

Research Report
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HIGHWAY RESEARCH

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Division of Research
Bureau of Highways
DEPARTMENT OF TRANSPORTATION
Commonwealth of Kentucky

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ROLE OF RESEARCH DIVISION

The Division of Research is responsible for:

1. Developing and carrying out a comprehensive research program on all aspects of transportation engineering and operations.
2. Maintaining lateral communication and coordination with other segments of the Department of Transportation regarding the development and conduct of research studies and special investigations of various operational and engineering problems.
3. Maintaining relations and cooperating with universities, professional organizations, and other transportation agencies; evaluating and reporting the research experiences of those agencies; and utilizing their findings directly or with further research for the benefit of the Kentucky Department of Transportation.
4. Maintaining an up-to-date library of research findings on various transportation activities throughout the world.
5. Reporting and documenting pertinent data and performance of experimental designs and construction features undertaken by other divisions and offices in the Department.

A significant portion of the program of the Division of Research is concerned with the development and conduct of a comprehensive research program in cooperation with the U. S. Department of Transportation, Federal Highway Administration. In addition to this formalized research program developed in cooperation with the Federal Highway Administration, the Division of Research also renders other services to the Department as may be required on a non-participating basis in the form of research studies and special investigations of various engineering and operational activities. This total program is based upon the needs and activities of the several divisions and staff engineers of the Department and is developed in consultation with divisional executives and the Kentucky Transportation Research Committee, composed primarily of top-level administrators, including division directors and district engineers.

Research is investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, and (or) the practical application of those new or revised theories or laws. Research is vital to progress and progress is valuable under a majority of circumstances. There is little doubt that separate offices of a given organization could perform their own "in-house" research if so directed. However, endeavors of that type often prove fruitless because research is overshadowed by daily routine operational matters. In such cases, research could become a per chance entity -- during performance of routine chores someone might happen upon a new idea or better way to do a job.

Research is not wholly a staff function nor a line function. The position in an organization chart is somewhat irrelevant -- it is an "in spite of" situation. Any organizational plan or mode of operation which provides due latitudes and prudent constraints -- and nurtures a healthy atmosphere -- surely will be productive and worthwhile. A necessary

ingredient, of course, is dedication to duty and some special kinds of insights. Personalities are important; they can overshadow organization plans.

Expertise is not necessarily a prerequisite. Learning and familiarization usually precede the productive phases of work. Learning may include advanced courses or on-job observations. Learning time and other allowances may be broader and more tolerable for in-house researchers than for outside consultants.

The Department does its work largely in-house. Lag-times are usually less. Also, research forces may be concentrated at times to advance a study ahead of schedule or to otherwise recover lost time. Priorities may be reordered and emphases shifted. Quality of work must be preserved.

Indeed, the Division's role in the D.O.T. is best related by its activities, programs, and reports. Not all activities achieve report status. Most of them do; few have been aborted. Some are reactions to crises, and some have been of a preliminary nature and never materialized any further.

Implementation sometimes runs the gauntlet, sometimes runs away, and sometimes runs down. More often, perhaps, research findings are nurtured through a trial period or evolutionary process; sometimes the findings are recycled -- and perhaps supplemented. The Division's most traumatic duty is the measurement of benefits. Perhaps not least in the many, unmeasurable benefits from research is the reassurance which somehow accrues from having people to call on for help and to offer due portions of sympathy. Sometimes research apparently is initiated as a way of avoiding or delaying a decision on a sensitive matter. Nevertheless, the Division's accomplishments have been numerous during the forty or more years in the business. About 540 major reports (see Attachment A) have been issued. About a third of the reports are published nationally. Mere numbers of reports, however, may not be the ultimate measure of productivity and success.

From a more philosophical point of view, research should not run the show; sometimes when the staff tries to do that, they are rebuffed by those whose authority is usurped. The staff must guard against mistakes such as reinventing or rediscovering things already researched and in use. The past or the present cannot be ignored. And, perhaps above all, the staff must continue open-mindedly to seek truths and to view them from the standpoint of their application now and in changing times ahead.

The "Annals of the Research Division," (Research Report 353, January 1973) describes the Division and its history to 1973.

RESEARCH PRIORITIES

From time to time the Division is asked: What are the high priority problems (needs) in research today? The problems rank in various ways, but generally often include (1) pavement slipperiness, (2) night visibility, and (3) the bump at the end of the bridge. Once landslides and bridge decks ranked as top problems. Now R-R-R is included. There is much concern about expansive limestone aggregates and D-cracking -- and rutting. Safety is a sacred trust. In the past, the Division never felt privileged to research the design of trucks from the standpoint of balancing efficiency of payload capacity with configurations of axles, wheels, and tires. Now, the Division visualizes some highway cargo haulers as truck trains having perfect tracking and doing minimum, but accountable, damage to pavements and bridges.

Some problems seem insolvable and grow more enigmatic; in some cases, the solutions are evident but impractical. In many cases, problems are defects in the roadway. In other cases, they may be economic, mechanistic, and (or) ecological. Whereas expenditures reflect levels of effort in terms of manpower and equipment, research priorities may not correspond in rank. Sometimes the highest yield of benefits arises from small investments.

BRIDGES

Deck Durability -- Historically, concrete in bridge decks has deteriorated more rapidly than concrete in pavements. Some authorities claim that deck concrete is inferior; others claim that decks simply freeze and thaw more often. Workmanship and placement methods have improved greatly during recent years. It appears that improved concreting practices, together with judicious use of protective coatings, will provide extended life expectancy. Latex-modified concrete overlays have proven to be very reliable for making repairs. Dense concrete shows good performance.

Constrained Welds -- Welded, rigid, box-like steel sections tend to retain residual stresses and to crack. Acoustic emission monitoring reveals residual stresses and crack growth. Early detection may avert disaster.

Suspension Cables -- The failure of the bridge at South Shore and Portsmouth has increased concern toward inspection of cables on the suspension bridges at Maysville and Covington. Detection and prevention of corrosion are essential to public safety; methods are being studied.

Loads and Fatigue Life -- Loads have been monitored; live-load strains have been recorded; probability of occurrences of loads have been determined; fatigue theories have been resolved.

Earthquake Criteria -- Design and retrofitting of bridges to meet earthquake criteria depend on geologic faults and ground accelerations; these are being studied.

PAVEMENTS

Rutting and Wear -- Wheel-track rutting occurs in bituminous pavements and is due to loading. It occurs during warm weather. It is attributed principally to plastic shear, but it does not necessarily signify weakening of the structure. Water channeled in the ruts during rainy weather causes excessive spray from vehicle tires and may cause hydroplaning. Additional crown or cross slope compensates somewhat for minor rutting. Severe wear is attributed to studded tires. The effects from wheel-track wear are the same as those arising from rutting.

Night Visibility -- Because of increasing traffic, the opportunity to use high-beam headlights is diminishing. In rainy weather, lane and edge lines (beaded paints) lose their reflectivity -- and that is when good visibility is needed most. Urban freeways and many major interchanges are lighted. Continuous lighting, imbedded glow-rods, etc. remain impractical under present economic conditions. More effective reflectorization is sought.

Preventing Slipperiness -- Pavement slipperiness is an insidious peril. Gritty, abrasive pavement surfaces are conceptually skid resistant when new; those which polish under traffic become slippery when wet. An armor coating of sharp grit provides good traction. To compensate for attrition of grit, a wearing course composed of a porous sand asphalt is considered ideal. Development is progressing and extensive implementation is anticipated.

Structural Design -- Structural theory has been developed; application to coal-haul roads is current. Deficiencies in design procedures are being eliminated.

Design of Overlays -- Extending service life is done principally by overlayment; criteria for determining thicknesses are being established.

Systems Management -- Development and implementation will require inventories, economic modeling, decision criteria, evaluation of consequences and impacts, and analyses of incremental user costs, revenues, and tax structures.

Monitoring of Highway Performance -- The monitoring of pavement roughness provides a means of evaluating the current serviceability levels of highways. The refinement of relationships between roughness and serviceability level will aid in the assigning of priorities for resurfacing programs and to measure the quality of new construction.

ENGINEERING GEOGNOSY

Settlement -- Highway embankments built on soil foundations slowly compress the underlying soil, and the embankments appear to settle or sag. The subsidence causes dips in the roadway and a "bump at the end of the bridge." Approach slabs are being considered as a means of easing the bump. Advance construction of some fills -- to allow for settlement before paving -- has been successful where significant long-term settlement was expected. Embankments may, otherwise, be cambered to compensate for expected settlement. The development and refinement of consolidation theories and testing techniques can lead to better estimates of settlement.

