THESIS

A STUDY OF MAINTENANCE COSTS OF MICHIGAN TRUNK LINE HIGHWAYS

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1922

A STUDY OF MAINTENANCE COSTS ON CERTAIN MICHIGAN TRUNK LINE HIGHWAYS TO DETERMINE THE RELATIVE ECONOMICS OF MAINTENANCE OF SURFACE TYPES.

A THESIS

SUBMITTED TO THE FACULTY OF

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PREFACE.

No definition of any profession has had wider circulation and more general acceptance than the old one formulated by Tredgold and adopted in its infancy by the institution of Civil Engineers.

"Engineering is the art of directing the great sources of power in nature for the use and convenience of man".

But the definition does not limit the field of engineering and the definition might reach to science in general.

Wellington, it seems, came closer in the following:

"Engineering is the conscientious application of science to the problems of economic production."

Since engineering in the common sense consists in solving problems in economic construction and operation it should be apparent to all that cost data are of primary importance to every engineer.

Comparison of unit costs is the only scientific criterion by which to judge the economic merit of a structure, a machine or a method of doing work and it is with this in mind that a comparison of the cost of

maintenance of the several types of surfaces of highways of this state are dealt with in this treatise.

This work was carried on under the supervision of G. C. Dillman, Deputy Commissioner of the Michigan State Highway Department, and it is to him and his office force that we owe the possibilities of making this study.

HISTORY

Michigan has approximately 6700 miles of State Trunk Line highways laid out in accordance with certain acts of the legislature, the first legislation of this kind being enacted in 1913.

In 1919 the law was changed in that all construction and maintenance heretofore supervised by the counties was to now be transferred, and all maintenance and construction of these State Trunk Line routes were to be put under the direction, supervision and control of the State Highway Commissioner.

The State Highway Commissioner contracts with all counties the first of each year for trunk line maintenance for the ensuing twelve months. These contracts cover all work to be done as near as can be estimated and this cost is met in the first instance

by counties. The State Highway Department then refunds to the counties every three months from five to fifty percent of the total account spent, upon approval of itemized statements of county expenditures. The percentage the state and county pay in each instance is based on the valuation per trunk line mile for each county.

The valuation per trunk line mile is determined for each county by dividing the equalized valuation for each county by three times the number of surveyed townships in the county.

METHODS OF MAINTENANCE

All Trunk Line routes passing through or in connection with counties are divided into sections (as shown in Appendix 11 on blue prints) for convenience of handling the work and as an aid in keeping accurate cost data on maintenance.

So far as is practicable one maintenance section covers but one type of surface and it is with these one type sections only that this thesis deals.

All maintenance costs are distributed to the following items:

1. Work on grade.
2. Bridges and culverts.
3. Dragging and patching.
4. Dust Layers.
5. Resurfacing.
6. Snow removal.
7. Roadside planting.

Supervision is an item of considerable amount in the aggregate but the percentage is small for dollar spent and is not considered in connection with this study.

TRAFFIC CENSUS.

The State Highway Department organized for taking traffic census in most counties in Michigan during the summer of 1921. Census wastaken at certain predetermined stations, the stations being located where traffic varied from the lightest to the heaviest. In most cases the census period was from 7 A. M. to 9 P. M. , a total of 14 hours , however, as some stations were adjacent to the larger cities twenty-four hour counts were taken. Before making a study of the census all of these were reduced to a twenty-four hour basis by adding ten percent to all fourteen hour counts.

The State Highway Department has computed from various traffic census that the average trunk line road carries a traffic, from 9 P. M. to 7 A. M. of approximately ten percent of the traffic of the day.

This traffic census taken in 1921 carried with it a cost of approximately $8,000.

METHOD

As was mentioned in the Preface the only true system of comparing the economic merit of a proposition is by comparision of unit costs, and the unit here considered being the maintenance vehicle mile cost i.e. The cost of maintenance on a road for the passage of one vehicle over one mile of surface.

Of the eighty-nine trunk lines in the State of Michigan this thesis covers 17 which are typical of the whole system.

In this study six types of road surfaces were used. They are with definition as taken from Blanchards' American Highway Engineer's Hand Books as follows:

1. Earth. A roadway composed of natural earthy material.

2. Gravel Roads of three types. Natural gravel roads, roads built by the surface method of construction and roads built by the trench method of construction.

3. Water Bound Macadam. A road crust composed of stone or similar material broken into irregular fragments compacted together so as to be interlocked and mechanically bound to the utmost possible extent.

4. Bituminous Macadam. A road having a wearing course of macadam with the interstices filled by a penetration method with a bituminous binder.

5. Cement Concrete. An intimate mixture of gravel, shell slag or broken stone particles with certain proportions of sand or similar material, cement and water made previous to placing.

6. Bituminous Concrete. A road composed of broken stone, broken slag, gravel or shell without or with sand, Portland cement, fine inert material or combinations thereof, and a bituminous cement incorporated together by a mixing method.

VEHICLE MILE COST COMPUTATION.

As to the method of computing the vehicle mile cost, we will describe from the taking of the traffic census to the final conclusion, the method used on Trunk Line

Route No. 17 lying between Cadillac Square, Detroit to the intersection with Trunk Line No. 11 at Watervliet.

During the summer of 1921, as has been stated, the State Highway Department authorized the County Road Commission of each county in the state to take traffic census points on State Trunk Line routes determined by the Maintenance Department.

The census were taken at these predetermined points in the following manner:-

A count as shown in (Appendix 11) was taken at Junction of Trunk Line No. 10 and No. 17, Dearborn Township, Wayne County on Tuesday, August 2nd of the following kinds of vehicles.

1. Single horse
2. Double team (Light)
3. Double team (loaded)
4. Motor Cycles.
5. 2 Passenger cars.
6. 5-7 passenger cars.
7. Busses.
8. Motor Trucks 2 tons and less
9. Motor Trucks 2-5 tons.
10. Motor trucks 5 tons and over.
11. Trailers.

The same count was made on Wednesday and again on Saturday the 6th and so on until a week of traffic data had been completed.

Generally counts were taken on a certain day of the week and then wait two weeks and one day and take another count until the week was completed, thus getting an average count per day over a period of several months.

After the counts were taken the data was sent to the State Highway Department to be filed. It was at this point that we take up the study of Maintenance Vehicle Mile cost.

On tracing cloth, mileage of surface in convention was platted as shown on prints in Appendix 4. Cities, county lines and maintenance sections were also platted in their proper location.

The next data involved was taken from maintenance cost sheets shown in Appendix 3. This data was collected from the different counties through which state trunk lines were routed and maintained, and tabulated according to trunk line route numbers.

Maintenance costs on this sheet were first tabulated per section cost and this figure, divided by the number of miles in the section, gave the average maintenance cost per mile over the section.

