

HIGHWAY RESEARCH BOARD
Special Report 13

Know Your Highway Costs

Highway Control Sections, A Basic Procedure
for Keeping Adequate Cost and Operating
Records of the Highway Plant.

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FRED BURGGRAF W. N. CAREY, JR. W. J. MILLER

2101 Constitution Avenue, Washington 25, D. C.

The opinions and conclusions expressed in this publication are those of the authors and not necessarily those of the Highway Research Board.

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Washington, D.C.

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Fred B. Farrell, Chairman
Chief, Highway Cost Section
Bureau of Public Roads

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Illinois

Fritts, Carl E., Director, Highways Division, Automotive Safety
Foundation, 700 Hill Building, 839 - 17th Street, N. W.,
Washington 6, D. C.

Gamble, Raleigh W., Superintendent of Bureau of Street Construction
and Repairs, Room 301 City Hall, Milwaukee 2, Wisconsin

Kipp, O. L., Assistant Commissioner and Chief Engineer, Minnesota
Department of Highways, 1246 University Avenue, St. Paul 4,
Minnesota

Lindman, B. H., Transportation Consultant, Operations Research
Office, Johns Hopkins University, Chevy Chase, Maryland

Wilson, H. R., Fiscal Manager, Division of Finance and Management,
Bureau of Public Roads, Department of Commerce, Washington 25,
D. C.

Winfrey, Robley, Highway Engineer, Office of the Commissioner,
Bureau of Public Roads, Department of Commerce, Washington 25,
D. C.

SUBCOMMITTEE ON CONTROL SECTIONS

Gronberg, Gordon D., Chairman, Transportation Economist, Bureau of
Public Roads, Department of Commerce, Washington 25, D. C.

Wilson, W. C., Road Life Manager, Highway Planning Survey, Nevada
Department of Highways, State Office Building, Carson City,
Nevada

Highway Research Board
Washington 25, D. C.

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KNOW YOUR HIGHWAY COSTS

THE building, maintenance, and administration of state highways is big business. It should be apparent that if commercial businesses maintain complete fiscal and cost accounting records, then, considered from magnitude only, the state highway departments should have equally adequate systems. In the past, however, it has generally been impossible for highway departments to correlate construction costs with maintenance costs, as maintenance sections were often consolidated, eliminated, or adjusted from year to year. Further, most departments have maintained records embracing only the total expenditures of funds for construction and maintenance. From the records thus maintained it has been impossible to determine the loss of investment resulting from obsolescence or structural deterioration, or to compute the annual roadway cost (which comprises construction, maintenance, depreciation, and operation costs). It has also been impossible for one state to review and profit by the experience gained by comparison of its costs with cost records of other states, due to lack of uniform systems of cost keeping and of standards for the exchange of information based on similar pieces of property.

Therefore, one of the major needs confronting the highway administrator and highway engineer has been the development of a workable system of recording highway expenditures pertaining to the cost of constructing and operating highway facilities. Some states have been experimenting with new methods, while others have been trying to make the old methods do with a bit of patching here and there. Out of these efforts have come some important developments. One of these was the development of a system of control sections for recording all data pertaining to highways; another was the suggested system of uniform accounting developed by the AASHO Subcommittee on Uniform Accounting.

Experience has shown that highway control sections are a practical and effective means whereby the vast amount of data relating to highway costs, operation, and performance can be assembled in an organized fashion.^{1/} Control sections have already been adopted in 17 states and Puerto Rico, and are under consideration in many of the remaining states.

The preliminary draft of "Know Your Highway Costs - Highway Control Sections -- A basic procedure for keeping adequate cost and operating records of the highway plant" was submitted to California, Connecticut, Florida, Idaho, Illinois, Kansas, Kentucky, Louisiana, Maine, Michigan, Minnesota, Mississippi, Nevada, New Jersey, Oregon, Rhode Island, Texas, Virginia, Washington, and Wisconsin for review and comments. It was believed that comments made on the control-section procedure by states operating on such a system would be beneficial to other states, particularly to those planning to adopt control sections and uniform accounting. The comments made by various states have, therefore, been included in the report.

^{1/} - "Highway Control Sections," by Fred B. Farrell, AMERICAN HIGHWAYS, Vol. 25, No. 1, January 1946; "Highway Control Sections, Their Establishment and Use," by Gordon D. Gronberg, PUBLIC ROADS, Vol. 26, No. 9, August 1951; and "Suggested Control Sections for a State System of Highways and Their Use in Statistical Cost Records," by R. C. Faltinson, Texas State-wide Highway Planning Survey.

The concept of control sections is predicated upon having available in each highway department a complete and up-to-date file of all basic factual data relating to highways. These basic records will give the latest information on such items as:

- Roadway construction costs
- Roadway maintenance costs
- Bridge construction costs
- Bridge maintenance costs
- Drainage features
- Design features
- Mileage
- Traffic
- Capacity
- Weight
- Usage
- Critical features
- Soils classification
- Accidents
- Sufficiency ratings

Such data are essential to the varied needs of modern-day highway planning, programing, and administration; they must be at hand in order that routine highway affairs can be managed properly and in order that legislative requests can be answered promptly.

Uniform construction and maintenance operation and cost records kept for permanently designated control sections are of great value in enabling states to make comparisons of costs based on similar pieces of property; factual information can be obtained on various kinds of highway work as affected by climate, traffic, etc.; and detailed studies can be undertaken on the annual costs for each control section.^{2/}

Certain control sections, of course, will not be suitable for a particular statistical or cost study as they will be composed of short sections of road of various surface types, ages, and widths. However, sections having undesired variations can be excluded and the special study made on the basis of the remaining sections.

Establishing Control Sections

The work involved in establishing control sections should be entrusted to one department or division, or to a special committee, in which one person who is thoroughly conversant with and sympathetic to the new system will head up the activity with complete and undisputed responsibility and authority for its establishment. The person responsible for establishing this new system should contact the administrative heads of all departments to explain the system in detail and to show how the data required in each department will be included. He should assist with the basic instructions of all personnel responsible for reporting data either in the division or headquarters

^{2/} - "A Procedure for Determining the Annual Cost of a Section of Rural Highway," by Harold W. Hansen, PUBLIC ROADS, Vol. 26, No. 7, April 1951.

office, or in the field for construction or maintenance purposes. Conferences with division and maintenance engineers, both in the divisions and at headquarters, meetings in the field, and correspondence where feasible should be adequate coverage for the instructional phase of the undertaking.

When designating control sections, the design engineers, division engineers, and maintenance engineers must be consulted as to the type and length of control sections which best meet their particular needs. Where differences of opinion exist, they must then be reconciled to conform with the over-all features desired of control sections.

