

REPORT OF THE CHIEF ENGINEER

OF THE

STATE HIGHWAY DEPARTMENT

JULY 1, 1947 TO JULY 1, 1948

FOREWORD

The mode of living in America has undergone tremendous changes since 1917 when the State Highway Department was created, so has the concept of governmental responsibility to the individual citizen. In consequence the people have come to look upon public highways generally in their true light as necessities rather than accommodations.

The State Highway Department is associated in the mind of the average citizen with the network of improved highways over which he travels to and from both his work and play and over which moves thousands of tons of foodstuffs, raw materials and finished products which enable our agricultural, commercial and industrial enterprises to command an important position in the economy of the nation.

The farmers increasing dependence on modern highways to transport not only the crop he raises but the supplies he needs makes it imperative for the Department to continue to improve and expand his road facilities.

Rural education with its emphasis on central schools makes modern highways an essential factor in successfully operating the educational system. Over these highways must be transported thousands of pupils in cars and busses.

The number of vehicles using the highways and the registration of vehicles in Delaware is climbing steadily. There is every reason to believe that this will continue at least for the next ten to fifteen years, at the same time commercial vehicle sizes and weights are double what they were a decade ago, all of which imposes an even greater burden on an already overloaded highway system.

Deficiencies in our Highway system have been analyzed and more details of this analysis are presented elsewhere in this report. Additional facilities for optimum operation of the State Highway system in Delaware can be predicted from these studies.

Preparation of plans and actual construction requires men, money and materials. Within the limits of the availability of these three factors, work is progressing on the extension, expansion and reconstruction of Delaware's highway system.

DIVISION OF PLANS AND SURVEYS

After a proposed construction schedule is established for new highways to be built or existing roads to be reconstructed, the main work of the Division of Plans and Surveys starts. Before any design of these proposed improvements can be accomplished much preliminary work needs to be done.

Field surveys are made by surveyors of the Department who are specialists in highway work. From these surveys the drafting room draws a strip map which shows concisely the present alignment and physical features along and adjacent to the alignment. This map shows property owners and utilities which will be directly affected by the building of the highway. This map is the backbone or basic structure upon which all future work is planned. Operations will be performed upon the body of the road, with the final road pattern being such as to suit the use for which the road is built.

In addition to this basic map, studies are made by the Soils Laboratory regarding the soils which must support the road metal and the loads which must be carried upon it. The results of these studies with suggestions are furnished to the Design Division for their use.

Drainage surveys are conducted to make sure that adequate facilities will be provided so that underground water, surface water, and floods will do the least damage to the road and the property owners along the highway.

Traffic surveys and trends of travel are supplied by the Traffic and Planning Division. Past accident records are provided to study hazards that exist along the present road. Information is obtained from public and private utilities regarding their surface and underground systems as these will influence the design of the proposed drainage structures.

All this information and data are carefully studied. From the analysis the proper road is designed so as to give the most satisfactory modern highway conforming to current scientific practices and practical usage to suit local conditions. This road is designed with the most economical first cost and the minimum maintenance upkeep over a period of years.

Special provisions are written to supplement the published general specifications so that the most recent methods and materials are used. Specifications start becoming obsolete the day of publication. Information for these is furnished by the Division of Tests.

After the plans and special provisions have reached this stage of completion, they are thoroughly checked by specialists heading the various divisions of the Department before being submitted to the Chief Engineer and on Federal Aid contracts the Public Roads Administration for their approval.

At this stage of development plans are furnished to the Right of Way Division so that lands necessary for the im-

provement of the present road or lands needed for a new site can be acquired. Prints are furnished to public and private utilities so that they may plan repairs, replacements or installations of new systems needed under or along the new road.

After approval of the plans by the Public Roads Administration, the project is placed under contract. From this point the Construction Division takes charge of the work.

After the construction is finished the Plans and Surveys Division assists with final surveys needed to check the amount of work performed by the contractor so that final payment can be made.

Besides this major work of roads, the Division performs sub-major work in connection with the improvement of streets in suburban communities under the Suburban Road Laws. This work is performed in exactly the same manner as for the construction of State Highways.

In addition this Division does minor work in preparing numerous miscellaneous plans, sketches and charts for the use of the Highway Department.

Below is tabulated the work necessary in making surveys and plans for the year ending June 30, 1948.

Surveys

65.2	Miles	Base Line
69.7	Miles	Topography
42.5	Miles	Cross Sections (Preliminary)
38.0	Miles	Cross Sections (Final)
39.1	Miles	Patch Survey
10		Borrow Pits (Preliminary)

Plans

79.0	Miles	Base Line Plotted
106.1	Miles	Topography Plotted
84.7	Miles	Profile Plotted
79.4	Miles	Index Maps Plotted and Traced
76.7	Miles	Plans Traced
73.7	Miles	Cross-Sections Plotted (Original)
42.5	Miles	Cross-Sections Plotted (Finals)
55.3	Miles	Grades Established
110.1	Miles	Quantities Estimated
106		Typical Sections
126		Miscellaneous Drawings

DIVISION OF ESTIMATES AND FEDERAL AID

This Division prepares the advertisements and proposals for lettings, checks and tabulates the bids when opened and computes and prepares the estimates for the monthly and final payments to contractors as work progresses. The division also acts as liaison office between the Department and the local representative of the Public Roads Administration.

During the period the Department authorized twenty-eight contracts for advertisement. Bids were received on the first contracts on August 6, 1947. Eleven lettings were held at regular intervals throughout the year with the last bids being received on June 9, 1948. One emergency contract was authorized for a temporary structure at Indian River Inlet.

Classification of the projects upon which bids were received is as follows: Roadway, 15; Bridge, 2; Maintenance, 3; Drainage, 3; Shore Protection, 1; Buildings, 1; Fuel, 1; Mosquito Control, 2. A total of one hundred seven bids were received. Contracts let during the year required the preparation of 870 proposal forms for bidding, office and field purposes. Contract documents for three subdivision projects were also prepared by the Division.