In platting onto the tracings shown in Appendix 4 the traffic census per 24 hours was platted at its

respective position on the layout of the trunk line. A traffic curve was then drawn through these points. The average maintenance cost was platted according to sections in a heavy dotted line.

In order to compute the vehicle mile cost as per example on Sec. 4, Wayne County of Trunk Line route No. 17, the traffic curve was first read and the average amount of traffic per 24 hours determined by getting the mean of the curve over the 21 miles in the section.

Since the maintenance cost is given per year it is necessary to use the amount of traffic per year also.

This was found by multiplying the average number of vehicles per 24 hours by the constant 200 which is a figure as has been stated, was determined by the Maintenance Division of the State Highway Department .

The average maintenance cost per mile per year divided by the traffic per year which is computed by the product of daily traffic times 200, gives the vehicle mile cost over the particular section which in the example stated is:-

$$\frac{4100 + 2100}{2} \times 200 = 620{,}000 \text{ vehicles a year.}$$

Reading from maintenance cost sheets.

Average maintenance costs per mile for Sec. 4 = $1114.00

$$\frac{\$1114.00}{620,000} = \$.0018 \text{ - Vehicle mile cost.}$$

This was then platted in horizontal solid lines above each section.

This same process was carried through on the seventeen trunk line routes taken in the study and a final summary which is shown in Sec. B of Appendix 1 was made after the material in Sec. A of Appendix 1 had been taken from the points.

In the summary it was only possible to use maintenance sections containing one surface type.

These sections and vehicle mile costs were tabulated and averaged by adding the total vehicle section costs and dividing by the total number of miles of the type taken.

Thus the figures arrived at in the final summary is the average vehicle mile maintenance cost for each type considered.

CONCLUSION

In conclusion, it can be said that a study of this sort is very general in its character though it covers the various types of highways in every part of

the state and embracing practically every type of maintenance, surface, kind and amount of traffic which our Michigan highways encounter, it gives fairly accurate results.

The comparison of the vehicle mile maintenance type costs show that per vehicle, an earth road requires more maintenance then the other types considered. Gravel roads seem to have the mean at about .57 of a cent per vehicle mile.

Bituminous and cement concrete require according to this study .18 and .36 of a cent respectively. Water bound and bituminous macadam uphold a vehicle mile cost of .6 and .36 of a cent each.

The possibilities of carrying this thesis further to find the total vehicle mile cost of each type instead of the maintenance vehicle mile cost would give a true comparison of the economics of the several surface types involved.

Typical Earth Road

Typical Gravel Road
Sanilac County

Typical Macadam Road (Surface Treated)
on Trunk Line No. 11, Emmet County

Typical Bituminous Macadam Road
on Trunk Line No. 12, Gogebic County

Typical Cement Concrete Road
on Federal Aid Road No. 27, Charlevoix
County

Typical Bituminous Concrete Road
on Federal Aid Road No. 16, Washtenaw
County

Year 1921

Location Michigan Avenue to Miller Road

Time 7 a.m. to 5 p.m.

Date	7/21 Thur.	7/23 Sat.	
Single Horse	18	16	
Double Team (Light)	23	11	
Double Team (Loaded)	28	11	
Motor Cycles	54	46	
2 Passenger Cars	436	415	
5-7 Passenger Cars	1755	2030	
Busses			
Motor Trucks - 2 tons and less	293	311	
Motor Trucks - 2-5 tons	276	255	
Motor Trucks - 5 tons and over	135	129	
Trailers			
Totals	3018	3224	

Daily Average = (Average of Sundays + Holidays) + (6 x week day a
7

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles _____ %

Motor Vehicles 98.2 %

* Hol

Estim

The following Traffic Census and Maintenance Report are for T.L.R. #17 & 18 in the study all other reports were used.

W.V.

TRAFFIC SUMMARY

Year 1921

State Trunk Line No. 17

Location Junction of Trunk line #10 and #17 - Dearborn Townshi

Time 7 a.m. to 9 p.m.

Date	8/2 Tues.	8/3 Wed.	8/6 Sat.
Single Horse	6	9	14
Double Team (Light)	12	11	4
Double Team (Loaded)	20	18	3
Motor Cycles	3	22	17
2 Passenger Cars	325	402	359
5-7 Passenger Cars	1934	2455	2716
Busses	40	48	47
Motor Trucks - 2 tons and less	239	249	192
Motor Trucks - 2-5 tons	115	156	139
Motor Trucks - 5 tons and over	72	98	60
Trailers			
Totals	2766	3468	3551

Daily Average = $\frac{\text{(Average of Sundays + Holidays)}}{7}$ + (6 x week day av

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles _____ %

Motor Vehicles 99.3 %

* Holi

Estima

TRAFFIC SUMMARY

Year 1921

State Trunk Line No. 17

Location Michigan Avenue at Merriman Road - Nankin Township

Time 7 a.m. to 9 p.m.

Date	8/1 Mon.	8/4 Thur.	8/8 Mon.
Single Horse	5	5	11
Double Team (Light)	2	2	2
Double Team (Loaded)	3	3	
Motor Cycles	9	14	19
2 Passenger Cars	357	340	277
5-7 Passenger Cars	1589	1888	1815
Busses	38	61	40
Motor Trucks - 2 tons and less	102	176	176
Motor Trucks - 2-5 tons	111	84	102
Motor Trucks - 5 tons and over	70	45	56
Trailers			
Totals	2286	2618	2498

Daily Average = (Average of Sundays + Holidays) + (6 x week day a
7

Percent of total from 9 p.m. to 7 a.m. _____%

Foreign Vehicles _____%

99.5 %

* Hol

Esti

TRAFFIC SUMMARY

State Trunk Line No. 17

Year 1921

Location Michigan Avenue at Wayne Road 5 - Nankin Township

Time 7 a.m. to 9 p.m.

Date	7/23 Sat.	7/25 Mon.	7/29 Fri.
Single Horse	26	16	22
Double Team (Light)	6	1	2
Double Team (Loaded)	1	2	3
Motor Cycles	42	20	30
2 Passenger Cars	458	378	404
5-7 Passenger Cars	2585	1994	1933
Busses	4	3	4
Motor Trucks - 2 tons and less	212	219	249
Motor Trucks - 2-5 tons	138	154	132
Motor Trucks - 5 tons and over	79	63	62
Trailers			
Totals	3551	2850	2841

Daily Average = (Average of Sundays + Holidays) + (6 x week day a
7

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles _____ %

Motor Vehicles 99.1 %

* Hol

Estin

TRAFFIC SUMMARY

State Trunk Line No. 17

Year 1921

Location Michigan Avenue at Canton Center and Belleville Road

Time 7 a.m. to 9 p.m.

