PROVINCE OF MANITOBA
DEPARTMENT OF AGRICULTURE AND CONSERVATION
WATER CONTROL AND CONSERVATION BRANCH

Red River Floodway

INLET CONTROL WORKS MODEL FLOODWAY TRANSITION - ANALYSIS OF TEST RESULTS

H.G. ACRES & COMPANY LIMITED
Consulting Engineers
Niagara Falls, Canada

November 12, 1962

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1 - Introduction

The inlet to the floodway channel is located on the outside of the bend in the Red River just upstream from the control structure. This location, together with the system of dykes around the inlet area, makes it almost impossible to predict the flow conditions which will prevail in the inlet area during periods of high flows. Therefore, detailed model studies were undertaken to determine whether the inlet transition should be protected against erosion and, if so, what form of protection would be the most suitable.

Recommendations as to hydraulic model construction and the testing program were outlined in Acres' memorandum of June 6, 1962. Testing was performed at the University of Manitoba under the supervision of the Floodway Division.

We present herein a brief description of the hydraulic model test program and our analysis of the test results.

2 - Description of the Model

The control works model covers an area representing that part of the river and flood plain to be occupied by the control structure, the temporary diversion channel and the floodway inlet, together with sufficient length of river both upstream and downstream from the inlet control structure to ensure development of stable flow conditions through those areas under study. Testing of the inlet transition to the floodway constituted Stage II of the test program for the inlet control works model.

A more detailed description of the model, which was constructed to a vertical scale of 1:60 and a horizontal scale of 1:120, is contained in the report on hydraulic model tests of the inlet control works.

3 - Testing Program

The original testing program included a recommendation that the inlet transition be tested in two locations as shown on Plates 1 and 2. It was suggested that flows which showed a tendency to scour should be continued for a period of six hours to produce stable scour patterns. Initial test results showed no tendency to scour, and the test periods were subsequently reduced to four and finally three hours duration.

However, initial test results did show a return eddy on the west side of the transition. In order to minimize this eddy, it was recommended that:

(a) - The radius of the nose dividing the Red River and floodway be increased.

(b) - The nose of the spoil disposal area be extended upstream as far as possible without overloading excavated slopes. This measure would aid in splitting the Red River and floodway flows at high discharges, and would also reduce the quantity of water entering the floodway from the west side.

Upon completion of these preliminary tests, the Floodway Division selected Arrangement 2 as the most suitable, and requested that this configuration be tested for ice conditions in the river. The transition for Arrangement 2 is as shown on Plate 1, but the west dyke ends with a 100-foot radius nose.

4 - Analysis of Results

Scour tests showed that:

(a) - As noted by the Floodway Division, the effectiveness of the floodway was reduced for low flows with the transition in its downstream position, as shown on Plate 2; that is, for flows of up to about 20,000 cfs in the floodway, the upstream water levels would have to be increased by approximately one foot to account for the increased head loss of the longer weir section.

(b) - Because of the increased hydraulic gradient, which occurs with the transition in its downstream location, velocities were higher than for the transition in its upstream location for all flows. For a floodway discharge of 100,000 cfs, velocities increased locally from 4.8 feet per second for the upstream location to 6.2 feet per second, and some scouring of the pilot channel was observed by the testing team.

Ice flow tests showed that:

(a) - For a floodway discharge of 5,000 cfs, approximately 75 per cent of the ice moved through the Red River control structure; this percentage decreased with increasing floodway flows until at 40,000 cfs, only 25 per cent passed down the river.

(b) - Under steady flow conditions, there was no evidence of any tendency for the ice to jam in the transition to the floodway channel.

(c) - For a discharge of 5,000 cfs through the floodway, and before the channel was filled up to normal depth, ice pans tended to ground and dig into the channel bed immediately downstream from the transition. Flows passing grounded ice pans would undoubtedly result in scour action. If operation of the prototype should result in severe scour under these circumstances, it may become necessary to pave the transition or to adopt some other measure, such as a glance boom at the entrance to the floodway, to direct all ice through the control structure until normal flow depth is attained in the channel.

Although serious scour is not anticipated with the transition in its downstream location, it is considered preferable to locate it upstream closer to the river as in Arrangement 2. This will obviate the need to slope the weir crest to compensate for the greater head loss experienced at low flows through the longer transition. However, it became apparent during preparation of the testing program for the control structure (Stage IV) that, because of the location of the diversion channel, the construction of the dykes for Arrangement 2 would be possible only if the transition were moved 130 feet downstream. This location, shown on Plate 3, increases the length of the minimum weir section from approximately 100 feet to 230 feet. Also, because of the diversion channel, the nose of the spoil disposal area cannot be moved upstream without overloading excavated slopes.