CLASSIFICATION OF CONTRACTS ADVERTISED

	Roadway Projects		Bridges (Over 20')		Drainage Projects		Maintenance Projects (Surf. Treat.)		Building Projects		Pest Projects		Shore Protection Projects	
	Miles	Total	No.	Total	No.	Total	No.	Total	No.	Total	No.	Total	No.	Total
Federal Aid Primary	32.680	\$1,338,562.90												
Federal Aid Secondary	33.172	1,372,961.15	1	\$169,413.50										
Federal Aid Urban	2.923	730,614.40												
State Projects			1	8,768.00	3	\$40,924.00	3	\$482,419.13	1	\$59,900.00	2	\$18,280.00	1	\$24,700.00
Totals	68.775	\$3,442,138.45	2	\$178,181.50	3	\$40,924.00	3	\$482,419.13	1	\$59,900.00	2	\$18,280.00	1	\$24,700.00

Classification Totals

Federal Aid Primary	\$1,338,562.90
Federal Aid Secondary	1,542,374.65
Federal Aid Urban	730,614.40
State Projects	634,991.13
Total	\$4,246,543.08

Low bid totals for all contracts were in the amount of \$4,246,543.08, exclusive of the motor fuel and emergency contracts for which a total contract price was not established in the bids.

A total of eighty-eight periodic estimates were processed for projects under construction. The value of estimates paid was in the amount of \$2,546,174.87, the Federal Aid share of which was \$1,090,723.46.

Twenty-five reimbursement vouchers were submitted to the Public Roads Administration for reimbursement in the amount of \$1,083,561.31. Reimbursement was received on twenty-six vouchers during the year in the amount of \$1,093,799.49. The accounts receivable on current projects is maintained at minimum.

FEDERAL AID

I believe that the importance of the Federal Aid Road Act on the Highways of our State should be more fully explained than possibly has been done in the past.

In 1916 the first Federal Aid Road Act was passed, since then the Act has been amended many times. These amendments have over the years resulted in a broadening of the scope of Federal participation in various types of Aid to the States. Recent Acts have materially increased the amount of funds available to the States for matching purposes.

Matching here means that the States are required to match dollar for dollar the Federal grants in order to secure these funds. This is true except on minor percentages where the States may elect to receive 100% participation as in Railroad Grade Crossing elimination.

APPORTIONMENT OF FEDERAL FUNDS

Federal Funds are apportioned to the States on the following basis: One-third in the ratio which the area of each State bears to the total area of all the States; one-third in the ratio which the population of each State bears to the total population of all the States as shown by the latest

available Federal census; one-third in the ratio which the mileage of rural delivery routes and star routes in each State bears to the total mileage of rural delivery and star routes in all the States at the close of the next preceding fiscal year, as shown by certificate of the Postmaster General, which he is directed to make and furnish annually to the Commissioner of Public Roads: PROVIDED, That no State shall receive less than one-half of 1 per centum of each year's allotment.

Secondary and feeder roads shall be apportioned among the States in the following manner: One-third in the ratio which the area of each State bears to the total area of all the States; one-third in the ratio which the rural population of each State bears to the total rural population of all the States, as shown by the Federal census of 1940, and one-third in the ratio which the mileage of rural delivery and star routes in each State bears to the total mileage of rural delivery and star routes in all the States:

PROVIDED, That no State shall receive less than one-half of one per centum of each year's allotment.

Allotments per year available for projects on highways in urban areas shall be apportioned among the States in the ratio which the population in municipalities and other urban places, of five thousand or more, in each State bears to the total population in municipalities and other urban places, of five thousand or more, in all the States as shown by the latest available Federal census.

DELAWARE'S SHARE

Delaware, by virtue of being a small State in area and population, receives the minimum grants of one half of 1 per centum of each year's allotment, which when the allotments are materially increased (as is the case in post war funds) results in substantial sums of federal money available for State use.

The effect of large Federal grants of money on State financing is to demand that substantial increases in State

funds be made to match dollar for dollar Federal grants. During the 1947 session of Legislature there was appropriated to the Department for construction purposes and for matching federal aid what was considered to be sufficient money to match certain portions of Federal Aid available. Ordinarily this amount of money would have unquestionably been sufficient to carry the Department through, if there were no emergencies. However the winter of 1947 resulted in damages to the highway system in excess of \$900,000. The Department had no alternative but to repair this damage, and it will undoubtedly result in our coming to the end of the construction year in December 1948 with no funds available to match Federal Aid until after appropriations are made by the 115th General Assembly, which convenes in January of 1949. Here I wish to point out that Federal regulations require that certain portions of their allotments be under agreement which means under contract by certain dates, otherwise apportionments allotted to the State revert to the Treasury of the United States and is no longer available for State use. The present One Fund Act, under which appropriations are made to this Department, should be reviewed in the light of these conditions and safeguards should be set up in order that these funds will not be lost to the State due to unforeseeable emergencies.

It may not be generally understood that the carrying out of the highway program requires letting of contracts that run over from one fiscal year to another, and, in order to prepare a program and have contracts let in ample time for the construction season, the winter months are used for preparation. If the funds for matching Federal Aid are exhausted, contract lettings cannot be gotten underway before the adjournment of the Legislature, resulting in the loss of valuable construction time, during the Spring and early Summer months.

The following tabulation shows my estimate of what the status of Federal Aid Highway funds will be at the close of the construction year in December, 1948:

ESTIMATED STATUS OF FEDERAL FUNDS

As of December 1948

Name of Funds	Under Contract	Contracts Completed And Paid	Federal Allotment	Balances Available For Matching
Prewar Primary	\$191,229.27	\$1,609,990.72	\$1,801,219.99	
Postwar Primary	1,774,831.20	390,183.80	4,251,093.00	\$2,086,078.00
Prewar Secondary	142,058.26	75,654.00	265,780.26	48,068.00
Postwar Secondary	962,876.61		2,834,063.00	1,871,186.39
Prewar Grade Crossing	374,462.82	20,117.00	394,579.82	
Postwar Urban	438,416.72		790,852.00	352,435.28
	\$3,883,874.88	\$2,095,945.52	\$10,337,588.07	\$4,357,767.67

From the above tabulation it is apparent that a large balance of Federal money will be available for construction of Federal Aid projects when matched dollar for dollar by State funds. Of the above balance of \$4,357,767.67, the sum of \$2,552,251.67 will be required to be under contract by June 30, 1951, and the first allotment of the 1948 Federal Aid Act in the amount of \$1,805,516.00 by June 30, 1952—to state it differently, the balance shown above will all have to be under agreement by June 30, 1952. It is estimated that these balances cannot be matched until after the 1949 session of Legislature appropriates funds for these requirements.