Date	7/24 Sun.	7/28 Thur.	7/30 Sat.
Single Horse	3	2	4
Double Team (Light)		1	1
Double Team (Loaded)		1	
Motor Cycles	21	12	11
2 Passenger Cars	481	216	317
5-7 Passenger Cars	3529	1194	1607
Busses	2	9	9
Motor Trucks - 2 tons and less	80	163	137
Motor Trucks - 2-5 tons	26	82	47
Motor Trucks - 5 tons and over	13	21	20
Trailers			
Totals	4155	1701	2153

Daily Average = (Average of Sundays + Holidays) + (6 x week day a
7

Percent of total from 9 p.m. to 7 a.m. _____%

Foreign Vehicles _____%

Motor Vehicles 99.8 %

* Hol

Estim

State Trunk Line No. 17

TRAFFIC SUMMARY
Year 1921

Location Michigan Avenue at Wayne and Washtenaw County Line - 1

Time 7 a.m. to 9 p.m.

Date	7/22 Fri.	7/26 Tues.	7/31 Sun.
Single Horse	1	6	2
Double Team (Light)	4		
Double Team (Loaded)	6		
Motor Cycles	6	12	18
2 Passenger Cars	262	225	520
5-7 Passenger Cars	1106	1059	3529
Busses	5	8	2
Motor Trucks - 2 tons and less	97	146	88
Motor Trucks - 2-5 tons	55	73	22
Motor Trucks - 5 tons and over	24	28	13
Trailers			
Totals	1566	1557	4194

Daily Average = (Average of Sundays + Holidays) + (6 x week day a

7

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles _____ %

Motor Vehicles 99.7 %

* Hol

Estim

State Trunk Line No. 17

TRAFFIC SUMMARY
Year 1921

Location South 1/8 post between sections 1 & 2, Ypsilanti Townsh

Time 7 a.m. to 9 p.m.

Date	8/5 Fri.	8/6 Sat.	8/7 Sun.	8
Single Horse	13	2	3	
Double Team (Light)				
Double Team (Loaded)	1	1		
Motor Cycles	18	1	39	
2 Passenger Cars	223	258	378	
5-7 Passenger Cars	1351	1165	3282	
Busses				
Motor Trucks - 2 tons and less	102	99	82	
Motor Trucks - 2-5 tons	158	124	33	
Motor Trucks - 5 tons and over				
Trailers				
Totals	1866	1650	3817	

Daily Average = (Average of Sundays + Holidays) ÷ (6 x week day s
7

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles _____ %

Motor Vehicles 97.5 %

* Ho

Esti

TRAFFIC SUMMARY

State Trunk Line No. 17 Year 1921

Location Intersection of the Trunk Line 17 and Dexter Road - An

Time 7 A.M. to 9 P.M.

Date	8/5 Fri.	8/6 Sat.	8/7 Sun.
Single Horse	20	15	5
Double Team (Light)	2	1	
Double Team (Loaded)	1		
Motor Cycles	4	2	12
2 Passenger Cars	148	128	169
5-7 Passenger Cars	577	492	986
Busses			
Motor Trucks - 2 tons and less	21	14	7
Motor Trucks - 2-5 tons	13	9	5
Motor Trucks - 5 tons and over			
Trailers			
Totals	786	661	1184

Daily Average = (Average of Sundays + Holidays) + (6 x week day av
7

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles 0.2 %

Motor Vehicles 97.5 %

* Holi

Estima

State Trunk Line No. 17

TRAFFIC SUMMARY
Year 1921

Location Near north section corner of 2 and 3 - Pittsfield Towns

Time 7 a.m. to 8 p.m.

Date	8/5 Fri.	8/6 Sat.	8/7 Sun.
Single Horse	3	5	2
Double Team (Light)	2		
Double Team (Loaded)	2	3	3
Motor Cycles	5	3	8
2 Passenger Cars	107	100	148
5-7 Passenger Cars	415	386	824
Busses			
Motor Trucks - 2 tons and less	15	9	4
Motor Trucks - 2-5 tons	20	11	8
Motor Trucks - 5 tons and over			
Trailers			
Totals	569	517	997

Daily Average = (Average of Sundays + Holidays) + (6 x week day a
7

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles _____ %

Motor Vehicles 98.4 %

* Hol

Estim

TRAFFIC SUMMARY

State Trunk Line No. 17

Year 1921

Location Two miles east of Jackson - Looni township

Time 7 a.m. to 9 p.m.

Date	9/15 Sun.	10/3 Mon.	10/8 Sat.
Single Horse	5	11	15
Double Team (Light)	2	10	7
Double Team (Loaded)	5	8	14
Motor Cycles	9	7	14
2 Passenger Cars	94	79	85
5-7 Passenger Cars	701	434	698
Busses			
Motor Trucks - 2 tons and less	105	104	97
Motor Trucks - 2-5 tons	99	85	63
Motor Trucks - 5 tons and over			
Trailers			6
Totals	1020	738	999

Daily Average = (Average of Sundays + Holidays) + (6 x week day a
7

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles 1.1 %

Motor Vehicles 97.0 %

* Hol

Estim

TRAFFIC SUMMARY

Year 1921.

State Trunk Line No. 17

Location One half mile west of Galesburg

Time 7 a. m. to 9 p. m.

Date	8/14 Sun.	8/18 Thurs	8/24 Wed
Single Horse	9	6	4
Double Team (Light)	1	22	3
Double Team (Loaded)		12	3
Motor Cycles	21	12	9
2 Passenger Cars	226	165	158
5-7 Passenger Cars	1907	950	875
Busses			1
Motor Trucks - 2 tons and less	24	108	113
Motor Trucks - 2-5 tons	17	9	36
Motor Trucks - 5 tons and over	4		9
Trailers	1	2	
Totals	2210	1286	1211

Daily Average = $\frac{\text{(Average of Sundays + Holidays)}}{7}$ + (6 x week day s

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles 10.3 %

Motor Vehicles 98.7 %

* Ho

Esti

TRAFFIC SUMMARY

State Trunk Line No. 17 Year 1921.

Location One half mile east of east city limits of Kalamazoo - 1

Time 7 a.m. to 7. a. m.

Date	8/6 Sat.	8/14 Sun.	8/18Thur
Single Horse	36	37	48
Double Team (Light)	12	8	43
Double Team (Loaded)	7	7	38
Motor Cycles	18	55	16
2 Passenger Cars	322	490	290
5-7 Passenger Cars	2140	2568	1854
Busses	6	7	2
Motor Trucks - 2 tons and less	193	64	220
Motor Trucks - 2-5 tons	79	13	65
Motor Trucks - 5 tons and over	11	33	28
Trailers	1	3	2
Totals	2825	3275	2606

Daily Average = (Average of Sundays + Holidays) ÷ (6 x week day a

7

Percent of total from 9 p.m. to 7 a.m. 16.2 %

Foreign Vehicles 6.5 %

Motor Vehicles 97.6 %

* Hol

Estim

TRAFFIC SUMMARY

State Trunk Line No. 17 Year 1921.