This latter arrangement was discussed with the Floodway Division and met with their approval. As requested by the Floodway Division, velocity traverses were completed through the transition for design flow conditions in the floodway (60,000 cfs) during testing of the control structure. All point velocities recorded for this test were less than four feet per second. These additional results will be used by the Floodway Division to finalize their design of the inlet transition.

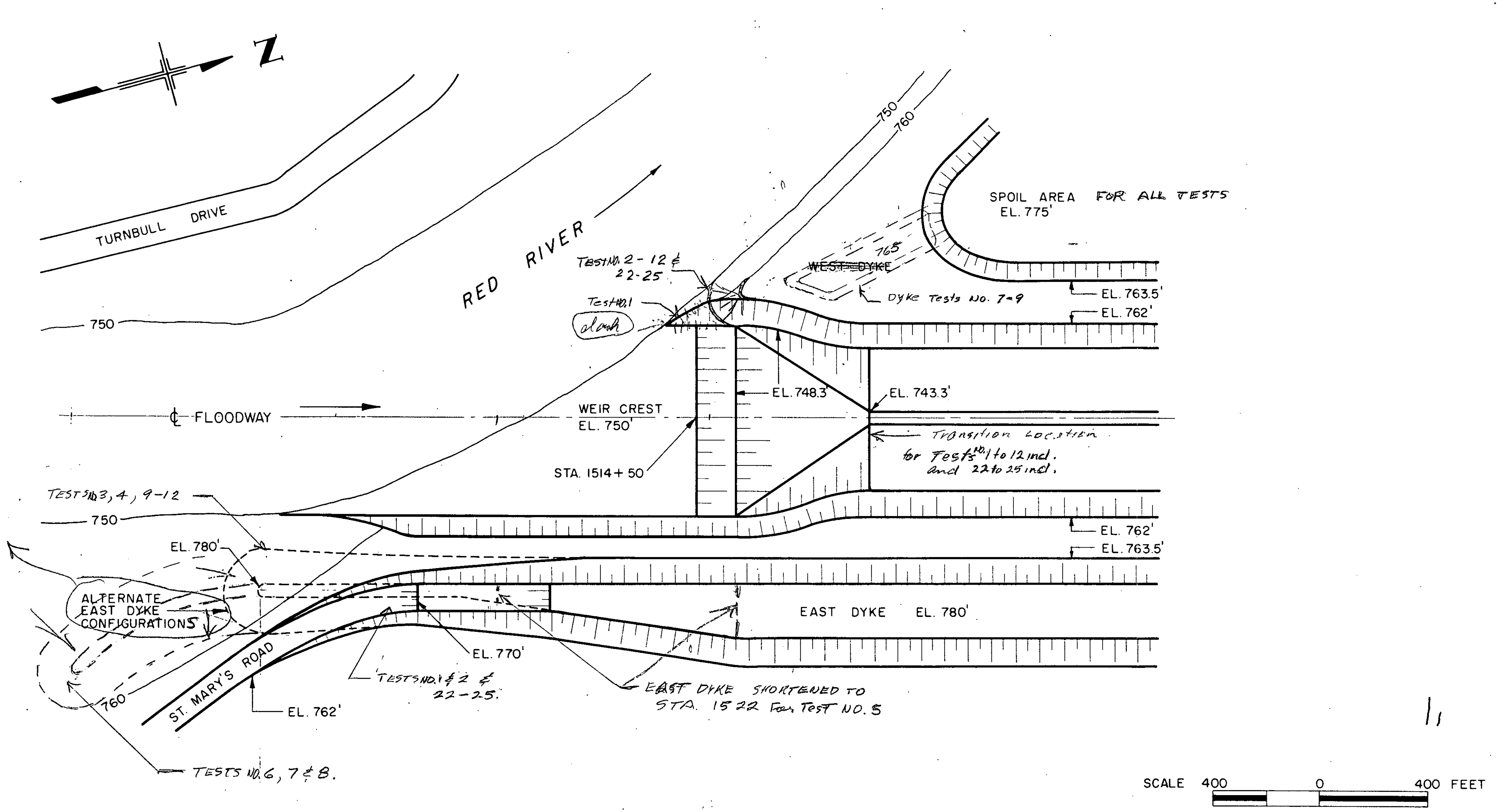
This modification of the weir length may prove of benefit if the transition is found to erode readily, as the increased section should ensure that an adequate plug is left, even after a severe flood, upon which repair materials may be placed.

Although not detected in the model, operation of the prototype at high flows may show that the slopes of the west dyke, below elevation 762 feet, require protection. If such is the case, a relatively thin gravel blanket should prove adequate since model tests show maximum point velocities of 4.8 feet per second through this area.