In brief, the foregoing endeavor simply involves subdividing the highway system into convenient, practical units for which design, construction and maintenance costs, inventory, and performance records are kept on a uniform and continuing basis. Once established these sections of highway, termed "control sections," are permanent units of the highway and become the basic reporting unit for each division of the highway department -- planning, programing, design, construction, maintenance, right-of-way, and accounting.

The essential attributes of a desirable control section include:

- (1) a unit with a reasonably uniform traffic volume throughout its length;
- (2) a logical unit for development to the same general type and standard;
- (3) a practical unit for reporting maintenance costs; and (4) a convenient and reasonably permanent unit for the compilation of statistical and research data.

Control Section Termini

Highway control sections terminate at county lines and major intersecting routes. In some states other criteria, such as changes in topography (mountainous or nonmountainous), traffic characteristics, and adaptability as maintenance sections, have been used. As a general rule, control sections should not be over 25 mi. long. For sections of highway over 25 mi. long with no intersecting routes, termini can be established where there is a change in soil conditions, road usage, etc. Where a bridge is encountered at the termini of two control sections or at a county line, the bridge and approaches are usually included in their entirety in one or the other control section. In some states, because of shared financial responsibility, it has been necessary to distribute a proportionate share of the cost of such bridges to each county. Major structures, interchanges, traffic circles, Y connections, and ramps are included either in the control section on the main or through route or with the route on which they were constructed. These special highway facilities can also be set up as separate control sections, if desired. When two control sections join and for a certain distance are coincident there should be no duplication of mileage. Either a separate control section can be established for the overlapping mileage or the control section for the feeder or less-important road can show a gap for the overlapping mileage. Control sections do not terminate at urban limits. Urban limits are continuously changing and are not ordinarily considered suitable as termini for reporting highway data on a control section basis. Subsections are usually established at urban limits.

Control sections are usually established on the entire state highway

system, but in a few states they have also been designated on the state-aid roads. Once established, control sections are permanent units of the highway and are not to be changed except as necessitated by relocation or where extensions or additions to the highway system are encountered in the future.

Control-Section Numbering

The system of numbering control sections which is in most common use and which appears to be the most satisfactory from all standpoints is to identify each section with a four- to six-digit number. The first two or three digits indicate the county number in alphabetical order and the last two or three digits indicate the section number within the county. However, some states have not used this numbering system. In Kansas, for example, the control-section numbering system incorporates the US and state route numbers with the county and section number. In this numbering system, where two US routes or two state routes follow the same highway the smaller route number is used and where a US and state route are coincidental the US route number is used. Little difficulty has been encountered so far in this method of numbering as route numbers in this state have seldom been changed. In general, it has not been found practicable to attempt to provide identification of the system, route number, etc., in the numbering scheme, because of difficulties encountered when a route number is changed or when a road is transferred to another system. Control sections are usually numbered from west to east and south to north. However, the method of numbering is of minor consequence so long as it is kept reasonably simple and the other more-important purposes of the control section system are accomplished.

The length of control sections varies, depending on the frequency of intersections, changes in topography, etc. In the eastern part of the United States the average length is 5 to 8 mi., in the central part from 10 to 12 mi., and in the western part from 15 to 18 mi. Figure 1 shows a portion of the control section setup in Idaho.

Figure 2 illustrates the usual procedure for handling control-section termini at rural-road intersections. As shown at the left in the figure, where the main route intersects a secondary route, the main route is continuous and the secondary route breaks at the intersection. As shown at the right in the figure, where the main route intersects another main route or an important secondary route, the volume of traffic at the intersections warrants a break in both routes. This can be handled by dividing the main route into two control sections with a Y connection in each section, or by treating the entire intersection as a separate control section.

Physical Designation of Control Sections

As an aid to construction and maintenance crews and other field personnel, control sections are usually identified on the ground by the installation of marker posts. Figures 3 and 4 are examples of the methods that have been used. In Maine the control section number that can be seen from the road is the section being entered (Fig. 3). In Nevada the posts are set at an angle and both control section numbers are visible from the road (Fig. 4). Control sections in Nevada are designated by two letters and two numbers, the former identifying the county and the latter identify-

ing the control section within that county.

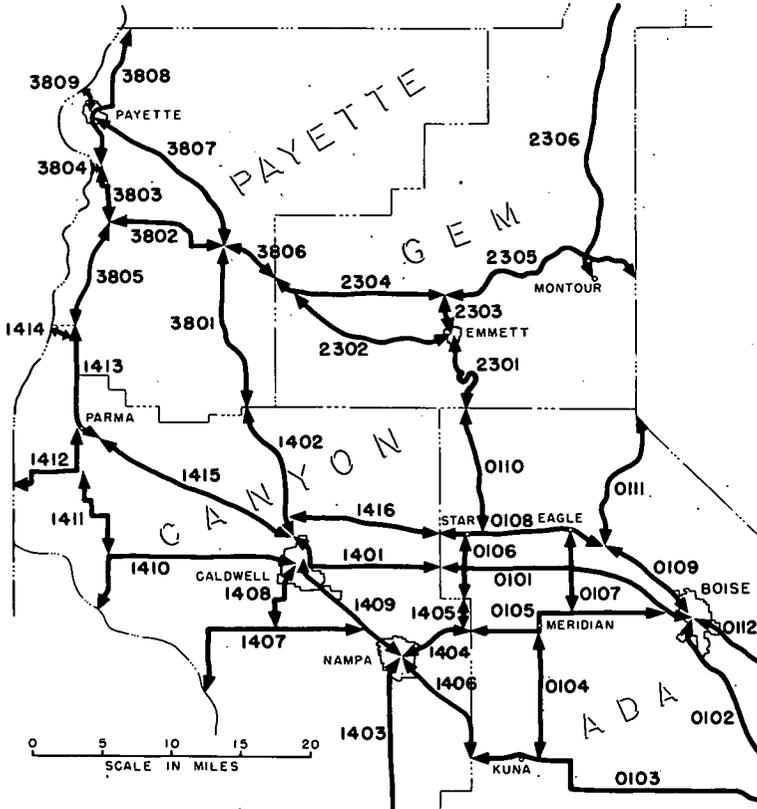


Figure 1. A portion of the control-section system in Idaho.

Subsection Designation

The various divisions of the highway department, for their own use, breakdown control sections into smaller segments, called subsections. For example, the determination of accurate maintenance costs requires that control sections be divided into subsections at urban limits, at changes in surface type, at variation in widths and ages, and for such highway facilities as bridges, interchanges, traffic circles, and grade crossings. Such subsections can also be used for traffic or accident studies, soil condition surveys, or any special study that a state desires to undertake and are established at the discretion of, and to meet the specific needs of, each particular division. Since they ordinarily affect only one division, they may or may not be permanent, depending upon the needs of that division.