Location West city limits of Kalamazoo - Kalamazoo Township.

Time 7 a. m. to 7 a. m.

Date	8/4 Thur.	8/10 Wed.	8/16 Tues.
Single Horse	39	23	22
Double Team (Light)	12	6	20
Double Team (Loaded)	8	14	14
Motor Cycles	3	13	1
2 Passenger Cars	231	183	177
5-7 Passenger Cars	1172	774	907
Busses	17	3	21
Motor Trucks - 2 tons and less	81	113	92
Motor Trucks - 2-5 tons	29	29	36
Motor Trucks - 5 tons and over	5		26
Trailers	3	7	1
Totals	1600	1165	1317

Daily Average = (Average of Sundays + Holidays) + (6 x week day av

7

Percent of total from 9 p.m. to 7 a.m. 16.9 %

Foreign Vehicles 9.0 %

Motor Vehicles 97.0 %

* Holi

Estima

TRAFFIC SUMMARY

State Trunk Line No. 17 Year 1921

Location One half mile west of Hartford - Hartford Towns

Time 7 a. m. to 9. p. m.

Date	9/4/Sun.	9/5/*Mon.	9/6 Tues
Single Horse	29	39	39
Double Team (Light)	2	11	18
Double Team (Loaded)	1	9	12
Motor Cycles	8	10	4
2 Passenger Cars	59	54	37
5-7 Passenger Cars	1553	1671	586
Busses	18	25	15
Motor Trucks - 2 tons and less	35	59	77
Motor Trucks - 2-5 tons	3	4	2
Motor Trucks - 5 tons and over		4	
Trailers		4	
Totals	1708	1886	790

Daily Average = (Average of Sundays + Holidays) ÷ (6 x week day a

7

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles 21.0 %

Motor Vehicles 94.5 %

* Hol

Estim

TRAFFIC SUMMARY

State Trunk Line No. 17 Year 1921

Location One mile east of Watervliet - Watervliet Township.

Time 7 a. m. to 9 p. m.

Date	8/15 Mon.	8/16 Tues.	8/17 Wed.
Single Horse	48	22	32
Double Team (Light)	11	10	9
Double Team (Loaded)	8	5	3
Motor Cycles	4	6	6
2 Passenger Cars	56	62	34
5-7 Passenger Cars	535	490	477
Busses	14	13	12
Motor Trucks - 2 tons and less	71	72	59
Motor Trucks - 2-5 tons	16	16	22
Motor Trucks - 5 tons and over			
Trailers			
Totals	763	696	654

Daily Average = (Average of Sundays + Holidays) + (6 x week day av
7

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles ~~22.3~~ %

Motor Vehicles ~~94.7~~ %

* Hol

Estim

TRAFFIC SUMMARY

State Trunk Line No. 17

Year 1921

Location One half mile west of Oshtemo, Oshtemo Township.

Time 7 a.m. to 9 p.m.

Date	8/28 Sun.	9/3 Sat.	9/9/ Fri.
Single Horse	5	14	17
Double Team (Light)		14	7
Double Team (Loaded)		2	
Motor Cycles	1	3	1
2 Passenger Cars	96	72	137
5-7 Passenger Cars	1598	968	606
Busses	6	14	12
Motor Trucks - 2 tons and less	20	69	29
Motor Trucks - 2-5 tons	11	11	10
Motor Trucks - 5 tons and over	1	7	5
Trailers	8	3	1
Totals	1746	1177	825

Daily Average = (Average of Sundays + Holidays) + (6 x week day a

7

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles 9.0 %

Motor Vehicles 98.4 %

* Hol

Estim

TRAFFIC SUMMARY

State Trunk Line No. 17 Year 1921

Location Three quarters miles east of Lawrence, Lawrence To

Time 7 a. m. to 9 p. m.

Date	8/22 Mon.	8/23 Tues.	8/24 Wed.	8
Single Horse	15	22	15	
Double Team (Light)	23	39	44	
Double Team (Loaded)	16	33	35	
Motor Cycles		1		
2 Passenger Cars	63	67	89	
5-7 Passenger Cars	554	607	664	
Busses	12	10	12	
Motor Trucks - 2 tons and less	64	69	71	
Motor Trucks - 2-5 tons	4	13	15	
Motor Trucks - 5 tons and over		1		
Trailers	1	1	2	
Totals	752	863	947	

Daily Average = (Average of Sundays + Holidays) ÷ (6 x week day a
7

Percent of total from 9 p.m. to 7 a.m. ____ %

Foreign Vehicles 5.1 %

Motor Vehicles 92.2 %

* Hol

Estim

TRAFFIC SUMMARY

State Trunk Line No. 17

Year 1921

Location W.H. Pierce Farm - Emmett Township

Time 7 a.m. to 7 a.m.

Date	8/13Sat.	8/21 Sun.	8/29 Mon.
Single Horse		1	7
Double Team (Light)	1	1	7
Double Team (Loaded)			
Motor Cycles	3	36	2
2 Passenger Cars	78	151	82
5-7 Passenger Cars	901	1419	776
Busses		1	2
Motor Trucks - 2 tons and less	50	37	102
Motor Trucks - 2-5 tons	11	2	9
Motor Trucks - 5 tons and over			
Trailers			1
Totals	1044	1648	988

Daily Average = $\frac{\text{(Average of Sundays + Holidays)}}{7}$ + (6 x week day av

Percent of total from 9 p.m. to 7 a.m. 15.1 %

Foreign Vehicles 8.0 %

Motor Vehicles 99.4 %

* Holi

Estima

TRAFFIC SUMMARY

State Trunk Line No. 17 Year 1921

Location One-quarter mile east of Marengo - Marengo Township

Time 7a.m. to 7 a.m.

Date	8/13 Sat.	8/21 Sun.	9/29 Mon.
Single Horse	2		5
Double Team (Light)	1	1	1
Double Team (Loaded)	1		
Motor Cycles	6	53	2
2 Passenger Cars	90	128	97
5-7 Passenger Cars	711	1143	604
Busses			
Motor Trucks - 2 tons and less	45	14	65
Motor Trucks - 2-5 tons	6	4	9
Motor Trucks - 5 tons and over		2	3
Trailers			
Totals	862	1345	786

Daily Average = (Average of Sundays + Holidays) ÷ (6 x week day a

7

Percent of total from 9 p.m. to 7 a.m. 13.9 %

Foreign Vehicles 4.7 %

Motor Vehicles 99.6 %

* Hol

Estim

TRAFFIC SUMMARY

State Trunk Line No. 17

Year 1921

Location Intersection of trunk line #17 and #37

Time 7a.m. to 7 a.m.

