day, which later on could be increased when this demand shall be exceeded by pumping at Deacon, or by the installation of additional pipe lines. Deacon thus marks the west end of the gravity aqueduct.

All the conditions entering into this arrangement have been carefully analyzed during the past two years, and these studies have shown the advisability of using a

Fig. 7.—Contract 31, Mile 40, Brokenhead River Siphon, Laying the Invert.

Fig. 8.—Contract 32, Mile 51, Backfilling in Wet Trench with Wet Material

reinforced concrete pipe 5 ft. 6 ins. in diameter in place of the 5-ft. o-in. steel pipe as recommended.

The pipe will be carried in practically direct line from Deacon to the outskirts of St. Boniface in a trench excavated to a depth of from ten to sixteen feet. It will be extended to the east bank of the Red River under the streets of St. Boniface, crossing underneath the Seine River en route. The line will be carried under the Red River through a tunnel excavated well down in the rock beneath the river bed. Borings are now being made to determine the nature and depth of the rock strata underlying the river. From the west bank of the river the line will be extended to McPhillips Street reservoir, probably as a 4-foot cast-iron main laid under the streets of Winnipeg.

A pumping plant will be located at a future date at the Red River tunnel, and from this point future lines can be extended when the capacity of the gravity supply beyond this point shall have been exceeded. By this arrangement the pumping plant will be located near the centre of gravity of the District.

It may be mentioned here that the location of the reservoir is some two miles further east than contemplated in the consulting engineers' original layout, due to the location of the final aqueduct line.

General Features of Construction.—The right-ofway, three hundred feet in width (except for the easterly twelve miles which is five hundred feet in width), was cleared by contract in the winter and early spring of 1914.

A standard gauge railroad was constructed forty feet from the south boundary of the right-of-way during the season of 1914 at a total cost of $1,325,000. The construction of the railroad presented no unusual difficulties, and was carried out with such dispatch that trains were operating over the whole of it in January, 1915. The present equipment consists of four 60-ton Mogul locomotives, forty 20-yard air dump steel cars, twenty-five 16-yard air dump steel cars (now under contract), twenty flat cars, ten box cars, three cabooses and two passenger coaches. Additional equipment is being purchased.

The road, which is operated by the District, is connected with the Paddington Transfer Yard, meeting there all the railroads running into Winnipeg, so that contractors' shipments can be made direct to their camps without reloading. Railroad headquarters have been established at Deacon, where the operating staff is located, and where a machine shop, forge shop and engine shed have been erected. A station building containing offices for the operating department and for one of the division engineers has also been erected at this point, as well as a cement shed, pumping plant, coal dock, oil house, camp buildings and electric light plant. Nine sidings and five 12,000-gallon water tanks have been located at nearly equi-distant points along the line.

A telephone line has also been erected from end to end of the right-of-way, which is used both for train dispatching and for communication between the division engineers and headquarters at Winnipeg. A circuit for use of one of the contractors has also been erected on the District's poles.

Methods of Aqueduct Construction.—There is considerable variation in the methods of handling the work. On Contract No. 30 the excavation is carried out with teams and scrapers and by means of a walking dredge, the cut on this section being comparatively shallow and on the open prairie. The final trimming of the bottom of the trench is done by hand immediately before the invert concrete is placed. This hand trimming is required on all contracts and is done to prevent any possibility of the soil drying out and cracking, and thus forming a spongy bed for the foundation. The walking dredge is a heavy timber trussed structure spanning the trench and provided with a forward dumping dipper excavator. It is provided with six timber pads, one on each corner and one intermediate pad on each side. By means of chains and winches the weight is shifted from the corners to the centre pads and the whole structure is pushed forward by chains working on the legs of these pads. The dredge is driven by a gasoline engine operating, through clutches

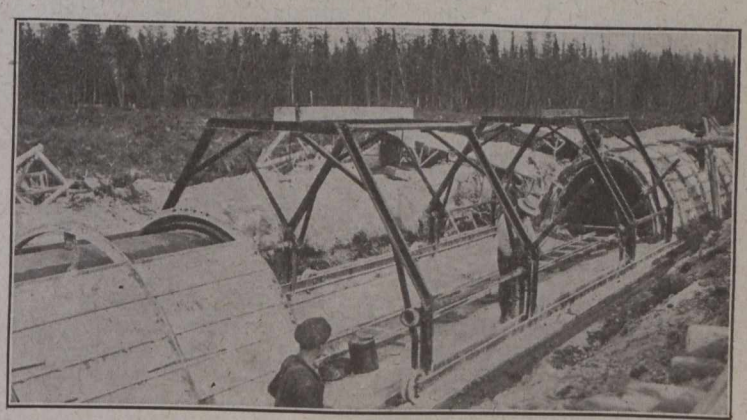

Fig. 9.—Contract 32, Mile 57, Traveller for Moving Outside Forms.

and belts, the various movements. The concrete plant on Contract No. 30 is placed on a flat car operated on a track built alongside the trench. Materials are fed to the mixer from the storage piles beside the District track by means of a travelling, stiff-legged derrick operating on a track midway between the railroad and the aqueduct trench.