SECONDARY ROAD ADMINISTRATION IN LINN COUNTY, IOWA

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SYNOPSIS

The county unit system of secondary road administration in Iowa had been in effect for twenty years on January first, 1950.

This paper presents a review of the progress made and practices followed under this form of administration in Linn County during that time.

A description of the county is followed by an organization chart and an outline of an initial inventory of roads and bridges made in 1929. Progress in road surfacing is illustrated by two maps.

That local taxes raise 56 percent of secondary road revenues is shown in an outline of the financial structure.

Under maintenance is shown an equipment inventory. Records dating from 1923 reveal that 82 cu. yd. of resurfacing material per mile per year have been applied to date. More limited records on motor patrol mileages, indicate that this item tends to reduce as the percentage of surfaced roads increases. Other factors such as grading of surfacing material and traffic have a bearing on this item, but require more intensive study for definite conclusions.

A special study of the county's bridge problem has been pursued since the initial inventory of 1929. Preliminary plans for a complete system of drainage structures by individual stream systems has been made. A program and a progress report on its status has been prepared for 66 pioneer truss bridges and 24 timber trestle bridges. A valuation and depreciation schedule of the entire bridge and culvert system is shown, which is also expressed by footage units which seems more useful than the dollar unit.

The annual depreciation on date 1940 was $36,168 per year; by footage for same date 674 lineal feet of bridges and 498 sq. ft. of culverts.

Surveying and mapping activities have been conducted with thought given to providing control for topographical surveys. A section cornerstone restoration and geodetic control survey commenced under WPA is in accordance with standards prescribed by the U.S.C. and G. S. and is well-advanced.

The First General Assembly of the State of Iowa met in 1846. They enacted one hundred and twenty-five laws, twenty-eight of which dealt with the building or laying out of roads. Since secondary roads in Iowa are considered as the farm-to-market roads, it has been politically expedient to give them the strict attention which they have received from our legislators following this initial effort.

In 1930, the county unit system of secondary road administration went into effect under the enactment which has been commonly known as the Bergman Law. Despite depression and war, the progress made by the counties on secondary roads since the passage of that law has been generally good—to such a degree, in fact, that at the session of the General Assembly in 1949 a series of enactments based on a broad concept of the general highway transportation problem were passed and have been agreeably accepted by the constituents.

On January 1, 1950, this Bergman Law had been in operation for a period of twenty years. This paper will present a review of secondary road administration as practiced in one of the ninety-nine Iowa counties during that period.

DESCRIPTION

Linn County is located in east central Iowa. It is a twenty congressional township county, 24 by 30 mi. in size. It has a population of 103,711. Cedar Rapids, the county seat has a population of 72,149 and embraces approximately 36 sq. mi., or one congressional township, within its corporate limits.

Its economy is closely tied to the agricultural soil as is the case for all of Iowa. Its industries, however, constitute a considerable percentage of the industrial Iowa which of late years has equaled and surpassed the agricultural Iowa in dollar volume. Road equipment manufacturing in Cedar Rapids, meas-

ured by the usual Chamber of Commerce yardstick, is now greater than its food processing industry.

It is one of the group of the oldest counties in the state, having been established by the first territorial legislature in 1839. A considerable number of territorial roads were established, the first a military road in 1839.

Territorial roads were established 70 ft. in width. On later establishments, widths were designated by the rod unit, four rods becoming a standard by a law in 1857, providing that to be the accepted width of a road unless specifically designated otherwise. The territorial roads were located to make the most direct connection between objectives that the terrain would permit. As a result, some of these roads are today known as ridge roads. If this practice had been continued, we would have had a more logical and economical road system to maintain than has been handed down to us by the introduction of the section line grid system we now have. Paradoxically, it would also better conform to the present contour farming methods than the grid system which was primarily introduced to fit rectangular field farming practice.