The usual procedure when adopting control sections is to retain the bridge-number identification that is in use. Connecticut, however, has found their present system of numbering bridges by route number and distance from beginning of route undesirable and has renumbered the bridges

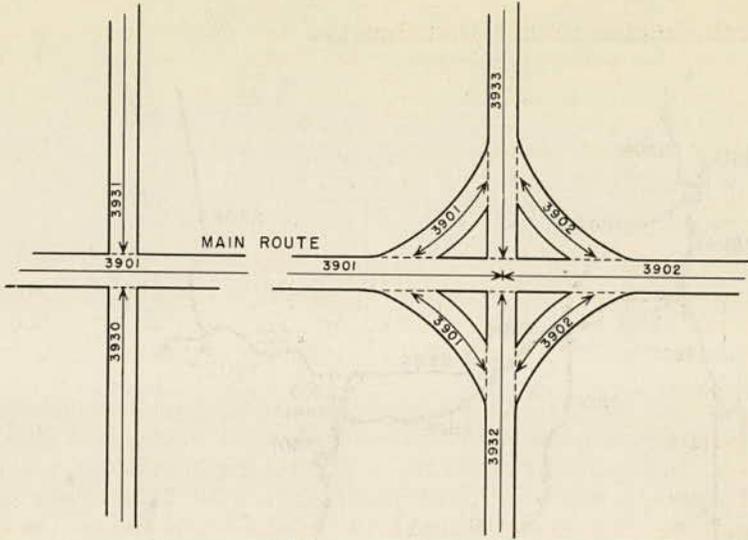


Figure 2. Control-section termini at rural intersections.

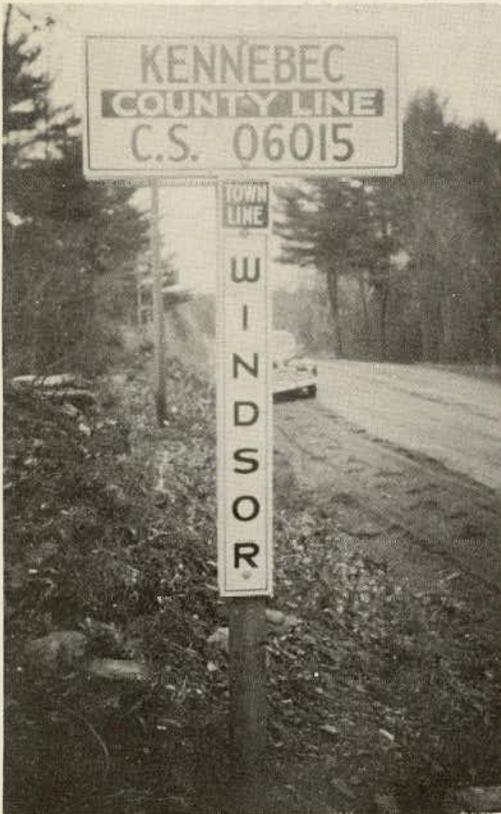


Figure 3. A Maine control-section marker.

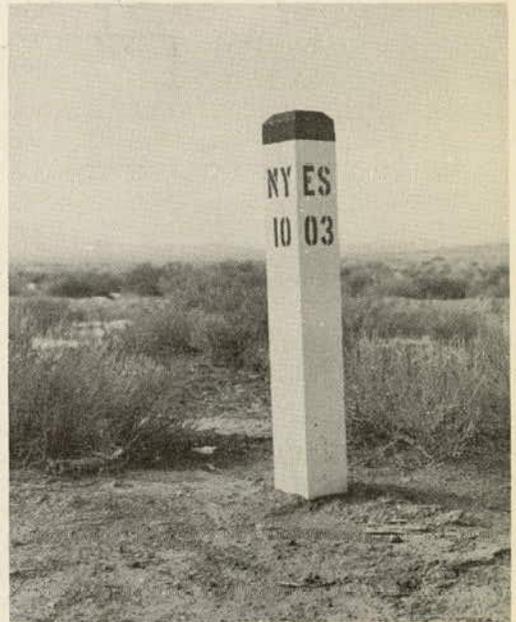


Figure 4. A Nevada control-section marker.

according to the control section number and the distance the bridge is from the beginning of the control section. For example, Bridge 8127-0611 is 6.11 mi. from the beginning of Section 8127. When length changes within a route occur under the new system, they will be confined to bridges within certain control sections instead of all bridges on the route.

Subsection Numbering

One system in use involves numbering subsections consecutively within a control section, utilizing a two-or three-digit number. Particular types of highway facilities can be identified by using blocks of numbers for bridges, special types of intersections, traffic circles, etc.

Another system uses, as an identifying number for each subsection, the distance in hundredths of a mile that the subsection is from the western or southern end of the control section. Subsections should be numbered in the same direction as the approved route description to facilitate the preparation of logs, etc. The first subsection within each control section will be numbered 0000, indicating that the subsection starts at one end of the control section. A subsection numbered 0351 would be the subsection starting 3.51 mi. from the western or southern end of the control section.

Uniform Cost Accounting

Only half the job has been accomplished when control sections have been established, as it is equally important that costs be reported on a uniform, logical, and practical basis. The adoption of a uniform system of accounts by state highway departments will enable comparisons of costs and accomplishments among states to be made which will lead to more-effective ways of planning, programing, constructing, and maintaining highways. The construction and maintenance cost data reported by control sections are being used by the officials of the highway departments for budget purposes and in planning financial construction and maintenance programs. It is unnecessary to enumerate all the benefits that may be derived from a uniform cost-record system because all state highway administrators and engineers are aware of the value of reliable cost data and the advantages to be gained by the use of such data.

The generally accepted guide on cost-accounting procedures is the preliminary "Manual of Accounting Procedure for State Highway Departments" prepared by the Subcommittee on Uniform Accounting of the American Association of State Highway Officials. One of the objectives of the uniform accounting system is to show the true expenditures for construction or maintenance, regardless of whether construction or maintenance funds are involved, whether the work is done by contract or day labor, or whether it is performed under the supervision of construction or maintenance divisions. In many states, additions and betterments to the highway system are done by maintenance forces and paid for from maintenance funds. Since additions and betterments are construction and not maintenance, in that they are capital investments which increase the value of the highway facilities, they should be reported as construction, even though maintenance funds are used and maintenance personnel perform the work.

One of the most-important phases of construction-cost accounting is the proper classification of costs. This classification affects several divisions of the highway department and, due to its importance, should be followed accurately, so that when construction expenditures in the form of preliminary engineering, construction engineering, payrolls, purchase order vouchers, and contractor payment estimates reach the accounting department, the items are in proper order for handling.

