

A METHOD OF SELECTION AND DESIGNATION OF A FEDERAL AID SECONDARY OR FEEDER ROAD SYSTEM

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SYNOPSIS

The selection of federal aid secondary highways in the State of Washington was based on the hypotheses that the primary and secondary routes must form an integral system because the primary and secondary highways are generally overlapping in service characteristics, that the primary systems now designated are not based on specific service characteristics and perhaps parts should be secondary, and that an integral system of primary and secondary routes may be selected leaving a tertiary system with a rather definite point of indication as to the beginning of the tertiary system.

The hypotheses were substantiated by measuring service to dwellings, school bus routes and postal routes, and total travel in each county as well as service to proper land use.

The guides used in this selection were "rural taxable land" and "rural population" factors applied to combined primary and secondary mileage with the provision that exceptions in the amount of mileage determined for each county must be made for special conditions.

This study shows that it would be almost possible to eliminate the use of factors for mileage allocation to each county and use a uniform percentage of travel served to determine the combined mileage of primary and secondary routes for each county.

The subject of the selection and designation of a Federal Secondary or Feeder Road system has been approached by the author with a feeling of humbleness and temerity because he realizes that every state in the Union is confronted with the same task. From the common effort of the 48 States, no doubt, sound and practical principles will be developed which will benefit us all.

The method described is used in the State of Washington and has been formulated after many hours of consideration of as many principles and theories as could be developed. The method perhaps cannot be used universally, but it is hoped that some of the theory may be helpful elsewhere, and we are inclined to believe it could be used in a great many other states.

We are dealing only with the selection and designation of a secondary system; however, it seems to me that some other important fundamental aspects must be considered before actual selection begins. First of all no system of high-

ways should be set up without consideration of the financial aspects. No system should be greater than the funds provided will construct and maintain, or else the funds must be readjusted to the requirements of the system. It would seem that first an analysis of the revenue sources should be made to insure the availability of money for the logical development and maintenance of the system proposed. In the instance of the secondary system, the final analysis should show whether or not revenues are sufficient for the mileage selected. In other words, without a related financial analysis it would easily be possible to get the cart before the horse by designating a system inconsistent with the possible revenue sources.

The source of revenue to be available for the several systems must be taken into consideration. For instance, if the secondary system is to be financed largely from highway user revenues, as it will be in the State of Washington, to what extent can we logically divert revenues from the heavy tax earning

primary system when improvements on that primary system are essential and will provide user benefits far in excess of those of the secondary system?

While we recognize the popular demand for improvement of feeder roads and agree wholeheartedly with the need for their improvement, can we overlook the immediate tremendous benefits to be gained by a greater number of road users from reduced operating expense, time saved, convenience and accident reduction by improvement first of important primary routes? It is necessary for present purposes to assume that due consideration has been given these financial matters and that our sole object is the selection of a secondary system.

The definition of "Secondary or Feeder Roads" is given in the Rules and Regulations of the Secretary of Agriculture for the carrying out of the improvement of these roads as follows: "Secondary or feeder roads shall mean roads outside of municipalities, except as herein after provided, which are not included in the Federal-aid highway system, and shall include farm-to-market roads, mine-to-market roads, rural-free-delivery mail roads, public-school bus routes, and other roads of community value which connect with important highways or which extend reasonably adequate highway service from such highways, or which lead to rail or water shipping points or local settlements. The limitation with respect to roads within municipalities shall not apply to the District of Columbia and shall not be construed to prevent improvements into or through small municipalities when such improvements are necessary for continuity of service."

From this definition, we conclude that there are many services to be given by and specific benefits to be derived from the system. It appears that two large uses of highways are to be excluded from consideration as basic services of the secondary system. first, service to

the long distance or intercity travel which is a primary highway characteristic; and, second, metropolitan routes which serve only city or residential areas. On the other hand, the underlying purpose of the system seems to be service to rural social and economic development. The service is to be not alone to agriculture, but includes mining and perhaps lumbering or other rural economic activities. It also should provide benefits to general governmental functions such as schools and mail delivery. And then it should provide roads of community value which we have interpreted to mean adequate highway service to recreational areas, community centers and connecting routes leading to the cities, because, after all, every rural resident nowadays has occasion to travel often to the city.

In our approach to the selection of a secondary system designed to accomplish the basic intended purposes, we have discovered that numerous difficulties arise due to the fact that the primary system, or at least portions of it, usurp in varying degrees the intended purpose of the secondary system. After our study we have concluded that the effect of the primary system must be considered in relation to the secondary system, especially in the allocation of mileage of that system to the counties. Most certainly the two systems should be integrated enough to provide the greatest possible service

It is our belief that if the primary system were chosen to achieve certain clear-cut purposes it might be possible to add the secondary system to provide a second degree of service. However, we find in Washington that the two groups of services overlap and that it is easier to combine their functions and then to leave as a land service system, a tertiary system. Accordingly we have attempted to choose a system of secondary roads which when added to the primary system leaves little doubt as to the end of the

secondary and the beginning of the tertiary system.

