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THE EXTENSION OF THE RIVER TRAINING WORKS AT GIDARPINDI BRIDGE.

By G. A. PLANK.

Gidarpindi Bridge which carries the Ferozepore-Jullundur line over the Sutlej River at Gidarpindi, was constructed in 1914 and consists of 20 spans of 100 ft. each. A pair of Bell Guide Bunds, extending 1000 ft. upstream and 250 ft. downstream of the centre line of the bridge, was provided at the same time. The length of these bunds, the ends of which were not curved, was based on the assumption that the depth of embayment was not likely to exceed 200 ft.

This assumption proved to be inaccurate, and within three years of the construction of the bridge embayments of well over 500 ft. had occurred. In subsequent years, the embayments on both sides extended to within a short distance of the approach banks, and finally, in August 1933 the river made a very serious attack on the left approach bank and the left upstream guide bund, breaching the quadrant bund, and causing serious erosion of the approach bank. The Barnaswah earth bund, on the left bank of the river about one mile from the bridge, was also seriously breached and the country for many miles around was flooded. Over 2 lakhs c. ft. of pitching stone was hurriedly placed on the left approach bank in an attempt to prevent the river breaching the line and outflanking the bridge. These measures proved successful though the position for a few days during the maximum flood period was critical.

It was apparent that the whole bridge structure was endangered, and it was therefore proposed to lengthen the guide bunds by 1350 ft. upstream of the bridge (shown in heavy lines—Plate I) and to provide them with curved ends. An estimate amounting to Rs. 5,30,000 was sanctioned in November 1933 and the work was started on the 21st of that month.

General Design.

The extensions to the guide bunds were designed in accordance with the principles outlined in Sir Francis Spring's Paper on River Training and Control. The slopes of the bunds were covered with 3 ft. thickness of pitching stone on a slope of 2 to 1, and the aprons have a cross section of 66 ft. by 5½ ft. thick on the straight, increasing to 75 ft., by 6 ft. round the moleheads. These dimensions provided sufficient stone to cover the submerged slopes with 3 ft. thickness of stone to a depth varying from

40 ft. on the straight portions to 60 ft. round the moleheads. In calculating these quantities an allowance for dispersion was made of 1% extra per ft. of fall, with a further allowance round the 180° curve of the nose on account of the conical surface, which this portion of the apron has to cover when it drops. Cross sections of the Left Guide Bund Apron are shown in Plate II.

A special feature of the design was the method adopted to prevent the stone on the slope from slipping. This was introduced by Lieut.-Col. W. Macrae, R.E., Chief Engineer of the North Western Railway and is described by him in his paper on "Training works in connection with shortening of the Empress Bridge over the River Sutlej" published in the proceedings of the Institution of Civil Engineers, Vol. 237, 1933-34.

The detail of the method is shown in Fig. 1 and consists of hand packing the stone on the slope right down to the level of the bottom of the apron at a slope of $\frac{1}{2}$ to 1.

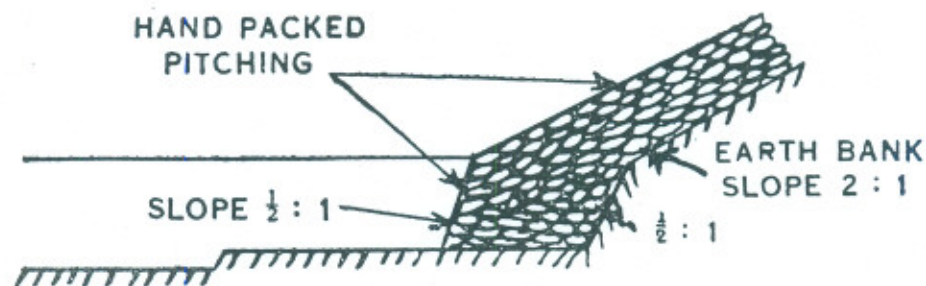


FIG. 1.

Description of the work.

Work at site was started on 21st November, 1933 with the idea that it would be completed by the end of the following April; that is to say, just over five months were allowed for 70 lakhs cubic feet of earth work and for placing 23½ lakhs cubic feet of pitching stone in position.

Before the commencement of the work, the river, above the bridge, was flowing in two separate streams, the main stream on the left bank cutting across at right angles to the nose of the left guide bund and a smaller stream on the right bank flowing more or less along the site of the proposed extension to the right guide bund (*vide* Plate I—the dotted lines indicating the positions of these streams).

