REPORT OF COMMITTEE ON HIGHWAY TRAFFIC ANALYSIS

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COMMITTEE RECOMMENDATIONS

Right of Way

The Committee recommends that legislation be enacted, permitting state highway departments and other highway authorities to establish or preserve highway right of way through the establishment of building set-back lines and similar methods

Trafficway

The following definition of "Trafficway" is recommended by the Committee for general adoption That part of the highway right of way, improved for the movement of traffic, is defined as the trafficway and is that part of the surface improvement exclusive of space reserved for parked vehicles or that part of the surface occupied by railroad or street car tracks and obstructions to the free movement of traffic

The Committee wishes to emphasize that·

1 Provision for motor vehicle storage facilities, off the highway or street right of way in congested traffic areas, is essential to free the highways or streets of stored vehicles which occupy highway right of way, and whose removal will in many cases eliminate the necessity of costly street widening projects

2 Lane marking on highway surfaces is used for two distinct purposes

(1) A danger line in the center of the roadway used at summits of hills, curves, approaches to railroad grade crossings, etc These lines must not be crossed at any time

(2) Lines marking individual lanes are always required on roadways of more than two lane capacity from the standpoints of safety and providing control conditions under which the highway may be used to its full traffic capacity. These lines may be crossed on necessity but at the responsibility of the driver crossing the line

Separate and distinct forms of marking should be used for these two purposes.

The Six-Wheel Truck

The Committee favors the utilization of the six-wheel truck equipped with pneumatic tires Its use will reduce roadway truck traffic on heavy truck traffic highways, because of the smaller number of trucks necessary to carry a given pay-load tonnage, and will provide a safer distribution for heavy loads, particularly on those sections of the highway which are not improved with modern surfaces To accomplish this purpose, the Committee recommends that the States enact legislation permitting, under proper restrictive conditions, the use of these vehicles on designated highways and structures and establishing a safe distribution of the load on the three axles

Accident Report Form

The Committee strongly endorses the adoption of a standard form for reporting accidents by State, County and Municipal authorities responsible for street and highway improvements, and suggests that these data be classified according to their several jurisdictions

Highway Planning and Construction in Regional Areas, the Centers of Population, Industry and Highway Traffic

The Committee urges the development of highway planning in metropolitan regional areas, based on traffic and engineering facts, believing that the most satisfactory systems of highways will be completed when areas of this character comprise a single jurisdiction for planning, constructing and financing the improvement of highways and structures

The typical metropolitan regional traffic area consists of a central city surrounded by suburban cities and villages The zone of traffic and population depends upon the size of the central city and its industrial characteristics In general, the problems are similar whether the regional zone is large or small Lack of modern planning and continuity of standard improvements, in the main, are caused by the several independent highway authorities, particularly the smaller cities and the villages of the area, which are individually responsible for highway development within their limits and whose highway officials are not trained in modern engineering practice

Highway transportation facilities in regional traffic areas are, in fact, part of an inter-related system of roads, independent of state, county or municipal boundaries, and their improvement should be planned and their construction financed by treating the area as a distinct unit, independent of existing governmental boundaries

The proper development of highway-transportation facilities in areas of this type requires regional planning based on correlated traffic and engineering facts and should include, in the region so planned, that

area in which traffic, produced by the population center, forms the principal part of all highway traffic

Highway improvement in regional areas encounters the following major problems

1 Lack of a unified plan of highway development

2 The concentration of large numbers of motor vehicles in the area and a resulting large daily volume of traffic on its highways and streets Various sections of the principal arterial routes within these areas carry from 15,000 to 60,000 vehicles per day These large volumes of traffic operating over a highway system, that has usually had no additional highway facilities provided since the advent of the motor vehicle, require the provision of additional highway facilities either by widening existing routes or the opening of new routes and connections

3 The convergence of highway routes approaching centers of population and traffic is typical of both large and small centers of traffic and is the heritage of the early period when highways were established, following the early trails, to serve horse drawn vehicle traffic with little regard for gradients, curves or sight lines and whose locations were controlled in many cases by existing river crossings or physical obstacles These existing points of convergence create traffic congestion sections, increase the accident hazard and are an economic loss to modern travel The opening of parallel routes and by-pass routes is essential to remedy this condition

4 The many independent highway jurisdictions and lack of centralized control over the planning, construction and financing of highway improvements The establishment of one highway jurisdiction, responsible for highway improvements within the area, is the final solution Its accomplishment will probably be a gradual evolutionary process

5 Narrow streets and highways and the use of the streets or highways for purposes other than highway transportation, particularly for traction and parking The widening of existing surfaces, set-back building lines, provision of storage space off of the travelled way and elimination of traction lines on the main arterial highways will improve this situation

6 A lack of connected main arterial and belt highways requires the construction of new routes and preservation of right of way for future routes

7 The financial burden involved in the major improvements, particularly bridges, essential to relieve the traffic crises existing in these areas requires a readjustment of present methods of financing

The scientific planning and construction of systems of highways, satisfactory for present traffic, and the preservation of rights of way for improvement for future traffic in the regional areas surrounding centers of population are the most difficult problems in the field of modern highway development.