5 - Conclusion and Recommendations

In order to combine maximum efficiency with low water velocities, it is suggested that the inlet transition be located as far upstream as possible. The model results for the transition in the location shown on Plate 3 suggest that the floodway invert and dyke slopes will not likely require protection against scour, although operation of the prototype should be carefully observed.

If the Floodway Division feels it may be advantageous to keep the floodway clear of ice, it is suggested that any measures designed to meet this requirement should be tested in the inlet control works model before it is dismantled.



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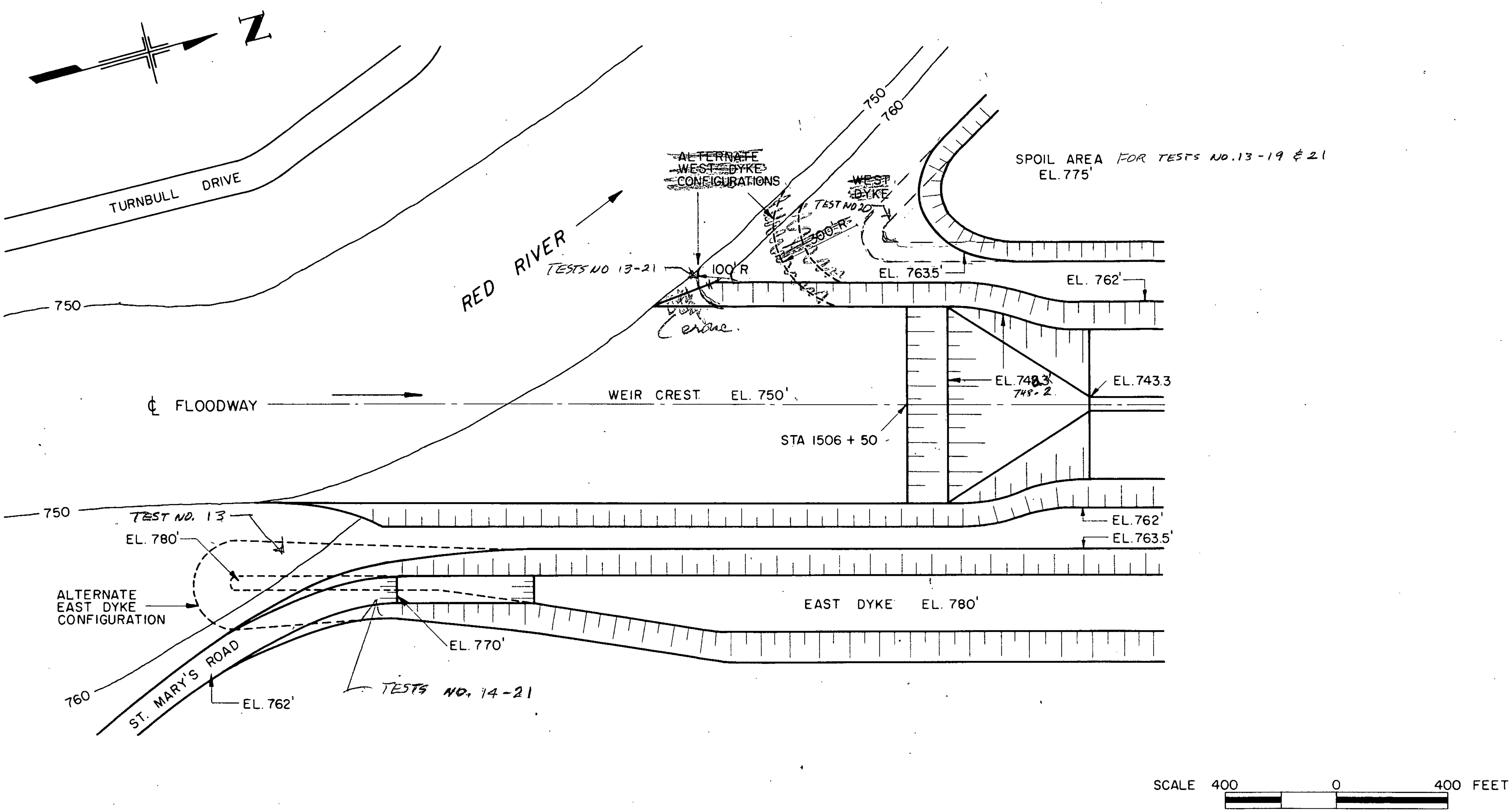
RED RIVER FLOODWAY

~~INLET WORKS MODEL~~ — STAGE II
CONFIGURATIONS AND TESTS WITH
FLOODWAY INLET TRANSITION IN
UPSTREAM LOCATION

Prepared by / Drawn By — H. G. ACRES & COMPANY LIMITED	DATE NOVEMBER 1962
	PLATE 1