It is our thought that the greatest service may be rendered by establishing a complete system of roads which may be compared to a tree. We believe it is necessary to grow the trunk and limbs to provide the means of carrying fruit-producing elements to the foliage. After all, we are principally concerned with a wholly planned system which will serve adequately to produce the greatest social and economic benefits.

If we find that the designation of the primary system has been deficient or in error, and if now we attempt to add a secondary system, we think we can throw the two systems together and formulate a combined system which takes into account all of the trunk and limbs on the tree and does not include any twigs or leaves. The leaves and twigs would then comprise the tertiary system. The inclusion of any of the tertiary system would be difficult because they are all routes of equal importance and most certainly on a tree we can tell the difference between limbs, and the leaves and twigs. Perhaps the determination of the distinction between secondary and tertiary roads is not so easy, but in the following analysis I think we can show a point of separation which indicates the ends of the limbs and beginning of the foliage.

If such an approach is used, the choice between primary and secondary classification is not so important because in its entirety we then have a comprehensive system bearing the main burden of highway use. And since improvements of necessity are to be made consistent with traffic requirements, whether or not they are primary or secondary, at least we shall have the beginning of the development of a logical system. If later on we conclude that a more accurate classification of the individual routes of the primary and secondary system is

desirable, say for purposes of application of specific revenues, it can be done without disturbing the system as a whole. Such reclassification seems desirable on a basis of service characteristics and traffic volumes if we ultimately are to complete our planning program. The advantages of primary and secondary systems of classification are desirable for administrative purposes, not only in respect to financial support, but also in many instances because of the administrative jurisdiction.

The rules for selection of the secondary system suggest that an initial system of 10 per cent of the total rural highway mileage be chosen as the initial secondary system in each state. In our state we find that this amount was rather a happy choice; however, due to the possibility of future development, our tentative or initial selection was reduced to about 8.2 per cent. It would seem that this percentage of mileage might vary somewhat as between states when the principles of selection we have used are applied. This 8.2 per cent of mileage in Washington when included with the primary system forms a combined system of 15.97 per cent of the rural mileage which carries 81.86 per cent of the traffic. By using that combined-mileage percentage we have taken in all the trunk and limbs of the tree and have left as a tertiary system the foliage which amounts to 84.03 per cent of the mileage and which carries only 18.14 per cent of the traffic. Thousands of additional miles might be added which would increase the general traffic service only slightly. We thus apparently have reached a point of diminishing return where by adding one per cent more mileage to the system we would not increase the traffic service by one per cent. The relative traffic service of the system is somewhat indicated by the average daily traffic which is 904 vehicles for the 3,682 miles of primary system, 285 vehicles for the 4,010 miles

of secondary system, and 24 vehicles for the remainder or 40,948 miles of tertiary system.

These figures would be adjusted somewhat between primary and secondary systems if a reclassification of the primary and secondary systems were made, but they indicate the relative lack of utility of the tertiary system, and the corresponding mileage indicates the tremendous burden that would be imposed for the service rendered if any portion of the tertiary mileage were included in the secondary system. It most certainly is indicated that, under the present form of taxation, the benefits derived by the

TABLE 1

| County | Dwellings per Mile | | | Percentage of Dwellings in County Served by Primary and Secondary Roads | Percentage of Total Mileage in Primary and Secondary Roads |
|----------|--------------------|-------------------|--------------|---|--|
| | Primary Highway | Secondary Highway | County Roads | | |
| Clark .. | 8 50 | 10 13 | 5 14 | 29 3 | 18 0 |
| Lincoln | 0 84 | 0 98 | 0 76 | 12 7 | 11 1 |
| Pierce | 5 07 | 8 51 | 4 08 | 34 6 | 23 2 |
| Whatcom | 5 80 | 10 43 | 6 04 | 34 0 | 25 9 |
| Whitman | 2 06 | 1 89 | 1 29 | 21.4 | 15 2 |

highway tax-paying group could in no manner compare with those of the primary and secondary system as selected. Other indices, such as service to rural residences and school bus and postal routes, indicate definitely the desirability of the maximum established breaking off point between secondary and tertiary systems.

Further evidence of the utility and service rendered by the combined system is shown by the service to rural dwellings in five typical counties in Table 1.

Of the total primary and secondary mileage chosen in the above typical counties, we find that the school bus and postal service to be as given in Table 2.