From the standpoint of the operations of the accounting division, it is necessary that each pay item in the final estimate be identified in such a fashion that the particular item can be charged to the proper account and control section. Thus, in order to facilitate the assembly of the numerous pay items into the desired construction accounts, the various pay items on the standard bid schedules can be assigned identification numbers, the first digit of which may be used for indicating the major account in which the pay item is to be included at such time as the final estimate is processed by the accounting division.

Proper classification of construction cost items is often complicated by the practice of combining the various construction items governed by the same specification into a single pay item on the bid schedules, estimates, and vouchers. For example, all Class A concrete is usually combined into one pay item, even though it may involve work on more than one cost account, such as drainage structures, surfacing, bridges, and traffic services. The task of breaking down this combined pay item on the voucher or estimate and its regrouping into the proper accounts poses a difficult problem to accounting personnel who are not familiar with engineering terminology and procedures. Such breakdowns should be furnished the accounting department by the construction division by indicating on the final contract estimate the various quantities of each combined pay item involved in the respective accounts for each control section.

Construction-Cost Accounts

The construction-cost accounts recommended by the Subcommittee on Uniform Accounting of the AASHO, which have been adopted by 17 states in connection with the establishment of control sections are listed below:

1. PRELIMINARY ENGINEERING INCLUDES:-

- Salaries
- Expenses
- Equipment Rentals
- Materials Investigation
- Foundation Tests
- Supplies for field parties
- Plans & estimate preparations

2. RIGHT-OF-WAY INCLUDES:-

- Title Fees
- Purchase costs
- Costs in lieu of purchase
- Damages
- Salaries
- Expense
- Equipment Rental

3. CONSTRUCTION ENGINEERING INCLUDES:-

- Salaries
- Expenses
- Supplies
- Equipment Rentals
- Office Rentals
- Inspection costs
- Testing of Materials
- Preparation of Final Records
- Signs & Markers used during construction
- Advertising

4. ROADWAY DRAINAGE & GRADING INCLUDES:-

- Clearing & grubbing
- Excavation of earth & rock
- Fine grading & excavation of subgrade
- Overhaul
- Borrow
- Backsloping & shoulder finishing
- Grading for approaches & driveway entrances
- Shoulder widening, fills & grade line changes
- Moving buildings & structures if part of construction operations
- Selected material for roadway
- Frost boil prevention work
- Rolling & compacting fills
- Earth shoulder lift when caused by resurfacing of roadway
- Fills for bridge & overpass approaches
- Open drainage ditches
- Excavation & fills for channel changes
- Tile & other subdrains
- Excavation for drainage structures--20 feet span or less
- Excavation & fills for roadside development if done in conjunction with original roadway

5. DRAINAGE & EARTHWORK PROTECTIVE STRUCTURES INCLUDES:-

- Structures of 20 foot spans or less
- Culverts--pipe & box
- Farm entrance culverts
- Flumes & wash checks
- Storm sewers
- Retaining walls
- Riprap & revetments
- Jetties & cribbing
- Slope drains
- Catch basins & manholes
- Curb & Gutter when not integral with roadway surface

6. ROADWAY SURFACE & BASE INCLUDES:-

- All materials used for subbase, base or roadway surface
- All materials used for curbs & gutters when integral with surface or base
- Additions of bituminous seal coats, surface treatment, mats or re-treads which add 3/4 inch or more in thickness in one operation
- The first seal coat regardless of thickness is construction if applied within one year

10.

7. IMPROVED SHOULDER & APPROACH SURFACING INCLUDES:-

Surfacing of shoulders

Surfacing of side approaches & turnouts where type of material used is superior to adjacent roadside & inferior to roadway surface

8. STRUCTURES INCLUDES:-

Structure over 20 feet in length

Structure excavation for above

Concrete, steel, masonry & wood structural work

Break waters

Cribbing & other devices strictly for bridge protection

Roadway paving & sidewalks when integral with structure

9. ROADSIDE DEVELOPMENT INCLUDES:-

Initial seeding, sodding & planting of shoulders, back slopes & roadside for landscaping or protection of earthwork

Bridle paths

Roadside parks

Picnic grounds

Shelter houses

Comfort stations

Historical markers

Excavation & fills for above if done separately from original construction

10. TRAFFIC & PEDESTRIAN SERVICE INCLUDES:

Installation of: Guard Rail

Structures built in place for snow protection

Plantings for snow protection

Route & Direction markers

Signs

Safety & Signal devices

Highway lighting

Pedestrian Underpasses & overhead

Sidewalks

Permanent traffic lane stripes

Original traffic line striping

Turnouts, including excavation & fills when not a part of original construction

Costs of adjustment of utility and other property, and detour expense during construction, where these items are carried separately in the contract pay items or where the work is done by day labor, may be classified separately if the state so desires, or they may be allocated to whichever of the construction cost classifications they are applicable.

Reporting total construction costs of a completed project or addition and betterment job by these construction classifications will necessarily require a recapitulation of the items in each contract. This can be most satisfactorily accomplished by requiring that preliminary estimates, contractor's estimates, and final vouchers show the groupings of the individual items into major classifications.

Maintenance-Cost Accounts

The maintenance-cost accounts recommended by the Subcommittee on Uniform Accounting of AASHO, which are in operation in the majority of state highway departments, are listed below:

1. ROUTINE ROADWAY SURFACE OPERATIONS INCLUDES:-
 - Patching holes and rough spots
 - Patching ruts and blowups
 - Repair of raveled edges
 - Sanding bleeding spots
 - Spot sealing
 - Temporary traffic ways
 - Dragging
 - Blading
 - Reshaping
 - Scarifying
 - Cleaning and raking
 - Picking up oversize rock
 - Filling and trimming expansion joints and cracks

2. SPECIAL ROADWAY SURFACE OPERATIONS INCLUDES:-
 - Application of dust palliatives
 - Temporary application of dust palliatives
 - Replacement of sand, sand-gravel, gravel, crushed stone, etc.
 - Reprocessing or reconditioning bituminous surfaces or shoulders when little or no new materials are added
 - Bituminous surface treatment
 - Seal coating--when applied later than the following construction season
 - Light road mixing operations
 - Major patching by special crews
 - Mud-jacking
 - Protection and handling of traffic during above operations
 - Addition of mats or retreads less than 3/4-inch thickness

3. SHOULDERS & SIDE APPROACHES INCLUDES:-
 - Patching
 - Dragging
 - Blading
 - Filling ruts
 - Replacing washouts
 - Reseeding or resodding
 - Ribbon bituminous treatment (without excavation)
 - Second or subsequent bituminous treatment
 - Replacement of gravel or stone

4. ROADSIDE & DRAINAGE INCLUDES:-
 - Repairing cuts, fills, slopes and washouts
 - Removal of minor slides
 - Cleaning or retrenching drains, channels and culverts
 - Maintaining drainage structures (20 feet or less)
 - Removal and burning of weeds

12.