Earthquake Criteria -- See the section on Bridges.

Shales -- Slaking rates may determine usability of shales in earth embankments and elsewhere. Tests and classifications are being devised.

Landslides -- Analysis and correction methods are being improved.

Embankment Stability -- Settlements or downward movements of earth embankments also may be accompanied by horizontal components which tend to impose stresses on the bridge abutment. These horizontal movements are not always fully considered in the design of the abutment. The horizontal movements and accompanying loads on the abutment generally are not known; techniques for estimating these loads and the soil-abutment interaction are being investigated.

Mapping -- Adding engineering data to the pedological soil surveys and maps prepared by the US Department of Agriculture expands the usefulness of such surveys for engineers and planners in four major ways: (1) to make soil reconnaissance surveys, (2) to locate construction materials deposits, (3) to organize and check field surveys, and (4) to correlate engineering performance with soil type. Efforts have been made to assemble such engineering data and to format it for computer storage for easy retrieval. The assembling of this data along with information from other earth sciences provides an engineer with a single source of geotechnical data which is currently not available elsewhere.

TRAFFIC, SAFETY, AND TRANSPORTATION SERVICES

With new emphasis on public accountability and program evaluation, the need for effectiveness measures to indicate the extent to which an agency's goals and objectives are being met is much more apparent. It is necessary to assemble current data and to generate other information in such a form that policymakers may determine whether transportation systems and services are improving or deteriorating. The appropriateness of certain measures of effectiveness and the methods of presentation of data need to be investigated. Some types of data required for an ongoing evaluation of the effectiveness of services include travel times delay measures, roughness, safety and accident statistics, environmental impacts,

traffic volumes, identification of hazardous locations, and economic impacts.

RESEARCH PROGRAM

The research program for Fiscal Year 1979-80 consists of 14 federally-supported studies and 41 studies financed with state funds (see Attachment B). The method of selecting in-house and contracted research studies is described in Attachment C.

ORGANIZATION AND STAFF

The Division consists of nine engineering sections, two support sections, and an administrative staff. The organizational structure and function of the Division and each of the sections are outlined in Attachment D.

The organization roster of the Division is shown in Attachment E. The staff consists of 18 engineers, 8 technologists, 19 technicians, 3 computer programmers, and 8 other support personnel.

All of the Division's engineers, except for two, are graduate engineers, and a majority of them have advanced degrees. Seventeen of the engineers are Registered Professional Engineers in Civil, Chemical, Electrical, Metallurgical, or Highway Engineering.

STAFF INVOLVEMENTS OUTSIDE OF THE DEPARTMENT

The high caliber and expertise of the engineering staff is widely recognized by various research and professional organizations, governmental agencies, and the academic community. This recognition manifests in serving, in behalf of the Department, on government advisory panels and task forces and on various technical committees, advisory panels, and groups of research and professional organizations; in presenting papers, serving on discussion panels, and of course, publishing papers through national organizations. Also, several staff engineers teach, on their own time, engineering courses at the University of Kentucky.

FACILITIES AND EQUIPMENT

The offices and laboratories of the Division of Research are located in Lexington and are adjacent to the University of Kentucky. The original facilities, located on the university campus, were constructed in 1942 and remained understaffed until 1946 because of World War II. Research was a branch of the Division of Design until 1949, when it became a Division of Research. The original facilities served as headquarters for the Department's research activities until late in the summer of 1967. The new facilities increased the Division's physical plant about threefold. The facilities and the variety of equipment and instrumentation used for routine tasks and evaluations of materials and special equipment and instrumentation for use in research are described in the "Annals of the Research Division."

HIGHLIGHTS OF SELECTED ACCOMPLISHMENTS

Over the years, research activities have led to significant advancements in approaches to departmental activities or have enabled the Department to accomplish certain tasks which might not otherwise have been achievable. Research has developed expertise, data files, and methodologies which have been brought to bear upon departmental functions. Some of these accomplishments are very briefly highlighted below.

Pavement Design -- methodologies for the design of the thickness of pavement systems which predict actual pavement performance remarkably well and which can be used to evaluate existing pavement structures so that overlay programs may be optimized.

Bituminous Concrete Paving Materials -- development and evaluation of mixtures which are stable under traffic loadings and which provide a skid-resistant surface.

Concrete and Concrete Structures -- investigations of concrete durability have led to the development of concreting practices and use of protective materials improving the performance of concrete bridge decks and other structures; advancement of slip-form paving resulting in smoother roadways at a lower cost; field investigations coupled with theoretical studies leading to more effective designs of box and pipe culverts; investigation of joint deterioration in portland cement concrete pavements; analysis of cracking and cracking control of continuously reinforced concrete pavements.

Aggregates -- development of mixtures and criteria for the use of aggregates (not only from high-quality conventional sources but also from marginal sources) in bituminous concretes and portland cement concretes; development of criteria and evaluative techniques for identifying expansive aggregates.

Pavement Surface Characteristics -- road roughness studies which have provided the basis for evaluating pavement deterioration and for assessing the quality of new construction; skid resistance studies and surveys advancing the state of knowledge of the relationship between skid resistance and accidents, and as an aid in identifying hazardous locations.

Soils and Foundations -- development of geologic and soils data files making geotechnical information obtained from previous projects readily available for use in the preliminary phases of future projects; evaluation and improvement of methods of exploration, techniques of interpretation of subsurface conditions, and methods of analyses, design, and construction to minimize slope failures; improvement in consolidation testing so as to better understand the problem of settlements of pavements at bridge approaches and to estimate the camber required in pipe and box culverts; development of procedures for the use of nuclear moisture-density measurements in the control of earthwork construction.

Drainage -- development of hydrological data for use in design of drainage facilities; investigations of the phenomenon of culvert corrosion and practices to minimize its detrimental effects.

Traffic and Safety -- development of techniques and factors to use in predicting traffic trends; evaluation of crash barriers and systems; development of a method to quickly and effectively identify high-accident locations; development of procedures to identify potentially hazardous locations; study of traffic flow to outdoor recreational facilities in Kentucky resulted in the development of a license-plate methodology for conducting origin-destination studies as well as providing a data base for highway planning and to justify federal funds coming to Kentucky for recreational purposes; development of predictive techniques to evaluate the effects of roadway design parameters upon highway-generated noise; evaluation of pavement marking systems and materials and specifications for reflectorizing high-

way signs; development of a method of synthesizing origin-destination data for small urban areas without extensive field studies; development of data bases and procedures for preparing overall safety improvement projects and for problem identification for annual highway safety plans.

Specialized Tasks -- The Division of Research performs many short-term and specialized tasks that others in the Department can not do because of a lack of expertise or equipment. Some of these tasks are referenced in the following list by short titles only:

- Special testing (e.g. sign materials, reflective pavement marking materials, reflectors, freeze-and-thaw of concrete)
- Preparing specifications and standards (e.g. license plate paint specifications, fill height tables for pipe culvert)
- Earthquake design criteria
- Socio-economic impact studies
- Specialized surveys (e.g. road roughness, skid resistance of pavements, pavement condition)
- Identification of hazardous locations and development of safety improvement programs
- Bridge decks
- Pavement management (R-R-R)

ATTACHMENT A
LISTING OF RESEARCH REPORTS

1939

1. *Selection of Aggregates for Concrete Pavements Based on Service Records*, Curtis Cantrill, 1939; also *Proceedings*, American Society for Testing and Materials, Vol 39, 1939.

1940

2. *Cooperative Investigation of Joint Spacing in Concrete Pavements*, Louis Campbell, 1940.

1942

3. *The Use of a Circular Track for Testing Bituminous Pavement Mixtures*, Curtis Cantrill, 1942; also *Proceedings*, Association of Asphalt Paving Technologists, Vol 13, 1942.

1945

- 3a. *Stability Investigation of Bituminous Pavements*, March 1945.
4. *An Outline of Prospective Research*, L. E. Gregg, December 1945.
5. *Summary Report of Concrete Investigations in Research Projects C-1, C-2, and C-17*, S. T. Collier, December 1945.

1946

6. *Stability Investigation of Bituminous Pavements, Preliminary Reports*, March 1946.
7. *Reports of Concrete Investigation in Research Projects C-14 and C-15, A Study of the Effect of Fine Aggregates on the Durability of Concrete*, S. T. Collier, January 1946.
8. *Report I on Research Project B-9, Bituminous Construction with Sandstone Aggregate, Johnson County, Project S. P. 58-37-1*, January 1946.
9. *Bond Characteristics of Commercial and Prepared Reinforcing Bars, Second Progress*

Report on Research Project C-18, S. T. Collier, January 1946.