MOSQUITO CONTROL DIVISION

The mosquito control program with its increased allotment for the 1947-1949 period permitted operations on a more satisfactory basis than for the past several years. However the increased allotment of from \$40,000 to \$125,000 for this biennium does not provide the necessary funds to extend the maintenance, construction, and spray program during the present inflationary period.

Confronted with a shortage of labor and equipment and realizing the public would demand relief before the ditch systems could be recleaned, air-spraying was adopted as a temporary control measure. The basic experimental work with DDT had already been accomplished through cooperative research with the University of Delaware Agricultural Experimental Station staff. Also in advance of any large scale operation the Federal Fish and Wild Life authorities were consulted. Considering the fact that the results of the 1947 season were highly successful a more elaborate spray program was then planned for the 1948 season.

During the 1947 season a total of 35,124 acres of marshland was treated with DDT at the recommended rate of two quarts of oil per acre containing two-tenths pound of DDT, also in June 1948 a total of 21,496 acres was likewise treated. The work at the first season was done at about two-

week intervals a large portion of which was within five miles of Rehoboth Beach. Also a typical area but smaller in scope was selected in the vicinity of Bethany Beach and was under continuous observation by the University staff. The results of our work was measured by mechanical light traps and from comments made by people living in the treated area. After the season many complimentary letters were received and a study of the trap records revealed that Rehoboth had only one night of annoyance between July 1 and September 1, with the catches averaging 4.6 mosquitoes per night, 25 mosquitoes per night being considered annoying. The weather was also favorable and added to the success of the program.

The manufacturers of DDT make up several formulations so that its use is simplified for the average person by requiring only the addition of oil or water to form the spray solution. In order that expenses might be cut a plant was designed to prepare the solutions from the raw DDT or 100% powder. In the design, a heating element was incorporated along with a mechanical agitator, centrifugal pump, special quick hose coupling units, and proper storage facilities. In this manner around 2,000 gallons of 5% DDT oil solution could be prepared in an eight hour day at a substantial saving and requiring the services of but one man. The plan as originally constructed did not contain all the features mentioned but had some of these added after the first season's operation.

The delivery truck was originally arranged for temporary work, but received further alterations in advance of the 1948 season. The truck is now equipped with a heavy duty 2" rotary pump, automatic metering system, agitation system by-passing the meter, a loading suction line, quick couplers for changing hose connections and four cellular tanks having a capacity of 1100 gallons of spray solution. The pump and meter system used was larger than normally provided for regular oil delivery trucks and capable of loading a plane in less than two minutes. The loading unit was planned and constructed by our own personnel at a

remarkable saving. Fast loading is important since only a few hours each day may be suitable for spray work.

The 1947 figures reveal that the cost of DDT powder, oil, mixing, and loading averaged approximately sixteen cents per acre plus the agreed price of fifty cents per acre plane rental bringing the total cost of these items to sixty-six cents per acre.

The spray work of 1947 meeting with such success, plans were formulated for expansion during 1948. In the new plan a spray program was arranged for the Governor Bacon Health Center and vicinity. With the amount of work along the coast from Lewes to and including Bethany Beach increased, it was estimated that the plan would require the treatment of a maximum of 65,000 acres for a normal season. With this amount of work in view a contract was prepared using the experience gained from the 1947 season's work as a guide. The contract was written on a maximum-minimum acreage basis with rates based on the total amount of acreage sprayed, so that regardless of the type of season we would not be bound to any certain acreage.

A total of eight bids were received ranging from $24\frac{1}{4}\text{¢}$ to 85¢ per acre. These, however, were submitted for the 1948 season of which but a small portion falls within the period covered by this report. Other work including the necessary preparatory work for aerial spraying, the maintenance of equipment and ditch systems. During the year hand and machine cleaning totalled 167,644 lin. ft., hand and machine ditching totalled 39,714 lin. ft. and ground spraying totalled $192\frac{1}{2}$ acres.

Public interest in mosquito control has been rapidly growing in Delaware as well as in other localities where the mosquito is prevalent. This interest has been stimulated by the experiences of our armed forces in many lands during the war; the reports of new and improved insecticides and methods of control, and the possibility that mosquitoes may be carriers of polio as well as of malaria, yellow fever and other diseases.

Uncontrolled, the mosquito pest is a serious menace to the comfort, and health of our people and to the prosperity and popularity of our shore resorts and towns in the vicinity of mosquito breeding areas.

Mosquito control work was started in Delaware during the depression when some 2500 miles of drainage ditches were dug by C. C. C. labor in the mosquito covered marshes of the State, under the direction of the Delaware Mosquito Control Commission appointed by Governor C. Douglass Buck.

Unfortunately the work was stopped before the job was completed although the Federal Government spent approximately \$1,000,000 on this work.

This was a big step, and the work done furnished foundations for all future control work. With the ending of the mosquito projects by C. C. C. in 1938, the State carried on a limited program of maintenance and in 1939 the Legislature placed the responsibility for this work upon the State Highway Department.

Conditions produced by the World War made it impossible to secure the labor or equipment necessary to maintain the ditch systems, but a limited amount was done with some assistance from German War Prisoners.

However, the end of the War brought no relief in costs of equipment or labor supply. Laborers have not been available, and refuse this type of work, which has many disagreeable features. This has made necessary a change in former methods. Mechanical ditch digging and cleaning machines became necessary but were not available nor were funds adequate at the increased price levels.

With increased appropriations granted by the Legislature in 1947, (\$125,000 for 2 years) it was decided under the existing conditions to resort to aircraft spraying of D. D. T. oil solutions on an experimental basis.

Contracts were entered into and carried out in accordance with the best known methods, following the recommendations of the U. S. Wild Life Service.

The results, measured by mosquito trap records and the personal reports of many individuals in the districts covered, prove that the mosquito nuisance can be eliminated in Delaware and without damage to wild life or agricultural interests.

Given the necessary funds the annoyance and disease caused by these pests to the residents and visitors of the State can be made a thing of the past.