- Removal of debris
- Planting or removal and trimming of trees
- Brush removal
- Planting or removal of shrubs
- Seeding and sodding to prevent erosion
- Care and replacement of special roadside development projects
- Repair and maintenance of sidewalks, dikes, riprap, retaining walls, pumping stations, slope pavement, right-of-way fences

5. TRAFFIC SERVICES INCLUDES:-

- Repair, repainting and resetting of direction markers, route markers, signals and gates and other safety devices
- Magnetic dragging to remove iron
- Traffic lane and guide line painting
- Repair and repainting of guard rails
- Highway lighting
- Electricity for the operation of signals
- Operation of comfort stations and picnic grounds
- Detours not chargeable to construction or other maintenance operations

6. SNOW, ICE AND SAND CONTROL INCLUDES:-

- Erection and removal of snow fence
- Removal of snow and ice
- Sanding icy surfaces
- Snow and ice removal to open waterways
- Removal of sand drifts

7. STRUCTURES (MORE THAN 20 FEET IN LENGTH) INCLUDES:-

- Repair, maintenance and operation of:
 - Bridges
 - Tunnels
 - Subways
 - Overhead grade separations
 - Other structures
- Operating expense of ferries

8. EXTRAORDINARY MAINTENANCE INCLUDES:-

- Special repairs and maintenance due to flood, storm, fire, major landslides or other catastrophe on:
 - Roadway surface
 - Roadbed
 - Shoulders
 - Roadside
 - Drainage facilities
 - Safety devices
 - Structures
- Handling and protecting traffic during emergency

9. MAINTENANCE GENERAL EXPENSE INCLUDES:-^{1/}

Headquarters office expense
 District office expense
 Field maintenance supervision
 Purchase and repair of small tools
 Rental charges on inactive equipment

Maintenance costs should be further broken down into objects of expenditure. The following objects of expenditures are suggested by the Subcommittee on Uniform Accounting: (1) materials, supplies and services; (2) salaries and wages; and (3) equipment operation. A further breakdown of these objects will depend on the requirements or desires of each state highway department.

Construction and Maintenance Coding System

With regard to a coding system for reporting construction and maintenance operations and costs, each state must devise its own procedure. Nevada utilized the following coding arrangement for reporting maintenance operations and costs:

2610 - 163 - WA-11 - B66 The 2610 represents the Reno field maintenance station in Division 2, 163 the maintenance account number for bridge painting, WA-11 the alphabetical designation for Washoe County (numerical designation not used) and 11 the control section number within the county, and B66 the bridge number.

Equipment-Cost Accounting

The states, particularly those which adopt control sections and uniform accounting, should have an adequate equipment-cost-keeping system in order to serve two important functions: (1) to give the total operating costs on various types of equipment, thereby contributing valuable data of aid in the purchase of the proper kind and type of equipment, and (2) to provide accurate equipment-operation costs for distribution to maintenance, construction, and other operations by control sections. The system must be flexible enough to be practical for field reporting, to fit office practices of each state, and to furnish sufficient and accurate information on equipment costs.

General Observations and Recommendations

1. For an average state the establishment of control sections on the state highway system, involving the selection and designation of termini and other preliminary work necessary in outlining a general plan of operation, can usually be accomplished in 2 or 3 weeks. In making the change-over to the new procedure, work of drafting control sections on county maps, preparing control-section descriptions, revising payroll and other forms,

^{1/} - Suspense account—prorated to other cost items during or at the end of the accounting period.

14.

and instructing field personnel in the use of new forms and coding procedures usually takes from 6 to 8 mo.

2. The change-over from the old to the new system should take place at a time which will cause the least possible inconvenience or confusion. Usually the beginning of the accounting year, whether fiscal or calendar, is the most feasible time to inaugurate a control section system. This is especially true if the change-over includes a new uniform accounting procedure. In some states control sections have been put into operation 3 to 6 mo. ahead of the date of the change-over to the new accounting system.

For example, in one state, where the change-over to the control section system was somewhat complicated and confusing because of the necessity of overhauling and revising the accounting system to conform with AASHO recommendations for uniform accounting, the period from July 1, 1949, to October 1, 1949, was a transition, or trial period during which as many errors of procedure as possible were eliminated. During this period new codes were introduced to become effective on October 1, 1949, for the identification of organizational units or departments, of items of expense, construction cost accounts, administration cost accounts, and ledger identification.

Likewise, IBM-tabulation procedure and techniques had to be worked out so that anticipated routine record-keeping and reporting could be provided by machine operation. These procedures were developed satisfactorily and the utilization of machine reporting, in lieu of manual, has been realized. This has been especially true for the preliminary engineering and the maintenance charges. To facilitate the translation of reporting methods and procedures to the IBM tabulations, the Statistical Accounting and Methods Procedure Department, under the supervision of the highway auditor, was established.

Of course, in those states where adoption of AASHO uniform accounting already has occurred, change-over to a control section system will be greatly simplified and many difficulties arising from lack of uniform accounting will be avoided.

3. The success of any new system is dependent to a considerable extent upon the introduction which it receives. A general memorandum from the chief engineer to all highway personnel will give the necessary authority for the undertaking and facilitate the inauguration of the new system. The support and cooperation of all highway personnel is likewise essential. Willingness on the part of those using the system — willingness to see that the system succeeds — can be fostered and assured only if the program is carried out with judgment and tact.

4. A control-section committee, composed of the heads of the various divisions of the highway department, should be organized when a state undertakes the establishment of control sections. Any proposed changes in control-section termini or the addition of new sections due to relocation or additions to the system are subject to the review and approval of the committee. This committee supervises the drafting of control sections on county maps, reviews control-section descriptions, edits manuals of procedures for reporting costs by uniform cost classification, and coordinates activities in federal-aid route and project renumbering with the Bureau of Public Roads. After the control sections have been in operation for a sufficient length of time for the reporting procedures to become routine, the

committee can be dissolved and one person be put in charge of the work. Usually an engineer in the planning division is charged with this responsibility.