Date	8/13Sat.	8/21Sun.	8/29Mon.
Single Horse	29	8	36
Double Team (Light)	15	3	17
Double Team (Loaded)	13	1	10
Motor Cycles	6	36	29
2 Passenger Cars	215	352	301
5-7 Passenger Cars	1363	2296	1285
Busses	15	26	30
Motor Trucks - 2 tons and less	14	31	74
Motor Trucks - 2-5 tons	6	3	11
Motor Trucks - 5 tons and over	2	1	1
Trailers	6	4	1
Totals	1684	2761	1795

Daily Average = (Average of Sundays + Holidays) + (6 x week day av
7

Percent of total from 9 p.m. to 7 a.m. 11.6 %

Foreign Vehicles %

Motor Vehicles 98.7 %

* Holi

Estima

TRAFFIC SUMMARY

State Trunk Line No. 17 Year 1921

Location 1½ miles west of Jackson- Blackman Township

Time 7 a.m. to 9 p.m.

Date	9/26 Mon.	10/1Sat.	10/6Thur.
Single Horse	20	24	19
Double Team (Light)	11	6	9
Double Team (Loaded)	6.	7	14
Motor Cycles	12	3	3
2 Passenger Cars	70	100	55
5-7 Passenger Cars	486	627	432
Busses	76		2
Motor Trucks - 2 tons and less	34	84	74
Motor Trucks - 2-5 tons		4	24
Motor Trucks - 5 tons and over			
Trailers	1		
Totals	716	855	632

Daily Average = (Average of Sundays + Holidays) ÷ (6 x week day av
7

Percent of total from 9 p.m. to 7 a.m. _____ %

Foreign Vehicles 3.1 %

Motor Vehicles 94.8 %

* Holi

Estima

TRUNK LINE ROUTE NO. 17

County	Maint. Sec. Number	Type	Sec. Mileage	Sec. Maint. Cost for Year.	Maint. Cost per mile for Year.	Maint. Cost per Vehicle Mile.
Wayne	17-4	Concrete	21.561	24,017.91	1114.00	.0018
Washtenaw	17-2	Concrete	2.826	664.43	235.11	.0006
	17-1	Gravel	4.828	10,798.38	2236.61	
	17-3	A.Concrete	4.723	202.07	42.78	.0003
	17-4	A.Concrete	15.618	7.98	.51	
Jackson	17-11	Earth	2.500			
	17-10	Earth	7.000			
	17-9	Gravel	3.000			
	17-1	Gravel	3.500			
	17-2	Gravel	5.000			
	17-3	Gravel	6.200			
Calhoun	17-6	Gravel	1.300	1,068.11	821.62	
	17-5	Gravel	2.300	917.74	399.01	.0016
	17-4	Brick	5.700	729.18	127.92	.0005
	17-3	Gravel	2.500	1,249.48	499.79	.007
	17-2	Gravel	9.600	6,053.98	630.62	.002
	17-2	Bit. Con.	0.600	378.37	630.61	.002
	17-1	Gravel	3.200	1519.24	474.76	.015
	17-1	Concrete	2.000	949.52	474.76	.015
Kalamazoo	17-4	Gravel	6.500	5,108.13	785.86	.028
	17-5	Gravel	2.500	1,274.12	509.64	.019
	17-6	Concrete	6.500	1,223.78	188.27	.0013
	17-7	Concrete	9.500	1,724.76	181.55	.0003
	17-5	Gravel	0.900	241.51	268.34	.0013
	17-5	Concrete	6.700	1,797.88	268.34	.0013
	17-4	Gravel	7.800	3,241.95	415.63	.002
	17-3	Gravel	4.000	1,858.28	464.57	.002
	17-2	Concrete	4.400	1,253.49	284.88	.0012

Trunk Line Route No. 10

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Saginaw	3	C. Concrete	8.900	.0046
Saginaw	2	Water Bound Macadam	6.700	.005
Bay	1	Cement Concrete	3.000	.001
Bay	2	Cement Concrete	6.400	.0148
Bay	3	Gravel	7.500	.016
Bay	4	Gravel	8.000	.011
Arenac	2	Gravel	6.750	.004
Arenac	1	Gravel	3.500	.016
Iosco	6	Gravel	4.500	.0147
Iosco	2	Gravel	7.800	.0057
Alcona	5	Gravel	6.000	.005
Alcona	4	Gravel	7.750	.008
Presque Isle	5	Gravel	11.000	.0018
" "	4	Gravel	6.000	.0063
" "	3	Gravel	7.750	.0094

Trunk Line Route No. 11

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Van Buren	7	Water Bound Macadam	10.200	.0043
Allegan	3	" "	3.500	.0046
Allegan	1	" "	6.000	.006
Mason	4	Gravel	6.400	.0008
Mason	5	Gravel	5.000	.0014
Mason	6	Gravel	5.000	.0014
Manistee	5	Gravel	7.500	.0051
Benzie	Twp. 1	Gravel	5.032	.007
Grand Traverse	1	Gravel	9.000	.003
Grand Traverse	2	Gravel	6.700	.0046
Grand Traverse	4	Gravel	8.400	.002
Antrim	1	Water Bound Macadam	6.500	.016
Antrim	4	Gravel	5.949	.0022
Charlevoix	1	Gravel	11.606	.0046

Trunk Line Route No. 12

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Chippewa	1	Water Bound Macadam	7.00	.0085
Chippewa	2	Gravel	5.500	.0015
"	3	Gravel	5.000	.009
"	4	Gravel	5.000	.0044
Mackinac	11	Gravel	12.500	.0045
"	10	Gravel	10.000	.0043
"	9	Gravel	4.000	.014
"	8	Earth	6.000	.0154
"	7	Earth	5.500	.0176
"	3	Water Bound Macadam	6.000	.0061
"	2	Earth	6.000	.0042
Delta	8	Water Bound Macadam	5.300	.0052
"	7	" "	5.272	.0061
"	6	" "	5.095	.0056

Trunk Line Route No. 12 Cont'd.