A combination of ditch maintenance and aircraft spraying with D. D. T. is necessary and increased appropriations will be required until the effects of the war years can be overcome.

Appreciation is expressed for the identification and research aid given by the Agricultural Experimental Station of the University of Delaware.

The success of the work during the period covered by this report would suggest that a program for the coming biennium be prepared and submitted to the next General Assembly for its consideration providing such extensions and increased acreage as deemed advisable.

DIVISION OF TESTS

Why does the State Highway Department need a laboratory or as it is officially known—the Division of Tests? The Department is certainly not a research organization or a testing agency but is engaged in planning, designing, construction and maintaining approximately 4,000 miles of roadway throughout the State, for the benefit of the general public. To answer this question let us look back a decade or so. There was a time when highway engineers depended solely on their judgment, experience and the tools of their profession—the transit and level; the slide rule and handbook; the smell, taste and feel of earth; or just the “look” of fresh concrete. Today it would be unwise to construct and maintain a highway system without taking advantage of the many scientific aids that are available for developing and testing new materials and methods as

well as improving current practices. This is why the State Highway Department finds it is necessary to maintain a laboratory.

In the Division of Tests, which forms an integral part of the engineering and construction organization of the State Highway Department, are found men trained and versed in the latest scientific methods of analysis and testing. It is their job to apply and coordinate these methods into tools for better planning, construction and maintenance of our highway system.

One application of these technical methods and skills into tools for a better highway system can be found in the manual of Standard Specifications compiled and issued by the Department. Our Specifications offer comprehensive instructions and advice in the quality and use of all construction materials, methods and practices. Periodically the Standard Specifications are revised by the Division of Tests to bring them up to date in light of the knowledge gained from field experience, new commercial developments and laboratory tests coupled with research findings. New developments which occur between editions are covered by supplemental instructions issued in the form of Special Provisions for each contract or project.

To insure the highest quality and use of all construction materials, as called for in the manual of Standard Specifications, the Division of Tests has performed countless tests. Many of these tests are, as would be expected where materials are produced in large quantities, performed at the source of supply, the stone quarry or gravel pit; the asphalt plant and refinery; the concrete pipe plant and the lumber treatment and processing plant; other tests are performed at the construction site, as an embankment is compacted or as a borrow pit is investigated. However, more thorough testing is carried on in the laboratory where the staff of skilled technicians conducted and performed over 8,854 tests during the past fiscal year. Such investiga-

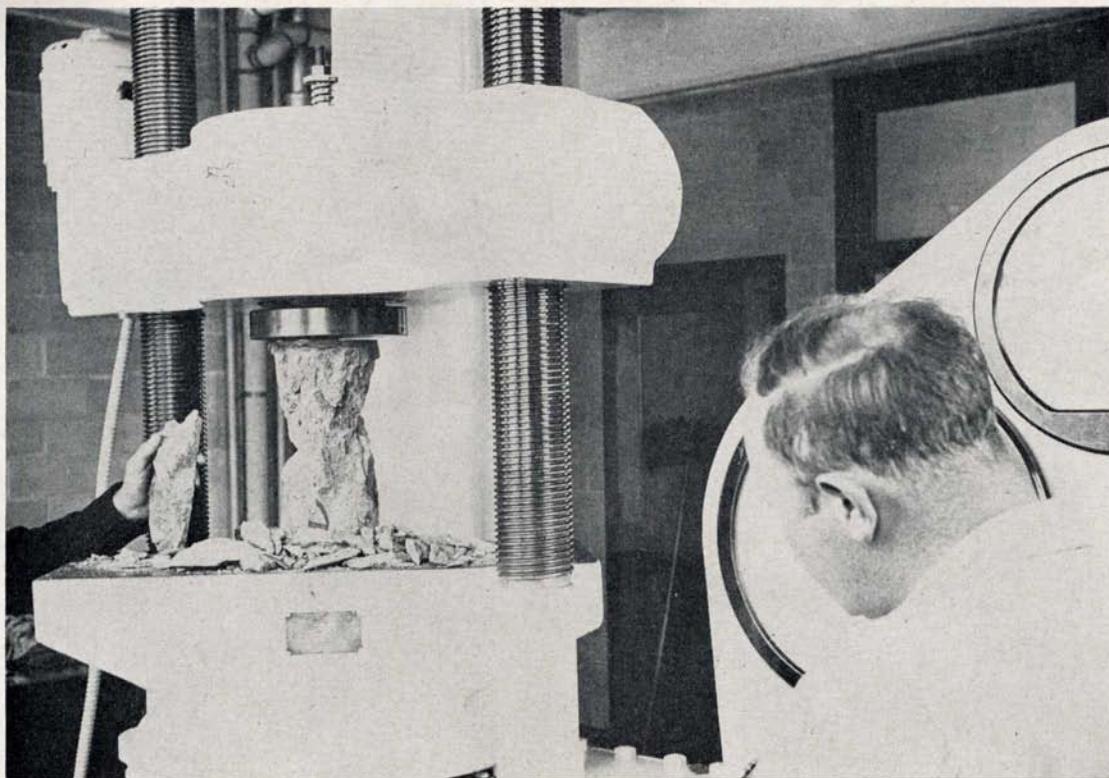
tion constitutes an initial phase in what might be termed the control and quality of materials. Finally, the laboratory staff may be called upon to solve special problems that arise in connection with the handling and use of materials. It is important to acknowledge that the quality and use of highway construction materials are not the sole interests of the Division of Tests. Oil for use in mosquito control, paper and ink for the Archives Commission and automotive equipment for the Motor Vehicle Division were also subjected to quality control tests and inspections.

To safeguard our highways by insuring that the best materials available are selected for a given purpose and that those materials are used to their best advantage the Division of Tests has a staff of approximately thirty engineers, technicians, inspectors, and clerks. The laboratory itself is housed in a compact two-story brick building constructed in 1939. About 2500 square feet of the building is devoted to testing and research work, 380 square feet to office space and about 1800 feet is required for storage, drying and handling of materials and samples.

At the present time, the Division of Tests has fifteen motor vehicles which were driven, during the past year, a total of 272,996 miles in the inspection and sampling of materials. This represents an increase of almost three times the mileage driven in 1946 and over 1½ times that driven last year.