SK - 940 - A - 98



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RED RIVER FLOODWAY

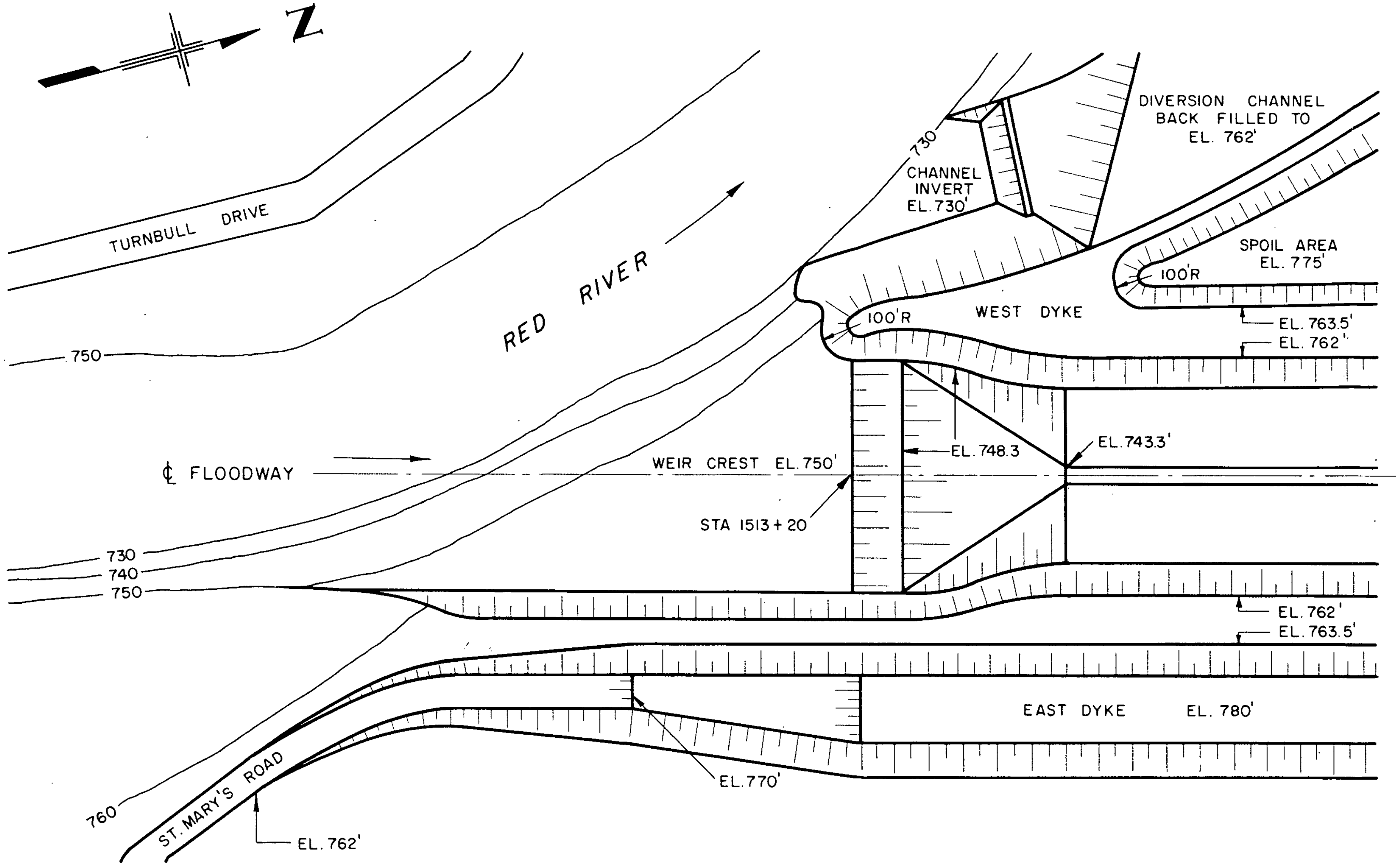
~~INLET WORKS MODEL — STAGE II~~
CONFIGURATIONS AND TESTS WITH
FLOODWAY INLET TRANSITION IN DOWNSTREAM LOCATION

Prepared by
Drawn by
H. G. ACRES & COMPANY LIMITED

DATE NOVEMBER 1962

PLATE 2

SK - 940 - A - 99



SCALE 400 0 400 FEET

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RED RIVER FLOODWAY

INLET WORKS MODEL — STAGE IV

FLOODWAY INLET TRANSITION AND
DIVERSION CHANNEL ARRANGEMENT

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DATE NOVEMBER 1962

PLATE 3

SK - 940 - A - 100