10. *Proposed Working Plan for a Study of the Properties of Coarse Aggregates*, February 1946.
11. *An Evaluation of Density and Stability Tests on Bituminous Mixes*, Cary Burns and L. E. Gregg, February 1946.
12. *Report on Study of Proposed Specifications for Bituminous Coated Corrugated Metal Pipe*, R. F. Baker, March 1946.
13. *Proposed Field and Laboratory Study of Flexible Pavements*, March 1946.
14. *Proposed Working Plan for a Survey and Pedological Classification of Kentucky Soils in Accordance with Highway Engineering Usage*, March 1946.
15. *Outline of Proposed Study of Sand Used as Concrete Fine Aggregates*, March 1946.
16. *Discussion and Outline of a Proposed Study of Soils as Related to the Pumping of Rigid Pavements*, March 1946.
17. *Study of the Effect of Blended Cements on the Durability of Concrete Incorporating an Inferior Coarse Aggregate*, S. T. Collier, April 1946.
18. *Durability of Concrete as Affected by Absorbed Moisture in Tennessee River Gravel Aggregate*, S. T. Collier, April 1946.
19. *A Summary of Experiments with Air Entrainment in Cement Concrete*, September 1946.
20. *Report of Portland Cement Concrete Pavement Condition Survey*, M. F. Johnson, A. O. Neiser, and D. H. Bray, March 1946.

1947

21. *Memorandum Report on Experiments with Pressure Method of Air Content Determinations for Cement Concrete*, L. E. Gregg, January 1947.

22. *A Study of the Effect of Blended Coarse Aggregate on Air Entrained Concrete, First Progress Report on Research Project C-23*, S. T. Collier and L. E. Gregg, January 1947.
23. *Outline of Proposed Research Project C-23, A Study of the Effect of Blended Coarse Aggregate on Air Entrained Concrete*, May 1947.
24. *Outline of Research Proposed for Project B-15, Adhesion of Bituminous Materials to Mineral Aggregates*, January 1947.
25. *Memorandum Report on Research with Mulches for Roadside Grasses*, March 1947.
26. *Memorandum Report on Measurement of Air Entrained in Aberdeen and Brownsville Bridges*, March 1947.
27. *Bond Characteristics of Commercial and Prepared Reinforcing Bars*, S. T. Collier, March 1947; also *Journal of the American Concrete Institute*, Vol 18, No. 10, June 1947.
28. *Progress Report No. 1 on Research Project C-22, A Study of the Properties of Coarse Aggregates*, J. L. Young, Jr., March 1947.
29. *Porous Backfill*, R. F. Baker, March 1947.
30. *Interim Report on Experiments with Western Kentucky Bank Gravel in Bituminous Concrete*, June 1947.
31. *Report No. 1 on an Experiment with Expanded-Metal Integrating Mats in Bituminous Concrete Pavements*, September 1947.
32. *Progress Report No. 2 on Research Project C-22, A Study of the Properties of Coarse Aggregate*, J. L. Young, Jr. and J. H. Havens, October 1947.
33. *Second Progress Report on Research Project C-23, A Study of the Effect of Blended Coarse Aggregate on Air-Entrained Concrete*, October 1947.
34. *Outline of Research Proposed for a Study of the Relationship between Subgrade California Bearing Ratios and Pumping of Rigid Pavements*, April 1947.
35. *Supplementary Report No. 1 on Experiments with Air Entrainment in Cement Concrete*, October 1947; also *Experiments with Air Entrainment in Cement Concrete*, L. E. Gregg, *Bulletin No. 5*, Engineering Experiment Station, University of Kentucky, September 1947.
- 1948
36. *Memorandum Report on Reflectorizing Surfaces for Signs and Markers*, L. E. Gregg, January 1948.
37. *Semi-Final Report on Research Project S-2, A Study of the Relationship between Subgrade California Bearing Ratios and Pumping of Rigid Pavements*, R. F. Baker, February 1948.
38. *Memorandum Report on Cold-Applied Mastic-Type Crack and Joint Filler Compound*, L. E. Gregg, May 1948.
39. *Separation, Fractionation and Mineralogy of Clays in Soils*, J. H. Havens, J. L. Young, Jr., and R. F. Baker, December 1948; also *Proceedings*, Highway Research Board, Vol 28, 1948.
40. *A Laboratory Investigation of Mineralogical, Chemical and Physical Properties of Limestone Aggregates*, J. L. Young, Jr., J. H. Havens, and L. E. Gregg, December 1948; also *Abstracts*, Highway Research Board, Vol 19, No. 6, June 1949.
- 1949
41. *Investigation of Field and Laboratory Methods for Evaluating Subgrade Support in the Design of Highway Flexible Pavements*, R. F. Baker and W. B. Drake, August 1949; also *Bulletin No. 13*, Engineering Experiment Station, University of Kentucky, September 1949; also *Proceedings*, Highway Research Board, Vol 28, 1949; also *Evaluation of Subgrade Support for Flexible Pavements by Field CBR and North Dakota Cone Test*, W. B. Drake, thesis, MSCE, University of Kentucky, 1949.

42. *Memorandum Report on Surfacing Materials for Signs and Markers*, L. E. Gregg, January 1949.
43. *Memorandum Report on Maintenance Installation of Cold Mastic Joint Filler on KY 50 in Fayette County*, L. E. Gregg, February 1949.
44. *An Examination of Equipment for Preventing Segregation in Storage of Coarse Aggregates*, S. T. Collier, February 1949.
45. *Memorandum Report on Experimental Installation of Joints with Neoprene Rubber Seal on U.S. 27, in Campbell County*, L. E. Gregg, February 1949.
46. *Memorandum Report on Concrete Pavement without Transverse Joints, U.S. 31-W, Franklin-Tennessee State Line Road*, L. E. Gregg, July 1949.
47. *Progress Report No. 4 on Cooperative Investigation of Joint Spacing in Concrete Pavements*, S. T. Collier, July 1949.
48. *Some Chemical, Physical, and Mineralogical Features of Soil Colloids*, J. H. Havens, J. L. Young, Jr., and W. B. Drake, December 1949; also *Proceedings*, Highway Research Board, Vol 29, 1949.
49. *Progress Report No. 3 on Research Project C-23, A Study of the Effect of Blended Coarse Aggregate on Air-Entrained Concrete*, S. T. Collier, November 1949.
50. *Memorandum Report on Study of Acid Water Conditions in Kentucky*, L. E. Gregg, December 1949.
51. *Memorandum Report on Erosion of Longitudinal 40" Corrugated Metal Pipe, 1-1/2 Miles Northeast of Princess, Kentucky, on U.S. 60*, J. H. Havens, September 1949.
52. *Report No. 2 on a Concrete Pavement without Transverse Joints*, W. B. Drake, December 1949.
53. *Report No. 1 on Measurement of Surface Irregularities and Riding Qualities of High Type Bituminous Surfaces*, H. J. Field, Jr., December 1949.
- 53a. *Geologic Considerations in Relation to a Materials Survey*, J. L. Young and L. E. Gregg, 1949.
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54. *Memorandum Report on Prefabricated Neoprene Joint Sealer*, A. C. Peed, Jr., January 1950.
55. *Progress Report No. 1 on an Installation of an Experimental Joint for Concrete Pavements*, H. J. Field, Jr., February 1950.
56. *Determination of Unit Weights of Aggregates in the Laboratory and at the Source*, S. T. Collier, February 1950.
57. *Supplemental Report on Unit Weights of Aggregates*, S. T. Collier, March 1950.
58. *Report No. 1 on Test Sections, BPR Project on Correlation of Truck Traffic and Pavement Conditions*, September 1950.
59. *Progress Report No. 1 on a Survey of Acidity in Drainage Waters and the Condition of Highway Drainage Installations*, J. H. Havens, J. L. Young, Jr. and H. J. Field, Jr., December 1950.
60. *Report No. 2 on Measurement of Surface Irregularities and Riding Qualities of High Bituminous Pavements*, H. J. Field, Jr., December 1950.
- 1951
61. *Observations on Seal Coats, Tack Coats and Penetration Macadam Construction in 1950*, W. B. Drake, January 1951.
62. *Report No. 1 on an Investigation of Lean Concrete Mixes as Base Courses for Bituminous Surfaces*, S. T. Collier, January 1951.
63. *Field and Laboratory Evaluation of Roadside Sign Surfacing Materials*, J. H. Havens and A. C. Peed, Jr., February 1951; also *Spherical Lens Optics Applied to Retrodirective Reflection*, **Bulletin 56**, Highway Research Board, January 1952.

