Probable effects on ground-water resources from construction of the proposed Grand River cut-off channel west of Lansing, Mich.

By

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This memorandum summarizes information brought out in correspondence between the office of the District Engineer of the Milwaukee District, U. S. Corps of Engineers, and the District Office of the Ground Water Branch of the U. S. Geological Survey at Lansing, Mich., concerning the probable effects on the ground-water resources of the Lansing area from the construction of a proposed flood-water cut-off channel for the Grand River to extend from Millett to Delta Mills, in Eaton County, Mich.

The part of the bedrock in the Lansing area of importance to water supply is a series of sandstones, sandy shales, shales, fire clays, and coal beds, which have been termed the Saginaw formation above and the Parma sandstone below. Recent usage by the Michigan Geological Survey includes the Parma sandstone in the Saginaw Group. The beds of this series range in composite thickness from 300 feet to perhaps 500 feet in Lansing and the contiguous suburban and rural areas. The bedrock crops out in numerous places along the Grand River in its course through Lansing and vicinity. A generalized section shows a succession of fire clays, black shales, coal, and thin sandstone members of the Saginaw formation overlying a relatively thick sandstone, the Parma.

There were frequent small to moderate oscillations in the level of the inland sea in which the Saginaw and Parma formations were laid down. The

land surface at the time was probably of low relief and the shore line was marked by numerous embayments that differed greatly in size. These conditions of deposition produced considerable variation in the lithology of the formations over relatively short distances, both horizontally and vertically, especially in the Saginaw. At a given stratigraphic horizon the material may range from dense shale through sandy shale to relatively coarse sandstone, thence through sandy shale back to dense shale. Similar variations occur frequently within vertical distances of less than 100 feet in wells penetrating a series of beds. The paucity of records of wells along the route of the proposed cut-off channel from Millett to Delta Mills rules out any quantitative estimate of the thickness or extent of bedrock to be encountered in the channel excavation. From studies of available drilling records it appears that the part of the cut-off channel extending from section 27 in Delta Township, Eaton County, northward to the terminus at Delta Mills should encounter little or no bedrock at the proposed base level. The stretch in which bedrock is most likely to be encountered extends from section 27 of Delta Township southward to the terminus near Millett. Although widely spaced test holes drilled by the Corps of Engineers along the channel route did not encounter bedrock, it is noted that the power-driven auger could not penetrate to channel-base elevation near Millett because of the great drilling resistance. Two test holes drilled to channel-base elevation south of Millett did not enter bedrock.. However, it would appear that those test holes were drilled in materials deposited by the Grand River, which probably scoured a channel in the bedrock surface that was wider and deeper than its present channel. There remains, therefore, a strong possibility that bedrock may be encountered in the course of channel construction in or near the Millett area.

Ground water in the Saginaw and Parma formations in the Lansing area occurs under artesian conditions, the piezometric surface ranging from 40 feet above to more than 100 feet below the low-water stage of the Grand River. In general, the piezometric surface is lowest in the central, north-central, and northwestern parts of Lansing, in which are located the principal municipal and industrial well fields. The piezometric surface rises with distance away from these centers of concentrated pumping. A few reported water levels in suburban and rural domestic wells finished in bedrock indicate that the piezometric surface in the sandstones ranges from about river level at the cut-off channel terminals to about 30 feet above the proposed channel bottom near the midpoint of the route.

Suburban residences cover the mile-wide belt between Lansing's west city limit and the Ingham-Eaton County line. For the most part, residents of this part of Lansing Township are served by the public water supply of the Landel Water District which obtains water from deep wells finished in the sandstones. There are many additional suburban residences in the 2½-mile belt of Delta Township in Eaton County that extends from the Ingham County line west to the proposed cut-off channel. There are about 600 homes in this area, more than half of them bordering West Saginaw Road, which intersects the proposed cut-off channel about 1½ miles south of the down-stream terminus at Delta Mills. Suburban residences in that part of Delta Township are largely clustered along West Saginaw Road, State Highway 43; along Waverly Road, the Eaton-Ingham County line; and along West Main Street, U. S. Highway 27 and State Highway M-78. Intervening areas are farmed at present. All these residences depend for their water supply on individual domestic wells, most

of them finished in the bedrock. These wells generally range from 2 to 8 inches in diameter, from 100 to 200 feet in depth, and from 5 to perhaps 200 gallons per minute in yield.

Through the southern third of the belt of Delta Township bordering the proposed cut-off channel the mantle of glacial drift is reported to consist largely of clay or clayey hardpan and occasional thin strata of permeable sand or gravel. In the central and northern parts of the belt appreciable thicknesses of sand and gravel were reported in holes drilled by the Corps of Engineers. Few household or farm wells have been finished in the drift, but isolated reports indicate that water levels in the drift aquifers are comparable to or somewhat higher than the levels reported for the bedrock sandstones.

Although not generally recognized in the past, the construction of canals or diversion channels will cause important changes in the ground-water regimen or an area if the excavation cuts important aquifers or permeable deposits that may be hydraulically connected to such aquifers. When water levels in the channel are maintained at levels below the initial static levels of the aquifers encountered, the canal or channel will serve as a drain which effectively lowers ground-water levels and diverts subsurface drainage over areas that may range from a few square miles to perhaps hundreds of square miles. If the water level in the channel is maintained at stages above the initial ground-water levels, the canal or channel will function as a line source to recharge the connected aquifers.

The amount, extent, and rate of water-level decline in an aquifer that discharges to an intercepting channel depends on the transmission and storage properties of the aquifer, the differential head at the channel intersection,

and the regional geologic and hydrologic controls. In general, the greatest decline in head occurs adjacent to the channel and the decline is progressively less with distance from the channel. The rate at which the appreciable lowering in head extends away from the channel may range from tens of feet per day initially to inches per day a few months after excavation of the channel. The piezometric surface at distances of a mile or more from the channel may not reach equilibrium for several years after the construction period.

The proposed cut-off channel west of Lansing will function as a diversion route only during periods of flood flow. During most of each year it will carry no flow except ground-water seepage from aquifers that it may intersect. From the meager data available, it seems probable that the channel will intersect the bedrock in the southern third of its course, but there is a chance that, where excavated, the bedrock may consist of poorly permeable or impermeable sandy shales or shales. Throughout it's course the channel will intersect glacial drift ranging from poorly to highly permeable. There is some possibility that the permeable sand and gravel deposits of the drift, in part, may be hydraulically connected to water-bearing sandstones in the underlying bedrock. Where such conditions exist, not only would the drift lose water, but the permeable sand and gravel deposits would transmit water from the bedrock to the channel.

The estimated low-water stage to be maintained in the cut-off channel probably will not be more than 40 feet below the highest reported ground-water level existing prior to excavation. Declines in ground-water level of comparable magnitude may occur in the immediate vicinity of the cut-off channel, but away from the channel they will decrease progressively from a few tens of feet to several feet at distances of a mile or two. The depth of most drilled rural and suburban wells in the area is sufficient to

obviate the necessity for any large-scale well replacement. However, the present setting of jet pumps in many of these wells may be too shallow for successful operation at lowered water-level stages, and additional ejector pipe and perhaps increased motor power may be required for operation at the increased lifts. If any shallow-well pumps are in use, it may be necessary for these well owners to install new pumps and, in some instances, drill new wells to accommodate larger-diameter pumps.

The nature and extent of potential damage to rural and suburban well users as a result of construction of the proposed Lansing cut-off channel could be determined only by means of a comprehensive study of the ground-water resources of Delta Township and contiguous areas.