UNSAFE CARS

Taken from State of Connecticut Department of Motor Vehicles Bulletin No 59

Apparently a justifiable conclusion concerning causes of motor vehicle accidents, especially those particular types occasioned by poor or worn-out mechanisms, is that the total number so caused is inconsiderable Out of 26,832 accidents which happened in Connecticut in 1927 only 2 9 per cent or 786 were clearly traceable to poor and incomplete mechanisms or failure of the proper working of parts So statistics as an index of what is going on hardly seem to justify any change in policy in the authorization of cars because of condition But at best statistics show only actual happenings to a qualified extent and no conclusion is ever possible in those numerous cases where accidents and mishaps occur as an indirect result of car condition For example, a car so worn that it cannot make reasonable speed on the highway may occasion any number of hazards, any one of which may result in trouble for other people The real reason for trouble of that kind is that there is an abnormal car on the highway, meaning a car which is not up to average condition Such facts are difficult of inclusion in statistics Leaving out for the moment any argument on the subject of lack of safety mechanisms such a car is a hazard, and the policy of a state ought to be directed toward its non-existence

There has always been a good deal of sentiment against cars which are unsafe and it is probable that within a reasonable time such sentiment will crystalize and it may be possible to weed out all the wrecks at least Perhaps, too, the standard of equipment on the highways can be improved so that there will be no cars running which will not qualify to perform their functions reasonably

It seems proper to consider how this can be done from the broad standpoint of public safety and the betterment of transportation It is often represented that the actual wrecks on the road, meaning those cars which are so far out of condition both in appearance and mechanical ability as to be unsafe, are discarded cars which have been sold through junk dealers It is a fact that many cars are kept on the highway for such great mileage and therefore are so worn out that the exchange or sale value is practically nil Then the only possible disposition for the owner is to scrap it or turn it in to a junk dealer for what it will bring The junk dealer is supposed to be selling parts. He takes a car, pulls it to pieces and sells its parts for replacement in other cars of the same make and thereby, at least so it is reported, does a fairly profitable business

He is responsible for the car cemeteries which are beginning to appear alongside our roads, some of them located in the most beautiful sections

of the state At present the size, extent and general ugliness of these attest the popularity and probable profit of this kind of business While there does not appear to be any method at the present time whereby the defacement of scenery and loss of attractiveness on the side of highways caused by such spectacles can be met, there should be some way devised by which owners of land are prevented from making it a public nuisance The argument in favor of this is perhaps idealistic but nevertheless it is practical The scenery, in Connecticut particularly because it is such a great vacation state, has a real and practical value People are attracted by the surroundings more than by any other characteristic to purchase real estate, to build homes and to use land for vacation purposes Apparently it is perfectly possible under existing laws to restrain other nuisances Why should there not be a law to prevent a man from making a nuisance in the esthetic sense, and thereby preserve for homebuilders the practical values of real estate?

In connection with the disposition of old broken down cars, there is now a Connecticut law making it a criminal offense to leave an abandoned car in the highway, so at least that step has been taken

But the junk dealer does not always sell parts, it is claimed It seems to be substantiated by considerable information that more often than selling parts he sells at a slight profit the complete car to some irresponsible person who wants something that will go, even if only a little, and who cares nothing about the safety of the public or thinks further than his own convenience It is possible, under existing law for anyone to buy a car from a junk dealer for practically nothing Probably anybody who has $25 can get such a car This particular type of business ought to be controlled. The junk dealer ought to be licensed to sell junk and kept strictly to that account He ought not to be allowed to sell a complete car

The law ought to go further than that and place a responsibility upon dealers who take second hand cars in trade to certify to the state department, or at least to make some kind of a guaranty to the person to whom that second hand car is sold, that the car at the time of sale is in good and safe condition for transportation of the type for which it is intended and that it will, with reasonable care run for the balance of the registration period without developing an unsafe or unusable condition Such a guaranty can be readily devised and so far as this subject is controllable through dealers it will certainly be to the advantage of every man who sells complete cars to have such regulation Moreover it would seem that such a law and practice would standardize the business of junk dealers who sell car parts and make it a more desirable and higher grade business than it is now. All of this brings the subject to the situation where it is possible to consider how a state can correct this

condition and to suggest the probability that a law may be introduced in the next legislative session

What constitutes the turnover period, so-called, of any car is probably ascertainable by consideration of second hand lists That is, there is a time during which a new car on the highway is still considered a new car and depreciation has not extended to a point that might put it under suspicion of being unfit In a general way the turnover period of cars may be considered to be about three years It is bound to be the object of the state to secure on its highways the largest number possible of first rate cars, capable of proper operation in traffic