Thus before any new work on the guide bund could be started it was necessary to divert the flow of water about 500 cusecs from these two channels. For this purpose two new channels, one main one (A. B.) 3000 feet long and 40 feet wide, and a second or smaller channel (C. D.) 1500 feet long only 5 feet wide were excavated down to the level of the water existing in the river at that time. This excavation work proved

to be much more difficult than had been anticipated because practically the whole of it was in wet sticky clay. Even though it was obviously desirable to make these new channels deeper than the river, this was found impossible.

Right Guide Bund.

After the construction of an earth dam at F on the right bank and the diversion of the small stream down the channel C. D. (Plate I) had been carried out with difficulty, the earth work for the right guide bund was taken in hand. Owing to the low water level being found to be much higher than had been anticipated, it became necessary to alter the original design of this guide bund by raising the level of the apron several feet at the nose.

The earthwork of the first 1000 ft. of the extension of the right bund was completed on January 8th and the first stone train arrived at Gidarpindi on the following day. The bulk of the supply of pitching stone was obtained from the railway quarries at Delhi and arrangements were made for one train to reach Gidarpindi every day. The average quantity of stone handled daily was 20,000 cubic feet contained in 48 to 50 trucks.

The provision of temporary sidings in the river bed to facilitate the handling of the stone trains was considered but it was decided that no advantage would be gained by their use. Sidings were laid on the top of each bund and all the stone was carried down the slopes of the bunds and placed in the aprons.

Throughout the progress of the work, the ballast trains from Delhi ran to a regular time-table arranged so that they were due to arrive at Gidarpindi station early in the morning and leave in the evening of the same day on the return journey to Delhi and for this purpose Gidarpindi was converted into a crossing station. The trains consisted of some 50 trucks and at Gidarpindi they were split up into two or three parts, depending on the space available at the site, and run out to the bunds on "Working line clear." Fortunately, the traffic on this line is comparatively light and ample time was available between the regular passenger trains.

Lack of space for stabling trains at Gidarpindi made it essential to complete the unloading of each train on the day of its arrival. Later on, additional stone trains were worked through from Gharibwal Quarry (near Malakwal) and also from the site of some abandoned bund near Bahawalpur. Previous notice of the running of these additional trains was given in good time and it was found that the labour available at site was sufficient to unload these trains on the day of their arrival.

By the end of January the whole of the earthwork of the right guide bund had been completed and the placing of the stone in the apron was well in hand. The hand packing work on the slopes was left until the

apron had been almost completed. A narrow strip about 10 ft. wide at the toe of the slope was kept clear of stone and the slope of the bund was redressed, the earth at the toe being cut down to the $\frac{1}{2}$ to 1 slope as shown in Plate II. The hand-packed stone work was then completed and the narrow strip of apron at the toe of the slope was filled up to its correct level. To facilitate the carrying of this stone down the apron, narrow pathways of earth were laid down the hand-packed stone slope.

On the left guide bund, the method of placing the stone was varied slightly. On account of the very short time available, the hand-packing on the slopes and the loose packing in the apron had to be carried out simultaneously. This involved a much more extensive use of the pathways of earth on the completed hand packed slopes for carrying stone down into the apron. The method, however, was found to be completely satisfactory, and justified the decision that extra sidings in the river bed were unnecessary.

Closing of the Sirhind Canal.

On January 12th, an incident occurred which might have had serious consequences and which emphasizes the necessity for closer co-operation between the various departments when work dependent on the amount of water flowing in river is in progress. Unofficial information reached the site that the Sirhind Canal had been closed on January 9th and that 6000 cusecs had been diverted into the river. Within a few hours of hearing this news, the river began to rise rapidly and by the following day had risen 4 feet. The whole of the apron of the right bund extension was flooded, and further excavation was held up for over a week. The main diversion channel was also flooded and this silted up very considerably. In addition, the building of the dam across the main stream at the diversion of the river into the new channel A. D. was delayed until the waters subsided. It was, however, possible during this period to carry on with the stone pitching in part of the apron of the right guide bund and with the earthwork of the portion of the left guide bund on dry ground. The repair of a 300 ft. breach in the quadrant bund on the left bank was also well on the way to completion by this time and the sudden rise of water did not interfere with this work.