The terrain of Linn County ranges from level river bottoms, through rolling prairies, to limestone palisades along several of its streams. The U. S. agricultural soils map of the county showing 39 varieties of silts, loams and clays in color might be mistaken as an abstraction in modernistic art. These soils are noted for their production of corn, but must be inversely rated in their ability to provide roadway bases. The Iowan and Kansan glacial drifts cover the county. The small quantity of second rate gravel borne by these drifts has been practically exhausted, and we are now dependent on limestone, of which there is an abundance of suitable quality for surfacing purposes.

The average annual precipitation is about 32 in. Its close proximity to the Mississippi River gives Linn County several large streams, two of which are meandered rivers with numerous tributary creeks. These present a problem in bridging which is considerably above the average for an Iowa County.

There are 116 mi. of rural primary and 1243 mi. of secondary roads in Linn County.

ORGANIZATION OF ROAD DEPARTMENT

The following is quoted from the Iowa Code: "It is the duty of the board of supervisors to construct, repair, and maintain the secondary road and bridge systems of the county, —they are required to employ one or more registered civil engineers, known as county engineers, under whose direct and immediate supervision all construction and maintenance work shall be performed, and for the efficient, economical and good faith performance of which he shall be deemed responsible."

The county engineer may be hired for a period of from one to three years, must furnish a bond, and may be dismissed by the board of supervisors at any time.

The organizational set-up for carrying out these provisions for Linn County is shown on the chart in Figure 1.

When it became evident in 1929 that the Bergman Law would be passed, the board of supervisors authorized the county engineer to make an inspection and inventory of the entire secondary road and bridge system. Bridges and culverts were given special attention in this inventory. Office data on structures were copied on cards which were checked by field parties, new cards being prepared by them when structures were discovered on which no record existed.

Upon completion of the field inspection the cards were filed in numerical order under township divisions, this file being known as the Index File. Duplicate copies were placed in another file known as the Inspection File. These cards were arranged in township divisions in an order providing for a reinspection of all structures over a period of five years, the inspector setting the date for reinspection.

The following is a classification of the 1804 structures totaling 5.82 mi. in length as recorded:

	Number	Length ft.
Timber	449	11,939
Steel	106	13,116
Concrete (Includes Culverts)	1249	5,686
Total	1804	30,741

A bronze tablet illustrated in Figure 2 was placed on each structure.

A county atlas by congressional township sheets which was in the process of develop-