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Delta	2	Water Bound Macadam	5.665	.0024
Delta	1	" "	5.665	.0042
Menominee	2	Gravel	3.500	.0033
"	3	Gravel	6.000	.008
Dickinson	1	Gravel	6.555	.0073
"	2	Water Bound Macadam	3.613	.0056
"	10	Gravel	2.157	.012
Iron	5	Water Bound Macadam	10.400	.0051
"	1	Gravel	21.600	.0036
Gogebic	3	Gravel	27.600	.014

Trunk Line Route No. 15

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Menominee	7	Gravel	3.500	.0130
"	8	Gravel	4.000	.0088
"	11	Gravel	5.300	.0024
"	12	Gravel	6.600	.0018
Delta	13	Earth	6.000	.0103
Delta	14	Earth	5.990	.0023
Baraga	1	Gravel	8.000	.021
Keweenaw	1	C. Concrete	1.300	.0046
"	2	Water Bound Macadam	.966	.0056
"	5	" "	1.500	.007
"	6	" "	3.600	.0103
"	8	" "	6.500	.0039

Trunk Line Route No. 16

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Livingston	4	Gravel	5.200	.0073
"	3	Gravel	5.200	.0045
"	1	"	6.000	.0017
Ingham	9	"	6.800	.003
"	7	"	5.600	.0043
Eaton	1	"	6.000	.005
Ionia	1	"	5.000	.0063
"	2	"	5.000	.007
"	6	"	4.500	.010
"	7	"	6.000	.005
Kent	17	"	7.600	.014
"	16	"	4.200	.010
"	13	C. Concrete	4.800	.0013

Trunk Line Route No. 17

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Wayne	4	Cement Concrete	21,561	.0018
Washtenaw	2	" "	2,826	.0005
"	3	Bit. Concrete	4,723	.0003
Calhoun	2	Gravel	9,600	.002
Kalamazoo	4	Gravel	6,500	.0027
"	7	C. Concrete	9,500	.0003
Van Buren	4	Gravel	7,800	.002
" "	3	"	4,000	.002
" "	2	C. Concrete	4,400	.0012

Trunk Line Route No. 20

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Osceola	4	Gravel	8,000	.0048
"	5	"	15,000	.0022
Lake	2	Earth	6,500	.015
Mason	8	Gravel	6,500	.0052
Mason	7	"	6,000	.0046

Trunk Line Route No. 21

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Genesee	3	B.& Concrete	6.000	.003
"	4	Gravel	7.600	.0033

Trunk Line Route No. 24

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Mecosta	8	Gravel	7.964	.0054
"	7	"	5.154	.0013
Newaygo	11	"	8.500	.0061
"	10	"	8.750	.0065
"	7	"	6.500	.0074

Trunk Line Route No. 39

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Branch	4	Gravel	11.800	.0075
"	5	Gravel	8.400	.0022
Calhoun	7	Gravel	6.700	.0023
"	8	"	7.750	.0063
Eaton	8	Gravel	4.700	.0033
"	7	"	3.600	.0054
"	6	"	4.600	.0048
"	5	"	3.000	.0053
"	11	"	1.854	.0036

Trunk Line Route No. 47.

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Shiawassee	10	Gravel	5.800	.0052
"	9	"	5.500	.0033
"	8	"	4.500	.004
Saginaw	5	Gravel	8.500	.0043
"	4	"	4.500	.0083

Trunk Line Route No. 52.

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Lenawee	4	Water Bound Macadam	7.000	.0126
"	3	" " "	4.750	.0023
"	2	Gravel	11.000	.002
"	1	"	4.750	.0013

Trunk Line Route No. 76.

County	Maintenance Section No.	Type	Mileage	Vehicle Mile Cost
Ogemaw	2	Gravel	9.000	.0053
"	3	"	5.500	.0056
"	4	"	6.250	.005

Type of Surface **Earth**

Trunk Line Route No.	County	Maintenance Section No.	Mileage	Vehicle Mile Cost	Vehicle Section Cost
12	Mackinac	8	6.000	.0154	.0924
12	Mackinac	7	5.500	.0176	.0968
12	Mackinaw	2	6.000	.0042	.0252
14	Hillsdale	2	7.500	.0036	.0270
14	Lenawee	1	6.000	.0073	.0438
20	Lake	2	6.500	.015	.0975
15	Delta	13	6.000	.0103	.0618
15	Delta	14	5.990	.0023	.01377
80	Lenawee	1	9.000	.003	.027
80	Lenawee	2	7.000	.0045	.0315
80	Lenawee	3	3.000	.0110	.033
		Total	68.490		.54977

Type of Surface Gravel

Trunk Line Route No.	County	Maintenance Section No.	Mileage	Vehicle Mile Cost	Vehicle Section Cost
10	Bay	3	7.500	.016	.120
10	Bay	4	8.000	.011	.088
10	Arenac	2	6.750	.004	.0270
10	Arenac	1	3.500	.016	.0560
10	Iosco	6	4.500	.0147	.06615
10	Iosco	2	7.800	.0057	.0444
10	Alcona	5	6.000	.005	.030
10	Alcona	4	7.750	.008	.0620
10	Presque Isle	5	11.000	.0018	.0198
10	" "	4	6.000	.0063	.0378
10	" "	3	7.750	.0094	.0728
11	Mason	4	6.400	.0008	.00512
11	Mason	5	5.000	.0014	.007
11	Mason	6	5.000	.0014	.007

Type of Surface Gravel

Trunk Line Route No.	County	Maintenance Section No.	Mileage	Vehicle Mile Cost	Vehicle Section Cost
11	Manistee	5	7.500	.0057	.0427
11	Benzie	Twp 1	5.032	.007	.0352
11	Grand Traverse	1	9.000	.003	.027
11	" "	2	6.700	.0046	.0308
11	" "	4	8.400	.002	.0168
11	Antrim	4	5.949	.0022	.0130
11	Charlevoix	1	11.606	.0046	.05338
12	Chippewa	2	5.500	.0015	.0082
12	Chippewa	3	5.000	.009	.045
12	Chippewa	4	5.000	.0044	.0220
12	Mackinac	11	12.500	.0045	.0562
12	Mackinac	10	10.000	.0043	.043
12	Mackinac	9	4.000	.014	.056
12	Menominee	2	3.500	.0033	.01155
12	Menominee	3	6.000	.008	.048

Type of Surface Gravel

Trunk Line Route No.	County	Maintenance Section No.	Mileage	Vehicle Mile Cost	Vehicle Section Cost
12	Dickinson	1	6.555	.008	.0524
12	Dickinson	10	2.157	.012	.0258
12	Iron	1	21.600	.0036	.0777
12	Gogebic	3	27.600	.014	.3864
14	Clare	1	7.500	.0110	.0825
14	Clare	2	11.000	.0104	.1144
15	Menominee	7	3.500	.013	.0455
15	Menominee	8	4.000	.0088	.0352
15	Menominee	11	5.300	.0024	.0127
15	Menominee	12	6.600	.0018	.01188
15	Baraga	1	8.000	.021	.168
16	Livingston	4	5.200	.0073	.0379
16	Livingston	3	5.200	.0045	.0234
16	Livingston	1	6.000	.0017	.0102