MATERIALS LABORATORY

Laboratory testing and field research techniques for the Division of Tests have been developed to a point where complete evaluation of materials can be made on a functional, quantitative and economic basis. Consequently determinations are made with regard to processing and construction requirements as well as in connection with methods of use. During the last fiscal year in testing 4308 samples the laboratory has played a vital role in the selec-



TESTING COMPRESSIVE STRENGTH OF CONCRETE CORES—DIVISION OF TESTS, DOVER

tion and use of materials employed in the construction and maintenance of Delaware's highway system involving the following approximate quantities:

MATERIAL	QUANTITY REPRESENTED
Bituminous Concrete (Hot Mix)	138,770 tons
Bituminous Concrete (Cold Mix)	1,520 tons
Asphalt	3,474,019 gals.
Concrete Pipe	41,571 lin. ft.
Lumber	333,542 ft. B. M.
Piling	29,142 lin. ft.
Guard Rail Posts	595
Coarse Aggregate	104,938 tons
Fine Aggregate	26,264 tons
Central Mix Concrete	6,811 cu. yds.

Materials embracing those supplied by manufacturers in finished form—such as Portland cement and reinforcing steel—constitute another broad program of quality control. However, due to the manufacturing of fabrication location of these materials it is more economical to have commercial testing laboratories of unquestionable reputation act as the Department's agent. During the past fiscal year approximately 77,032 barrels of cement and 243 tons of reinforcing steel were inspected, sampled and tested by commercial laboratories for the Division of Tests.

As has been the practice of former years, the Division of Tests has been in complete charge of all hot-mix plant inspection. To insure that our previous high quality of hot-mix was maintained the Assistant Materials Engineer devoted the greater portion of his time to this end. Through his efforts the combination of competent field inspection has been coupled with efficient plant inspection and operation producing a hot-mix asphaltic concrete of the highest quality. It is hoped that in the near future we will be able to correlate our Marshall Stability field results with job site performances and plant production in order that an even more uniform mixture of hot mix may be produced.

In an effort to safeguard and insure that the contract specifications for the thickness of Portland cement and bitu-

minous concrete pavements are observed, the Division of Tests makes use of a truck-mounted core drill. A total of 757 concrete cores plus numerous hot mix cores were drilled not only to preclude the acceptance and payment of concrete below the required specification thickness but as a day-by-day check on the quality of the finished pavement.

Laboratory and field control does not stop with determination of acceptability of the finished materials or end product. Through well-directed investigation, defects are compensated or means for their elimination are devised, new uses developed and improved methods of use are determined. Typical developments resulting from such research investigations are illustrated by the following examples.

In addition to the usual acceptance tests, aggregates are subjected to further tests to determine their suitability for use in Portland cement concrete. For example, a rock quarry or gravel source may pass all the routine standard acceptance tests for gradation and abrasion but further special tests may reject it. Electronic and strength tests or microscopic examination may indicate this material to be susceptible to large volume changes with wetting and drying, and concrete beams containing this aggregate would show excessive drying shrinkage and very low freezing and thawing durability. The laboratory is currently engaged in such an investigation whereby the standard acceptance tests involving tedious procedures fraught with the possibility of errors are supplemented by new tests which may be carried out in hours instead of weeks. In essence, a concrete beam being tested is placed in an electronic apparatus which calculates the modulus of elasticity or the strength and durability of concrete by measuring the velocity of a sound wave, set up by an impulse or hammer blow, as the wave passes a microphone or pick-up. Thus, aggregates which can cause early deterioration of our concrete pavements are eliminated.

This year, as in the past, a series of tests on papers and inks were conducted for the Public Archives Commission. It is necessary that public documents such as school

records, vital statistics, and banking records be written on paper and with ink that will survive the passage of time. Serious confusion would result if such records were to deteriorate, fade and become undecipherable. With apparatus furnished by the Archives Commission the Division of Tests conducted such tests as to enable the Commission to publish a list of approved sources of paper and ink that would stand the ravages of time.

SOILS LABORATORY

An engineering structure, such as a roadway or bridge with which the State Highway Department is primarily concerned, can be no better than the foundation on which it rests and the materials of which it is made. Adaptations to natural site conditions through appropriate design and construction, will determine in a large measure the effectiveness of such structures. These conditions require expert interpretations. And inasmuch as they involve primarily the soil, groundwater and rocks, things in which the soils engineer is versed, it is natural that the soils laboratory assume primary responsibility for their interpretation.

Out of the need that the designer and construction engineer have the best information obtainable about natural conditions to which they must adapt their structure, there has developed over the past decade or so a new kind of engineering—soils engineering. The Soils Laboratory under the direction of the Soils Engineer studies the natural conditions of a project site, but their primary concern is to interpret this and supply the answers to such questions as: Will this foundation settle, how much and how rapidly? Will this cut or bank stand intact or fail by landslides? Will this material make an excellent shoulder for the roadway, will it wash away, be muddy or will it be rutted and dusty? How thick should this Portland cement or bituminous concrete pavement be to withstand the ever-increasing truck traffic or another severe winter?

In performance of these functions all the technical aids and apparatus of many sciences must be available if



TESTING BITUMINOUS HOT-MIX—DIVISION OF TESTS, DOVER

the information required by the design and construction engineers is to be assembled most thoroughly, clearly and economically. For example through the use of aerial photographs, geologic and soil maps a forecast can be made as to possible drainage problems, type of subgrade and possible selected material locations. Thirty-five more borrow pits were investigated this year than last year. A total of 118 possible selected material sites were investigated of which 10% of the sites were recommended for purchase or use by the Department.

Normally the development of a highway project from the earliest preliminary studies to the operation of the completed highway or bridge progresses through the following stages: preliminary design, final design and specification, construction and maintenance.

PRELIMINARY DESIGN—In this stage a number of possible routes may be examined for the types of different soils and the engineering problems they may cause. When the choice of alternate routes has been decided the selected site is subjected to supplementary exploration for data to be used in preliminary design and estimates. Interpretation of aerial photographs in this preliminary work may save days of tedious and expensive field work.

