

A PLAN OF IMPROVEMENT OF
HARPER ROAD AT SYCAMORE CREEK,
INGHAM COUNTY, MICHIGAN

Thesis for the Degree of B. S.

MICHIGAN STATE COLLEGE

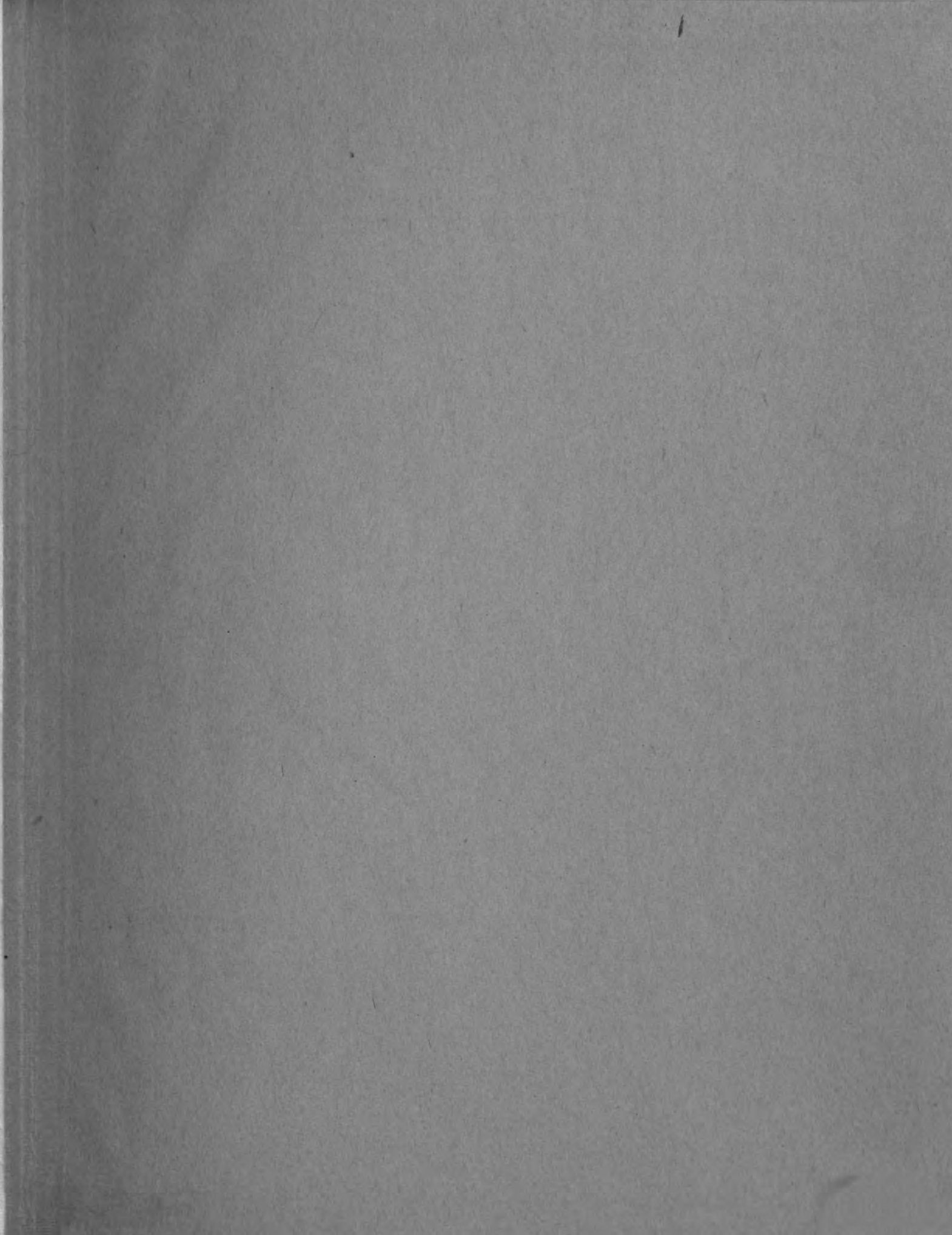
J. C. Preston — W. G. Wood

1949

THESIS

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**SUPPLEMENTARY
MATERIAL**
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A Plan of Improvement of Harper Road at
Sycamore Creek, Ingham County,
Michigan

A Thesis Submitted to

The Faculty of

MICHIGAN STATE COLLEGE

of

AGRICULTURE AND APPLIED SCIENCE

by

J. C. Preston

W. G. Wood

Candidates for the Degree of

Bachelor of Science

June 1949

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TABLE OF CONTENTS

CHAPTER	PAGE
I. The Problem	1
II. The Field Work	3
III. The Office Work	4
IV. Recommendations	12