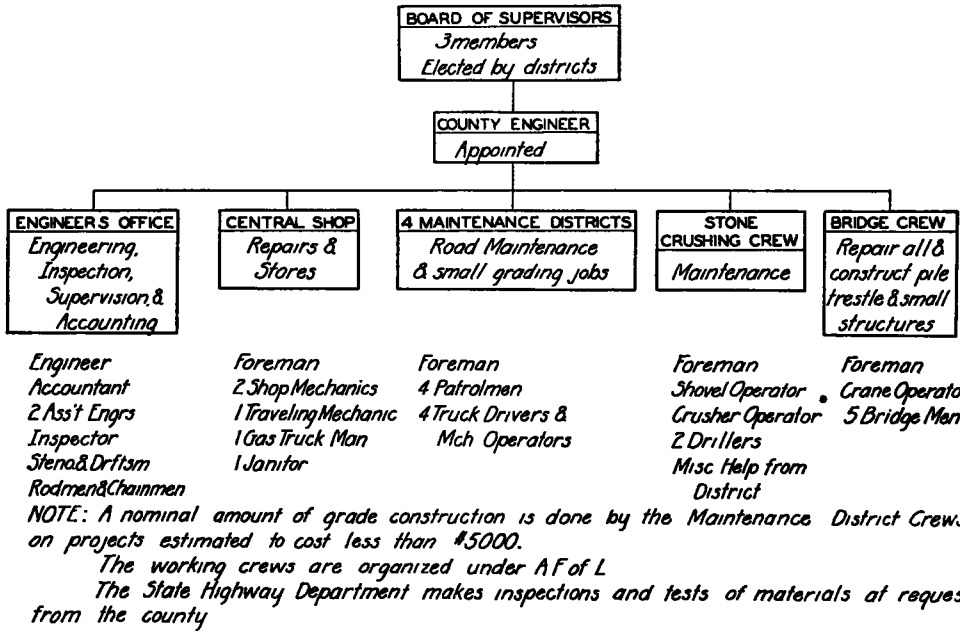

Figure 1. Organization Chart—Secondary Road Department—Linn County, Iowa

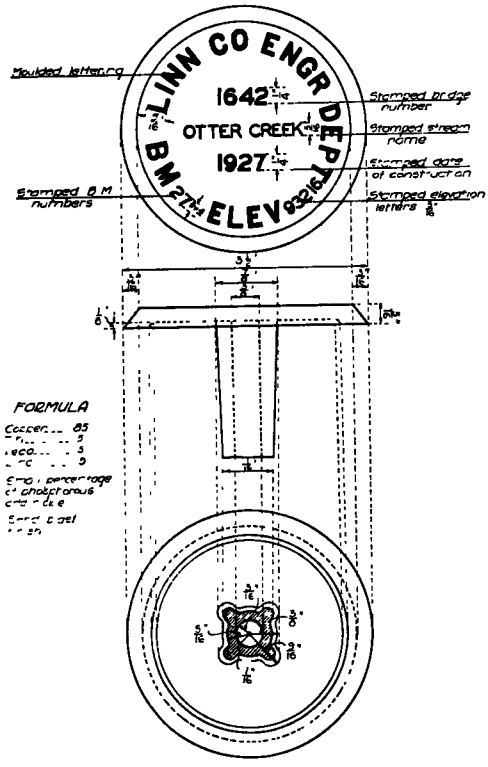

Figure 2. Bridge Marker

ment at this time and was ready for field checking served the inspectors for making field notes. Cloth prints approximately 28 by 28 in. in size for a township, on a scale of 1500 ft. per in. mounted on drawing boards served this purpose. Road conditions were noted, corrections indicated, farmsteads spotted (for the first time on a Linn County atlas), hedges, heavy timber growth and other items calling for special attention were noted. All drainage structures were spotted by symbols, distances were clocked by speedometer from sectional lines unless better measurements existed. When completed, the following classification of road types and condition were compiled:

Type	Miles
Trunk (all surfaced)	139.65
Local Surfaced	143.11
Local Unsurfaced	947.53
Total Secondary Roads	1230.29

Condition Jan. 1, 1930	Miles
Fit for Power Maintainer	950.73
Unfit for Power Maintainer	139.64
Not Maintained in 1929	129.92
Abandoned	17.53
Total	1230.29

The reason for the classification "Fit for Power Maintainer" will be more readily under-

stood when it is recalled that township road maintenance at that time was carried on with horse-drawn blade graders or King drags. It was proposed to institute power maintenance of surfaces as soon as possible. A more clear mental picture of road condition existing at that time can probably be visualized if reminded that the power maintainer of 1929 date was usually of the crawler tractor type. Vivid word pictures of some conditions existing were drawn by our inspectors. You are referred to our archives for them.