Diversion of the River.

The worst consequence of the closing of the Sirhind Canal was that whereas the previous discharge at Gidarpindi had been only 290 cusecs before the closure, it was round about 500 cusecs at the time of the diversion of the river into channel A.B., the increased discharge adding considerably to the difficulty of the work.

The original plan for diverting the river was to build a bund of sand bags and earth across the river at a point E where the width of the river

was 100 ft. and the average depth 3'-6" and where the right bank was of firm earth and clay rising about 6 ft. high above water level and the left bank consisted of sand and was quite flat.

The left flank was faced with sand bags and efforts were made to fill up the gap by working from the bottom upwards. To prevent scouring of the bed, a complete layer of sand bags was laid down and the process of filling up was carried forward up to a certain level, when the water became headed-up by about 1 foot. The current then became so strong that the bags of earth were washed away faster than they could be dumped and progress came to a standstill. The diversion of the whole stream into the channel A.D. necessitated the heading up of the river water by at least 3 feet which would have resulted in a fall of 1 foot on the downstream side. With the resulting pressure from a head of 4 feet of water being produced on the dam it became evident that a bund built of sand bags could not withstand the pressure. It would probably have been better had the main diversion channel A.B. been made much wider than 40 feet so that the whole of the discharge of the river could have been taken with a maximum heading up of the water by about one foot. Eventually, the construction of the earth dam at E had to be abandoned and in its stead it was decided to construct a stone dam across the stream at the site of the apron of the proposed extension of the guide bund. At this point the river was 60 feet wide and as much as 10'-6" deep. Before the building of this stone dam was started the flanks were reinforced by the dumping of heavy clay and earth on both banks, the majority of the materials, that is clay and earth, having to be brought by ballast train from Gidarpindi yard and the remainder from the excavation of channel A.B.

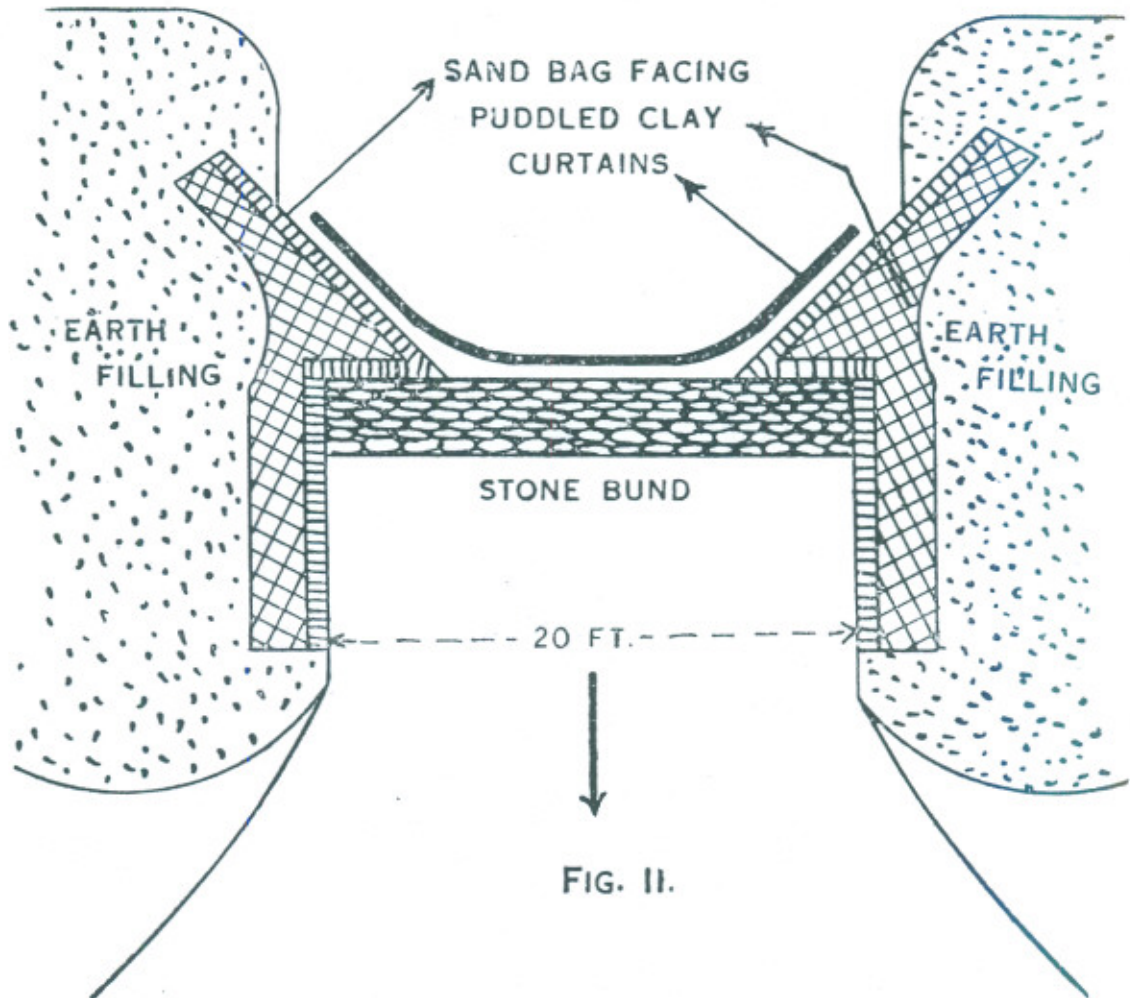
A bridge of boats was then made for carrying the pitching stone across the river and the stone bund starting from each end was extended towards the middle until the current began to increase appreciably. The middle portion was then filled up with stone from the bottom upwards forming a solid dam of pitching stone which had the effect of heading up the water by about 3 feet and caused part of the river to take the new channel.

