any region the thickness of the drift may vary within short distances. The rock surfaces are very uneven and hence the bed rock often lies at a variable distance below the surface, a fact that engineers should remember in sinking foundations.

Coarse River Gravels, Hull, Quebec

The glacial deposits consist in general of boulders, cobbles, pebbles, sand and clay, forming a confused, unassorted mass; the stones of the drift, although worn, are not rounded but rather subangular in form and are often striated and polished. Many of the rocks distributed through the drift are of kinds occurring many miles to the north of where they are now found.

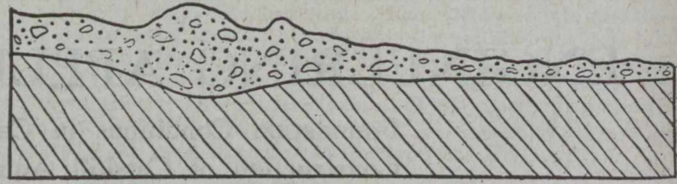
Large ice-transported boulders, many tons in weight, are also found scattered over the drift-covered area, regardless of topography. Large boulders in the drift are sometimes mistaken for bed rock in drilling, especially

Glacial Drift, Coarse and Fine Together

where wash borings are made. In fact, a case came under notice in Montreal where a test bore hole was put down to what was believed to be solid rock but which later, after the contractor got into difficulty, proved to be a boulder of Laurentian gneiss.

Boulder clay usually affords good foundations, but occasionally it has within it seams of water-laden sands that frequently are of the nature of quick-sands which give trouble and cause heavy expense if not guarded against.

Many of the present streams occupy the partly, or completely, filled pre-glacial valleys. During the glacial period these valleys or gorges became completely clogged with glacial drift so that after the recession of the glacier



A

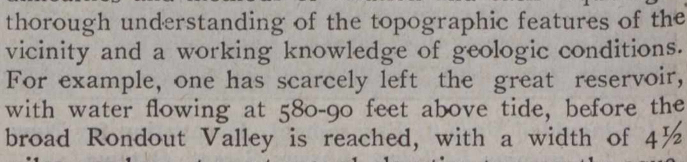
Section Through Glacial Drift and Bed Rock, Showing How Disposition of Morainal Material Has Made Surface More Irregular

these streams had to cut new channels. Abundant modification of stream drainage has resulted. In some cases a stream has sunk its channel through the thickness of the drift; in others not, while in still others the deflection to one side of its former valley had enabled it to cut through the underlying hard rock. Again, others are flowing in new channels on the drift cover.

The Catskill Aqueduct

One of the best examples of geology as applied to engineering was in connection with the location and construction of the Catskill aqueduct. In connection with the location of the aqueduct, cut and cover was adopted as much as possible. The length of the aqueduct was 92 miles and the difference in level between the point of supply and the point of distribution in New York City was only 300 feet. While this was sufficient head to permit gravitational flow, it meant that in order to maintain a flowing grade in all tunnels, channels or tubes it was necessary when a depression had to be crossed that the pressure be maintained so that the water may rise again to a suitable level on the other side.

The undertaking resolved itself into a series of problems, each having its own characteristics and peculiar



B

Section Showing How the Disposition of Glacial Drift Has Reduced Surface Irregularities

difficulties and methods of solution and each requiring a thorough understanding of the topographic features of the vicinity and a working knowledge of geologic conditions. For example, one has scarcely left the great reservoir, with water flowing at 580-90 feet above tide, before the broad Rondout Valley is reached, with a width of 4½ miles, nowhere at great enough elevation to carry the aqueduct at grade. If it is to be crossed at all, and it must be crossed to reach New York City, some special means must be devised. If a trestle be proposed, one finds that it would have to be 4½ miles long (24,000 feet), and in some places 300 feet high, and at all points large enough and strong enough to carry a stream of water capable of delivering 500,000,000 gallons daily—a stream that, if confined in a tube of cylindrical form, would have a diameter of about 15 feet.