Type of Surface **Gravel**

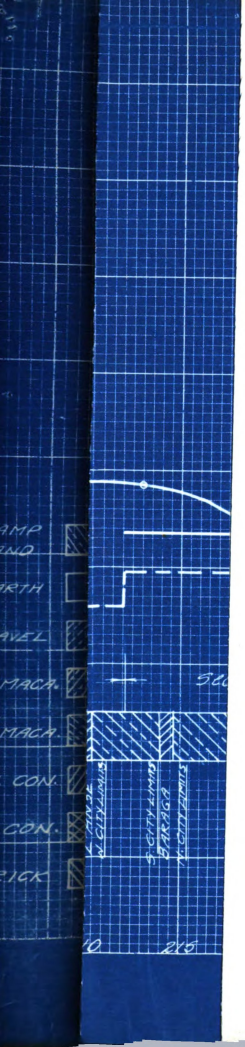
Trunk Line Route No.	County	Maintenance Section No.	Mileage	Vehicle Mile Cost	Vehicle Section Cost
16	Ingham	9	6.800	.003	.0204
16	Ingham	7	5.600	.0043	.0240
16	Eaton	1	6.000	.005	.030
16	Ingham	9	6.800	.003	.02040
16	Ingham	7	5.600	.0043	.02400
16	Eaton	1	6.000	.005	.03000
16	Ionia	1	5.000	.0063	.03150
16	Ionia	2	5.000	.007	.03500
16	Ionia	6	4.500	.010	.04500
16	Ionia	7	6.000	.005	.03000
16	Kent	17	7.600	.014	.10640
16	Kent	16	4.200	.010	.04200
16	Oakland	2	4.181	.002	.00836
16	Oakland	3	3.199	.0023	.00735

Type of Surface Gravel

Trunk Line Route No.	County	Maintenance Section No.	Mileage	Vehicle Mile Cost	Vehicle Section Cost
16	Oakland	4	4.261	.0025	.01065
16	Oakland	5	2.857	.0028	.00799
16	Livingston	5	4.700	.0005	.00235
17	Calhoun	2	9.600	.002	.0192
17	Kalamazoo	4	6.500	.0027	.01755
17	Van Buren	4	7.800	.002	.0156
17	Van Buren	3	4.000	.002	.008
20	Osceola	4	8.000	.0048	.0384
20	Osceola	5	15.000	.0022	.0330
20	Mason	8	6.500	.0052	.0338
20	Mason	7	6.000	.0046	.0276
21	Genesee	4	7.600	.0033	.02508
24	Mecosta	8	7.964	.0054	.043
24	Mecosta	7	5.154	.0013	.0067

Type of Surface Gravel

Trunk Line Route No.	County	Maintenance Section No.	Mileage	Vehicle Mile Cost	Vehicle Section Cost
24	Newaygo	11	8.500	.0061	.0518
24	Newaygo	10	8.750	.0065	.05687
24	Newaygo	7	6.500	.0074	.0481
29	Branch	4	11.800	.0075	.0885
29	Branch	5	8.400	.0022	.01848
29	Calhoun	7	6.700	.0023	.01541
29	Calhoun	8	7.750	.0063	.048825
29	Eaton	8	4.700	.0033	.01551
29	Eaton	7	3.600	.0054	.01944
29	Eaton	6	4.600	.0048	.02208
29	Eaton	5	3.000	.0053	.0159
29	Eaton	11	1.854	.0036	.00667
34	Lenawee	3	11.000	.0043	.0473
34	Lenawee	4	5.000	.0022	.0110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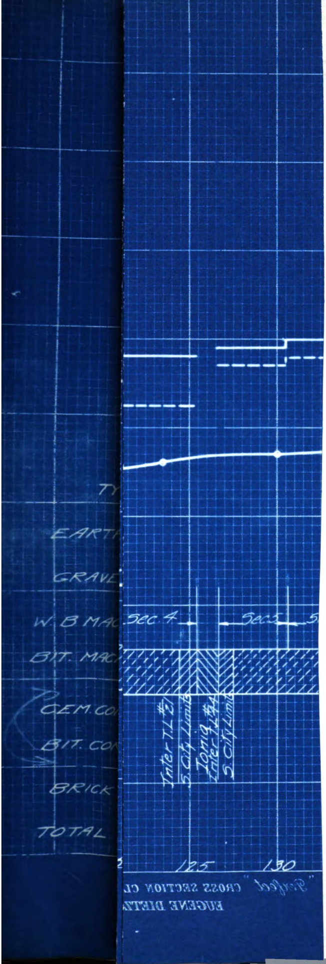
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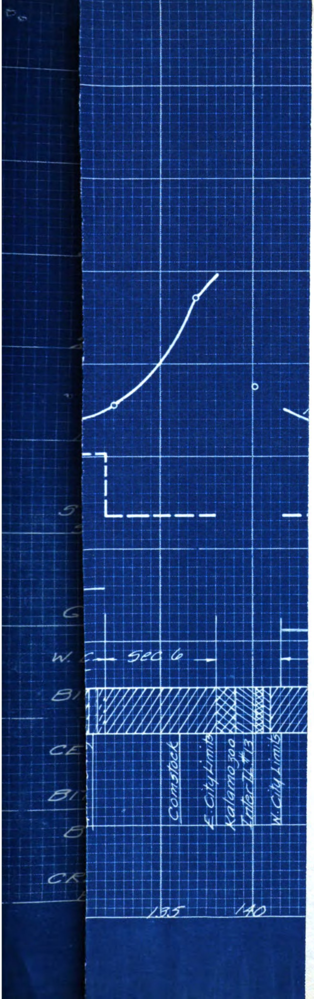
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Type of Surface Water Bound Macadam

Trunk Line Route No.	County	Maintenance Section No.	Mileage	Vehicle Mile Cost	Vehicle Section Cost
15	Keweenaw	2	.966	.0056	.0054
15	Keweenaw	5	1.500	.007	.0105
15	Keweenaw	6	3.600	.0103	.0370
15	Keweenaw	8	6.500	.0039	.0253
52	Lenawee	4	7.000	.0126	.0882
52	Lenawee	3	4.750	.0023	.0109
		Total	111.276		.67274

Type of Surface Bituminous Macadam

Trunk Line Route No.	County	Maintenance Section No.	Mileage	Vehicle Mile Cost	Vehicle Section Cost
11	Emmet	1	6.000	.004	.024
11	Emmet	2	3.000	.0023	.0069
11	Emmet	3	7.500	.0038	.0285
		Total	16.500		.05940