64. *Report No. 3 on a Concrete Pavement without Transverse Joints*, W. B. Drake, February 1951.
65. *Progress Report on Experimental Jointing Installations for Concrete Pavements*, S. T. Collier, June 1951.
66. *A Report of an Inspection of Pavement Construction on the New Jersey Turnpike*, L. E. Gregg, June 1951.
67. *Memorandum Report on Proposed Specification Class I, Type C and Blade Spreading Hot Mixes*, L. E. Gregg, 1951.
68. *Final Report on Evaluation of Plant Mix Surface Treatments by Road Test Sections*, W. B. Drake, July 1951.
69. *Clay Mineralogy and Soil Stabilization*, J. H. Havens and W. A. Goodwin, November 1951; oral presentation at ASCE Soil Mechanics and Foundation Division, New York, 1951 (unpublished); referenced in **Bulletin 183**, Highway Research Board, 1957.
70. *Memorandum Report on Vibratory Compaction of Base Courses*, November 1951.
71. *Observation on Seal Coats, Tack Coats, Penetration Macadam, and Blade Spread Hot Mix in 1951*, W. B. Drake and H. J. Field, Jr., December 1951.
72. *A Comparative Study of the Physical Properties of Traffic Paints*, A. C. Peed, Jr., December 1951; also *Physical Properties of Traffic Paints*, **Bulletin 57**, Highway Research Board, 1952.
73. *Geological Considerations in Relation to a Materials Survey*, J. L. Young, Jr. and L. E. Gregg, 1951; also **Bulletin 62**, Highway Research Board, 1952.
74. *Spherical Lens Optics Applied to Retro-Directive Reflection*, J. H. Havens and A. C. Peed, Jr., December 1952; also **Bulletin 56**, Highway Research Board, 1952.
75. *Report No. 1 on a Bank Gravel Base Containing Calcium Chloride*, W. B. Drake, February 1952.
76. *Report No. 1 on a Study of Runoff from Small Drainage Areas and the Openings in Attendant Drainage Structures*, E. M. West and J. O. Cornell, April 1952.
77. *Report No. 1 on a Test Road for the Evaluation of Sandstone as an Aggregate in Plant-Mix Bituminous Pavements*, E. G. Williams, April 1952; also *Evaluation of Sandstone as a Aggregate in Plant Mix Bituminous Pavements*, E. G. Williams and L. E. Gregg, **Proceedings**, Association of Asphalt Paving Technologists, Vol 22, January 1953.
78. *Memorandum Report of Observations on Bituminous Pavement Containing Uncrushed River Gravel, Daviess and Henderson Counties*, E. G. Williams, May 1952.
79. *Memorandum Report on Proposed Special Specification for Reflectorizing Glass Spheres*, J. H. Havens, May 1952.
80. *Memorandum Report on Corrosion of Highway Structures by Acid-Bearing Drainage Water in Hopkins County*, J. H. Havens, June 1952.
81. *Memorandum Report on Calculations of Head on Structures, U.S. 23 -- Greenup*, E. M. West, July 1952.
82. *Report No. 1 on a Limestone-Calcium Chloride Stabilized Base*, W. B. Drake, August 1952.
83. *Evaluation of Traffic Paint in 1952*, A. C. Peed, Jr., December 1952.
84. *Progress Report on the Performance of Cold Mastic Joint-Sealing Compounds and Sawed Joints in Concrete Pavements*, D. H. Sawyer, December 1952.
85. *A Compendium on Class I, Type C Mixes*, E. G. Williams, December 1952.
86. *Progress Report No. 2 on a Survey of Acidity in Drainage Waters and the Condition of*

1952

Highway Drainage Installations, J. H. Havens, December 1952.

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87. *Report No. 4 on a Concrete Pavement without Transverse Joints*, W. B. Drake, December 1952.

96. *Pavement Investigation, Middletown-Eastwood Portion of U.S. 60 Louisville-Shelbyville Road*, W. B. Drake, June 1954.

88. *Report No. 2 on a Bank Gravel Base Containing Calcium Chloride*, W. B. Drake, December 1952.

97. *Memorandum Report of Proposed Revision for Specification for Reflex-Reflective Materials for Highway Signs*, J. H. Havens, August 1954.

89. *Report No. 2 on an Investigation of Lean Concrete Mixes as Base Courses for Bituminous Surfaces*, D. H. Sawyer, December 1952.

98. *Blown Mulch for Roadside Erosion Control on U.S. 60, Henderson-Morganfield Road, Project No. AF 62(3)*, J. C. Taylor, October 1954.

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90. *Report No. 2 on a Test Road for the Evaluation of Sandstone as an Aggregate in Plant-Mix Bituminous Pavements*, E. G. Williams, April 1953.

99. *An Investigation of Bituminous Coatings and Pavements on Corrugated Metal Culverts*, E. M. West, November 1954.

91. *Applications of Geology to Highway Engineering in Kentucky*, L. E. Gregg and J. H. Havens, February 1953.

100. *Application of Wire Mesh Reinforcement to Asphaltic Concrete Pavement Overlays, Franklin-Shelby County Project FI 172(12)*, E. G. Williams, December 1954.

92. *Report No. 1 on Vibratory Compaction of a Macadam Base*, E. G. Williams, December 1953.

101. *Memorandum Report on Inspection of Full Depth Modified Dense-Graded Aggregate Base, Plant Mixed (Tennessee Project)*, W. B. Drake, December 1954.