So the state could take a leaf out of the tax laws of some of the Canadian Provinces, and while there is no such principle as yet applicable to motor vehicles anywhere, it could be worked out that after the expiration of the turnover period the owner of any car older would have to pay an additional registration fee for each year of its age in excess Such a principle if made without any qualifying arrangement would discriminate against deserving cases, where cars have been kept in unusually fine repair and where the use of them is safe and they are maintained to produce the utmost in practical efficiency To meet this situation and make it possible for persons who want to keep cars indefinitely without being penalized, the state could provide an examination, which can be done without extensive organization, but through which for small fee any person intending to keep a car after the turnover period could have it certified as fit to run for the registration period

This would have an effect on the car market It would compel rigid scrutiny by police and it would develop that the second-hand cars put on the market could pass the examination It would give the person who owns the car and who has had it examined at slight expense a certificate of condition which would be invaluable in the event of an accident, for it would mean that, if the condition of the car involved was so certified, in order to prosecute actual negligence in keeping up the car would have to be proven

It would mean also a much closer and stricter supervision of the whole second-hand car problem With the two measures suggested, at the present time in the crudest and most general form, the problem could be worked out so that there would be no more improper and imperfect cars on the highways of the state Just like any other general principle which has to do with the motor vehicle accident problems and perhaps with all other problems of active life the attack for a correction has to be made against extremes and abnormalities and not against an average which is safe

It will probably be urged by academically minded persons that the kind of action proposed is paternalism in its worst form, and against it may possibly be claimed that the measure suggested is directed against

the person of small means as distinguished from the rich man and is discriminatory against him

As to paternalism, the whole management of motor vehicle matters on the highways is based upon the theory of licence The state determines who may have a car and who may operate it and under what restrictions It would seem to be no more paternalistic to determine what car is fit to be on the highway, so far as safety is concerned, than it is to determine who may be on the highway as an operator The principle appears to be the same Possibly it is a little more direct and more effective to try to discipline a man through his property than on the basis of his personal characteristics The definition relative to property and the determination as to whether or not any given car should be on the highway is an exact one The determination as to one's characteristics is necessarily an approximation

The possible argument that this proposed measure is a rich man's measure and discriminates against the poor man seems to be taken care of by the plan to examine and certify cars No man, rich or poor, ought to be allowed to have on the highway any motor the status of which is such as to endanger the public It is a fact that vehicles which have been run a long time and long distances are more apt to be out of order and in the hands of persons who are wilfully negligent of their condition Fact and not theory ought to govern in this If the conditions as set forth appear to have evidence enough behind them, then there is small hardship involved in bringing the car once a year to the examiner for certification, and having to pay for this is more than compensated for by the additional safety which is thereby guaranteed to its owner for his own purposes and for all other users of the highway

There are many ways in which such a principle as that suggested can be worked out The one mentioned seems the most direct and the easiest to put into execution, but any adoption which will secure adequate supervision by a state department over the condition of cars on the highway and which can be carried on as a continuing policy is bound to result in a great deal of good and in better all round conditions of traffic

ROADWAY WIDTH AND TRAFFIC CAPACITY

The primary function of a highway is to serve moving traffic Storage space is not a function of traffic but of business and should be provided off the travelled way Roadway width should, therefore, fundamentally be a function of present and future highway traffic To determine the required roadway width for various volumes of highway traffic, it is necessary to know the facts concerning actual traffic speed on roadways of various widths and various volumes of traffic

Attached to this report is an analysis of the more important factors influencing traffic capacity from which conclusions and recommendations are drawn.

ANALYSIS OF MOTOR VEHICLE ACCIDENTS

An appendix to this report covers the analysis of motor vehicle accidents in Pennsylvania with requirements for investigation and report

The Committee believes that a trained observer should be detailed for this work who is required to personally inspect the location and obtain any needed details on which to base recommendations

ACCIDENT REPORT FORMS

A very complete set of forms for reporting investigations of fatal accidents on highways has been devised by the Pennsylvania Department of Highways. Copies of these forms and instructions pertaining to them can be secured by sending request to the Pennsylvania Department of Highways

SUBJECTS FOR FUTURE REPORT

The following subjects are recommended as major projects for investigation and report during the coming year.

1 The basis of determination for the separation of railroad and highway grade crossings
2 Time loss of traffic at intersections and in congested areas
3 The establishing of adequate rights of way in suburban areas and on rural highways and the determination of the most practical and expeditious method of legal proceedure necessary in the acquisition of ultimate rights of way.