Type of Surface **Cement Concrete**

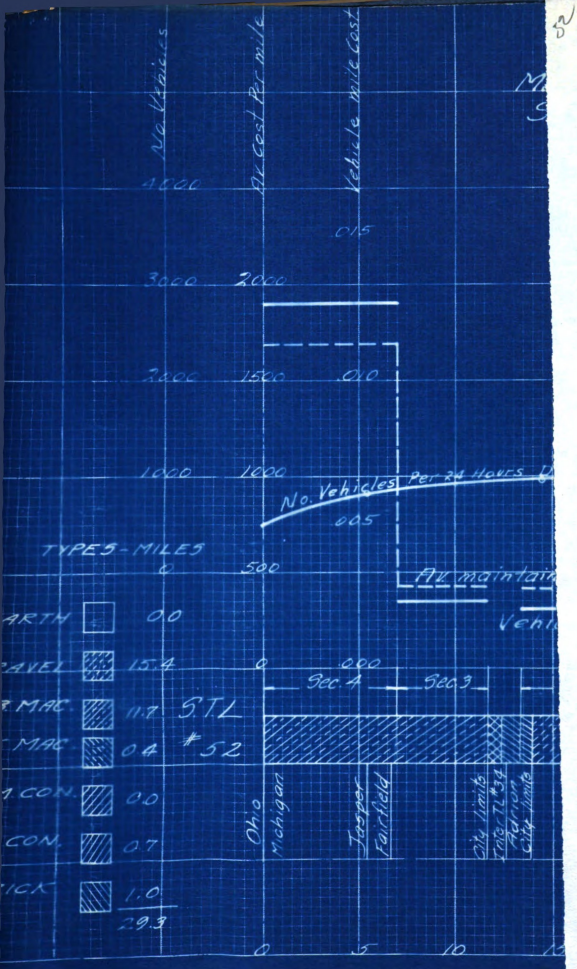
Trunk Line Route No.	County	Maintenance Section No.	Mileage	Vehicle Mile Cost	Vehicle Section Cost
10	Saginaw	3	8.900	.0046	.0409
10	Bay	1	3.000	.001	.003
10	Bay	2	6.400	.00148	.0096
15	Keweenaw	1	1.300	.0046	.00598
16	Kent	13	4.800	.0013	.00624
16	Wayne	3	11.702	.0026	.03042
16	Oakland	1	4.335	.0007	.00303
17	Wayne	4	21.561	.0018	.0388
17	Washtenaw	2	2.826	.0005	.00141
17	Kalamazoo	7	9.500	.0003	.0028
17	Van Buren	2	4.400	.0012	.00528
		Total	78.722		.28712

Type of Surface Bituminous Concrete

Trunk Line Route No.	County	Maintenance Section No.	Mileage	Vehicle Mile Cost	Vehicle Section Cost
21	Genessee	3	6.000	.003	.018
17	Washtenaw	3	4.723	.0003	.001416
		Total	10.723		.01941

FINAL SUMMARY OF STUDY

Type of Surface	Total Mileage	Total Vehicle Type Cost	Vehicle Mile Cost
Earth	68.490	$ .54977	.008027
Gravel	677.844	3.89309	.005743
Water Bound Macadam	111.276	.67274	.006045
Bituminous Macadam	16.500	.05940	.003600
Cement Concrete	78.724	.28712	.003647
Bituminous Concrete	10.723	.01941	.001810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AVEL 15.4
R. MAC. 11.7
MAC. 0.4
A. CON. 0.0
CON. 0.7
ICK 1.0
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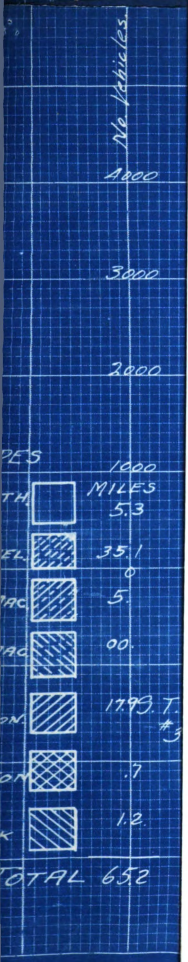
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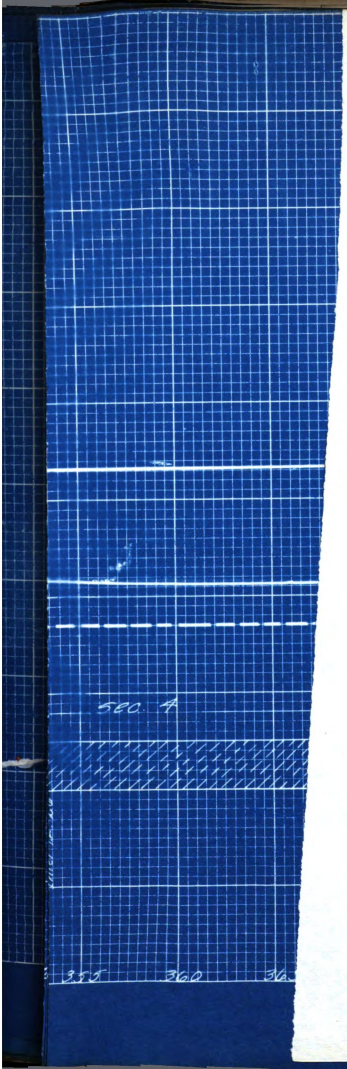
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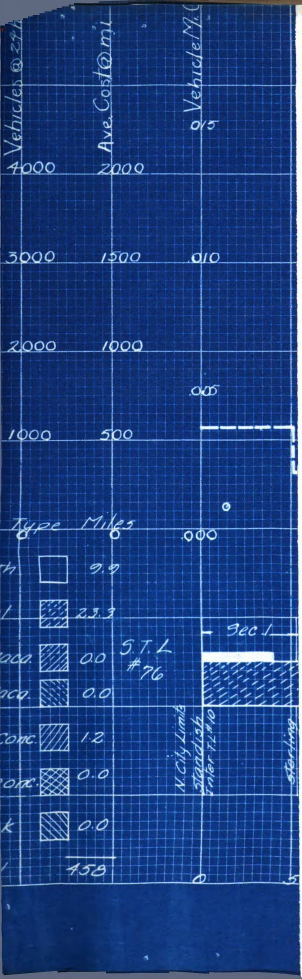
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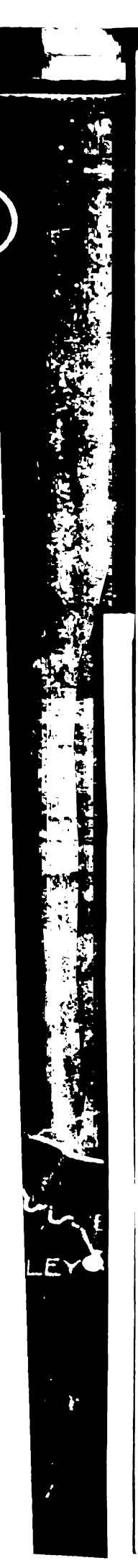
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