippi River above the city water supply intake, located about one-half mile south of the sink (Figure 1). The Illinois Geological Survey was called into consultation by the Division of Sanitary Engineering and this paper describes how the probable point of discharge was determined and the factors involved in the determination.

Factors Influencing Sub-surface Drainage Character of Rock Formations.

The rock formation involved in the region under consideration are the basal Ste. Genevieve and the Upper St. Louis limestones. The Ste. Genevieve is for the most part a pure limestone, locally oolitic. The St. Louis consists of thin, medium and thick beds of limestone some of which are very pure, others very argillaceous. In particular, a bed about 12 inches thick lying beneath a brown layer about 18 inches thick which in turn underlies the conglomeratic beds of the upper St. Louis, is highly argillaceous and in the bluffs about a mile and a half above the business district of Alton is responsible for numerous springs and seeps, as well as a rather extensive development of underground aque-

*Courtesy of the Chief, Illinois State Geological Survey.

ducts which descend to the general level of this bed irrespective of its elevation above the River.

Dip of the Rock Strata.

The dip of the limestone exposed in the river bluff has a great variation due to extremely local warpings, but in general is thought to be from 1 to 2 degrees, approximately S. 20° E.

Jointing.

In the area under consideration there are two principal and rather pronounced sets of joints, one trending about N. 60° E., the other N. 45° W. Of these the former is the most important in influencing sub-surface drainage, for by far the greater number of observable underground water channels trend approximately in the direction of this set of joints.

The Sinks.

The sinks vary in size from relatively large depressions about 300 feet in diameter at the rim and 60 to 80 feet in depth, to small ones of a few tens of feet in diameter and of proportionately shallow depth. Many of the sinks show limestone in their funnels and a few are the termini of small surface drains.

Conclusions Concerning Underground Drainage.

From a study of field evidence the following conclusions are thought warranted, and thought to apply to the sinks of the region:

(1) That the water draining into the limestone sinks descends through enlarged crevices and joints in the rock, moving principally downward until it reaches a layer of limestone which, because of its argillaceous or siliceous character, is less previous, and less soluble than the rock generally.

(2) That joints in these argillaceous beds tend to become clogged by materials, residual from the solution of the calcium carbonate from the rock and by settlings from the descending water whose movement may be partly or wholly impeded by the argillaceous beds.

(3) That the water moves laterally along these less soluble beds until it encounters crevices or joints which have not been closed and permit further downward descent.

(4) That the water entering sinks other than those immediate to the river bluff, flows in rather well-developed, mature sub-surface drainage systems.

(5) That the sinks immediate to the river bluff probably drain toward the bluff and such water as they collect issues through the caverns in the bluff.

(6) That the age of a given sink relative to others in the same region and rock formation is generally indicated by its size, and that the larger and deeper sinks are the older.

(7) That the alignment of the older sinks indicates the route of the oldest underground water channels and that these are probably the course of the major sub-surface drainage.

Determination of Underground Drainage.

With the foregoing points in mind the elevations of the bottom of the largest sinks throughout the area were contoured.[1] The resulting map (fig. 1) shows an alignment of older sinks which suggest that water entering the proposed disposal sink probably takes a southeasterly course, as indicated by the arrows in Figure 1, for about 700 feet. This course is possibly induced by the N. 45° W. joint system. Then, the underground drainage turns almost due south to the sink with an elevation of 120 feet. From this point the direction of flow is problematical because of the lack of elevations on sink bottoms. Either the N. 45° W. set of joints was most effective in influencing the course of the drainage and it went southeast to the Grand Avenue Creek system, itself an enlarged and united series of sinks, or else the effect of the major system of joints, the N. 60° E. set, with offsets in the course of the drainage due to the N. 45° W. joints, should result in the discharge of the water from the spring at A.

With these two potential points of discharge in mind, fluorescein was introduced into the stream of water entering the disposal sink. The dye was introduced at 3:30 P. M.

[1]The elevations of the bottoms of the sinks were taken from a topographic map kindly lent the author by Mr. J. E. Schwaab, City Engineer of the City of Alton.

and had not appeared in either of the potential discharges by 6:00 P. M. The following morning, however, spring A was flowing green water. The color persisted for about 200 feet out into Mississippi River. Examination of other springs along the river bluff in the suspected discharge area failed to reveal the discharge of dye-colored water from any other springs or seeps.

Conclusions.

The phenomena described suggest that at least in some regions of limestone sinks, it is possible to determine the general direction of the flow of underground water from contours drawn on the bottoms of the major sinks of the region, coupled with data on the jointing of the area and its effect on sub-surface drainage.

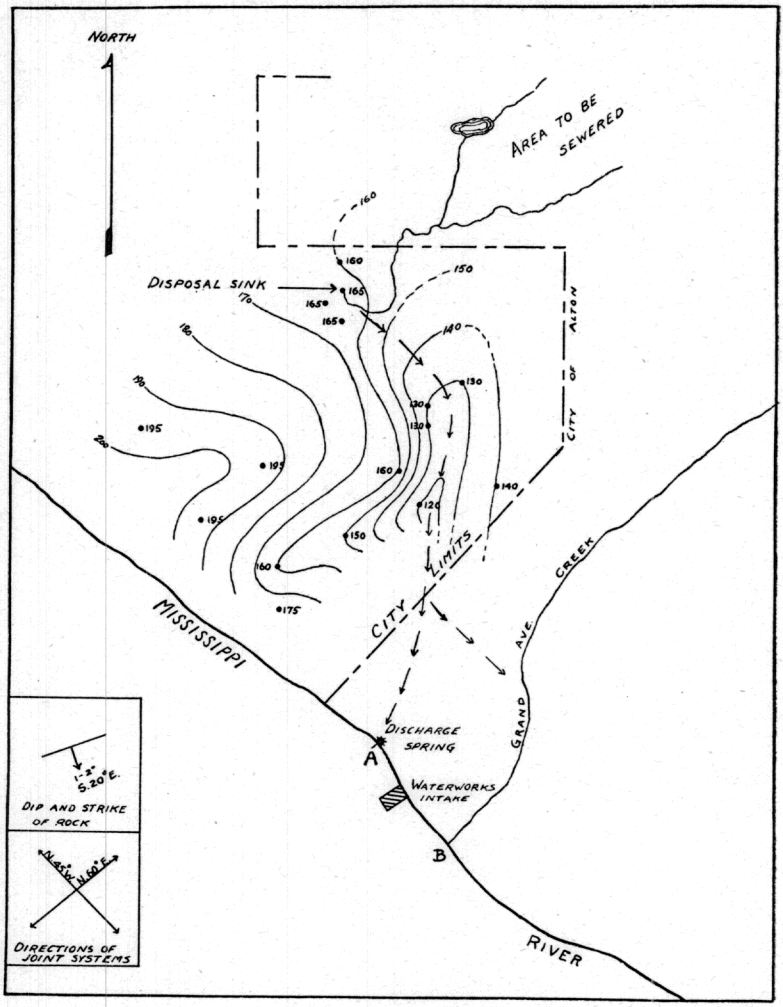
NORTH
AREA TO BE SEWERED
DISPOSAL SINK
CITY OF ALTON
CITY LIMITS
MISSISSIPPI RIVER
GRAND AVE. CREEK
DISCHARGE SPRING
WATERWORKS INTAKE
A
B
DIP AND STRIKE OF ROCK
DIRECTIONS OF JOINT SYSTEMS

FIG. 1.