RECOMMENDED RESEARCH PROJECTS

It is recommended that your Committee, The United States Bureau of Public Roads, state highway departments or a national organization finance and investigate the following projects

1. Relative traffic carrying capacity efficiency of a four-lane roadway, two adjoining two-lane roadways, each for traffic in only one direction, and two independent two-lane roadways, each for traffic in both directions

2 Efficiency and practicability of two independent two-lane roadways each serving the same rural territory, one for passenger motor vehicles and motor trucks normally operating at speeds over twenty-five miles per hour, and the other for motor trucks normally operating at speeds less than twenty-five miles per hour, tractors, trailers and horse-drawn vehicles

3 Traffic density at the intersection of two highways which would justify grade separation.

APPENDIX

TO REPORT OF COMMITTEE ON HIGHWAY TRAFFIC ANALYSIS

Traffic Capacity and Roadway Width

The following are the more important factors influencing traffic capacity

A Roadway:

1 Surface width and number of traffic lanes
2 Condition of the surface—roughness, crown, condition of shoulders, position of poles, etc , closeness of the road metal to the edge, curbs, drainage depressions, skidding wet or dry, radius at intersections, lane marking.
3 Obstructions to the free movement of traffic—parked vehicles, intersecting traffic routes, railroad grade crossings, excessive curves, sharp grades, obstructions to free sight line, street car tracks, street car loading platforms, and motor bus stops
4 Developments adjacent to the roadway—stores, schools, theatres, etc

B. Traffic·

1 Traffic density
2 Hourly, daily, and seasonal variations in traffic—maximum traffic periods, morning, evening and Sunday.
3 Composition of traffic, ratio of passenger cars, motor trucks and motor busses Motor vehicle parking, traffic on intersecting routes, and the volume of local traffic moving back and forth on certain sections of roadway

A problem involving such a large number of independent variables necessitates the accumulation of a large volume of detailed data before definite conclusions can be drawn

A device for measuring traffic speed under various conditions on the highways of the Cleveland, Ohio, Regional Area was described in the 1927 report of this committee [1]

During the past year data obtained by the use of this instrument has been supplemented by records obtained with a mechanical recorder This recorder consists essentially of a clock, an odometer recording in hundredths of miles, and a chronometric speedometer so arranged as to record on a moving tape the actual speed of movement when the car is in operation.

For each test run there is recorded by the instrument a curve representing the actual vehicle speed in miles per hour plotted on the vertical

[1] New Traffic Flow Recorder in Use on Cleveland Traffic Survey, by J G McKay, Seventh Annual Proceedings Highway Research Board, page 247

axis and time in minutes plotted on the horizontal axis This instrument can be mounted on any car and is attached to the regular speedometer mechanism

If the speedometer gear ratio is different from that for which the recorder is designed, a mechanical adapter is used The test car is operated so as to "float" with traffic, representing the average vehicle

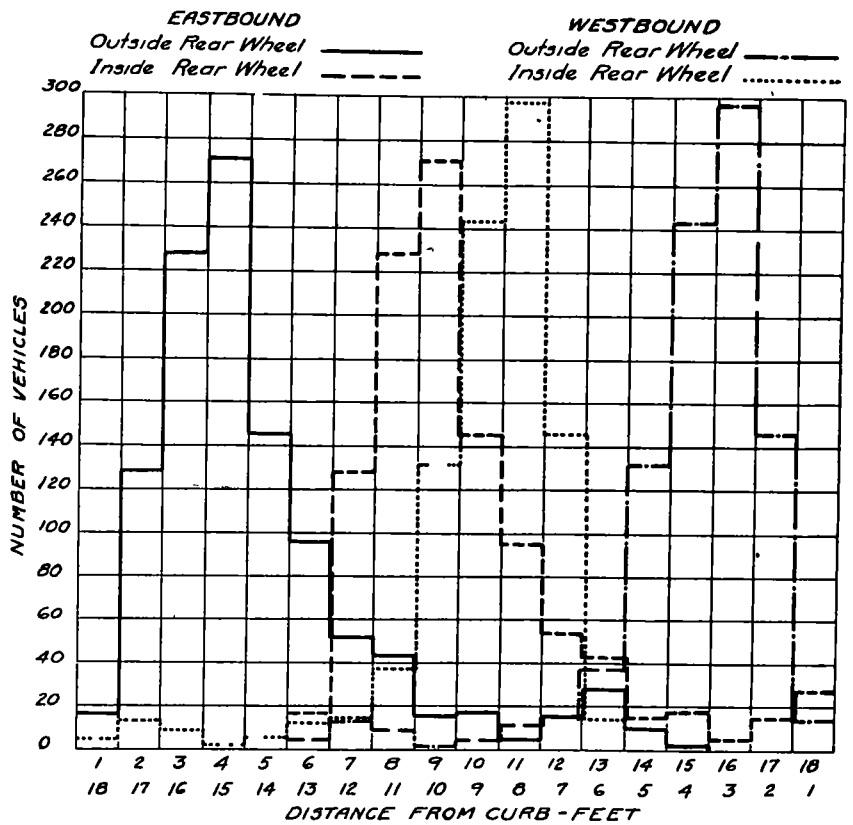

Figure 1. Illustration of Transverse Distribution of Passenger Car Traffic on an 18-foot Pavement Based on Total Passenger Car Traffic from 7 00 A M. to 5 00 P.M.