The data in Tables 1 and 2 show the overlapping service given by the primary and secondary systems. They also indicate the relatively higher values of service rendered by the two systems over the tertiary or county road systems. Table 1 shows that the number of dwellings served per mile by primary and secondary systems is higher in each instance than on the county road system. It also shows that the percentage of dwellings served on the primary and secondary is much higher than the percentage of total mileage in the two systems. The variation in service to dwellings results from the wide difference in population existing in the typical counties.

TABLE 2

| County | Total Mileage Primary & Secondary | Miles Used by Both School Bus & Postal Service | Miles Used by School Bus or Postal Service | Miles Used by Neither |
|---------|-----------------------------------|--|--|-----------------------|
| Clark | 162 | 143 | 16 | 3 |
| Lincoln | 297 | 172 | 93 | 31 |
| Pierce | 388 | 201 | 135 | 52 |
| Whatcom | 263 | 204 | 34 | 24 |
| Whitman | 348 | 192 | 111 | 44 |

Table 2 indicates the high degree of service given to school bus and postal routes. The results of study in the five typical counties show approximately 90 per cent of the combined primary and secondary roads serving the two functions of school and postal routes.

In order to provide an impartial allocation of secondary highway mileage among the counties, it was suggested that some system of factors be used. Such a process is highly desirable to eliminate so far as possible the human errors that are bound to develop if the choice is left to mere judgment. We presume that the selection of factors has caused in many states no end of conscientious endeavor because that was the case in our State. However, after factors are found and

applied and mileage selected accordingly, we are inclined to believe that a great many states will find, as we did, that the corresponding ultimate selection will not fit the mileage factor because of the tests of service, and perhaps because of a previous erroneous selection and classification of primary mileage. We therefore used the factor system as a guide for our initial determination of mileage and then made such adjustments as became necessary to comply with basic considerations of service in the final tests. Our conclusion was that factors could be used as a base from which to start, and that special conditions would have to be treated individually to achieve the final result.

Now, keeping in mind the services rendered by the secondary or feeder system, we shall attempt to choose and use a series of factors designed to provide an equitable distribution of mileage to each county always keeping in mind that this system of factors may not give the final answer because the primary system may be so designated as to render a much higher percentage of these same secondary services in some counties than it does in others.

In a state such as Washington, we find small counties and large counties, rich counties and poor counties, densely populated and sparsely settled areas, counties with large mileage and some with little mileage, counties varying widely in products and development, small farms and large farms and many other diversities creating difficulties of proper adjustment of mileage.

After consideration of many factors and many hours of trial applications of suggested related factors, we finally chose four items which we believed would be indicative of a proper distribution of mileage to each county.

The first of these factors was the "Net Land Area". By net land area, we mean the land remaining after a deduction of

the areas of incorporated towns having a population of over 1,000, and Federal reservations. Both of these items were excluded because the rules and regulations restrict expenditures to rural areas outside cities and National reservations. "Land area" was chosen because it was believed to be a factor that would give corresponding benefit to the larger counties which have relatively small populations. Wheat farming areas and timbered areas require more mileage to serve the same number of rural population than do areas having smaller farms such as fruit or dairy farms. Also, it was believed that an area factor was a better index than "existing mileage" because many counties have a large mileage of unnecessary, little-used roads, while in other counties the same mileage is of considerable importance.

In some counties, where Indian reservations have been opened up to settlement and lands have become taxable, we have not made an area deduction because it has become necessary to supplement the reservation funds by State motor-user revenues because of traffic requirements. Such cases are few and only considered where traffic services in keeping with the intent of the system are being given.

Bearing in mind that the service of this secondary system is to be essentially rural, we have used also the factor of "rural population". In King County, we have delimited the densely populated area north of Seattle because the population of this area is mainly urban in character. By using rural population, we inject all elements of rural development because the population may be engaged in farming, part-time farming, fishing, timber development, recreational service, mining or other rural economic pursuits.

Next we looked for some factor that would prevent the building of roads into areas of low economic significance. We selected the "actual value of rural area",

as shown by assessed valuation as being the simplest and most expedient consideration. From this factor we excluded public utilities because in many instances the public utility means nothing to the county but simply traverses it because of topographic necessity.

For the last factor, we used the item of "vehicle miles of travel", exclusive of traffic on the primary system. It seems to us that travel is one of the best indications we have of the necessity for road improvement. Where development exists, travel must necessarily exist, and in most instances travel indicates the state of development of economic and social life. And since the system we are selecting is secondary and cannot possibly include the tertiary mileage, traffic cannot be overlooked. When we consider improvement of the tertiary system, we will then have to consider other indices because travel will be so low that other factors will assume more importance. Also we must not overlook the financial support of the system and so must provide benefits to the greatest majority of our rural population which, of course, can be accomplished by improving first the more heavily traveled routes.