5. A manual of instructions should be written for state personnel who will report construction and maintenance charges, etc., by control sections. This manual should provide detailed instructions, and be written in simple and plain fashion so that it can be easily understood by the personnel who are responsible for making charges. It is often desirable to issue memorandums covering particular topics from time to time before the final manual is written so that field personnel will be thoroughly familiar with the new procedures before they are put into operation. This procedure was followed in one state where a series of memorandums giving specific instructions were issued from headquarters to division engineers, resident engineers, chiefs of party, and department heads. These memorandums contained the following instructions:

- a. The present county, route, and section designations will not be used for any purpose whatever after July 1, 1949.
- b. For cost-accounting purposes, the federal-aid (FA) primary route section and project agreement numbers and the federal-aid secondary (FAS) numbers will not be used.
- c. Control section numbers will be used for all preliminary engineering activities up until the time that a contract number is assigned (see item d below), including charges for rights-of-way, plans and estimates, surveys and reconnaissance, material surveys if any, bridge design, preparation of special provisions and advertising, etc. The contract number will be used for all such charges after it is assigned.
- d. All construction and construction engineering charges will be identified by contract number only. (When control sections were first set up these costs were broken down later by control sections in the road life study. This procedure has been revised and now the charges are broken down by control sections as early in the reporting and accounting process as possible.)
- e. All construction engineering charges incurred against a project prior to the date of release (by Bureau of Public Roads) are nonparticipating and will be identified by Code 75; charges incurred after the date of release by Bureau of Public Roads are participating and will be identified by Code 70. Code 79 will be used only for administrative charges which are always nonparticipating.
- f. New operation or work codes are being formulated but until they are available all preliminary engineering charges will continue to be designated as R/W, P/E. S/R, M/S, B/D, etc., in conjunction with the control-section number.

6. A handbook should be written which gives the description of each control section, system, length, and the breakdown into subsections for changes in surface type, width, age, and for such highway facilities as bridges, complicated interchanges, etc. This handbook should be in loose-leaf form so that revision can be made frequently without reprinting the entire book. The following control-section descriptions and subsection designations were taken from the control-section handbooks issued in Nevada and Minnesota:

Nevada
Churchill County

Control Section	Sub. Sec.	Struc. No.	System No.	Mileage	Control Section and Subsection Termini	Project Number	Contracts	Day Labor or Job Authorization	Maint. Sta.
CH-03	1/			9.338	From CL RS 006-5 (SR 2) near Leeteville to CL RS 006-4 (SR 1A) Fallon	FA 34 FA 66A Reop. FA 3 FA 49-NRM	2-3-16-48- 74-178-182 -206-212- 400-567	36-43-153-173 -326-408-432	Fallon 2604
	1			.230	From CL RS 006-5 (SR 2) near Leeteville to Bridge #391				
		391		.011	Mahala Canal Bridge #391				
				6.864	From Bridge #391 to Bridge #97				
		97		.033	Carson River Bridge #97				
				.364	From Bridge #97 to Bridge #98				
		98		.017	Bridge #98				
			1.206	From Bridge #98 to WCL of Fallon					
	1			8.725					
	2			.613	From WCL of Fallon to CL RS 006-4 (SR 1A) in Fallon				
	2			.613					

1/ - Subsection 1 contains the rural mileage in CH-03. Subsection 2 was used to segregate mileage within the City of Fallon.

MinnesotaBenton County

Control Section a/	T. H.	FA No. FAS No. Non-F.	Length in Miles	Termini
0502	10-27	27	20.62	Jct. T. H. 23 in St. Cloud - N. Co. Line
			0.78	Jct. T. H. 23 in St. Cloud - N. Limits of St. Cloud (S. Limits of Sauk Rapids)
			2.54	S. Limits to N. Limits of Sauk Rapids
			1.03	N. Limits of Sauk Rapids - S. Limits of Sartell
			0.51	S. Limits to N. Limits of Sartell
			8.72	N. Limits of Sartell - E. Limits of Rice
			2.79	E. Limits to N. Limits of Rice
			4.25	N. Limits of Rice - N. Co. Line

a/ - Subsections are established for rural and urban mileage, etc., but are not numbered.

In some cases subsections have been established to permit segregation of (1) mountainous terrain from flat or rolling terrain as mountainous terrain presents special maintenance operations (falling rocks, slides, snow removal, etc.) and also particular construction and reconstruction problems (drainage, cuts, and fills, sight distance, and traffic services), (2) federal-aid secondary mileage on the state system from federal-aid secondary mileage off the state system, (3) mileage within forest, park, and recreational areas from regular state mileage, and (4) mileage within one maintenance district from that of another maintenance district (where the boundaries are not at county lines or major intersecting routes and where it would not be feasible to establish a control-section termini because of frequent changes in maintenance-district boundaries).

7. County maps showing control sections should be reduced sufficiently for a handy reference for field personnel. See Figure 5 for example of county maps that were reduced to 9-3/4 in. x 12-3/4 in. for use by field personnel in Michigan.

8. A centrally located record that will be available to all divisions of the highway department should be maintained for all pertinent data relating to each control section. While the amount of detailed information may vary in each state the accompanying "Highway Control Section Data" forms are suggested for recording the basic data.

9. Since the usefulness of the results obtained from control sections are dependent upon the consistency in and the accuracy of the classification of charges which originate from work performed by field personnel, it is important that proper recognition be given to the cost-recording system principles in classifying and submitting the charges. Further, before control sections are put into operation the field personnel should be carefully

schooled and fully instructed in the most-practical methods of reporting operations and costs.

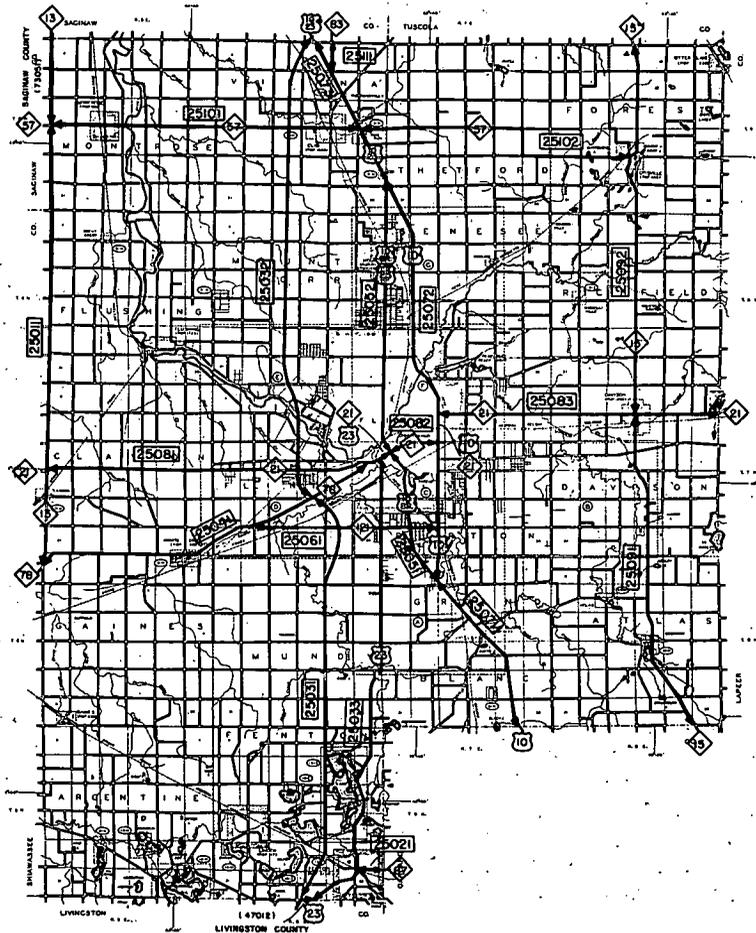


Figure 5. Control sections in Genesee County, Michigan

10. Inventory, traffic, road life, and other planning-survey records should be adjusted to conform with the newly established control sections.