FINAL DESIGN AND SPECIFICATIONS—Detailed and comprehensive exploration are performed at this stage to permit final design and completion of specifications. The investigations would involve detailed field study and sampling, field observations of groundwater levels, sub-surface information and undisturbed samples of bridge sites and comprehensive laboratory testing and analysis, including bearing, unconfined compression, consolidation, permeability, and frost susceptibility studies. Also, percentages of sand, silt and clay are determined along with their individual properties. These studies lead to provisions in the final plans and specifications as to the type and thickness of base and pavement, and construction procedure to be fol-

lowed in processing the base course and shoulder materials and if a bridge is to have piling—if so, what type and length.

During the past year the Soils Laboratory has prepared such design reports as described above on approximately 93 miles of primary and secondary roads.

CONSTRUCTION—In this stage investigation continues as excavation and embankment progresses so that unforeseen conditions may be quickly recognized. Laboratory techniques and equipment are frequently used in the field for not only the solution of construction problems but in controlling construction procedures toward a more stable and durable structure.

MAINTENANCE—In this stage investigations are of miscellaneous character, because of the great variety of maintenance problems. To illustrate: The Kent County Maintenance Division wished to correct several poorly-drained areas by the use of perforated metal pipe but was doubtful if this method would be successful due to the unusual soil conditions. Detailed field studies and laboratory investigation of the porosity, permeability, saturation and other properties of the undisturbed soil provided the criteria by which the extent, location and feasibility of this method of drainage could be carried out.

Each of the stages enumerated above, proceeding from the superficial to the highly detailed, has its own immediate objectives, and in each stage the procedures of the investigation must be tailored to the special problems of the area and project. Tangible dollar and cents savings which result from adequate soils laboratory participation in investigation programs are by no means the true measure of the laboratory's contribution. Its major contribution lies in the avoidance of costly mistakes and the promotion, through a better understanding of natural conditions, of lower costs and more durable highways and bridges.

JOINT HIGHWAY RESEARCH PROGRAM

Early in May of this year the State Highway Department and the University of Delaware entered into a joint technical investigation of the factors entering into the design, construction and maintenance of both hard-surface and earth roads in the State of Delaware.

The State Highway Department has accumulated a vast amount of engineering data during the past few years on road performance and conditions of the highways already in service. These data are to be studied and correlated to determine whether current design and construction practices are suitable or should be modified. The School of Engineering at the University of Delaware is undertaking the task, with the Department's cooperation and assistance. Based on these factual data, it may be possible to draw conclusions regarding our present highway design and construction, and, where conclusions suggest changes in present practice, offer recommended changes.

TRAFFIC AND PLANNING DIVISION

On July 1, 1947, the Highway Planning Survey work of this division was reactivated after the war lapse. A concerted effort is underway to finish the basic studies started in 1941 and to publish a report showing the results of the Highway Planning Survey in Delaware.

The status of several of the phases of the Survey are listed below:

Road Inventory

All the changes resulting from construction or additions to the highway system have been incorporated in the latest figures for highways in Delaware which are a part of this report. Each year the mileages as indicated will become more accurate as actual survey distances will replace the distances obtained by a car-operated odometer during the basic road inventory work. As of June 30, 1948,

the official mileage of streets and highways exclusive of local municipal streets is 3905.03.

This figure compares with 3899.31 reported June 30, 1947.

Traffic

Each year traffic is increasing. The accompanying table show some comparisons of automatic counter information collected over the past years.

In the past fiscal year traffic volumes at these locations are 9.83 percent over the volumes for the same stations in 1946-1947, and in turn, the volumes for the same stations for 1946-1947, are 9.4 percent higher than in the years 1941-1942.

Continued observation of the traffic patterns in other states and in Delaware make obvious the need for continued planning and the construction of highways which will have the design standards and the capacities to adequately care for the volumes of passenger cars and commercial vehicles expected in the foreseeable future. See Figure 17 for accompanying table.

Railroad Grade Crossing

In the early part of the Highway Planning Survey field parties visited each railroad highway grade crossing location in the State and made an inventory of the physical conditions existing at the location.

The types of protection for the motorist were noted, the sight distances available, the grades and curvature of the road and other important items. A twenty-four hour traffic count is being obtained at each crossing and through the cooperation of the three companies operating in Delaware, the Pennsylvania Railroad, the Baltimore and Ohio Railroad, and the Reading Railroad, information on the number and speed of trains at the crossings, and the accidents at each crossing are being obtained. There are 366 railroad grade crossings in the State.

Railroad Highway Grade Crossings in Delaware

County	Watchman	Gates, Flashing Signals and/or Bells	Signs	Total
New Castle	11	40	107	158
Kent	11	15	57	83
Sussex	11	18	96	125
Total	33	73	260	366

Mapping

The three county general highway maps made by the Highway Planning Survey are still very popular. During the year some 404 maps were sold to interested agencies or individuals.

At present a state-wide general highway map is being drafted. This should also prove to be very popular. Following the completion of this map new and improved maintenance maps for each county will be prepared.

Road Use—Motor Vehicle Allocation Studies

During the spring of 1942, this phase of the Highway Planning Survey was initiated and the data compiled. The analysis of this data was not completed during the war years but was started during this year.

A knowledge of the geographic distribution of motor vehicles, the travel habits of motor vehicle owners, the relative use of the different highway systems, and the fees and taxes paid by motor vehicle owners is necessary to the establishment of an equitable allocation of funds to the several highway systems as well as the preparation of impartial tax laws which will prevent the subsidization of one motor vehicle use group by another.

This information is now being analyzed and will be available in report form in the near future.

Fiscal Study

A joint research program was set up between the University of Delaware Department of Economics and Business Research in the latter part of the year. A part of this program will be to have Dr. Herbert E. Newman of the University staff supervise the collection of data for the Fiscal Study and to assemble the data for this study.

The Fiscal Study is directed primarily towards a determination and analysis of highway income and expenditures in all units of government throughout the State, the extent to which highway users provide funds for highway activities and the amounts which are derived from other sources. This information will be analyzed and made available in report form in the next year.

Road Life Study

Another phase of the Highway Planning Survey was also initiated during this year. The main objective of the Road Life Study will be to determine the probable average life of each of the several highway surface types in use in the state highway system. With this determined, the retirement rates for each type of system can be set up, and future financial requirements of the system more accurately estimated. Another part of the Road Life Study is to prepare project logs which present graphically the history of construction activities on each road built by the State Highway Department. This information will also be available in report form in the next year.