Many will say that if we improve the roads, travel will increase, which is true in many instances. For that reason I think it is proper that we hold the initial selection to a lower percentage than is suggested. We then can expand the system by adding those routes that give proper evidence of induced traffic equal to the minimum traffic specified. Traffic induction is possible in many instances and will provide many benefits, but each individual route considered should be added only after enough factual evidence is offered to insure that the traffic service will be developed sufficiently to warrant inclusion. We therefore believe that traffic is one of the factors to be considered most heavily as an indication of the service to be given by the secondary system.

Using these four factors a tentative application to each county was made. We then proceeded to select mileage on that basis, and after the use of cumulative diagrams chose the eligible routes in each county. We were not satisfied, because when certain tests of our selection were made, we found evidences of inadequacy. One of these tests was the extent of service to travel. We found that in some counties, exclusive of the primary system, the highways served only 40 per cent of the total rural travel while in other counties they served 60 per cent, and we found that the whole method of selection seemed to provide no definite indication of service.

We then added to our factors the service to travel by the combined primary and secondary system and found some degree of stability, which convinced us that we would have to include and treat the primary and secondary mileage together in any one county to insure a fair and logical distribution of combined mileage to the several subdivisions. The factors were applied to the intended total primary and secondary mileage, and although the tests were more acceptable, we were not fully satisfied so we analyzed further.

By this study of the combined mileage service it was found that the two factors of "area" and "valuation" could be eliminated, and the one factor of "rural taxable lands" was substituted. "Population" and "vehicle miles" had almost parallel effects so the "vehicle mile" factor was also dropped and only "area of rural taxable lands" and "rural population" were used.

These two simple factors provided the best distribution of mileage that were obtained, and even then exceptions had to be made. The tabulation of factors is shown in Table 3.

In making a selection of the individual routes, we followed the method suggested by the Public Roads Administration in using cumulative mileage diagrams as

illustrated in Fig. 1. These diagrams vehicle miles of all rural roads by traffic-volume groups within each county.