LIST OF PLANS AND MAPS

1. Preliminary Survey Map
2. Bridge Plan and Details
3. Plan and Profile of New Channel
4. Plan and Profile of Roadway

CHAPTER I

THE PROBLEM

The problem of this thesis is typical of those solved by the county engineer in carrying out a county road improvement program. The designs resulting from the solution of such problems are unique in detail of any special location. The location selected for this problem was recommended by Mr. Robert O. Schaeffer, engineer, of the Ingham County Road Commission and is included in the Ingham County program of work covering the next two years.

A 600 foot section of Harper Road at Sycamore Creek, Alaledon Township, Ingham County was surveyed to determine necessary improvements. At present the load capacity of this section of Harper Road is limited to 2 tons by two antiquated bridges of 12 and 35 feet spans. Another serious road hazard is created by the narrow roadway with large trees on the road shoulders.

The designs herein presented eliminate these hazards and will improve this section of the road to be consistent in design with the adjacent sections of Harper Road. Seven hundred and fifty feet of new channel will be excavated to straighten the stream and thus eliminate the necessity of two bridges. These bridges will be replaced by a Multi Plate arch. The roadway is to be widened to standard width

and elevated to a grade that is several feet above spring high water.

The following chapters describe in detail the field work, the office work and the resulting designs. Recommendations for a more detailed and complete improvement study are given in the last chapter.

CHAPTER II

THE FIELD WORK

In order that the topography adjacent to Sycamore Creek could be thoroughly considered in locating the new channel it was necessary to draw up a topo map of the area. The first step of the mapping was to establish a horizontal and vertical control traverse. This was done completely by stadia. The plane table was used for all map work.

Establishment of the new road center line presented a more difficult surveying problem. Harper Road lies partly on the section line between sections 30 and 31, Alaiedon Township. In order to justify the new center line location it was necessary to establish the quarter section line. The new center line was found to parallel the section line at an 18 foot offset.

Level circuits were run along the new channel center line and along the new road location to determine elevations for cross sectioning and profiling. The running of these circuits completed the field work.

CHAPTER III

THE OFFICE WORK

The first work undertaken in the office was the drawing of the preliminary survey map. This was accomplished by filling in details, such as contouring, on the plane table map. The section line and the new road center line were then plotted on the map and a tracing made for reproduction purposes.

The completed preliminary survey map afforded a good means of locating the new channel center line. The location selected was chosen so as to be in the center portion of the creek "valley" and in the direction best suited for any future continuation of the channeling in either direction.

A plan and profile of the new channel was drawn for the purpose of establishing the channel grade and estimating the amount of earth excavation. Lack of time for further field work prevented the gathering of cross section elevations required for an accurate earth work computation.

A plan and profile was also drawn of the existing road in order to plot the new grade. The maximum fill elevation was determined by the required thickness of cover over the Multi Plate arch which will bridge the new channel. Minimum fill elevation was established as being three feet above maximum high water. Grades were chosen to allow for

minimum possible fill and a reasonable sight distance. Cross sections were plotted on the plan and profile for earth work computations.

As determined by use of the Drainage Map of Ingham County (1932), Sycamore Creek at Harper Road drains almost 42 square miles of area. It should be noted that this includes the town of Mason. The importance of providing a bridge and channel of sufficient flow capacity is obvious.

According to the policy of the Ingham County Road Commission, with whom we conferred, the most logical type of structure as far as efficiency, economy, and ease of construction is concerned, is a double-arch Multi Plate bridge. Inspection of several typical structures in this vicinity confirmed our selection.

To avoid unwarranted references and foot-notes, it should be pointed out that the bridge design and computations follow very closely those outlined in the 1945 edition of the "Handbook of Culvert and Drainage Practice" published by the Armco Drainage Products Association, Middleton, Ohio and that any tables or charts referred to are contained therein unless it is specifically stated otherwise.

The required plates for this bridge would be ordered from the mentioned firm according to arch number, number of plates, bevel, and length.

We have selected two Number 20 arches which have a total cross-sectional area of 310.4 square feet providing an area comparable to that required.

COMPUTATIONS

Talbots Formula: $a = \sqrt[4]{A^3 \times C}$

A = area in acres.

a = waterway in square feet.

c = 0.15 for this section of Michigan.

$a = (26624)^{3/4} \times 0.15 = 312 \text{ sq. ft.}$

Table No. 66: "Cross-sectional areas on preferred combinations of Multi Plate with spans of even feet."