Final Report

The joint research program with the Bureau of Economics and Business Research of the University of Delaware also provides for Dr. W. H. Fisher of the University staff to supervise the presentation of the Highway Planning Survey data in graphical report form. This report will show the existing factual conditions relative to the State Highway System. It will be available next year.

Wilmington Transportation Study

In the past quarter of a century the State of Delaware has made considerable progress in the road-building field. Most of the roads have served to link together the various sections of the state and to help people move about between the various cities in which they live.

Today, it is in and near the large cities that traffic is delayed and inconvenienced by congestion which causes waste of valuable time, increased gasoline consumption and additional repair costs, as well as irritation and fatigue for car occupants. These costly and unpleasant consequences of congestion ensue alike to motorists who remain entirely within the limits of a city, to those who travel back and forth between a city and its suburbs, and to those who drive into or through urban areas from other parts of the State or from other states; hence city, state and federal governments are mutually interested in the problem.

It is quite obvious that more money will have to be spent on urban highway construction in the years to come in order to keep pace with the accelerated traffic conditions now staring us in the face.

The extremely high costs of correcting these traffic conditions necessitates the securing of basic traffic data to determine the practical location for new construction facilities with respect to an overall, long range traffic improvement program.

Consequently, the State Highway Department, in conjunction with the Public Roads Administration of the Federal Works Agency and with the cooperation of the Mayor and Council of Wilmington and New Castle County, started an Origin and Destination Study for the Wilmington Metropolitan Area.

It is not possible to decide where new highway improvements should be located by merely observing the flow of existing traffic. Only through the comprehensive knowledge of origins and destination of people and materials can authorities be certain as to the correct location and adequacy of such traffic facility improvements.

In order to obtain information essential for planning new street, highway, and parking facilities it will be necessary to know where people go, the time of day they go, the type of transportation they use, and other pertinent facts concerning their daily travel. The best way to obtain this information is to interview residents in their homes.

A ten percent sample of the dwelling units in the survey area was carefully selected, with regard to place of residence in the proportion as the population was distributed. The residents of these dwelling units were visited by a corps of interviewers and questioned concerning the travel habits. Travel information was obtained for each member of the family. Some 5604 dwelling units were visited and the occupants questioned.

In addition origin and destination information was obtained from the drivers of a large number of motor vehicles as they entered and left the survey area. In this phase of the study some 54,197 vehicles were stopped and interviewed out of 63,302 crossing the cordon line which enclosed the survey area. Vehicles were stopped on 20 different roads entering and leaving the metropolitan limits of Wilmington.

Information was also obtained from truck owners and taxicabs, and from the public utilities in the area.

The area being surveyed extends from Naamans Road on the north to the New Castle County airport on the south and from Barley Mill Road on the west to the Delaware River on the east. There are 46 square miles included in the cordon line and approximately 150,000 people.

The data obtained from the survey will furnish the information necessary to prepare a master plan for a strategic network of arterial highways through the metropolitan area of Wilmington. Future construction work of Wilmington should follow this master plan. The survey will provide the information on which construction schedules can be set up so that the major amount of traffic and people will be most efficiently served.

A report of the results of this study will be forthcoming during the next year.

Traffic Engineering Studies

Traffic Engineering services are constantly being performed by members of the Traffic and Planning Division to assist the respective Division Engineers and to offer to the towns in the State who do not have such assistance available some guidance.

Other traffic engineering work involving accident studies, speed checks, turning movement and volume traffic counts were performed throughout the State.

Miscellaneous

The Traffic and Planning Division also prepared several monthly and annual tables for the use of other state agencies, the U. S. Public Roads Administration and the general public. Among these are Monthly Traffic Tables, Monthly Detour Bulletins, Annual Loadometer Tables, Annual State Mileage Tables, Annual Report for the Delaware Safety Council, Annual Tables on State Income and Expenditures, and other varied types of statistical information.

FIGURE 17

TRAFFIC VOLUMES AT FOUR AUTOMATIC COUNTER STATIONS BY YEAR BY MONTH WITH RELATED PERCENTAGES

Month	AVERAGE DAILY TRAFFIC			PERCENT CHANGE	
	1941 1942	1946 1947	1947 1948	1927-48 to 1941-42	1947-48 to 1946-47
July	22,721	18,215	21,792	- 4.09	+19.64
August	22,328	18,234	21,434	- 4.00	+17.55
September	19,902	17,504	19,300	- 3.02	+10.26
October	17,491	16,579	19,175	+ 9.63	+15.66
November	17,056	15,654	17,373	+ 1.86	+10.98
December	16,174	14,876	15,848	- 2.02	+ 6.53
January	13,421	13,211	13,511	+ 0.67	+ 2.27
February	13,736	12,551	14,361	+ 4.55	+14.42
March	14,062	15,522	17,171	+22.11	+10.62
April	15,583	17,327	17,988	+15.43	+ 3.81
May	14,744	19,027	20,423	+38.51	+ 7.34
June	13,810	21,543	21,552	+56.06	+ 0.04
Total	201,028	200,243	219,928	+ 9.40	+ 9.83

TABLE I
OFFICIAL MILEAGE OF STREETS AND HIGHWAYS
BY SYSTEM CLASSIFICATION BY COUNTY

SYSTEM	NEW CASTLE	KENT	SUSSEX	TOTALS
State—Primary	327.15	273.65	414.47	1,015.27
State—Secondary	467.48	729.99	1,392.92	2,590.39
Urban—Extensions	46.49	46.55	55.28	148.32
Private Developments	137.33	5.54	8.18	151.05*
TOTAL	978.45	1,055.73	1,870.85	3,905.03

* 40% of Private Development Mileage not maintained by Department.