in the traffic stream and a series of test runs determines accurately the normal speed of traffic on different sections of streets and highways

The operator is accompanied by a recorder, who notes on a prepared log all the causes for variation in speed during the run, an analysis of the speed curve and the log determines the effect of the different variables on traffic speed

Supplementing these data, it is essential to have an accurate knowledge of the volume and composition of traffic on each section of the

TABLE I

TRAVEL SPEED ON DETROIT AVENUE COMPARED WITH THAT ON THE BULKLEY BOULEVARD, LAKE AVENUE AND WEST LAKE ROUTE

Detroit Avenue

From	To	Miles	Width feet	Average weekday traffic: Automobiles	Trucks	Busses	Time	Speed m p h	Obstructions
Ontario St	W 117th St	4 63	38–45	9,034	2,527	238	21 5	13	Street Cars, Loading Platforms, Parking at Curbs
W. 117th St	Wooster Rd	3 66	42	8,667	1,736	—	21 48	10	Street Cars, Loading Platforms, Parking at Curbs
Wooster Rd	Clague Rd	2 95	32	3,635	830	57	5 42	34	Small amount of parking
Total		11 24					48 15	14	

Bulkley Boulevard, Lake Avenue, West Lake Route

From	To	Miles	Width feet	Average weekday traffic: Automobiles	Trucks	Busses	Time	Speed m p h	Obstructions
Ontario St	Bulkley Blvd and Main St	1 06	45	57,269	5,433	619	4 15	15	Street Cars, Loading Platforms, Parking at Curbs
Bulkley Blvd and Main St	Lake Ave and Webb	6 49	36–50	33 466 13,766	46 115	8* 2*	13 1	30	No parking on Bulkley Boulevard Small Amount of Parking on Lake Avenue
Lake Ave and Webb St	Wagar Road	2 47	20	7,395	325	16	6 0	25	Small Amount of Parking
Total		11 68					25 45	27	

* Traffic Bulkley Boulevard and Edgewater Drive

route during the period the test runs are made Figure 1 shows a typical record of the transverse distribution of traffic on an 18 foot pavement

Analyses of these studies indicate clearly the effect of various factors on traffic speed

A sample of the results obtained is shown in Table 1

Table 1 shows a comparison of alternate routes from the Cleveland Public Square to Clague Road Although the distance is approximately the same for the two routes, there was a saving of 22 minutes in the eleven-mile trip for each car operator who used the Bulkley

TABLE II

MAXIMUM HOURLY TRAFFIC ON PRINCIPAL ROADS IN THE CLEVELAND REGIONAL AREA

1928

Road	Location	Width of Roadway Feet	Maximum hour			Total day
Bulkley (3 lanes, direction max traffic)	W. of W 25th	40	EB 8–9 A M		2,540	34,396
			WB 5–6 P M		3,235	
High level bridge (3 lanes, direction max traffic)	West end	44 75	EB 7–8 A M		3,627	63,321
			WB 5–6 P M		3,723	
Carnegie (3 lanes, direction max traffic)	At E 40th	56	WB 8–9 A M		2,058	28,268
			EB 5–6 P M		1,911	
Edgewater Dr (3 lanes, direction max traffic)	E of Clifton	50	EB 7–8 A M		2,507	32,644
			WB 5–6 P M		3,235	

Boulevard, Lake Avenue and West Lake Road route as compared with the Detroit Avenue-Detroit Road route

A low rate of average speed of traffic on the main routes in the heavy traffic zone of the City of Cleveland and its suburban area contrasts sharply with the high average rate of vehicle movement outside of these two areas

Inadequate pavement widths, street car operation, street car loading platforms, parking at the curb, large volumes of motor truck traffic, intersecting traffic routes, and traffic control at intersections are in general the principal causes of the slow rate of movement within the city and its adjacent suburban zones

The problem of providing adequate approaches to highway structures carrying large volumes of motor vehicle traffic is important On Superior Avenue and West 9th Street, the eastern approaches to

the Superior High Level Bridge, the average rate of speed ranges from 4 68 miles per hour to 6 84 miles per hour The total volume of traffic which moves to and from Superior Avenue and West 9th Street to the Superior High Level Bridge averages approximately 62,000 motor vehicles during each week-day

In translating the results of the traffic capacity studies made in the Cleveland Regional Area into required roadway widths certain fundamental assumptions are made