TABLE 3

| Counties | Area of Rural Taxable Lands | Rural Population | Average Factor | Total Factor Mileage Primary & Secondary 4000 Mile System | Total Existing Primary Mileage | Net Secondary Factor Mileage | Actual Secondary Selected | Miles Above or Below Factor Mileage | Actual Primary & Secondary Miles | Selected Miles Over or Under That of the Factors % |
|--------------|-----------------------------|------------------|----------------|---|--------------------------------|------------------------------|---------------------------|-------------------------------------|----------------------------------|--|
| Adams | 4 31 | 1 00 | 2 66 | 204 | 81 | 123 | 114 | -9 | 195 | 4 4 |
| Asotin | 1 19 | 88 | 1 03 | 79 | 48 | 31 | 24 | -7 | 72 | 8 9 |
| Benton | 2 40 | 1 32 | 1 86 | 143 | 38 | 105 | 93 | -12 | 131 | 8 4 |
| Chelan | 2 12 | 2 64 | 2 38 | 183 | 139 | 44 | 89 | +45 | 228 | 24 6 |
| Clallam | 1 88 | 1 72 | 1 80 | 138 | 88 | 50 | 89 | +39 | 177 | 28 3 |
| Clark | 1 35 | 3 21 | 2 28 | 175 | 36 | 139 | 126 | -13 | 162 | 7 4 |
| Columbia | 1 47 | 47 | 97 | 75 | 28 | 47 | 51 | +4 | 79 | 5 3 |
| Cowlitz | 2 41 | 2 13 | 2 27 | 174 | 48 | 126 | 96 | -30 | 144 | 17 2 |
| Douglas | 3 54 | 1 27 | 2 41 | 185 | 141 | 44 | 54 | +10 | 195 | 5 4 |
| Ferry | 3 19 | 72 | 1 96 | 151 | 88 | 63 | 21 | -42 | 109 | 27 8 |
| Franklin | 2 40 | 44 | 1 42 | 109 | 48 | 61 | 79 | +18 | 127 | 16 5 |
| Garfield | 1 32 | 35 | 84 | 65 | 41 | 24 | 22 | -2 | 63 | 3 1 |
| Grant | 5 46 | 1 37 | 3 41 | 262 | 176 | 86 | 85 | -1 | 261 | 0 4 |
| Grays Harbor | 3 09 | 3 37 | 3 23 | 248 | 127 | 121 | 117 | -4 | 244 | 1 6 |
| Island | 45 | 90 | 68 | 52 | — | 52 | 46 | -6 | 46 | 11 5 |
| Jefferson | 99 | 73 | 86 | 66 | 88 | -22 | 50 | +72 | 138 | 109 1 |
| King | 3 61 | 10 22 | 6 86 | 527 | 213 | 314 | 227 | -87 | 440 | 16 5 |
| Kitsap | 75 | 3 27 | 2 01 | 154 | 62 | 92 | 92 | — | 154 | — |
| Kittitas | 3 70 | 1 51 | 2 61 | 201 | 135 | 66 | 81 | +15 | 216 | 7 5 |
| Klickitat | 3 70 | 1 47 | 2 59 | 199 | 72 | 127 | 129 | +2 | 201 | 1 0 |
| Lewis | 3 93 | 4 55 | 4 24 | 326 | 161 | 165 | 158 | -7 | 319 | 2 1 |
| Lincoln | 5 39 | 2 00 | 3 69 | 284 | 176 | 108 | 121 | +13 | 297 | 4 6 |
| Mason | 1 56 | 1 17 | 1 37 | 105 | 65 | 40 | 58 | +18 | 123 | 17 1 |
| Okanogan | 5 62 | 2 43 | 4 03 | 310 | 214 | 96 | 158 | +62 | 372 | 20 0 |
| Pacific | 2 02 | 1 57 | 1 79 | 138 | 95 | 43 | 25 | -18 | 120 | 13 0 |
| Pend Oreille | 1 70 | 1 02 | 1 36 | 104 | 91 | 13 | 14 | +1 | 105 | 1 0 |
| Pierce | 2 22 | 7 70 | 4 96 | 381 | 152 | 229 | 236 | +7 | 388 | 1 8 |
| San Juan | 41 | 52 | 47 | 36 | — | 36 | 18 | -18 | 18 | 50 0 |
| Skagit | 2 04 | 3 49 | 2 77 | 213 | 63 | 150 | 137 | -13 | 200 | 6 1 |
| Skamania | 82 | 64 | 73 | 56 | 40 | 16 | 24 | +8 | 64 | 14 3 |
| Snohomish | 2 32 | 6 74 | 4 53 | 348 | 78 | 270 | 276 | +6 | 354 | 1 7 |
| Spokane | 3 76 | 4 98 | 4 38 | 336 | 127 | 209 | 155 | -54 | 282 | 16 1 |
| Stevens | 3.70 | 2 59 | 3 15 | 242 | 160 | 82 | 80 | -2 | 240 | 0 8 |
| Thurston | 1 63 | 3 30 | 2 47 | 190 | 58 | 132 | 155 | +23 | 213 | 12 1 |
| Wahkiakum | 57 | 65 | 61 | 47 | 41 | 6 | 20 | +14 | 61 | 29 8 |
| Walla Walla | 2 94 | 2 10 | 2 52 | 193 | 73 | 120 | 104 | -16 | 177 | 8 3 |
| Whatcom | 1 57 | 4 22 | 2 89 | 222 | 87 | 135 | 176 | +41 | 263 | 18 5 |
| Whitman | 5 01 | 3 25 | 4 13 | 317 | 147 | 170 | 201 | +31 | 348 | 9 8 |
| Yakima | 3 46 | 8 09 | 5 78 | 444 | 158 | 286 | 278 | -8 | 436 | 1.8 |
| | 100 00 | 100 00 | 100 00 | 7682 | 3682 | 4000 | 4079 | | | |

cumulative mileage of all rural roads by traffic-volume groups and the cumulative-

Each chart has two parts; the lower part being a diagram showing the

cumulative curve of all rural-road mileage by traffic-volume groups, and the upper half of the chart being a diagram showing the cumulative-vehicle mileage curve of all rural roads by traffic-volume groups.

The minimum traffic of interest as determined from these diagrams was used as a major control in selecting the individual routes: First, by applying

the factor-mileage figure was scaled downward and then projected horizontally to the left to intersect with the cumulative-mileage curve. At this point of intersection on the curve, the line was projected downward to intersect with the traffic volume abscissa which gave the minimum traffic volume of interest; Third, by projecting a line upward from