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482. *Traffic Conflicts as a Diagnostic Tool in Highway Safety*, C. V. Zegeer and R. C. Deen, November 1977; also *Record 667*, Transportation Research Board, 1978.
483. *Analysis of Tandem Axleloads by Elastic Theory*, H. F. Southgate, R. C. Deen, and J. H. Havens, November 1977; also *Record 671*, Transportation Research Board, 1978.
484. *Traffic Conflicts, Erratic Maneuvers, and Near-Miss Accidents: State-of-the-Art*, C. V. Zegeer, November 1977.
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487. *Seatbelt Usage in Kentucky*, K. R. Agent and M. Barclay, January 1978.
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490. *Development of a Traffic Conflicts Procedure for Kentucky*, C. V. Zegeer, January 1978.
491. *Loads on Box Culverts under High Embankments: Analysis and Design Considerations*, D. L. Allen and R. L. Russ, January 1978.
492. *Analysis of Time-Independent Consolidation Data*, E. G. McNulty, T. C. Hopkins, and C. T. Gorman, January 1978; also **Proceedings**, Use of Computers in Geotechnical Design and Construction, American Society of Civil Engineers, April 25, 1978.
493. *Simulation of External-Internal and Through Trips for Small Urban Areas*, J. G. Pigman, February 1978.
494. *Heating Bridge Decks by Electrical Resistance*, J. H. Havens, W. V. Azevedo, A. S. Rahal, and R. C. Deen, February 1978; also **Proceedings**, Second International Symposium on Snow Removal and Ice Control Research, May 15-19, 1978.
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496. *Green-Extension Systems at High-Speed Intersections*, C. V. Zegeer and R. C. Deen, April 1978; published by Southern Section, Institute of Transportation Engineers.
497. *Acoustic Emission and Fatigue Characteristics of Typical Bridge Steels*, Theodore Hopwood and J. H. Havens, April 1978 also **Record 664**, Transportation Research Board, 1978.
498. *Characteristics of Bicycle-Related, Motor Vehicle Accidents in Kentucky*, K. R. Agent and C. V. Zegeer, July 1978.
499. *Seasonal Variations in Pavement Skid Resistance in Kentucky*, J. L. Burchett, July 1978.
500. *For a Better Transportation System*, a Special Report in Commemoration of the 500th Report issued by the Division of Research, August 1978.
501. *Pavement Evaluation Using Road Rater Deflections*, G. W. Sharpe, H. F. Southgate, and R. C. Deen, August 1978.
502. *Determination of Rutting in Asphaltic Concrete Pavements: Field Instrumentation and Laboratory Characterizations*, D. L. Allen, August 1978.
503. *Green-Extension Systems at High-Speed Intersections*, C. V. Zegeer and R. C. Deen, September 1978; also the **ITE Journal**, Institute of Transportation Engineers, November 1978.
504. *Evaluation of Paint Stripe Beads*, J. G. Pigman and K. R. Agent, September 1978.
505. *Warrants for Left-Turn Signal Phasing*, K. R. Agent, and R. C. Deen, October 1978; also **Record XXX**, Transportation Research Board, 1979.
506. *Simulation of Travel Patterns for Small Urban Areas*, J. G. Pigman and R. C. Deen, October 1978; also **Record XXX**, Transportation Research Board, 1979.
507. *A Rational System for Design of Thickness of Asphaltic Concrete Overlays*, H. F. Southgate, G. W. Sharpe, and R. C. Deen, October 1978; also **Record 700**, Transportation Research Board, 1979.
508. *Priority Programming for Highway Construction*, C. V. Zegeer and R. L. Rizenbergs, November 1978; also **Record 698**, Transportation Research Board 1979.
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510. *Seatbelt Usage in Kentucky*, K. R. Agent, Michael Barclay, and R. C. Deen, November 1978; also **Record XXX**, Transportation Research Board, 1979.
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512. *Statewide Survey of Skid Resistances of Pavements*, R. L. Rizenbergs, and J. L. Burchett, November 1978.
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515. *Acoustic Emission Monitoring of Weldments*, Theodore Hopwood and J. H. Havens, December 1978; also **Journal of Testing and Evaluation**, American Society for Testing and Materials, Vol 7, No. 4, July 1979.
516. *Use of Economic Analyses and Dynamic Programming in the Selection of Projects for Resurfacing*, C. V. Zegeer, K. R. Agent, R. L. Rizenbergs, February 1979.
517. *Interstate Safety Improvement Program*, J. G. Pigman, K. R. Agent, and C. V. Zegeer, March 1979.
518. *Fatigue Damage of Flexible Pavements under Heavy Loads*, J. H. Havens, H. F. Southgate, and R. C. Deen, April 1979; also **Record XXX**, Transportation Research Board, 1979.
519. *An Evaluation of Permissive Left-Turn Phasing*, K. R. Agent, April 1979.
520. *The Effectiveness of Regulatory School Flashers in Reducing Vehicle Speeds*, C. V. Zegeer and R. C. Deen, April 1979; also **Proceedings**, International Symposium on Traffic Control Systems, August 6-9, 1979, Berkeley, California.
521. *Problem Identification for Highway Safety Plan*, J. G. Pigman and K. R. Agent, May 1979.
522. *Raised Pavement Markers at High Hazard Locations*, J. G. Pigman and K. R. Agent, June 1979.
523. *Road Rater and Benkelman Beam Pavement Deflections*, G. W. Sharpe and H. F. Southgate, June 1979.
524. *Cost-Effectiveness of Lane and Shoulder Widening of Rural, Two-Lane Roads in Kentucky*, C. V. Zegeer and J. G. Mayes, July 1979.
525. *Kentucky Culvert Study: An Engineering Review of Policies and Practices Related to Procurement of Culvert and Sewer Pipe*, Byrd, Tallamy, MacDonald and Lewis, June 1979.
526. *Development of Warrants for Left-Turn Lanes*, K. R. Agent, July 1979.
527. *Delineation of Stop-Sign Approaches*, K. R. Agent, July 1979.
528. *Statewide Survey of Skid Resistances of Pavements (1978)*, R. L. Rizenbergs and J. L. Burchett, July 1979.
529. *Cracking in Concrete Pavements*, R. C. Deen, J. H. Havens, A. S. Rahal, and W. V. Azevedo, October 1979; also **Journal of Transportation Engineering**, American Society of Civil Engineers, 1970.
530. *Truck Design and Usage and Highway Pavement Performance*, R. C. Deen and H. F. Southgate, October 1979.
531. *Corrective Measures for Unstable Bridge Approach Embankment over the Licking River*, E. G. McNulty, November 1979.
532. *Seasonal Variations in the Skid Resistance of Pavements in Kentucky*, J. L. Burchett and R. L. Rizenbergs, November 1979; also **Record XXX**, Transportation Research Board, 1980.
533. *Evaluation of Triaxial Testing Equipment and Methodologies of Three Agencies*, T. C. Hopkins and D. L. Allen, December 1979.

534. *Evaluation of the FHWA Highway Traffic Noise Prediction Procedure (SNAP 1)*, K. R. Agent, January 1980.
535. *Occurrences of Expansive Limestone in Kentucky*, R. G. Coy and J. H. Havens, January 1980.
536. *Bicycle-Motor Vehicle Accidents in Kentucky*, K. R. Agent, C. V. Zegeer, and R. C. Deen, January 1980; also *Journal of Transportation Engineering*, XXX 1980.
537. *The Effect of Truck Design on Pavement Performance*, R. C. Deen, H. F. Southgate, and J. G. Mayes, January 1980; also *Proceedings*, Association of Asphalt Paving Technologists, 1980.
538. *Rutting Models for Asphaltic Concrete and Dense-graded Aggregate from Repeated Load Tests*, D. L. Allen and R. C. Deen, January 1980; also *Proceedings*, Association of Paving Technologists, 1980.



ATTACHMENT B
1979-80 RESEARCH STUDIES

**KENTUCKY PROJECT HPR-PL-1(15)
WORK PROGRAM - PART II
FISCAL YEAR 1980**

LINE ITEM NO.	STATE STUDY NO.	STUDY TITLE	ESTIMATED COST FY 1980
TYPE A CONTINUING STUDIES			
1	80-50	Salaries, Social Security and Allowable Expenses	67,200
2	80-51	Highway Research Correlation Service	29,200
3	70-49	Full-Depth Asphaltic Concrete Pavements	14,700
4	71-65	Heating Coils in Pavements and Bridge Decks	5,000
5	72-68	Loads on Box Culverts under High Embankments	33,600
6	72-69	Soil-Bridge Abutment Interaction	32,000
7	72-72	Determination of Flexible Pavement Rutting Behavior	10,100
8	75-74	Controlled Rate of Strain and Controlled Gradient Consolidation Testing	3,700
9	75-76	Wet-Surface Accidents and Their Relation to Pavement Friction	25,000
10	75-77	Development of a Rational Overlay Design Method for Pavements	37,900
11	75-78	Propagation of Traffic Noise	3,000
12	76-79	Road Roughness Performance of Pavements	34,000
TYPE B CONTINUING STUDIES			
13	79-80	Settlement of Bridge Approaches and Embankments	5,000
CONTINGENCIES			
		Contingencies	46,700
Total			347,100



KENTUCKY PROJECT HPR-PL-1(15)
 WORK PROGRAM - PART III B
 FISCAL YEAR 1980

LINE ITEM NO.	STATE STUDY NO.	STUDY TITLE	ESTIMATED COST FY 1980
1	64-3	Corrosion Resistance of Culvert Materials	\$ 3,500
2	64-13	Engineering Geognosy	50,500
3	70-20	Slope Stability Analysis	9,000
4	72-24	Noise Abatement and Monitoring	8,000
5	71-25	Specially Constructed Bridges	28,600
6	71-27	Paved Shoulders	3,500
7	72-32	Characteristics of Traffic Streams on Rural Multilane Facilities	4,000
8	72-38	Landslides	35,000
9	72-39	Voidless Concrete Mixtures for Bridge Decks	26,000
10	73-42	Socio-Economic Impact Studies	6,000
11	73-48	Evaluation and Application of Roadway Delineation Techniques	12,000
12	80-50	General Administration	150,200
13	80-52	Scholarship Program Coordination	10,700
14	80-55	Specification Testing	7,500
15	80-56	Impromptu Investigations	58,300
16	74-60	Pavement Slipperiness Studies	86,000
17	74-61	Pavement Roughness and Serviceability Surveys	26,500
18	74-62	Evaluation of Waterproofing Membranes on Concrete Bridge Decks	10,500
19	74-64	Data File Management	27,700
20	75-68	Dynamic Testing of Pavement Structures for Maintenance Requirements	52,900
21	75-70	Development of Warrants for Separate Left-Turn Lanes and Signal Phasing	4,000
22	75-71	Characteristics of High-Risk Drivers	2,000
23	75-73	Investigations of Traffic Flow and Safety Characteristics, Relationships, and Parameters	15,500
24	75-74	Investigation of the Effects of Gradation and Compaction on the Performance of Crushed Stone Base Courses	10,400
25	75-75	Evaluation of Rumble Strip Design and Usage	7,000
26	75-77	Evaluation of Experimental Crash Cushions	7,500
27	76-79	Engineering Properties and Uses of Kentucky Shales	50,200
28	76-80	Safety and Design Innovations for Bicycle Travel	4,000
29	76-81	Evaluation and Application of Traffic Conflict Techniques	8,000
30	76-82	Subsurface Drainage Systems for Highway Pavements	5,000
31	77-83	Earthquake Forces	21,000
32	77-84	Interstate Safety Improvement Program	16,500
33	78-85	Identification, Analysis, and Correlation of High-Accident Locations	2,000
34	79-86	Effects of Vehicle Characteristics on Highway Safety	6,000