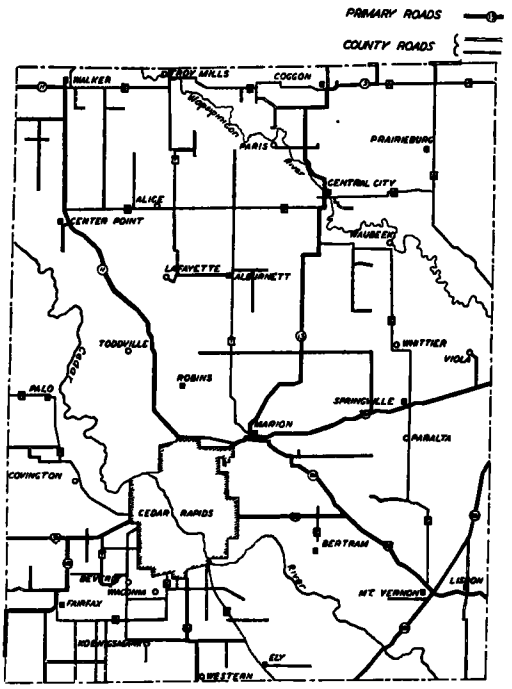

Figure 3. Surfaced Roads as of Jan. 1, 1930 —Linn County

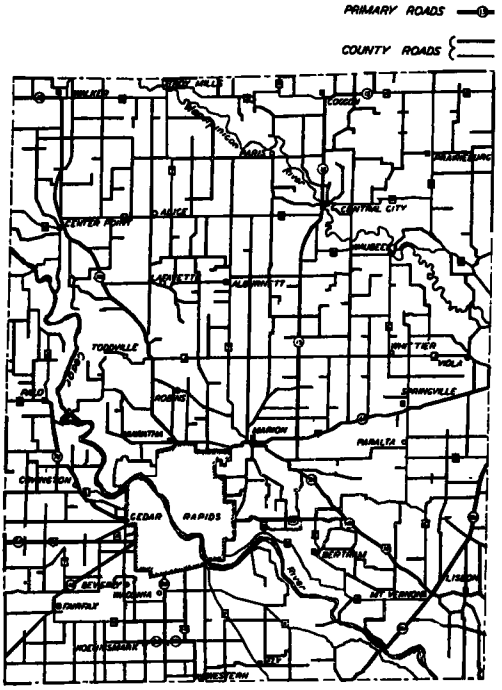

Figure 4. Surfaced Roads as of Jan. 1, 1950 —Linn County

The inspection was made by two field parties in 130 days of work. 13,500 mi. were traveled and the cost of field work totaled $3412.54.

The progress made on road surfacing during the twenty years under the Bergman Law is illustrated by comparing the maps in Figures 3 and 4.

It should be noted that 99.81 mi. of the trunk system shown on the 1930 map were graded, bridged and surfaced through a $864,000 bond issue, during the years 1927–28.

FINANCES

Finances for constructing and maintaining secondary roads in Iowa are obtained from the following sources:

Local Tax Levies: (Maximum Permissible)

1. $\frac{5}{8}$ mill on all taxable property within the County
2. $2\frac{1}{2}$ mills on all taxable property except in cities which control their own bridge levies. (Cedar Rapids only is exempt.)
3. $8\frac{5}{8}$ mills on all taxable rural property.

Another source of local revenue is from road surfacing assessment districts. The board of supervisors may require that 25 percent of the cost of surfacing a road placed on their adopted road construction program of from one to three years in length, may be assessed against the abutting property. In addition, interested parties may donate or petition for an assessment of not less than 50 percent of the county engineer's estimated cost for surfacing a road, in which case the road so petitioned must be graded, bridged and surfaced in the generally accepted manner, within the year following a December 1st deadline date for filing.

Fifty percent of a road use tax fund collected by the state is also dedicated to secondary roads. It is distributed among the coun-

ties in the following manner: 70 percent on an area basis to the counties' construction funds; the remaining 30 percent is dedicated to the farm-to-market road fund, $\frac{3}{5}$ of which is allocated on an area basis as are also federal aid funds. The $\frac{2}{5}$ remaining of the farm-to-market road fund is known as an equalization fund and is distributed by the state highway commission among the counties on a need basis.

Table 1 is an estimate of our 1951 revenues.

56 percent of the total in Table 1 is derived from local sources, 39 percent from the state, and 5 percent from Federal Aid.

Financial statements are made monthly to the board of supervisors by the engineer's office.

TABLE 1

ESTIMATE OF 1951 REVENUES

Local Sources:	
Property Levy:	
1. $\frac{5}{8}$ mill on $125,640,000 valuation	$ 78,525
2. $2\frac{1}{4}$ mills on $44,140,000 valuation	110,350
3. $8\frac{5}{8}$ mills on $35,000,000 valuation	301,875
Assessment Districts & Donations	40,000
	$530,750
State Sources:	
Road Use Tax:	
Counties' share of 35% on area basis	$268,170
Farm-to-market $\frac{3}{5}$ of 15% on area basis	69,700
Farm-to-market $\frac{2}{5}$ of 15% on need basis	28,100
	$365,970
Federal Aid:	
Estimated	$ 46,000
Total	$942,720

A comprehensive report on secondary road activities including financial statements must be prepared by the county engineer each year for the state highway commission on forms supplied by them. A summary of these reports is compiled and issued in an annual report.

