

REFERENCE NO. 3.

To ascertain the best method of providing for the control of the said river and its tributaries so as to safeguard the lands affected, and to provide for the effective control and improvement of the said river and its banks.

The works recommended by your Commissioners are shown on plans marked 2, 3, and 4, hereto attached, and consist generally of—

(a.) The raising of the present traffic-bridge at Balclutha, the strengthening of its piers by the sinking of another cylinder up-stream, and by bracing all three together in a substantial manner.

Your Commissioners consider that the erosion of the terrace under the bridge on the left bank should be encouraged by ploughing the surface when a flood is likely to occur. The character of the river is such that ample warning can be obtained from stations higher up the river. Under the bridge, and along the banks in its vicinity on the right bank, the present inordinate growth of willows should be kept within bounds sufficient only to protect the works, so that silting-up in that locality during periods of low river and moderate freshets will not be encouraged.

(b.) The main levee protecting the town of Balclutha must be raised by an average height of 6 ft., at the grades shown on plans. It should be constructed of solid material, preferably a mixture of clay and rock from the hillsides from which the original material was obtained.

The suggestion has been made that the levee should be constructed with material pumped from the bed of the river, preferably on the Barnego side. While the material so obtained would not be so suitable for a levee, your Commissioners are satisfied that the cost would be no less, and probably would be greater, and the increase in the cross-sectional area of the stream obtained from the dredging-out of the material would be nullified by the first flood.

When the levee has been constructed to the raised height, and to the dimensions indicated (9 ft. on the top, with 3-to-1 batters at the back and $1\frac{1}{2}$ -to-1 at the front), it might with profit be dedicated as a public road after being sufficiently widened on the top, with natural batters. Its use as a public road would allow of subdivision for residential purposes of the land not now served by a public road, and would result in its being constantly patrolled and maintained, and therefore no longer serving as a harbour for rabbits, as it has done in the past, and does still to some extent, in spite of the alleged rabbit-proof fences.

In view of the fact that no maintenance to the riprap has been done for forty years, your Commissioners consider that the time has now arrived when a quantity of stone—say, 10,000 yards—should be distributed along the toe of the levee. This could best be done by tipping from barges moored at fixed distances from the water's edge, so that the stone is delivered exactly where required. It may be possible to place the stone by tipping it off the levee, but there is doubt as to whether it would roll into the desired position. Experiments should be made by this method before the barges are constructed.

(c.) From the end of the raised traffic-bridge a levee of similar dimensions to the levee just specified, and to the grades shown, should be carried down and connected with the present south abutment of the railway-bridge.

In 1919 the river-bed had been silted up to such an extent that the low-water level was considerably higher than the low-water level in 1878; and yet during the flood of 1919 the flood-level was lower than the flood of 1878 by 12 ft. 6 in. at Alexandra, 7 ft. at Beaumont, 4 ft. 6 in. at Clydevale, and 4 ft. at Pukeawa. At these places the conditions, other than that due to the silting-up of the river-bed, are very similar to what they were in 1878.

The effect of confining the flood-waters between levees must necessarily be to raise the flood-level; this point cannot be too strongly emphasized. In the case of the big flood of 1878 no levees worth mentioning existed at Balclutha, and the flood-waters had a clean sweep across the peninsula. This resulted in a much decreased flood-height compared with what would now be the case should a flood of similar dimensions occur, when the flood-waters would be confined by the levees to a definite channel.

Your Commissioners, after careful consideration of all the facts and data at their disposal, estimate that a similar flood to that of 1878 would, under existing