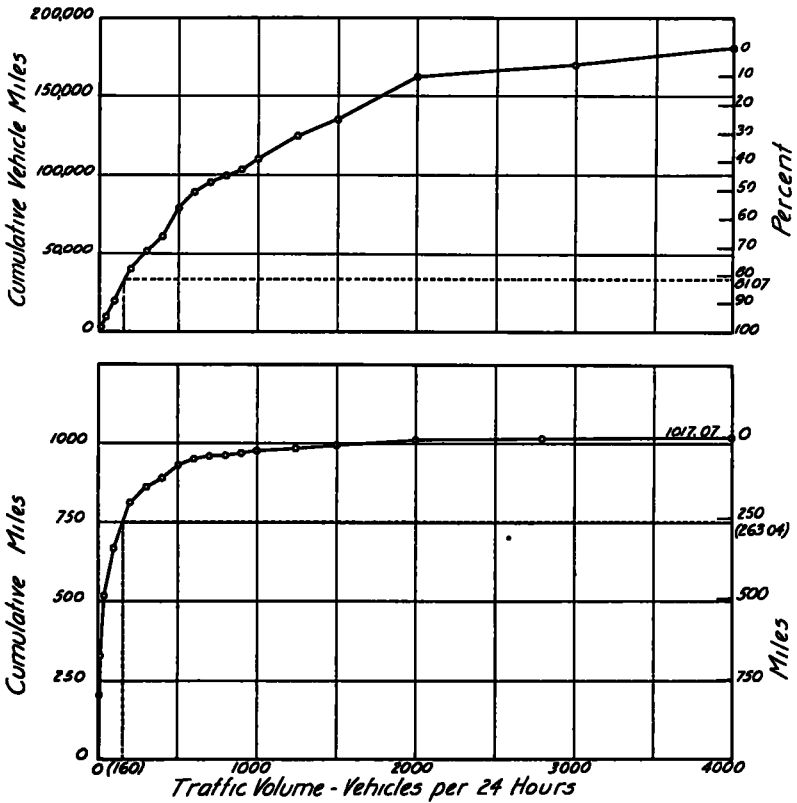


Figure 1

the percentage factor developed for each county to the total factor mileage in the primary and secondary-road system determined generally the resulting mileage figure representing the miles of road to be selected within the county as illustrated in Table 4; Second, by reversing the scale of cumulative miles on the lower half of the cumulative mileage diagram as shown on the right side of the chart,

the point of intersection of the cumulative-mileage curve to intersect with the cumulative-vehicle mileage curve, and then projecting a line horizontally to the right from this point of intersection to intersect the reverse ordinant scale in percentage of the cumulative-vehicle miles, gave the percentage of the total traffic accommodated by the eligible roads for inclusion in the selected primary

FRITTS—SELECTION OF SECONDARY ROAD SYSTEMS

COMPARISON OF MILEAGES AND VEHICLE-MILES OF THE PRIMARY STATE HIGHWAYS AND THE PARTIALLY SELECTED FEDERAL AID SECONDARY HIGHWAYS TO THE TOTAL RURAL HIGHWAYS