Arch No. 20:

Area = 72 sq. ft.

Span = 204 in. = 17 ft.

Rise = 71 in. = 5 ft. - 11 in.

No. Plates = 5 1/2

R/S Ratio = 0.35

Radius = 108 in.

Total Area Provided = 310.4 sq. ft.

Table No. 29: "Recommended minimum gages for Multi Plate Arches--Highway Loadings." (For various spans, heights of cover, and live loads.)

Recommended minimum height of cover for unpaved, untreated road surfaces is 24 in.

Height of cover=proposed road grade-(proposed abutment elevation+rise)

$868.00 - 866.00 = 2.00$ ft.

With H-15 live load, 2 ft. cover, 17 ft. span, and gage No. 1 plate is required.

CALCULATION SHEET TO DETERMINE VERTICAL AND
HORIZONTAL REACTION OF MULTI PLATE ARCH

Date May 2, 1949

Location Sycamore Creek Calc. by Preston and Wood
at Harper Rd.

Rise(R) 5'-11" Span(S) 17'-0" Rise/Span(R/S) .35

Height of Cover(HC) 2'-1" Live Load(L) H-15 Length

Vd = (1) 1500 X (R/S Factor-1-A) .90 = 1350

Vd' = (2) 850 X (HC) 2 = 1700

(Backfill-100#/cu.ft.) Total Vd = 3,050[#]

Vl = (3) 2150 X (R/S Factor-3-A) 1.02 = 2193

For H-20 Loading. For other loading take
proportional amount.

For H-15 $3/5$ X 2193 = 1320

Total Vl = 1320[#]

Total V = 4370[#]

Hd = (4) 370 X (R/S Factor-4-A) 1.36 = 503

Hd' = (5) 360 X (R/S Factor-5-A) 1.54 X (HC) 2 = 1110

(Backfill-100#/cu.ft.) Total Hd = 1613[#]

Hl = (6) 1120 X (R/S Factor-6-A) 1.6 = 1795

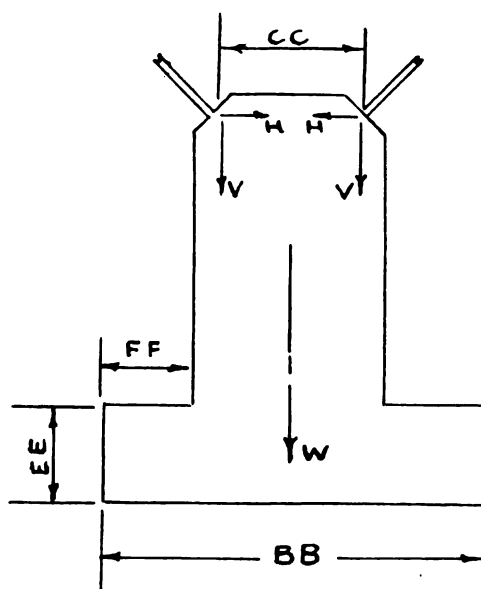
For H-15 $3/5$ X 1795 = 1075

Total H = 2688[#]

V/H = 1.63

V+H = 7058

DESIGN OF PIER FOOTING



$$\begin{aligned}
 \text{Vertical load} &= (HC+R+DD) \times (CC+1) \times (100) + (2V) \\
 &= (2+5.92+8) \times (2+1) \times (100) + (8740) \\
 &= 15,110 \text{ lbs.}
 \end{aligned}$$

Table 30:

"Required depth EE, of plain concrete pier footings
in terms of length of projection FF."