TABLE III

BOTH DIRECTIONS—1927

Road	Location	Width of Road way-Feet	Distance from public square, miles	Maximum hour			Total day
Lake Shore	At E 185th	2(18)	10	Sun	6–7 P M	1,887	17,978
Superior Rd	W of Coventry	2(24)	6	Sun	5–6 P M	1,911	23,567
Mayfield	E of Taylor	2(18)	7 5	Sun	6–7 P M	1,731	17,204
Coventry	N of Euclid Hgts Blvd	2(18)	6	Wk	5–6 P M	1,051	10,427
Lee	S of Cedar	28	6 5	Sun	6–7 P M	1,438	16,036
Fairmount	W of Coventry	2(20)	6	Wk	5–6 P M	1,082	10,949
Kinsman	W of Lee	2(15½)	7	Sun	6–7 P M	1,138	12,113
W 25th	NE of Broadview	46	4	Sun	6–7 P M	2,351	26,720
Broadview	SE of W 25th	40	4	Sun	6–7 P M	813	8,821
Wooster Pike	NE of Ridge	24	4 5	Sun	3–4 P M	1,228	11,875
Wooster Pike	Fowles Road	16	11 5	Sun	5–6 P M	1,106	8,099
Riverside Drive	NE of Brook Park	24	9	Sun	4–5 P M	1,054	8,623
Franklin Ave	E of W 28th	32	1	Wk	5–6 P M	1,244	13,965
Lorain	W of W 25th	46	1 2	Wk	5–6 P M	1,187	14,542
Detroit Road	Wooster Road	32	7 5	Sun	5–6 P M	1,280	13,002
Westland Ave	Detroit Road	20	7 5	Sun	5–6 P M	1,268	15,017
West Lake	Clague	24	10	Sun	4–5 P M	1,033	10,048
Center Ridge	W of Clague	14	10 5	Sun	5–6 P M	714	6,300
Lake Shore	W of Vine St	14 5	16	Sun	4–5 P M	1,321	11,054
Route B	S of Peninsula	18	22	Sun	5–6 P M	693	6,563

1. The traffic capacity of a roadway is reached when any further increase in traffic volume, all other factors remaining constant, results in a marked decrease in traffic speed

2 The normal traffic speed is established at 25 miles per hour

Relative to roadway width and traffic capacity based upon investigations made by the Committee, the following conclusions have been reached.

1 That the trafficway for all two-lane roadways should be 20 feet and space for parked vehicles should be provided outside this area.

2 Normal distribution of traffic requires an even number of traffic lanes When the volume of traffic exceeds the capacity of a two-lane roadway, a four-lane roadway (approximately 40 feet) is recommended The three-lane roadway is found satisfactory in a few cases where there are very pronounced peak periods of traffic in alternate directions at different periods of the day and particularly when the acquisition of right of way for a four-lane roadway is extremely difficult or prohibitive in cost The three-lane roadway, when used, requires lane marking and police traffic control

3 All roadways designed for more than two lanes of traffic should have complete lane marking and provisions made for regulation of traffic to conform with lane marking.

4 The normal traffic capacity of a two-lane trafficway under open road conditions, i e , through areas outside of suburban development, with little local traffic and relatively infrequent cross traffic routes, at a traffic speed of 25 miles per hour, and normal traffic distribution, is approximately 1,000 per maximum hour, and 10,000 vehicles per day In suburban sections with parking adjacent to the roadway surface, and a larger volume of cross traffic and local traffic, the capacity of a two-lane roadway is reduced approximately to 800–1000 per maximum hour, and 8,000 vehicles per day An abnormally high proportion of large capacity trucks, busses or other slowly moving vehicles will decrease these limits

Motor Vehicle Accidents in Pennsylvania

The 1928 report of the National Safety Council shows 23,251 deaths during the year 1927 classified as motor vehicle fatalities The number of deaths from collision of motor vehicle with trolley car and motor vehicle with railroad train increases the number to 25,775

No reliable data are available as to the nation-wide totals of non-fatal injuries and property damage

The 1920 census showed for the United States a population of 105,-710,620 and 24,351,676 families If we visualize the United States as comprising 25,000,000 families, it is apparent at the present accident rate that in the ensuing twenty years, four out of five families may expect personal injuries and two of seventy-five families may expect death from motor vehicle accident

A Highway or Motor Vehicle Accidents—Time Analysis The time analysis of accidents with parallel consideration of volume of traffic flow is likely to furnish significant data A four-year record of accidents, by months, reported to the Pennsylvania Department of Highways, is shown in Table 4

In Table 4 the numerical average of the twelve figures representing

relative hazard by months is 122 5 and it is of particular interest that the highest hazard is for the month of least traffic and that the four months of heaviest traffic, July to October inclusive, all show below the average, October having the minimum hazard rating.