MAINTENANCE

There are now 1243 mi. of Linn County secondary roads. Seventy-two percent or 825 mi. are surfaced with crushed stone. On the estimate that 13 percent of a rural road system are land service roads only and will not need to render all weather service, we still have 186 mi. of road to build.

The personnel organization chart in Figure 1 indicated that some construction work is carried on by county forces. The following list of equipment owned by the county also reflects that trend:

In each of 4 maintenance districts:

- 4 patrol graders with snow plows and scarifiers
- 1 loader
- 1 pickup-truck
- 1 6 to 8 ton truck with snow plow
- 1 2 ton all-wheel-drive truck with snow plow
- 4 2 ton trucks
- 2 crawler tractors
- 1 dozer
- 2 scrapers
- 1 blade grader

Stone crushing plant:

- Portable crushing plant
- $\frac{3}{4}$ CY Shovel
- Air Compressor
- Wagon drill
- Pickup truck
- Panel truck

Bridge Crew:

- $\frac{1}{2}$ CY Wheel crane with leads and dragline bucket
- 2 ton truck and trailer
- Utility truck
- Pickup truck

Miscellaneous Equipment:

- 2 elevating graders
- 1 rotary snow plow
- 1 motor powered scarifier and pulverizer
- Sand blast, paint spray, pumps, tar kettle and miscellaneous small equipment.

Major equipment repairs and overhaul work on this equipment is done in a central shop in Cedar Rapids, a brick building 48 by 110 ft. in size. Each maintenance district has a headquarters shop building and three patrol station garages where machines are serviced and housed. These are frame buildings 42 by 40 ft. in size. Miscellaneous small buildings bring the present ground area of buildings up to 34,764 sq. ft. A total of 40,000 sq. ft. of space is indicated from experience as desirable. This would provide 32 sq. ft. per mi. of road.

It is our objective, of course, to have a completely surfaced system as soon as possible. Each mile of surfaced road added, however, means added maintenance cost for resurfacing. From records kept since 1923, we find that we have used an average of 82 cu. yds. per mi., per yr. This is approximately $\frac{1}{4}$ in. of loose material on a 20-foot width of roadway.

The conditions of the roads during the later

part of this period suggest that at least 100 cu. yd. or one third of an inch of material would have been desirable. At that rate, 82,500 cu. yd. of resurfacing are required annually on the present system. This is equivalent to surfacing 55 mi. of new road per year at the rate of 1500 cu. yd. per mi. The significance of maintenance costs becomes apparent when it is pointed out that the average rate of new surfacing has been only 27 mi. per yr. during the last 20 years.

To this must be added surface maintenance by patrol graders. A record of the mileages for this purpose are shown in Table 2.

Surface maintenance by patrol graders is an expensive item. We feel that it is being

TABLE 2

Year	Mileage Operated	Total Miles Secondary Roads	Percent Surfaced	Average Number Round Trips Per Mile per Year
1931	56,038	1217	26	23
1932	61,334	1217	32	25
1933	42,817	1217	32	18
1934	44,361	1220	33	18
1935	55,920	1220	33	23
1936	58,633	1220	36	24
1937	71,947	1220	38	29
1938	82,919	1218	40	34
1939	83,969	1252	50	34
1940	93,332	1263	58	37
1941	83,665	1263	59	33
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—				
1949	70,735	1243	72	28

reduced automatically by increasing the percentage of surfaced roads, making for less back-tracking in wet weather. We believe that grading our surfacing and resurfacing stone from 100 percent passing the ¾-in. sieve with from 30 to 45 percent passing the No. 8 sieve gives us a compact surface requiring less blading. Maintenance of a constant depth of at least three inches of well graded materials would, we feel, decrease the amount of resurfacing required. Thinner surface crusts tend to break loose from the subgrade to be pulverized by traffic and lost. We have found that calcium chloride applied to the surface or integrally mixed brings the necessary surface blading down to what is probably the irreducible minimum for stone roads. Traffic counts show that we have some 150 mi. of road carrying from 100 to 200 vehicles a day and 50 miles carrying upwards from 200 vehicles with a probably maximum of 600 vehicles a day. Our present plans call for the development of bases on this mileage by stepping up the tempo of resurfacing, and by the application of calcium chloride on a limited mileage, making them ready for treatment with more stable surfacing materials.