35	79-87	Improved Traffic Flow Through Innovations in Traffic Signal Systems	14,000
36	79-88	Long-Span Culvert Structures	4,000
37	79-89	Effectiveness of Transportation Services	22,100
38	79-90	Evaluation of Experimental Pavement Surfaces	7,100
39	79-92	Problem Identification for Highway Safety Plan	6,000
40	79-93	Heavy-Duty Pavements	6,100
41	79-94	Determination of Fracture Toughness of Structural Steel from Standard Tensile Tests	9,900
42	78-202	Raised Pavement Markers and High-Hazard Locations	2,000
43	79-203	Reflective Marker Paint Stripe Skipper	6,000
44	79-204	Sprinkle Treatment for Bituminous Concrete Surfaces	5,200
45	79-205	Discarded Tires in Highway Construction	12,000
46	79-206	Evaluation of Snowplowable Markers	29,000
		Total	898,900



ATTACHMENT C
SELECTION OF RESEARCH STUDIES

RESEARCH

INITIATION AND PURSUIT OF RESEARCH STUDIES, SURVEYS, AND INVESTIGATIONS

The Division of Research is headed by a Director who is directly responsible to the Assistant State Highway Engineer for Research. Services of the Division are available to all offices, divisions, and districts within the Bureau and opportunities and suggestions for research-type studies are welcomed. Procedures for establishment of a study vary and depend upon the nature and involvement of the study. Services of the Division of Research may be obtained through requests from division directors, district engineers, or office heads directed through the Assistant State Highway Engineer for Research to the Director of the Division of Research. All requests shall be in the form of a memorandum stating the service to be performed, urgency of the information required, specific instructions relating to the project, name or names of person(s) to whom findings of the investigation are to be reported, and project number to which charges are to be made in the event salaries, equipment, and materials are to be interaccounted. The Director of the Division of Research is responsible for granting or securing approval for a study prior to commencing work on the project.

Projects of national interest or those involving experimental features are eligible, in whole or in part, for federal-aid funds available under 23 United States Code, Section 307 (c), referenced in and implemented by Volume 4 and 5 of the Federal-aid Highway Program Manual. The Director of Research will review all requests or proposals to determine those which are eligible for federal-aid funding. Studies deemed eligible and worthy for such support are submitted to the Federal Highway Administration for review and approval. The Director of Research is responsible for submitting proposals and coordination of research activities supported by funds as provided in Volume 5 of the FHPM. All information resulting from federally-supported studies shall be considered as belonging to the Bureau and to the Federal Highway Administration.

FEDERALLY-SUPPORTED (KYHPR) RESEARCH STUDIES

In general, research studies which are of common interest to highway agencies throughout the nation (cf. Federally Coordinated Program) as well as those studies involving experimental features are eligible for federal aid as provided above and in the FHPM 4-1-2-1. Studies of more specific interest to the Bureau may also

be eligible for such funds. The management and coordination of individual research studies utilizing Federal Aid Highway Planning and Research (HPR) funds must conform to the policies and procedures outlined in the Federal Highway Administration's most current issue of Volume 5 of the Federal-Aid Highway Program Manual and those of the Bureau governing such areas of activity. Suggestions for projects utilizing these funds may originate from any office within the Bureau or Federal Highway Administration. These projects are subject to approval by both the Federal Highway Administration and the Bureau.

Preliminary research proposals are to be prepared by the Director of Research or designated staff members. Any office requesting a study will be responsible for supplying sufficient details or other such data as may be necessary for preparation of the proposal. All proposals are subject to review and acceptance. The proposal, as revised or accepted, shall then be returned to the Director of Research for assignment of a KYHPR study number and duplication for distribution to the appropriate offices of the Federal Highway Administration. The study, as approved or revised by the Federal Highway Administration, is then included in the work program, and the Director of Research is responsible for assignment of a principal investigator and support staff.

NON-PARTICIPATING (KYP) RESEARCH STUDIES

Those research studies undertaken by the Bureau without the support, in whole or in part, of Federal-Aid Highway Planning and Research (HPR) funds are designated as non-participating studies. The administration of such endeavors is very similar to that for projects involving federal funds, excepting Federal Highway Administration policies and procedures do not apply. These studies are commonly of a more specific interest to the Bureau and are not necessarily of national concern. Proposals for these studies may originate from any office within the Bureau and shall be submitted to the Director of Research for review. Approved studies shall then be assigned a KYP study number.

CONTRACTED, FEDERALLY SUPPORTED STUDIES

In the event services to be performed require facilities, experience, and(or) personnel not available within the Bureau, or if the prevailing work load is such that the work cannot be accommodated within the Bureau, the service may be conducted, under contract, by other agencies. The administration of contracted services which are supported in whole or in part with Federal-Aid Highway Planning and Research (HPR) funds shall conform to the policies and procedures contained in the Federal Highway Administration's FHPM 4-1-2-2. In addition, such contracts must conform to applicable Bureau policies and procedures. Proposals for studies may originate from any office within the Bureau or the Federal Highway Administration. All proposals and necessary supporting data, plans, specifications, etc. shall be submitted to the Director of Research for review.

The Director of Research shall then submit the proposal for review and selection of an agency to perform the study. A preliminary contract for each study shall be agreed upon by the Bureau and agency selected to perform the work prior to submission to the Federal Highway Administration. The Director of Research shall then be responsible for submission of the proposed contract, study proposal, a statement in support of the proposed contract showing the overall need for the study covered by the proposed contract, status of previously known studies in the particular field, and a breakdown of the estimated cost according to major phases of work within purview of the contract, such as field collection of data, data processing, and data analysis. If the cost of the proposed contract exceeds \$50,000, an audit shall be submitted in accordance with the Federal Highway Administration's FHPM 1-7-2. Upon approval by the Federal Highway Administration, a contract may then be executed between the selected agency and the Bureau.

Due to the variable nature of studies that may be undertaken by contract and the status of agencies involved, there is no standard format for such contracts. Contract changes which may be deemed desirable during the course of work shall be subject to approval of all parties concerned. Subcontracting or specialized services in addition to that set forth in the original contract shall be subject to the written approval of the Bureau and the Federal Highway Administration.

The Director of Research shall act as coordinator between the contracting agency, the Bureau, and Federal Highway Administration. Contracting agencies shall submit necessary invoices for payment, requests for right of entry to project sites, correspondence, etc. directly to the Director of Research. The Director of Research shall be responsible for the review of all work performed prior to initiation of payments. Bureau and Federal Highway Administration personnel shall have authority to review and inspect study activities and all records during the course of work. The contracting agency shall be notified of such reviews or inspections sufficiently in advance by the Director of Research.

NON-PARTICIPATING, CONTRACTED RESEARCH STUDIES

Non-participating studies requiring facilities, experience, and personnel not available within the Bureau may be contracted to other agencies for study. The administration of such endeavors shall be similar to that as outlined under CONTRACTED, FEDERALLY SUPPORTED STUDIES, excepting the Federal Highway Administration has no authority in such studies. The Director of Research shall be responsible for coordination of all activities on the study between the contracting agency and Bureau.

SELECTION AND USE OF RESEARCH AGENCIES OR CONSULTANTS

In the event unsolicited proposals are received, a determination shall be made of interest and need for the research proposed. If proposal is found to be worthy of consideration in a program year in terms of overall priorities and assignments of funds, only the proposer shall be considered for the work; negotiations may ensue. The proposal may be otherwise returned to the sender or filed away and action deferred.

In the event decisions are made to contract for specific research work, proposals may be invited from one or more agencies or consultants considered eligible and qualified in the area of expertise specified. The research may be described briefly and generally in a problem-and-task statement. Guidelines and instructions covering format and necessary contents of proposals may be furnished along with the invitation. In such cases, there would be an implied intent to rely upon the ingenuity, resourcefulness, originality and understanding of the proposer to develop the concept as well as the detailed plan. Alternatively, the invitation may include detailed descriptions of the work to be performed. When the work is outlined and defined in the invitation, and when more than one prospective respondent is known, an invitation may be issued to each one or as many as desired. The respondent(s) shall submit staffing plans, credentials of principals, schedules, and a proposed project budget.