TABLE IV

	Per cent accident 1924	Per cent accident 1925	Per cent accident 1926	Per cent accident 1927	Per cent accident 1928	Numerical average for 5 years	Per cent traffic	Factor	Relative hazard
January	6 5	2 1	5 5	8 9	4 9*	5 6	4 5	1 24	146
February	4 0	2 6	3 2	6 5	6 4*	4 6	3 6	1 28	151†
March	4 1	3 9	6 0	7 4	8 6*	6 0	4 9	1 22	144
April	6 0	4 6	8 2	10 3	8 9*	7 6	7 2	1 05	124
May	7 5	9 5	11 9	9 9	8 6*	9 5	8 1	1 17	138
June	10 2	9 7	9 8	7 8	9 5*	9 4	9 8	0 96	113
July	9 9	16 5	12 6	12 0	9 8*	12 2	12 7	0 96	113
August	12 1	16 0	13 8	9 9	11 4*	12 6	13 6	0 93	109
September	13 4	14 5	9 6	7 4	10 1*	11 0	11 6	0 95	112
October	12 8	9 5	8 5	7 7		9 6	11 3	0 85	100‡
November	7 6	5 6	6 3	7 4		6 7	6 7	1 00	118
December	5 9	5 5	4 6	4 8		5 2	6 0	0 87	102

* Based on assumption that in January to September inclusive 78 per cent of 1928 accidents have occurred

† Highest hazard

‡ Lowest hazard

TABLE V

THE PENNSYLVANIA ACCIDENTS REPORTED BY DAY OF WEEK FOR THE SAME PERIOD

	Per cent accident 1924	Per cent accident 1925	Per cent accident 1926	Per cent accident 1927	Per cent accident 1928	Numerical average for 5 years	Per cent traffic	Factor	Relative hazard
Sunday	21	23	18	19	21	20 4	24 5	0 83	100*
Monday	13	14	15	13	12	13 4	12 1	1 11	134
Tuesday	11	10	13	12	11	11 4	11 1	1 03	124
Wednesday	12	11	11	12	12	11 6	11 8	0 98	118
Thursday	12	13	12	12	12	12 2	12 1	1 01	122
Friday	13	11	12	13	13	12 4	12 8	0 97	117
Saturday	18	18	19	19	19	18 6	15 6	1 19	143†

* Lowest hazard

† Highest hazard

The 1924–1927 inclusive accidents reported are on the State Highway System only. 1928 accidents shown are for urban streets and county township roads as well Traffic variation is as determined in 1924 for the State Highway System These comments apply also to Tables 5 and 6

In Table 5 there is particular interest in Sunday, the day of heaviest traffic, showing the lowest hazard

The hourly record shows the highest hazard between 2 00 and 3 00 A M , the hour of least traffic

TABLE VI

HOURLY ANALYSIS OF FOUR YEARS' ACCIDENTS REPORTS IN PENNSYLVANIA

Hour	Per cent accident 1924	Per cent accident 1925	Per cent accident 1926	Per cent accident 1927	Per cent accident 1928	Numerical average for 5 years	Per cent traffic	Factor	Relative hazard
A M									
12–1	1 71	2 00	2 39	2 41	2 61	2 22	0 7	3 17	566
1–2	1 71	1 80	2 66	1 91	2 22	2 06	0 4	5 15	920
2–3	1 00	1 26	1 09	1 61	1 29	1 25	0 2	6 25	1,116*
3–4	1 14	1 00	1 30	1 20	1 03	1 13	0 3	3 77	673
4–5	1 49	1 53	1 84	1 20	0 57	1 33	0 7	1 90	339
5–6	1 35	1 60	2 52	0 91	0 35	1 34	2 4	0 56	100†
6–7	3 34	2 73	4 91	5 22	1 24	3 49	3 5	1 00	179
7–8	3 98	2 80	3 21	3 61	2 11	3 14	4 0	0 78	139
8–9	4 20	4 20	3 82	4 32	2 69	3 85	4 7	0 82	146
9–10	4 98	4 60	5 52	5 02	3 33	4 69	5 1	0 92	164
10–11	5 90	4 86	5 80	5 12	3 87	5 11	5 2	0 98	175
11–12	6 19	5 60	3 21	5 22	4 82	5 01	5 0	1 00	179
	36 99	33 98	38 27	37 75	26 13	34 62	32 2	1 07	191
P M									
12–1	4 27	2 80	3 68	2 81	5 13	3 74	5 9	0 63	113
1–2	3 34	4 86	5 80	4 32	4 61	4 58	6 9	0 66	118
2–3	6 04	5 66	5 80	5 62	5 61	5 75	7 6	0 76	136
3–4	7 40	7 66	8 12	5 72	6 60	7 10	8 4	0 85	152
4–5	9 03	9 26	6 89	8 23	7 87	8 26	8 3	0 99	177
5–6	6 83	8 00	6 55	6 93	9 27	7 52	6 5	1 16	207
6–7	4 41	6 20	5 46	6 43	7 02	5 90	6 6	0 89	159
7–8	5 76	4 86	5 52	5 92	6 64	5 74	5 8	0 99	177
8–9	5 19	5 13	4 30	4 42	6 40	5 09	4 4	1 16	207
9–10	3 84	3 46	4 02	4 62	5 28	4 24	3 4	1 25	223
10–11	2 77	3 73	2 73	3 41	4 91	3 51	2 5	1 40	250
11–12	4 13	4 40	2 86	3 82	4 53	3 95	1 5	2 63	470
	63 01	66 02	61 73	62 25	73 87	65 38	67 8	0 96	171