BRIDGES

The drainage area map of the county will serve as an introduction to the problem of

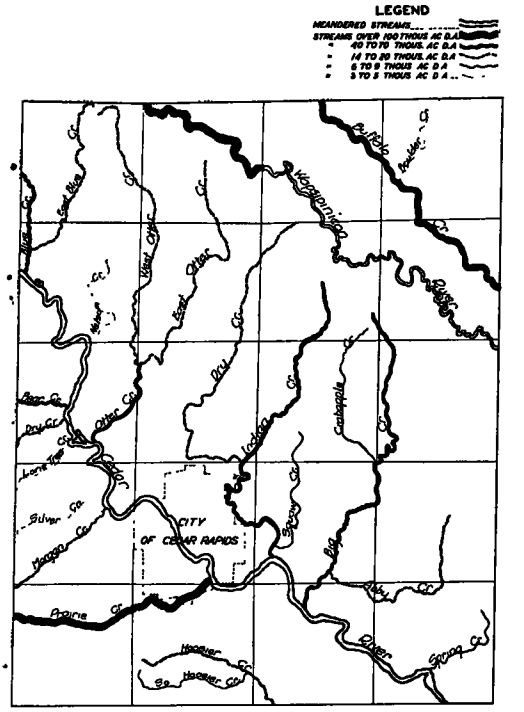

Figure 5. Drainage Map—Linn County

constructing and maintaining drainage structures on a close meshed network of roads imposed upon its area.

The following studies have been made in order to gain a perspective of the factors involved in this problem. Maps of individual streams and their drainage areas have been prepared for streams shown in Figure 5.

On a comparatively small stream having a total drainage of 4950 acres, we found that 62 structures would be required. Drainage from an accumulative total of 17,847 acres must be accommodated, requiring a total of 1522 sq. ft. of waterway.

Design of drainage structures in regard to size or capacity on a stream system basis rather than on an individual road basis holds forth, we feel, the possibility of economy in final design.

Obsolescence is an important factor to be considered on a bridge system which is still, in a manner of speaking, within hailing distance of its pioneer stage. A program of reconstruction involving 66 truss bridges built before 1912 and having a total length of 9575 feet, plus 24 untreated timber trestle bridges of a total length of 2180 feet, were placed on a special program in 1932. Progress reports have been made from time to time as illustrated by Figure 6.

In 1939, a valuation of the entire bridge system was made. The following classification by type with predicted life in years was the basis for determining present worth as of January 1, 1940:

Bridge Classification	Predicted Life
Truss Class I	75
Truss Class II	75
Truss Class III	75
Concrete Bridges	75
I-Beam Bridges	75
Treated Pile Trestles	30
Untreated Pile Trestles	15
Concrete Box Culverts Class I	60
Concrete Box Culverts Class II	40
Corrugated Metal Culverts	30
Fords	
Miscellaneous:	
Corr. Mult. Circular	50
Corr. Mult. Arch	60
Balance of Misc	30