11. Control sections can be put into operation for the entire state highway system or on a trial basis for 1 or 2 mo. in only one district. The entire state system can then be converted to control sections at the beginning of the accounting year. The trial method will eliminate much of the confusion in reporting costs by the new accounts, payroll forms can be revised for reporting time by control sections, and the accounting department can be geared into processing costs by control sections.

12. The general objectives of the control-section procedure are clear cut and should not be made complicated or rendered burdensome by the incorporation of too much detail.

Federal-Aid Route and Project Renumbering

In connection with the establishment of control sections in recent years, some of the states have availed themselves of the opportunity to renumber the federal-aid routes and to redesignate the federal-aid projects. When adapting the federal-aid procedures to a control section setup, it is desirable that such changes as are necessary be accomplished with the minimum number of adjustments.

The expansion of the federal-aid systems in the past has been accomplished by chronologically numbering routes as they are added, with the result that there is no logical pattern of numbering. Likewise, in the majority of states these routes are composed of numerous short federal-aid projects which do not indicate system or route identification. The termini of these old federal-aid projects in many cases do not conform to modern-day construction practices, and due to the requirements that all plans, specifications, and estimates be broken at these termini, there has resulted a great amount of paper work. Many savings can, therefore, be realized through adoption of a logical plan of numbering. To overcome these deficiencies, a numbering procedure has been employed by many states which gives the approximate geographical location of a route or project within a state. In this procedure, short routes are combined or added to other routes to form continuous routes within or across the state following present-day traffic patterns. The revised routes are numbered from south to north and west to east, with sufficient numbers skipped for expansions, as routes are added or modified, without losing the initial advantage of the geographical arrangement. For details of this renumbering procedure, reference should be made to the Bureau of Public Roads' memorandum dated November 17, 1952, on Renumbering of Federal-Aid Routes and Projects.

Figure 6 shows a section of federal-aid Route 1 in Maine that has been renumbered to conform with the new numbering procedure, divided into route sections which contain a number of old federal-aid projects in their entirety, and broken down into control sections for record-keeping purposes. For purposes of facilitating the assembly of cost data, traffic information, and so on for any given federal-aid project, it should be noted that new federal-aid projects include one or more control sections in their entirety.

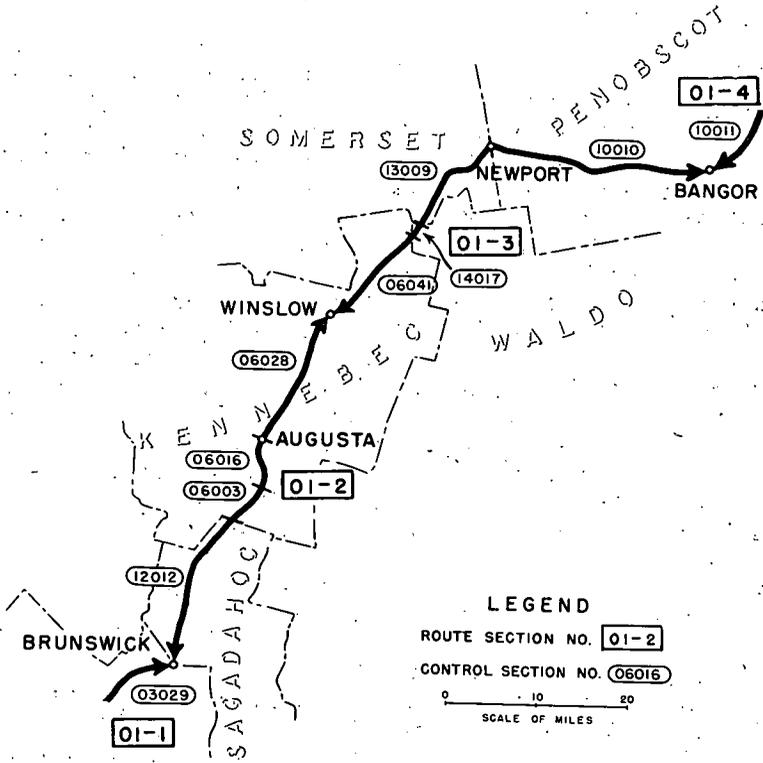


Figure 6. Route sections and control sections on a portion of Maine federal-aid Route 1.

Form No. _____

HIGHWAY CONTROL SECTION DATA

Control Section No. _____

State Highway No. _____

CURRENT RECORD OF ROAD STATUS

Sequence No. _____

U. S. Route No. _____

C. S. Mi. Pt. ____ to Mi. Pt. ____

F. A. Route No. _____

Control Section Length _____

County _____

Year built	Miles built
Rural—urban classification	Surface type
Federal route section:	Surface type code
Route No.	Surface width
Section No.	Traffic lanes
Agreement No.	Divided highways:
Old Federal project:	Surface type—1st roadway
Project No.	2nd roadway
Section No.	Surface width—1st roadway
	2nd roadway
R. O. W. — width	Dividing strip—width
Right side	Kind
Left side	Shoulder type—Right Left
	Shoulder width—Right Left

Sequence No.

Cards are numbered to follow the control section description. The first card will be numbered 010, the next 020, etc., to the end of the control section. The third digit provides for future changes due to construction or reconstruction operations without revision of the sequence number of other cards. If a section of the road on cards 010 and 020 are reconstructed it will be necessary to prepare three new cards. These cards will be numbered 010, 011, and 020.

Remarks:

C. S. Mi. Pt. ____ to Mi. Pt. ____

Enter the control section mile points of the beginning and end of the portion of road recorded on the card.