* Highest hazard

† Lowest hazard

B Safety on Rural Roads as Compared with City, Borough, Town and Village Streets (Urban Streets) Of 19,041 accidents reported to the Bureau of Motor Vehicles of the Pennsylvania Department of Highways, from January to September inclusive, 1928, 470 (incomplete returns)

resulted in the deaths of 513 persons, and lacking information as to distribution of accidents by State highways and urban streets the reports for the 513 deaths are analyzed to show the relative safety of urban streets and rural roads as follows,

The total of fatalities charged to rural roads is 360 as compared to 153 fatalities charged to urban streets Since, in Pennsylvania, it is estimated that the volume of traffic, in vehicle miles, is slightly less on rural roads than on urban streets, it is apparent that the death rate of the rural roads is more than twice that of the urban streets.

Included in the 513 reported deaths, there were 265 pedestrians and 5 bicyclists Of these 270 deaths, 155 are reported as having occurred in urban streets and 115 on rural roads Although there is no reliable estimate of amount of pedestrian traffic, it is certain that the death rate of pedestrians on rural highways is vastly greater than on urban streets

Eliminating the pedestrians and bicyclists and considering the 243 car occupant fatalities, there were 205 which occurred on rural roads as compared with 38 on urban streets, the ratio being approximately 6 to 1

The analysis is drawn from a limited number of reports and it is possible that more complete returns may show somewhat different ratios

C Safety of Improved Roads Compared with Lightly Improved or Unimproved Roads The comparison of accidents with reference to road improvement is made from analysis of fatal accidents reported in Pennsylvania from January to September inclusive, 1928

166 reports of deaths suffered in accidents on rural roads show the type of road at the accident location and are analyzed as follows:

	Unimproved*	Improved†
Road Miles of State Highway (January 1, 1928)	3,600	6,800
Approximate Annual Average Daily Traffic	300	1,200
State Highway Daily Traffic Vehicle Miles	1,080,000	8,160,000
166 Rural Death Reports Showing Type of Miles	7	159
Death Rate Factor	6 4	19 5
Relative Rate	1 0	3 0

* Earth, cinders, gravel, flint, shale and stoned roads
† Oilbound broken stone and higher types

For computation the assumption is made that all fatalities occurred on State highways Since county and township road traffic is undoubtedly more than one-eighth on unimproved roads, this assumption makes the 3 0 ratio a conservative estimate

The traffic averages are estimated

D. Effect of Physical Condition of Road on Recurrence of Accidents
Accidents reported to the Pennsylvania Department of Highways, during 1926, were found to include 53 per cent occurring on straight road, 26 per cent on light curve, and 21 per cent on sharp curve

Plans for 103 selected sections of road were assumed to be representative of the State highway system and included 66 per cent tangent, 31 per cent of curvature under 10 degrees and 3 per cent of curvature 10 degrees or more.

In the analysis of accidents with relation to horizontal curvature, the accident rate is found to be—

Tangent	1 00
Light curve	1 05
Sharp curve	8 75

Making a similar analysis for gradient it was found that 83 per cent of the line is under 6 per cent grade and 17 per cent of the line 6 per cent or more, and the relative accident rate—

Light grade	1 00
Heavy grade	5 08

TRAFFIC SURVEYS, AND THEIR BEARING ON THE FINANCING OF ROAD BUILDING PROGRAMS[1]

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Highway systems should provide satisfactory transportation service for the movement of people and commodities by the most direct, practicable routes between the various sources of traffic in a given area The expenditure of public funds for the improvement of the several classes of highways should be based primarily on the traffic that now travels and, in the future, is expected to travel on state, county and township roads

The first basic principle of highway production management is that the improvement of each of the four groups of highway systems, national, state, county and township, should follow an established plan of development in which the improvement of various sections of each highway system, the character of the improvement, and the investment of public funds in each project should be based on present and expected future

[1] This paper was arranged for by the Committee on Highway Traffic Analysis Conclusions and recommendations are those of the author and have not been endorsed by the committee