This stone bund was of course not watertight, and in order to seal it, a number of large sheets made of gunny bags sewn together was prepared. Ropes were fastened along the top edge of the sheet and the bottom edges weighted with large boulders. These sheets were then taken by boat and lowered into the water some 20 feet upstream of the bund, the force of the current carrying the sheets up to the face of the dam where the ropes were made fast. When all the sheets covering the face of the dam were in position the flow of water ceased entirely and it was then an easy matter to fill in the earth behind the bund. The actual time taken in filling in the 20 ft. gap with pitching stone, placing these sheets in position and dumping earth to a width of 20 ft. was 5 hours.

It was then that the re-inforcing of the flanks showed itself to be justified as the headed-up water started forcing its way round the

extremities of the stone bund, and in order to relieve the pressure the middle portion of the dam had to be opened out again. The flanks were further reinforced by adding more earth and by lining the faces with gunny bags filled with clay and with a filling of puddled clay between the bags and the earth bank.

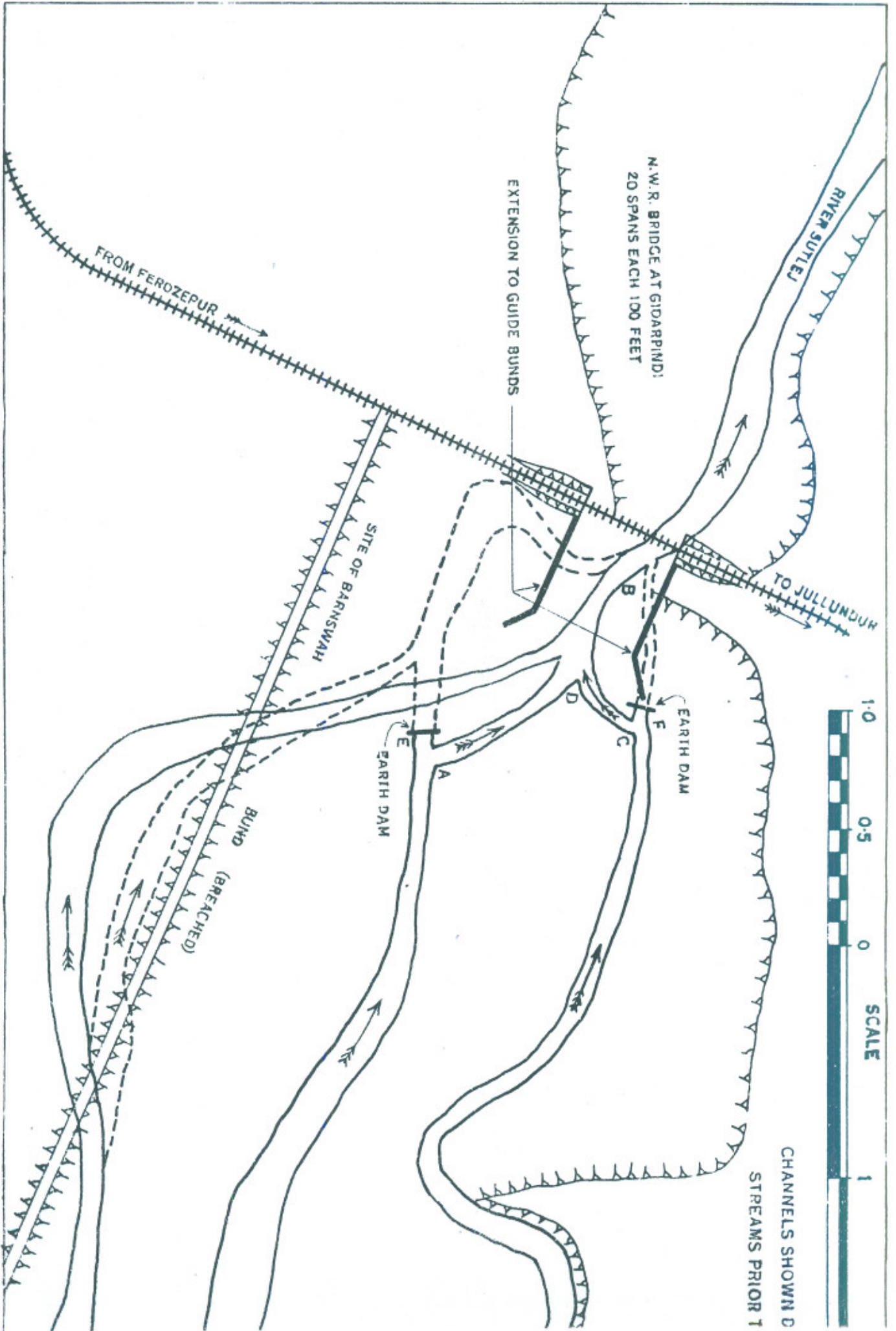
The following sketch plan indicates the construction finally adopted:—



On the completion of this dam on the 21st of February, the stream was diverted and the construction of the left guide bund went ahead. This work actually being completed and the track laid down by the 25th of that month.

No other points of interest arose during the extension of the river training works at the Gidarpindi bridge, the work being finally completed on the 14th of May, just one fortnight later than had been estimated.

In presenting this paper the author wishes to thank Lieut.-Col. W. Macrae, R. E., Chief Engineer, North Western Railway for his permission to put this data before the Congress.



N.W.R. BRIDGE AT GIDARPINDI;
20 SPANS EACH 100 FEET

EXTENSION TO GUIDE BUNDS

FROM FERROZEPUR

RIVER SUTLEJ

TO JULLUNDUR

SITE OF BARNSWAH

EARTH DAM

EARTH DAM

BUND (BREACHED)