Only one proposal shall be chosen for further, ensuing negotiations for the purpose of entering into a contract. In the event that the ensuing negotiations fail to produce an agreement and differences cannot be reconciled, a second-choice or alternate proposal may be considered for negotiations. Any or all proposals may be rejected if such action is considered to be in the best interest of the Bureau and the Department.

FACTORS TO BE CONSIDERED IN SELECTION

When the proposer is invited to develop the concept and a detailed plan, the contents thereof may, therefore, comprise the initial basis for selection of the agency or firm for ensuing negotiations. In all instances, factors shall be considered without discrimination regarding sex, religion, national origin, race, or color.

The factors to be considered are as follows:

1. Interest and experience of principal(s) in the problem area,
2. Education and training; also learning and(or) training time, if needed,
3. Demonstrated capabilities to conduct, manage, and implement researches and studies,

4. Demonstrated capabilities to organize, compose, style, and complete research reports,
5. Concurrent work load and commitments to others during the Term of the project; also, percentages of work time pledged to project,
6. Accountability and auditability of business records,
7. Financial stability and responsibility,
8. Progress and completion schedules,
9. Reasonableness of fees and total cost of work,
10. Probability of successfully meeting the objectives and purposes of the project.

PREQUALIFICATION

Prequalification, as required for consulting engineers and other professional service contractors, may be waived if necessary to obtain the expertise and specialized services being sought. Ad hoc prequalification requirements may be established.

REVIEWS AND EVALUATIONS OF PROPOSAL

Proposals received may be referred to functional divisions and offices having inherent interest in the problem area for review and evaluation. The referral may be discretionary. The State Highway Engineer may through the Assistant State Highway Engineer for Research, order the referral. The State Highway Engineer may, as Chairman, order a meeting of the Executive Research Committee to guide his decisions or plan of action.

COMPLIANCE WITH CIVIL RIGHTS LAWS

When a decision has been made to engage a consultant or firm to perform a research project under contract, the EEO (Title VI) staff will be contacted and notified of prospective respondents in a listing. EEO (Title VI) will be requested to ascertain the current employment practices and compliance program of the parties named and to furnish information concerning essential revisions or improvements needed to fully comply with Title VI of the Civil Rights Act of 1964, Section 162 (a) of Federal-Aid Highway act of 1973, and other state and federal regulations. The EEO (Title VI) staff may make inquiries to identify other prospective respondents. Invitations to submit proposals or to respond to proposals will be sent to respondents regardless of sex, religion, race, color, or national origin.

When a consultant or firm has been selected for further negotiations, all known, possible non-compliance factors will be brought into issue. In the event that agreement is not reached on these matters, negotiations shall be terminated for stated reasons; otherwise, negotiations may proceed. Compliance reviews and inspections will be provided in the contract. Notices of any, known non-compliance by the prime contractor and(or) any subcontractors during the term of the contract shall be given in writing. Failure to instigate satisfactory improvements in a reasonable time, not to exceed 90 days, will be considered cause for termination of the contract.

PREPARATION OF FINAL CONTRACT DOCUMENTS

Unless otherwise ordered, the Director of Research shall prepare the final contract documents, submit them to the Office of General Counsel for approval as to form and legality, obtain recommendations for approval from Division Directors involved, obtain the contractor's signatures, and present originals and copies to the Assistant State Highway engineer for Research for confirmation by Bureau and Department officials. Prior concurrence of FHWA will be obtained by the Director of Research when required. Proposals, by attachment to and referenced thereto, become part of the contract document.

Upon approval of the contract by the Commissioner of Highways and the Federal Highway Administration (if required), the Division of Contract Procurement shall process the executed agreement and issue the necessary encumbrance documents.

The Division of Contract Procurement shall issue CH contract and process the contract through the Division of Accounts and the Department of Finance and Administration for encumbrance of funds. Upon receipts of approved CH contract confirmation, copies shall be forwarded to the Division of Research.

The Director of Research shall determine that the contractor has received all contract confirmation documents also.

PROSECUTION OF WORK

Research contracts should, whenever feasible, contain provisions for measuring progress and achievement of significant goals. Progress reports should be required at significant stages. Provisions for partial payments may not allow payments exceeding an equivalent proportion of work completed. Undue delays in completion of work or violation of regulations may be cause for annulment or termination of the contract. The Director of Research shall monitor the progress of work and authorize payments. Amendments, revisions, and extensions of monies or increases in total costs shall be treated and processed in the same manner as the original contract. Final payment may

not be made until a satisfactory report has been received and accepted. Audits, progress reviews, and compliance inspections on the contractor's premises shall be provided in the contract.

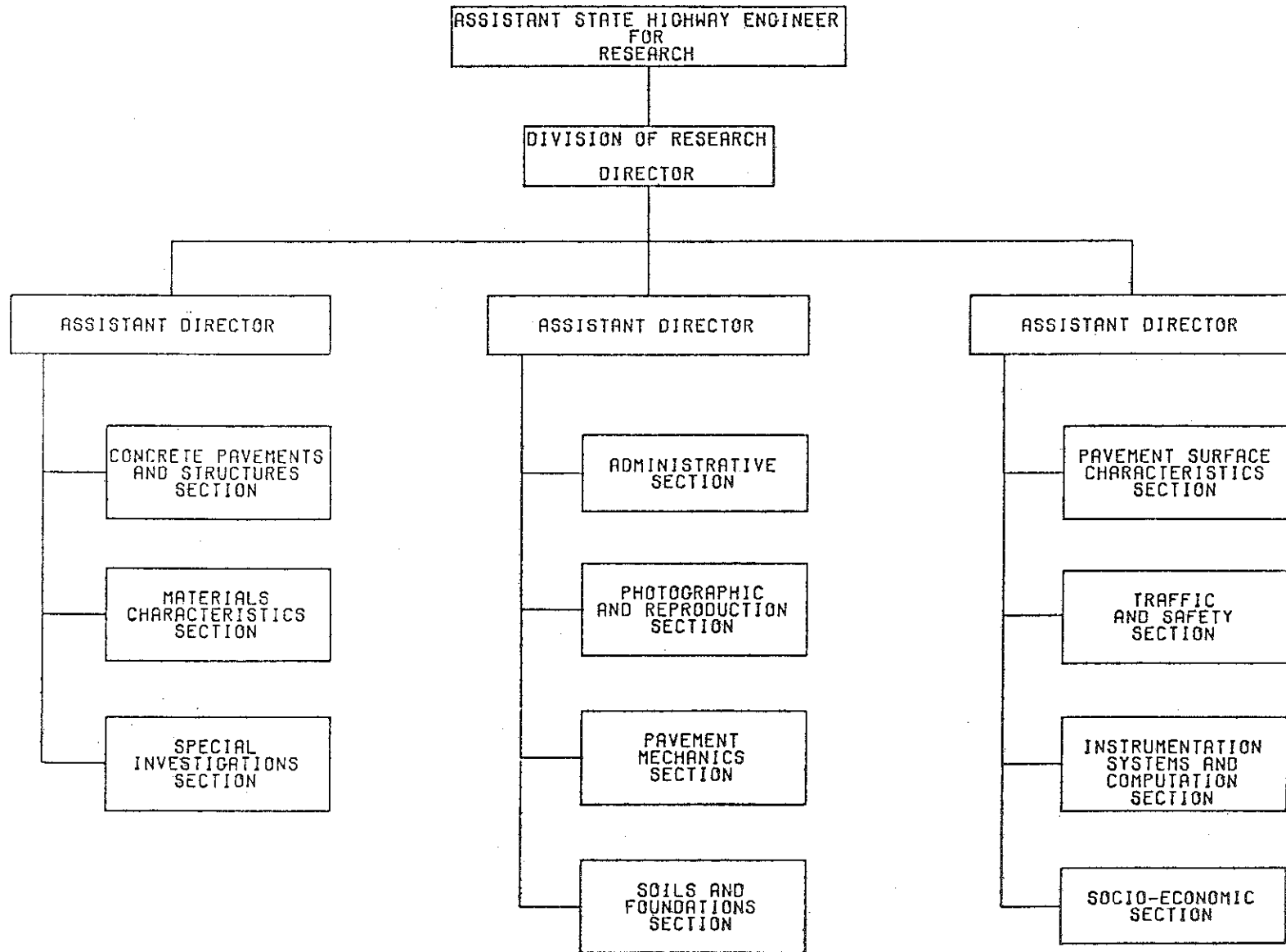
COOPERATION WITH OTHER STATE AGENCIES AND STATE UNIVERSITIES

The Division of Research, upon direction from Bureau officials having authority, will cooperate with other state agencies and state universities in endeavors of mutual interest in accordance with Kentucky statutes and regulations. In the event that research or specialized services are engaged or exchanged through a letter of understanding and interaccounting of costs, the Commissioner of Highways may determine the terms thereof and may so order.