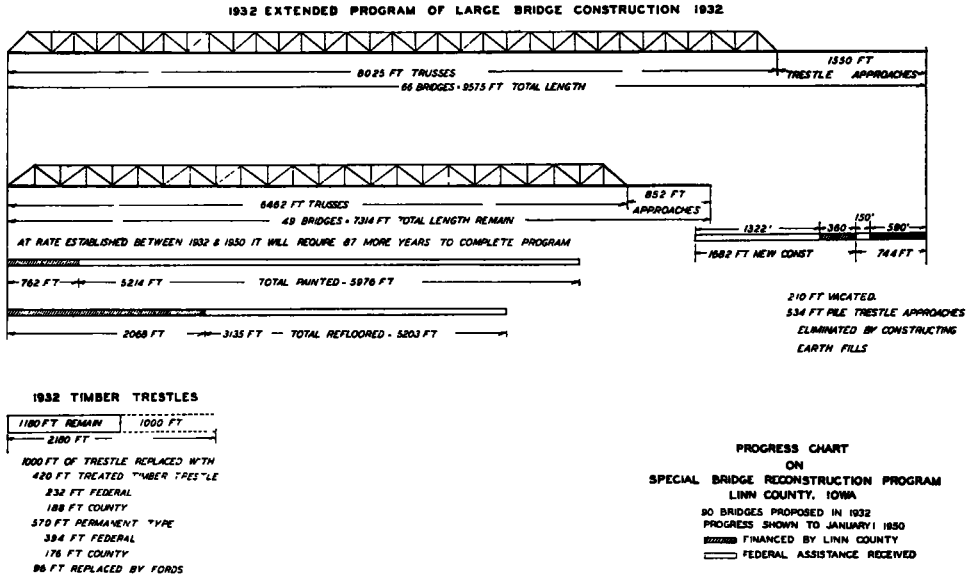

Figure 6

A summary of the valuation as determined is as follows:

Initial cost	$1,754,860.69
Depreciation to January 1, 1940	744,147.05
Residual Value January 1, 1940	1,010,713.64
Annual Depreciation	36,188.41

This valuation was set up for individual structures in a new set of bridge files of the visible index type. Our bridge file is now an integral part of our accounting system.

Two annual financial loss or gain statements have been prepared in the past. We now consider that a depreciation schedule based on footage units more clearly demonstrate our annual loss or gain. This schedule is as follows:

Bridges:

Total lineal footage Jan. 1, 1940	23,322
Annual Depreciation, *ft.*	674

Total depreciation to Jan. 1, 1940, *ft.*	12,384
Percentage of depreciation to Jan. 1, 1940	53
Culverts:	
Total square footage Jan. 1, 1940	23,418
Annual depreciation, *sq. ft.*	498
Total depreciation to Jan. 1, 1940, *sq. ft.*	8,141
Percentage of depreciation to Jan. 1, 1940	35

Bridges constitute somewhat less than 20 lineal feet of our average road mile and require an additional 20 sq. ft. of culvert opening. The traveling public, by its insistent demand for improved road mileage, does not seem to be aware of the importance of these comparatively small units. There is apparently no dirth of bridges to cross before we come to them, but highwaywise there is a possibility of coming to a bridge and not having one to cross. This is a situation we hope to avoid.

SURVEYS AND MAPS

The 1500-ft. to the inch scale township maps originally used in our 1929 road and bridge inventory have been very useful throughout the years. Reproduction to a reduced scale of two inches to the mile has since been found desirable for certain purposes.

Since the last war we have had a great increase in the demand for county maps. It is apparent that a better understanding of maps exists and that they are being put to practical use by others besides engineers. The large scale maps are frequently selected and it is not uncommon to have requests for topographical maps. Contour maps would be invaluable to the county engineer's office and we have directed our survey activities in a manner that we think will expedite the production of such maps.

Through a W.P.A. cornerstone restoration and geodetic control survey, considerable progress has been made toward furnishing the controls for contour mapping.