| County | P.S.H. Mileage | P.S.H. Vehicle Mi. | F.A.S. Mileage | F.A.S. Vehicle Mi. | Total Mileage P.S.H. & F.A.S. | Total Vehicle Mi. P.S.H. & F.A.S. | Total Mileage Rural | Total Vehicle Mi. Rural | P.S.H. & F.A.S. | |
|--------------------|----------------|--------------------|----------------|--------------------|-------------------------------|-----------------------------------|---------------------|-------------------------|----------------------------|---------------------------------|
| | | | | | | | | | Percent of Total Rural Mi. | Percent of Total Rural Veh. Mi. |
| Adams | 80 80 | 27,077 | 114 31 | 11,866 | 195 11 | 38,943 | 2,229 61 | 46,709 | 8 75 | 83 37 |
| Asotin | 47 93 | 10,915 | 23 68 | 3,127 | 71 61 | 14,042 | 447 86 | 17,349 | 15 99 | 80 94 |
| Benton | 37 67 | 28,085 | 92 70 | 13,160 | 130 37 | 42,245 | 1,706 80 | 55,041 | 7 64 | 76 75 |
| Chelan | 189 19 | 95,153 | 89 24 | 20,720 | 228 43 | 115,873 | 1,706 80 | 139,933 | 19 45 | 82 81 |
| Ciellam | 87 70 | 45,884 | 14,134 | 20,720 | 176 60 | 60,018 | 1,719 97 | 74,318 | 24 53 | 80 76 |
| Clark | 36 11 | 115,805 | 125 98 | 55,217 | 162 09 | 171,022 | 903 04 | 209,219 | 17 95 | 81 74 |
| Columbia | 27 69 | 20,090 | 51 05 | 4,918 | 78 74 | 25,008 | 656 53 | 32,945 | 11 99 | 75 91 |
| Cowlitz | 48 22 | 122,884 | 95 90 | 21,098 | 144 12 | 143,982 | 511 02 | 155,144 | 28 20 | 92 81 |
| Douglas | 141 29 | 58,559 | 53 74 | 4,632 | 195 03 | 63,191 | 1,799 87 | 74,065 | 10 84 | 85 31 |
| Ferry | 87 55 | 8,766 | 21 15 | 1,855 | 108 70 | 10,621 | 1,112 65 | 16,808 | 9 77 | 63 19 |
| Franklin | 47 71 | 19,778 | 79 02 | 7,100 | 126 73 | 26,878 | 952 59 | 34,749 | 13 30 | 77 35 |
| Garfield | 41 56 | 14,909 | 22 16 | 1,785 | 63 72 | 16,694 | 567 00 | 22,456 | 11 24 | 74 34 |
| Grant | 175 72 | 71,095 | 85 43 | 5,509 | 261 15 | 76,604 | 2,000 99 | 101,076 | 13 05 | 75 79 |
| Grays Harbor | 126 74 | 123,974 | 117 54 | 38,741 | 244 28 | 162,715 | 764 17 | 183,739 | 31 97 | 88 56 |
| Island | — | — | 45 91 | 15,284 | 45 91 | 15,284 | 377 94 | 20,047 | 12 15 | 52 62 |
| Jefferson | 87 61 | 28,862 | 50 56 | 8,163 | 138 17 | 37,025 | 448 81 | 44,793 | 30 79 | 82 66 |
| King | 213 37 | 511,128 | 227 23 | 139,275 | 440 60 | 650,403 | 2,517 14 | 840,041 | 17 50 | 77 43 |
| Kitsap | 62 09 | 66,760 | 91 51 | 22,725 | 153 60 | 89,485 | 779 23 | 108,077 | 19 71 | 82 80 |
| Kittitas | 134 95 | 169,109 | 81 14 | 23,376 | 216 09 | 192,485 | 1,065 04 | 207,889 | 20 29 | 92 59 |
| Klickitat | 72 34 | 28,772 | 129 54 | 15,503 | 201 88 | 44,275 | 1,402 31 | 60,567 | 14 40 | 73 10 |
| Lewis | 161 14 | 144,836 | 158 55 | 35,870 | 319 69 | 180,706 | 1,225 79 | 209,908 | 26 08 | 86 09 |
| Lincoln | 175 88 | 91,830 | 121 23 | 15,269 | 297 11 | 107,099 | 2,657 25 | 128,296 | 11 18 | 83 48 |
| Mason | 64 78 | 51,434 | 58 13 | 12,801 | 122 91 | 64,235 | 664 36 | 78,627 | 18 50 | 81 70 |
| Okanogan | 214 30 | 52,476 | 158 10 | 13,259 | 372 40 | 65,735 | 2,389 66 | 89,014 | 15 58 | 73 85 |
| Pacific | 95 02 | 40,168 | 25 81 | 2,665 | 120 83 | 42,833 | 358 85 | 53,997 | 33 67 | 79 32 |
| Pend Oreille | 91 00 | 26,722 | 14 10 | 584 | 105 10 | 27,306 | 862 15 | 34,944 | 12 19 | 78 14 |
| Pierce | 151 89 | 232,630 | 236 00 | 115,306 | 387 89 | 347,936 | 1,672 09 | 409,409 | 23 20 | 84 98 |
| San Juan | — | — | 17 97 | 1,629 | 17 97 | 1,629 | 234 71 | 7,059 | 7 66 | 23 08 |
| Skagit | 62 93 | 89,254 | 137 48 | 63,427 | 200 41 | 152,681 | 758 44 | 179,165 | 26 42 | 85 22 |
| Skamania | 40 38 | 39,971 | 24 13 | 3,538 | 64 51 | 43,509 | 521 95 | 55,653 | 12 36 | 78 18 |
| Snohomish | 78 15 | 208,632 | 276 45 | 117,460 | 354 60 | 326,092 | 1,594 00 | 373,507 | 22 25 | 87 31 |
| Spokane | 127 33 | 184,919 | 155 06 | 36,187 | 282 39 | 221,106 | 2,775 59 | 298,989 | 10 17 | 73 98 |
| Stevens | 160 23 | 43,441 | 80 09 | 7,481 | 240 32 | 50,922 | 2,304 51 | 69,592 | 10 43 | 73 17 |
| Thurston | 57 57 | 140,224 | 155 56 | 53,689 | 213 13 | 193,913 | 857 87 | 222,244 | 24 84 | 87 25 |
| Wahakum | 40 54 | 12,934 | 19 85 | 2,043 | 60 39 | 14,977 | 158 06 | 17,856 | 38 21 | 83 88 |
| Walla Walla | 73 05 | 67,625 | 104 40 | 20,739 | 177 45 | 88,364 | 1,303 53 | 107,258 | 13 61 | 82 38 |
| Whitcom | 86 95 | 72,917 | 176 09 | 74,274 | 263 04 | 147,191 | 1,017 07 | 181,562 | 25 86 | 81 07 |
| Whitman | 147 30 | 93,972 | 200 95 | 28,392 | 348 25 | 122,364 | 2,292 26 | 154,469 | 15 19 | 79 22 |
| Yakima | 157 71 | 166,224 | 277 68 | 116,748 | 435 39 | 282,972 | 2,856 01 | 345,188 | 15 24 | 81 98 |
| Totals and Average | 3,682 39 | 3,328,814 | 4,084 32 | 1,149,549 | 7,766 71 | 4,478,363 | 48,641 20 | 5,470,602 | 15 97 | 81 86 |

and secondary system to the total rural-road vehicle mile travel

There always are exceptions to every rule and when we had made our final choice we found we had more mileage than our factors allowed in some counties and less in others, but as a whole the system seemed to be well selected

Some of the exceptions are perhaps worthy of comment.