State University faculty members' having consulting privileges granted by the University may be contracted with directly and as outlined later under SELECTION AND USE OF RESEARCH AGENCIES AND CONSULTANTS.

State University Research Foundations established for and acting as a contracting arm of the University shall be considered eligible to receive invitations to submit proposals as outlined later under SELECTION AND USE OF RESEARCH AGENCIES AND CONSULTANTS.

ATTACHMENT D
ORGANIZATIONAL STRUCTURE



DIVISION OF RESEARCH

RESPONSIBILITY

Responsible for developing a comprehensive Research Program of all aspects of Highway Engineering through the use of scientific research principles and practices.

FUNCTIONS

The functions of the Division of Research are divided among the following sections:

ADMINISTRATIVE

1. Provides secretarial and clerical assistance to the Division.
2. Prepares and processes personnel documents including time reports.
3. Assists in the preparation of the divisional budget.
4. Maintains building and vehicles.

PHOTOGRAPHIC AND REPRODUCTION

1. Prints all research reports and lab forms including layout, camera, offset press, and bindery work.
2. Develops and prints black, white and infra-red film and processes and mounts color transparencies.
3. Investigates and evaluates new methods of photography that may be utilized by the division.

CONCRETE PAVEMENTS AND STRUCTURES

1. Performs basic and applied research toward the development of improved designs, engineering procedures and the most efficient and economical usage of concrete, concrete pavements and concrete structures.
2. Develops test procedures for evaluating concrete mixes and its constituent materials, concrete pavements and concrete structures.

MATERIALS CHARACTERISTICS

1. Performs basic and applied research on the mechanistics and rheologic behavior of engineering materials (including soils and bituminous materials) aimed at providing a more thorough understanding of these materials and improving design procedures and usage.

DIVISION OF RESEARCH

FUNCTIONS (Cont.)

2. Develops test procedures for evaluating the mechanical properties of engineering materials.

SOILS AND FOUNDATIONS

Performs basic and applied research leading toward the development of a background of knowledge concerning soils and their interaction with structures and structural foundations, and uses such knowledge to develop and improve engineering designs and procedures that may lead to a more efficient and economical usage.

SPECIAL INVESTIGATIONS

Conducts research studies and investigations related to special problem areas, such as pavement construction and maintenance practices, not otherwise classifiable or outside the responsibilities assigned to other sections.

PAVEMENT SURFACE CHARACTERISTICS

Conducts research studies related to the measurement and evaluation of surface characteristics, such as roughness and slipperiness, of highway pavements.

TRAFFIC AND SAFETY

1. Conducts research studies for measuring the traffic-carrying capacity of highways.
2. Makes continuous studies of the various human and mechanical factors affecting highway traffic and safety.

SOCIO-ECONOMICS

1. Makes investigations of economic factors involved in highway construction, maintenance, taxation, and financing.
2. Keeps abreast of current research as to the socio-economic aspects of highway programs throughout the country.
3. Determines the benefits of highway development to both users and non-users by investigating the influence of the highway development program on transportation economics.
4. Determines highway needs through research and development of new techniques and of traffic, economic, and social analyses.

DIVISION OF RESEARCH

FUNCTIONS (Cont.)

INSTRUMENTATION, SYSTEMS AND COMPUTATION

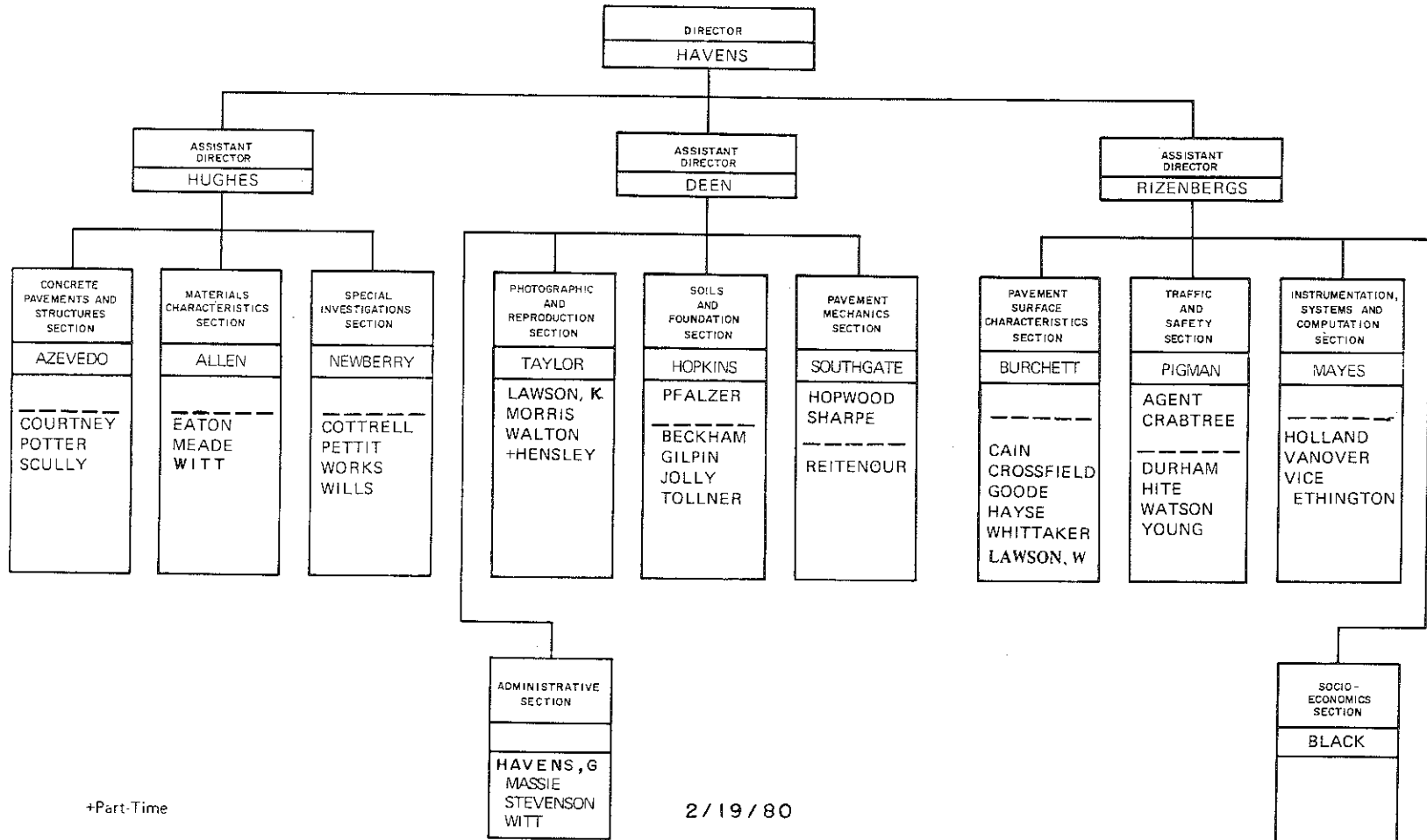
1. Maintains and operates an instrument shop, troubleshoots, maintains, repairs, designs, constructs, and calibrates electronic devices, systems and related equipment.
2. Selects, recommends and prepares specifications on instrumentation and specialized equipment, systems and devices, and assists in operation of same.
3. Conducts or assists in research studies relating to the use of specialized instrumentation and systems and employment of unique test equipment applicable to highway technology.
4. Assists in preparation of computer programs, prepares card decks, and advises on use of available programs.
5. Maintains library on computer programs and computer related reference materials, and maintains equipment files and catalogs on electronic components, instruments and devices.
6. Operates IBM 2770 Data Communication Terminal and IBM 29 Card Punch Unit.

PAVEMENT MECHANICS

1. Performs basic and applied research toward development of improved structural designs for bituminous pavements and substructures as related to the mechanical response of these structures to applied traffic loads and environmental effects.
2. Develops and standardizes methods of test and test procedures for structural evaluation of bituminous pavements and substructures.

ATTACHMENT E
ORGANIZATIONAL ROSTER

KENTUCKY DEPARTMENT OF TRANSPORTATION
 BUREAU OF HIGHWAYS
 DIVISION OF RESEARCH
 ORGANIZATION ROSTER



+Part-Time

2/19/80