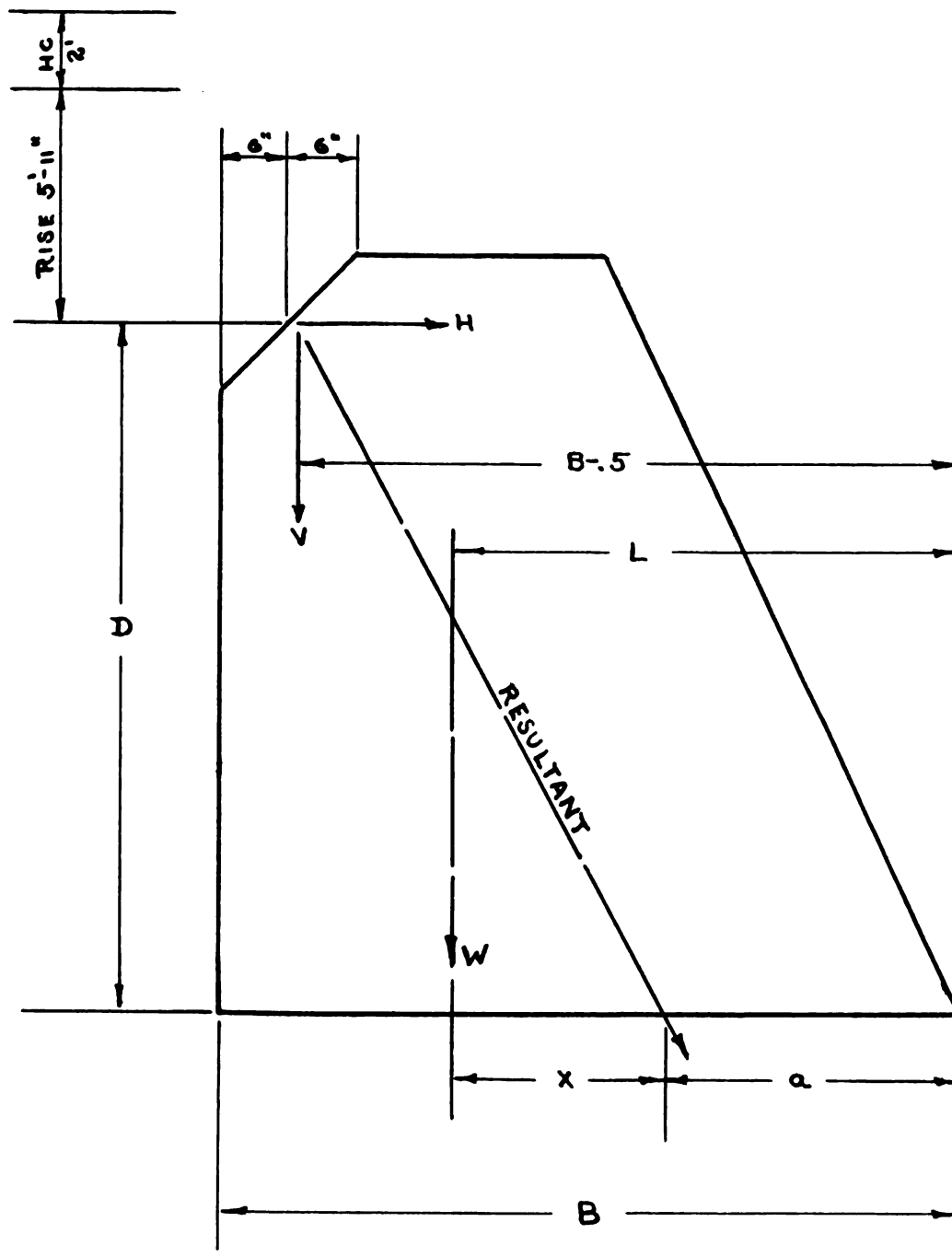
Curve 4, Figure 73:

Let BB=6 ft.

Let FF=1 ft.

therefore EE=1 ft.

COMPUTATIONS FOR ABUTMENTS



CONSTANTS	OPERATION	SYMBOL	OPERATION	RESULTS
$V = 4370$	1	$R + HC$	$R + HC$	7.92
$H = 2688$	2	$(R + HC)/D$	$1 \div D$	.99
$HC = 2.0$	3	F	Curve 1, using 2	114
$R = 5' 11''$	4	L	Curve 2, using 2	3.0
$D = 8.00$	5	Volume	$(1 + D) \times B$	95.6
<u>Let $B = 6.00$</u>	6	W	5×3	10900
	7	Mr	$4 \times 6 + \sqrt{V \times (B - .5)}$	56700
	8	Mo	$H \times D$	21500
	9	F.S.	$7 \div 8$	2.64
	10	P	$6 + V$	15270
	11	N	$7 \div 10$	3.72
	12	X	$8 \div 10$	1.41
	13	a	$11 - 12$	2.31
	14	B/a	$B \div 13$	2.60
	15	Z	Curve 3, using 14	1.60
	16	ABP	$10 \div B$	2540
	17	T	15×16	4060

CHAPTER IV

RECOMMENDATIONS

In view of the curtailment of time allotted to thesis preparation, it became necessary to eliminate three important phases of this improvement plan. These are an economic study of applicable bridge types, writing of specifications, and cost estimating.

The multi plate arch was selected in this project because of the simplicity and ease of design. The bridge study should include a cost comparison of several bridge types to determine that type that will be most economical in all aspects.

