

struction, which, instead of \$4,750,000, should be placed at \$5,250,000.

It may also be stated that in previous canal surveys along the St. Lawrence, various datums were employed, making the results somewhat confusing, or only intelligible after a good deal of trouble. An attempt has been made to avoid this by referring the levels of the Soulanges Canal to mean tide at New York. To do this, lines were run from a bench mark established by the United States coast and Geodetic Survey at Rouse's Point, N.Y., to the head of the Beauharnois Canal. In this way the mean level of Lake St. Francis was found to be 154.80; and directly connected with the records at the Valleyfield lock since 1849. The United States Army Engineers have determined the mean height of Lake Ontario (1860-75) at 246.61 above the same datum, so that the difference between Lakes St. Francis and Ontario should be (to close the circuit) say 91.81 feet. Lines run under the writer's direction between Coteau Landing and Kingston confirmed these figures. But the previously accepted distribution of fall was found to be quite erroneous. The descent from Kingston to Prescott was supposed to be three or four feet. It is now approximated at about one-third of a foot, pending the completion of the precision levels begun some years ago under the able direction of Rene Steckel, M. Can. Soc. C.E., of the Public Works Department. This work has not yet been continued along the St. Lawrence above Lachine. It may be stated, however, that levels recently taken by the engineers of the United States Deep Waterways' Commission only differ 0.12 from the figures given above as representing the relative level at Rouse's Point and Valleyfield—about 47½ miles apart.

Attention was drawn to the lithographic profile of the St. Lawrence, prepared for the Canadian Deep Waterways' Commission of 1895, as explanatory of the foregoing remarks. This profile shows the position and length of the various canals between Kingston and Montreal. The fall in the river is about 220 feet. That overcome by locks is about 204 feet. It will be seen that Lake St. Francis is 33 miles long. It is merely an expansion of the river—a pool above the rapids between it and Lake St. Louis. The fall between these lakes is 82½ feet at mean water. In this distance of about sixteen miles there are the Coteau, Cedars, Split Rock and Cascades Rapids. At some points on the river there is a depth of not more than six feet in the channel at extreme low water. It is to surmount these rapids that the Soulanges Canal has been constructed. Its position is shown on the small sketch map which accompanies this paper.

The canal is 14 miles long, and leaves the foot of Lake St. Francis at Macdonald's Point, just below the village of Coteau Landing. Thence it runs straight 1½ miles, touching the margin of the river about a mile from the upper entrance. From the end of this tangent the line sweeps round to the north-east behind the village of Coteau du Lac for about three miles on a curve of 14,324 radius. It is then continued by a second tangent of some 8½ miles long, passing about a mile inland from the Cedar's Village. At the termination of this, the line bends slightly to the north, and is led straight into the Ottawa River, about two miles from its junction with the St. Lawrence at Cascades Point. The canal is, for all practical purposes of navigation, a straight line throughout, and is two miles shorter than the route by the river. The fall of 82½ feet is overcome by four locks. 70 feet of this is at the Cascades end, where the bluff forming the right bank of the Vaudreuil branch of the Ottawa gives an opportunity of locating

three of these in the first mile; each having a rise of 23½ feet. The original design was for five locks. This was subsequently made four, and, after extended examination, the writer, in January, 1894, proposed a further reduction to three. In this view he was sustained by Messrs. Shanley and Keefer, who were retained by the Government to advise in the matter. The height of these lifts constitutes a peculiar feature in the Soulanges Canal. There is an interval of over two miles between the third and fourth locks. The latter is about three miles from the lower entrance. Here the lift is variable. It is about 12½ feet at mean water of Lake St. Francis—but at extreme high periods it would (if this water were permitted to enter the canal) be about 15 feet. At the upper entrance there is a guard lock by which the surface level of the summit can be regulated without interruption or danger to navigation. At periods of high water, this will be used as a lift lock, but, at ordinary stages of the lake, its surface level will be that of the canal. It is needless to point out to this audience the necessity of this arrangement. Canal engineers of experience will admit that such a safeguard is indispensable. About 1,000 feet above lock No. 4 there are a pair of guard gates placed for safety to the lower locks in case of accident.

It will be observed that the surface of the blue clay along the summit reach gradually rises towards the west and culminates at the crossing of the St. Emmanuel Road, where it is almost level with top bank, being only covered with a thin layer of sandy soil. Wherever this clay was cut into by the prism, there was danger of slides, roughly in proportion to the depth of the cutting. This danger was greater on the north side, which intercepted the natural drainage towards the river, so that in time the slope became so saturated as to break loose and slip into the canal. In other words, by the excavation of a deep trench of such dimensions, a similar condition of things was set up as that existing along the bank of the St. Lawrence between Coteau and Cascades, where, from time immemorial, *deboulements* have occurred, causing in many places a wearing away, which in some cases is measured by hundreds of feet. One of these slides took place on the 25th October, 1897; when, without any previous perceptible warning, the north bank of the canal, for over a quarter of a mile in length, slid into the prism, taking with it the abutment of the St. Emmanuel bridge, which was thrown bodily forward about fifty feet into the centre of the canal. This occurrence is considered to be of so much interest as to warrant its being made the subject of a separate paper. To discuss it in detail at present would take up too much time. Slides have also occurred more or less for a mile or so to the west of the St. Emmanuel Road, but a plan of repairs has been adopted which will enable the north slope to be satisfactorily restored in time for the opening of navigation through the canal. Towards the crossing of the river Delisle, the surface of the blue clay lowers rapidly. At the river itself rock of the "calcareous" is encountered, and this alternates with the clays and sands of the drift formation for some two miles to the west. At the upper entrance the guard lock and surrounding structures are all founded upon solid rock. There are about 6¼ million cubic yards of clay of all sorts, and 300,000 cubic yards of rock of various kinds in the excavations for the canal.

The level of the bottom of the summit reach at the foot of the guard lock is 137.00 above datum. Ordinary surface of Lake St. Francis may be taken at 155.50, at which time there will be 18½ feet of water in the canal, equal to a cross sectional area of 2,534 square feet. Propellers