CLASSIFICATION OF MAINTENANCE COSTS

1. ROUTINE ROADWAY SURFACE OPERATIONS INCLUDES:--

- Patching holes and rough spots
- Patching ruts and blow-ups
- Repair of raveled edges
- Sanding bleeding spots
- Spot sealing
- Temporary traffic ways
- Dragging
- Blading
- Reshaping
- Scarifying
- Cleaning and raking
- Picking up oversize rock
- Filling and trimming expansion joints and cracks

2. SPECIAL ROADWAY SURFACE OPERATIONS INCLUDES:--

- Application of dust palliatives
- Temporary application of dust palliatives
- Replacement of sand, sand-gravel, gravel, crushed stone, etc.
- Reprocessing or reconditioning bituminous surfaces or shoulders when little or no new materials are added
- Bituminous surface treatment
- Seal coating--when applied later than the following construction season
- Light road mixing operations
- Major patching by special crews
- Mud-jacking
- Protection and handling of traffic during above operations
- Addition of mats or retreads less than 3/4-inch thickness

3. SHOULDERS & SIDE APPROACHES INCLUDES:--

- Patching
- Dragging
- Blading
- Filling ruts
- Replacing washouts
- Reseeding or resodding
- Ribbon bituminous treatment (without excavation)
- Second or subsequent bituminous treatment
- Replacement of gravel or stone

4. ROADSIDE & DRAINAGE INCLUDES:--

- Repairing cuts, fills, slopes and washouts
- Removal of minor slides
- Cleaning or retrenching drains, channels and culverts
- Maintaining drainage structures (20 feet or less)
- Removal and burning of weeds
- Removal of debris
- Planting or removal and trimming of trees
- Brush removal
- Planting or removal of shrubs
- Seeding and sodding to prevent erosion
- Care and replacement of special roadside development projects
- Repair and maintenance of sidewalks, dikes, riprap, retaining walls, pumping stations, slope pavement, right-of-way fences

5. TRAFFIC SERVICES INCLUDES:--

- Repair, repainting and resetting of direction markers, route markers, signals and gates and other safety devices
- Magnetic dragging to remove iron
- Traffic lane and guide line painting
- Repair and repainting of guard rails
- Highway lighting
- Electricity for the operation of signals
- Operation of comfort stations and picnic grounds
- Detours not chargeable to construction or other maintenance operations

6. SNOW, ICE AND SAND CONTROL INCLUDES:--

- Erection and removal of snow fence
- Removal of snow and ice
- Sanding icy surfaces
- Snow and ice removal to open waterways
- Removal of sand drifts

7. STRUCTURES (MORE THAN 20 FEET IN LENGTH) INCLUDES:--

- Repair, maintenance and operation of:
 - Bridges
 - Tunnels
 - Subways
 - Overhead grade separations
 - Other structures
- Operating expense of ferries

8. EXTRAORDINARY MAINTENANCE INCLUDES:--

- Special repairs and maintenance due to flood, storm, fire, major landslides or other catastrophe on:
 - Roadway surface
 - Roadbed
 - Shoulders
 - Roadside
 - Drainage facilities
 - Safety devices
 - Structures
- Handling and protecting traffic during emergency

9. MAINTENANCE GENERAL EXPENSE INCLUDES:--^{1/}

- Headquarters office expense
- District office expense
- Field maintenance supervision
- Purchase and repair of small tools
- Rental charges on inactive equipment

^{1/} Suspense account--prorated to other cost items during or at the end of the accounting period.

Form No. _____
 State Highway No. _____
 U. S. Route No. _____
 F. A. Route No. _____

HIGHWAY CONTROL SECTION DATA

Control Section No. _____
 Control Section Length _____
 County _____

TRAFFIC

Year									
Direction of travel ^{1/}									
Practical capacity									
Average daily traffic									
All types									
Commercial (busses)									
Combinations									
Gross loads / 1000 vehicles									
15 tons and over									
20 tons and over									
25 tons and over									
Axle loads / 1000 vehicles									
8 tons and over									
9 tons and over									
11 tons and over									
Daily tonnage (carried load)									
Daily ton-miles (carried load)									
30th highest hourly volume									
Accidents									
Fatal									
Other									
^{1/} Form may be used for directional movements or both directions combined.									

Form No. _____
 State Highway No. _____
 U. S. Route No. _____
 F. A. Route No. _____

HIGHWAY CONTROL SECTION DATA

Control Section No. _____
 Control Section Length _____
 County _____

CAPACITY ^{1/}

Year _____

Distance scale in miles	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Urban or rural																						
No. of traffic lanes																						
Ideal practical capacity																						
Surface type ^{2/}																						
Surface width																						
Lane width																						
Shoulder type ^{3/}																						
Shoulder width																						
Restrictive lateral clearance ^{4/}																						
Number per mile																						
Avg. distance from pavement edge																						
Percent commercial vehicles																						
Imperfect alignment ^{5/}																						
Grades ^{6/}																						
Combined factor																						
Practical capacity																						
See reverse side for footnotes.																						

CAPACITY

Footnotes:

1/ See Highway Capacity Manual.

2/ Code - Surface Type - GAM-308:

- D Soil surfaced
- E Gravel or stone
- F Bituminous
- G Mixed bituminous
- H Bituminous penetration

- I Bituminous concrete, sheet or rock asphalt
- J Portland cement concrete
- K and L Brick or block
- M Combination

3/ Code - Shoulder type:

- 1 Earth, sand clay, etc.
- 2 Sod
- 3 Gravel or stone
- 4 Bituminous stabilized

4/ Restrictive lateral clearance:

Anything less than shoulder width, such as bridge railings, curbs, abutments.

5/ Imperfect alignment:

Percent of control section with restricted sight of less than 1500 feet for 2-lane roads only. Not a factor for 4-lane roads.

6/ Grades:

Describe as LEVEL - ROLLING - MOUNTAINOUS. In case of exceptional grades, treat separately.

Form No. _____

HIGHWAY CONTROL SECTION DATA

Control Section No. _____

State Highway No. _____

Control Section Length _____

U. S. Route No. _____

TRAFFIC CONTROL - CRITICAL FEATURES

County _____

F. A. Route No. _____

Year _____

Scale of miles	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Traffic control																						
C. L. No Passing zones																						
Speed zones																						
Warning signal light																						
Intersection S. and G. lights																						
Intersections																						
Roads																						
Driveways (No./mile)																						
Median type																						
Median width																						
Roughness index																						
Accidents																						
Fatal																						
Other																						
Grades - Percent																						
Length																						
Curves - Degree																						
Restricted sight distance																						
Right																						
Left																						
Bridges																						
Underpasses																						
R. R. crossings																						

The Highway Research Board is organized under the auspices of the Division of Engineering and Industrial Research of the National Research Council to provide a clearinghouse for highway research activities and information. The National Research Council is the operating agency of the National Academy of Sciences, a private organization of eminent American scientists chartered in 1863 (under a special act of Congress) to "investigate, examine, experiment, and report on any subject of science or art."