All of the section corners and quarter section corners of the rural areas were recovered and monumented. Control surveys were run to U.S.C. and G.S. standards (Fig. 7). Second order traverse loops approximately 6 mi. square were run and tied to three primary triangulation stations. These loops were crisscrossed with third order traverse tieing the section and quarter section corners to the secondary loops. All monuments are intervisible on both systems and in most cases; the tie monuments are located within 100 ft. of the section corners. The section corners are monumented with 3 ft. concrete posts, 4 by 4 in. on top and 6 by 6 in. on the bottom. There are a total of 2444 of these. Control traverse stations are monumented with 4-ft. concrete posts, 6 by 6 in. on top and 8 by 8

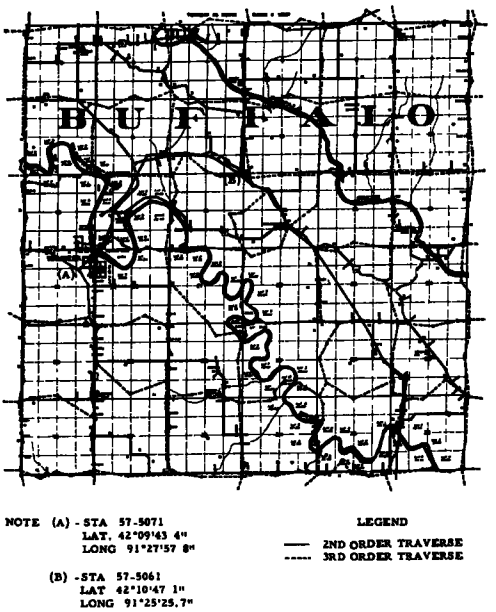

Figure 7. Second and Third Order Traverses Near Waubeek in Linn County

on the bottom. There are a total of 4262 of these. Both have suitable bronze tablets. The record of local ties to all monuments is kept in visible index filing cabinets.

Second order levels have been run over the second order loops. The state coordinates as designated by the U.S.C. and G.S. have been calculated for the monuments on these loops and also the geographic positions for the intersections. These data are contained in a bound volume.

The office is proceeding on calculation of coordinates on the third order traverse and section corners as time permits and our road survey levels are being tied to the controls as they are made.

A set of aerial photographs made by the Agricultural Adjustment Administration covering the county are filed in the engineer's office. It would now seem impossible to function properly without them, but we are still looking forward to having a set of contour maps.

CONCLUSION

The combined record of the ninety-nine counties of our state working under the county unit system of secondary road administration casts a favorable reflection upon that method, for conditions existing in Iowa. We hope that Linn County has been able to sustain the average rating established.

DEPARTMENT OF TRAFFIC AND OPERATIONS

WILBUR S. SMITH, *Chairman*

A STUDY OF VEHICLE, ROADWAY, AND TRAFFIC RELATIONSHIPS BY MEANS OF STATISTICAL INSTRUMENTS

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AND

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SYNOPSIS

The Committee on Vehicle Characteristics, with the cooperation of the automotive industry developed a group of statistical instruments measuring speed, fuel economy, deceleration, torque, and throttle opening. This paper covers the development and use of these instruments.

The report is divided into two sections. The first section includes a discussion of the apparent need for means of measuring effects and relationships existing between the motor vehicle characteristics, highway characteristics, and the traffic conditions. Also included in the first section is a description of the instruments, their development, and operation.

The second section of the report pertains to the experience with the use of the instruments and the results obtained. The results include the comparison and rating of highways under different conditions of traffic in rural and urban areas, and the comparison of different types of traffic control systems by means of the instrumentation. Also included is a comparison of different drivers by means of the instruments.

The Highway Research Board Committee on Vehicle Characteristics was organized in September, 1946. Its assignment was to make a study of the characteristics built into motor vehicles and their relation to traffic problems.

The first meeting of the Committee was held in Washington, D. C., on Wednesday, December 4, 1946, at which time the objectives and their related problems were discussed and a plan of action was laid out. Since that time progress has been made on the plan, and although the work is far from complete, it was felt that sufficient results had been obtained to warrant a report.

It appears that there is one general objective toward which all people having anything to do with the motor vehicle are working. That objective is the provision of the most rapid individual transportation possible, consistent with the maximum possible safety, and the greatest possible economy. This Committee is concerned with the characteristics of the motor vehicle built into it by the manufacturer, how these characteristics are used by the driving public, and how their use is related to traffic and highway.

Motor vehicles have many built-in characteristics which can be studied with interest. Of these, however, there are only a few which are related directly to the vehicles' behavior