An overall county road improvement program ordinarily includes a priority listing and an estimate of cost of all projects involved. Even though all the work is to be done by the county with their own equipment, the cost estimate will be required by the commissioners before approving any project. The cost may also have an important bearing on priority.

The Ingham County Road Commission has adopted the Michigan State Highway Department's bridge specifications for all bridges to be constructed. Specifications for road construction, however, vary in detail from project to project and therefore each new project requires new

detailed specifications.

The inclusion of the above described phases of planning into the work described in Chapters II and III would result in a complete and justified design.

1. Pocket has:
1 map
3 plans

122
312

122
312
THS
Plan 2

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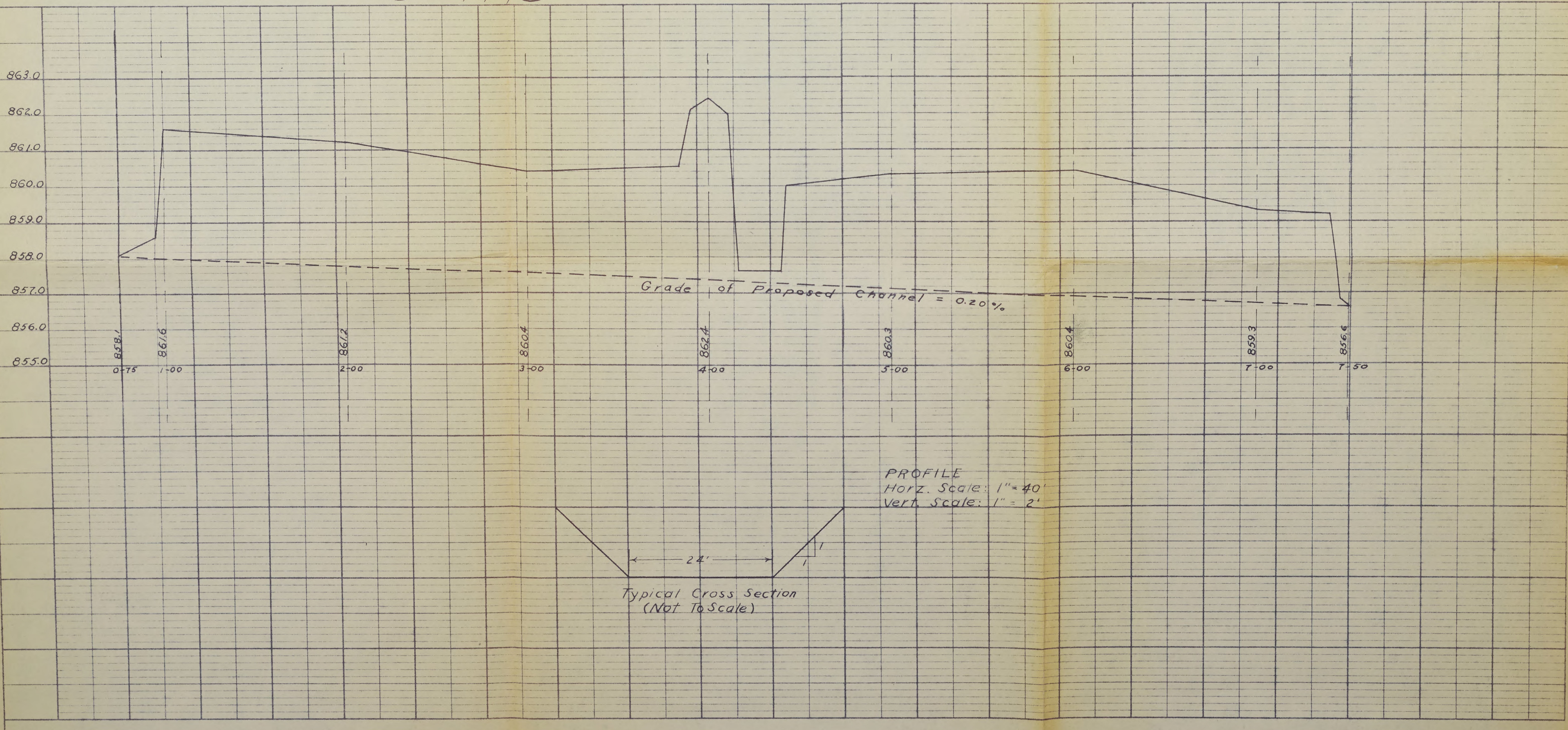
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**SUPPLEMENTARY
MATERIAL**

122



PROPOSED CHANNEL
Estimated Excavation: 2335 cu yds



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