1.0
0.5
0
1
SCALE

CHANNELS SHOWN D
STREAMS PRIOR T

2 MILES

SCALE

0

0.5

1.0

CHANNELS SHOWN DOTTED REPRESENT COURSE OF
STREAMS PRIOR TO EXTENSION OF GUIDE BUNDS

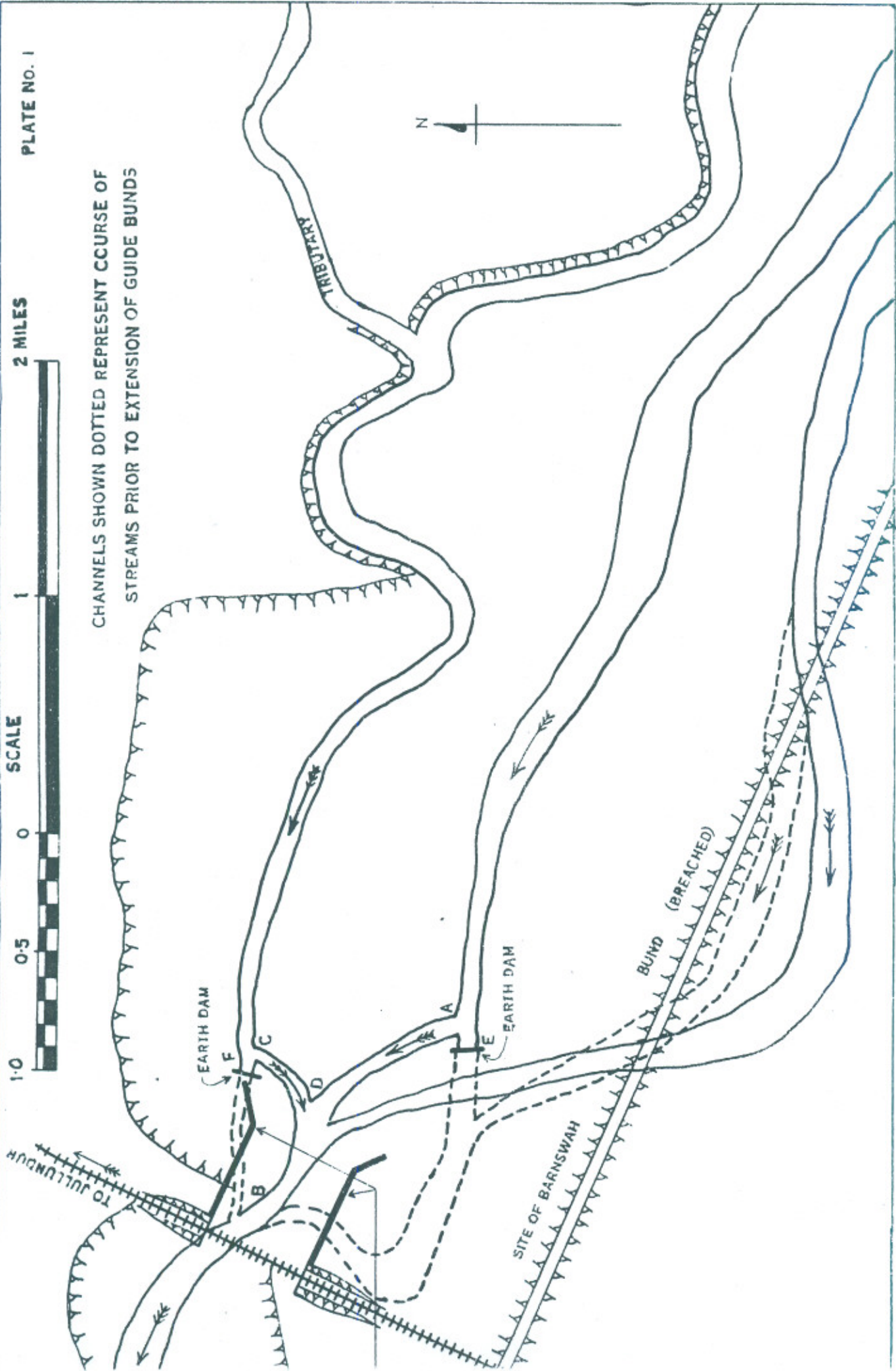
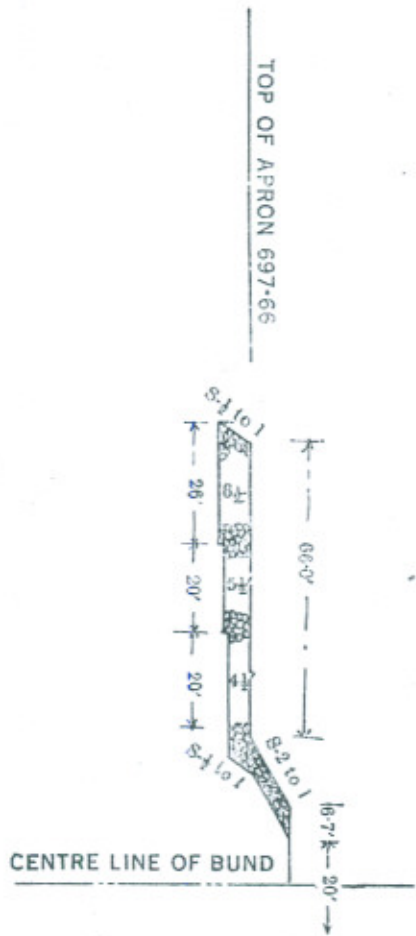


PLATE NO II

CROSS SECTION OF LEFT GUIDE BUND APRON

CROSS SECTION ON STRAIGHT



CROSS SECTION THROUGH NOSE