In Chelan County we had more mileage than was permitted by the factors. Chelan County is an area of mountains and valleys and lakes. The mountainous areas are in national reservations which are subject to recreational travel, and considerable settlement exists in the narrow valleys. Roads are necessary to reach the farmed valleys and recreational areas, and the terrain required more mileage than our factors indicated.

Clallam and Jefferson Counties contain the Olympic primary highway, and in their westerly regions they have a large mileage that serves hardly any population. Since this primary mileage is of little local use, it makes necessary an exception in the allocation to these two counties.

Cowlitz County has a large area of assessed timber that is unpopulated, which creates an unusually high mileage factor. The routes selected provide a high degree of service to its productive valley areas and further mileage is unnecessary until the forest products demand increased mileage.

Ferry County is thinly populated requiring large mileage to cover its area, and the selection was limited to less than the factor determination. In this county the minimum traffic of interest was below the amount considered advisable for inclusion. We believe that because support of this system is partly supplied from highway user revenues a lower traffic limit should not be considered. If additional mileage were given to this county, traffic volumes thereon would be

lower than in any other county in the State and we do not believe that condition is justified. In this county also, as well as Okanogan, we included the area of Indian reservation lands because a considerable portion of the land has become taxable and the population is the cause of considerable traffic. Also, investigation has shown that road funds inside reservations are generally inadequate for improvement of primary and secondary routes.

In King County apparently we have not selected sufficient mileage in spite of the fact that we deleted the urban area and population outside the city of Seattle. Our measure of traffic service indicates the desirability of adding more mileage, but we have refrained from doing so because we believe local revenues would be sufficient to care for the remaining system.

San Juan County is composed of four small islands, and traffic volumes are too low to warrant any additional mileage.

In other counties exceptions fall under similar cases.

It appears to us that there are a few tests that can be made of the final selection. The first of these is traffic service to the county. After the first selection we found that by measuring the percentage of vehicle miles on the combined primary and secondary systems that a near uniformity existed in each county. We returned to those counties which were out of line and found that in nearly all instances the addition of more miles or a deletion would be indicated by both the factors and the table of percentage of travel on the primary and secondary highways. The exceptions to the factors have already been noted. After a readjustment of mileage a striking uniformity of service in each county was found as shown by Table 4.

The indication of traffic service uniformity of the systems selected for the various counties is shown by Table 5

which gives for the five typical counties the percentages of the total traffic served by the selected mileages

It would almost be possible to determine mileage allocation to each county by picking this figure from the cumulative curve for each county as in Figure 1.

Another measure of the utility of the combined system is the service to school bus and postal routes which has been demonstrated by Table 2 in the five typical counties.

A final test of the selection is by use of the land-use map. We know of no better means than this of indicating the value of roads to agricultural development.

Briefly then we arrive at the following general conclusions concerning the selection of the secondary or feeder road system

1. That the primary and secondary routes must form an integral system because the primary and secondary highways are generally overlapping in service characteristics.

2. That the primary systems now designated are not based on specific service characteristics and perhaps parts should be secondary, therefore factors for mileage allocations to counties are difficult to apply because of the disturbing effect of the existing primary system.

3 That an integral system of primary and secondary routes may be selected leaving a tertiary system with a rather definite point of indication as to the beginning of the tertiary system

4. That distinction between primary

and secondary systems may be made later according to definitions to be determined.

5. That proof of the proper selection of an integral system can be achieved by measuring service to dwellings, school bus routes and postal routes, and total travel in each county as well as service to proper land use.

6. That factors for allocation of mileage to the individual counties can be used as a guide when applied to combined primary and secondary mileage.

TABLE 5

| | County | Percentage of total traffic served by the selected mileages of primary and secondary roads |
|---|---------|--|
| 5 | Whitman | 79 |
| 2 | Lincoln | 83 |
| 1 | Clark | 82 |
| 3 | Pierce | 85 |
| 4 | Whatcom | 81 |

7. That "rural taxable land" and "rural population" were the best factors to use in Washington as shown by final tests.

8. That exceptions in the amount of mileage determined for each county must be made for special conditions

9. That it would be almost possible to eliminate the use of factors for mileage allocation to each county and use a uniform percentage of travel served to determine the combined mileage of primary and secondary routes for each county.