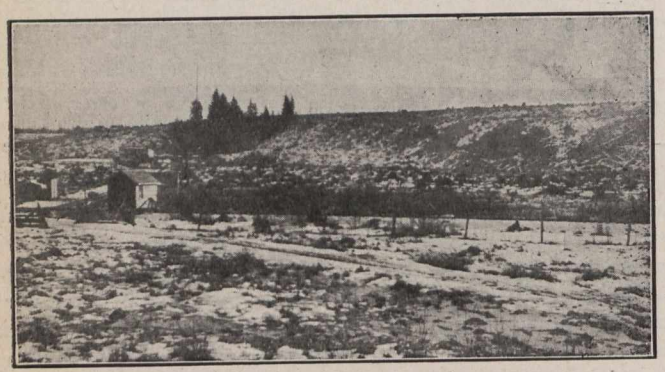
availab e, for although a depth of 30 ft. of water was obtained 100 ft. from shore for practically the whole two and a half miles of water frontage, 45 ft. is found 100 ft. out from the shore for the entire length of the wharf, and for severol hundred feet farther west. The accompanying cross section of the wharf gives an accurate idea of the river bed at the point in question.

The sounding rods were then used to determine the nature of the foundation for piling. It was with great difficulty that the rods were put down, and with still greater difficulty that they were withdrawn. The soil is a river silt for a depth of at least thirty feet. This silt is a very



View of Port Mann Townsite, Looking South.—Taken from the Wharf.

fine sand, sticky like quicksand, when wet, but much firmer. Before making out a bill of piling, it was thought advisable to drive test piles. Two test piles were accordingly driven. The first was given a 25-ft. penetration, going at the last blow under a six-foot drop of a 4,300-lb. hammer, a distance of 15 inches. The second pile was given a penetration of 35 ft., going at the last blow 6 inches under a 10-ft. drop. Both piles were allowed to stand over night. Next morning the shorter pile penetrated only 3 inches under a 10-ft. drop of the hammer, while the longer pile resisted driving for seven blows under a 10-ft. drop of the hammer, and finally, being started, went 4 inches at a blow. It was accordingly decided that 30 to 35 feet of penetration was sufficient. It was found later that 35 ft. of penetration best suited the inner half of the wharf, while 20 to 25 feet was ample for the outer piles.

The distance between piles was, of course, governed by the loading of the wharf and the bearing power of the piles. When an impenetratable stratum of material is met with the pile probably derives its bearing power to the greater extent from this end bearing, but where penetrable soils are encountered throughout the driven length of the pile, the bearing is derived almost entirely from frictional resistance on the surface of the pile. The maximum bearing power of any pile is, of course, fixed by the strength of the projecting portion of the pile as a column.

To determine the bearing power of piles from calculation the Engineering News formula is the most simple and quite as reliable as any.

$$P = \frac{2\,w\,h}{d - 1}$$

where P is the safe bearing load in tons
W is the weight of the hammer in tons.
h is the fall of the hammer in feet, last blow.
and d is the penetration in inches, last blow.

Another simple formula is given by Saunders.

$$P = \frac{w\,h}{8\,d}$$

the notation being the same as above with the exception that "d" is the penetration in feet. Both are empirical formulae, and must, of course, be used with judgment. I consider that either of these formulae is very reliable and convenient. The following is a comparison of values given for "P" for the same pile.

W = 1.5 tons.
h = 10 ft.
d = 2½ inches = 0.21 ft.

Engineering News formula—

$$P = \frac{2 \times 1.5 \times 10}{2.5 - 1} = \frac{2 \times 1.5 \times 10}{3.5} = 8.6 \text{ tons.}$$

Saunders' formula—

$$P = \frac{1.5 \times 10}{8 \times .21} = \frac{1.5 \times 10}{1.68} = 8.9 \text{ tons.}$$

This is, indeed, a very good comparison, having less than 4 per cent. variation.

Before giving the details of construction of Port Mann wharf, it may be well to note the dimensions, which are as follows: Floor length, 1,000 ft.; floor width, 102 ft. The floor of the wharf is 16 ft. above mean water level of the Fraser River at this point. A bill of material covering all the materials of construction is given at the close of this article. The east 500-ft. section is known as the rail unloading wharf, and the west 500-ft. section as the freight wharf, over which it is proposed to construct freight sheds 76 ft. by 490 ft.

Let us now look at the details of construction of the wharf. First, to consider the foundations; cedar piles were used entirely for bearing. Under the rail unloading wharf the piles were spaced at 9 ft. centres, the bearing load per pile being 16 tons (of 2,000 lbs. each). This was equivalent to the dead load of 400 lbs. per sq. ft., corresponding to eight single tiers of 80 lb. steel rails piled as closely as possible. As a matter of fact, portions of the rail unloading wharf have had occasion to carry the weight of six double tiers of rails, or twelve single tiers, and not the slightest settlement was noted. The freight wharf piles were spaced at 10 ft. centres, the designed load being 300 lbs. per sq. ft.,

Rear View of Port Mann Wharf and Yards Under Construction.

which gave a total bearing of approximately 15 tons per pile. In every case where the driven piles were allowed to stand over night, and the hammer put on the next morning, they resisted driving entirely for several blows, so that a bearing load of 15 or 20 tons per pile gave an entirely ample factor of safety. The piles used were a splendid quality of cedar, such as are only to be found in British Columbia, being straight, sound and maintaining well their size. The longest of these was 90 feet. Springing piles at the face and end