TABLE II
MILEAGE OF STREETS AND HIGHWAYS
BY SURFACE TYPE BY COUNTY

SURFACE TYPE	NEW CASTLE	KENT	SUSSEX	TOTALS
Concrete	131.26	182.79	296.69	610.74
Bituminous Concrete	120.65	26.71	27.33	174.69
Brick .....	.82	.51	.05	1.38
Belgian Block	1.00	.04	.....	1.04
Bituminous Penetration.....	9.51	7.69	.97	18.17
Dual Type	33.58	59.95	48.90	142.43
Combination Type	1.71	.....	4.59	6.30
TOTAL PAVED	298.53	277.69	378.53	954.75
Sand Asphalt	5.64	.40	20.88	26.92
Bit. Surface-Treated	340.61	124.68	348.48	813.77
Other Low Type Bit.	57.71	11.99	5.30	75.00
Gravel or Stone	40.17	122.00	29.19	191.36
Soil Surfaced	157.52	423.47	391.40	972.39
TOTAL SURFACED	601.65	682.54	795.25	2,079.44
Graded and Drained				
Earth	13.18	77.23	648.20	738.61
Unimproved	15.34	5.61	28.48	49.43
Primitive .....	.38	2.18	19.65	22.21
TOTAL UNSURFACED.....	28.90	85.02	696.33	810.25
TOTAL TWO AND FOUR LANE HIGHWAYS	929.08	1,045.25	1,870.11	3,844.44

DIVIDED HIGHWAYS

SURFACE TYPE	NEW CASTLE	KENT	SUSSEX	TOTALS
Concrete	16.37	4.27	.71	21.35
Bit. Concrete	2.36	.18	.....	2.54
Brick .....	.....	.....	.03	.03
Dual Type	30.64	6.03	.....	36.67
TOTAL DIVIDED HIGHWAYS	49.37	10.48	.74	60.59
TOTAL ALL TYPES	978.45	1,055.73	1,870.85	3,905.03

BRIDGE DIVISION

General

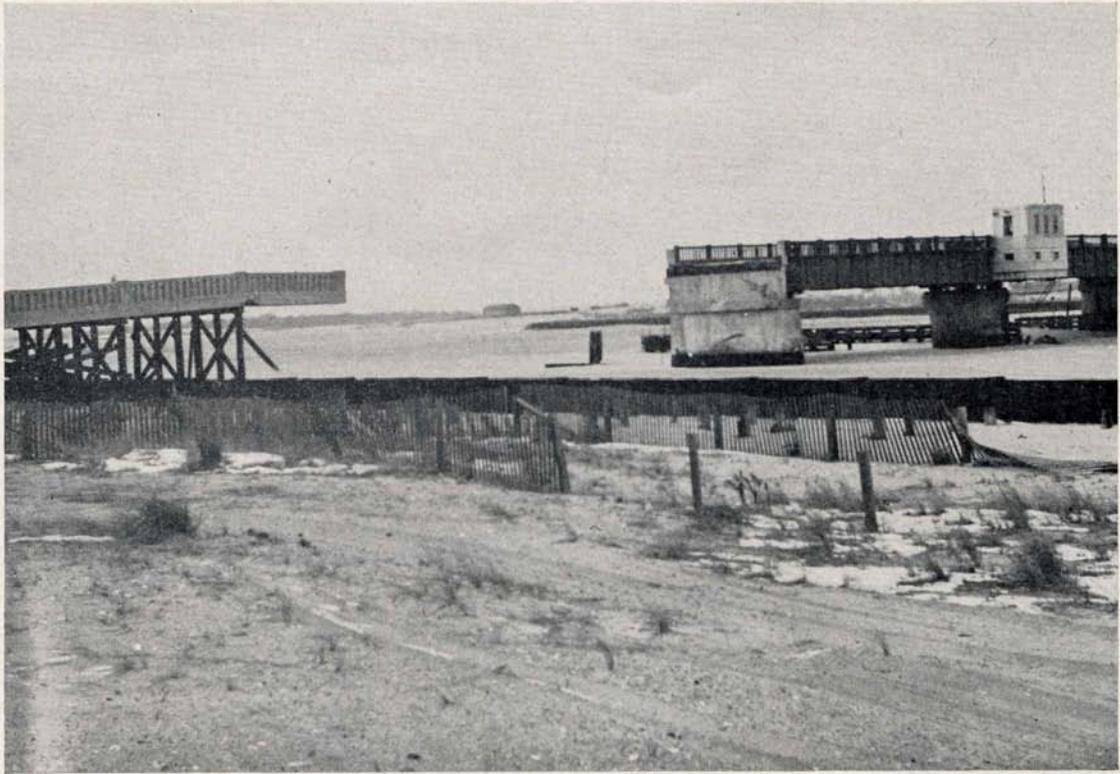
On April 30, 1948 Mr. Arthur G. Livingston retired from State Service after serving for over 30 years. Mr. Livingston was appointed Bridge Engineer in 1922 and served as such until his retirement last April. His devotion to the welfare of the State during that period set an example worthy of emulation by all employees. Hours meant little to Arthur Livingston. He could be found at his desk after normal closing hours almost every night in the week. The Department will miss his services and wishes him every success in his future activities.

The major portion of work done by the Bridge Division this year was the extension and reconstruction of bridges on road widenings. However, a few projects other than roadway were also designed and constructed. These were Slaughter Beach and Lewes Groins, Shallcross Dam, Selbyville School Sewer and Slaughter Neck Tide Gate.

PROJECTS

South Market St. Bridge—Wilmington

The wood floor on this bascule span had been rapidly deteriorating in the last few years due to the increase of traffic. A study of floorings showed that timber was no longer suitable and that some type of steel floor was indicated.



CHARLES W. CULLEN BRIDGE SHOWING SECTION DESTROYED BY ICE—FEBRUARY, 1948

Since the 2½-inch steel mesh floor had been used on the River Front Bridge it was thought that the 5-inch I Beam Lock Floor should be used, so a comparison could be made under actual traffic conditions.

Although this type of floor was heavier per square foot than the 2½-inch mesh floor, the total weight was comparable as no cross sills were needed to distribute the loads to the floor stringers. The cost of the floor itself was higher per square foot than the 2½-inch mesh but the ease of installing and the absence of sills made the total cost comparable, so that the use of these two floors was a matter of personal choice.

At the present time this floor has shown no distress of any kind and has produced a very satisfactory riding surface. The question of ice and snow removal and effect on traffic has not yet been determined.

CHARLES W. CULLEN BRIDGE

General

This structure failed on February 10, 1948 due to a combination of unusual circumstances, namely tide, wind and ice flow. The permanent replacement of the damaged section presents the most difficult project now facing the Bridge Division. Abstracts from the report of Howard, Needles, Tammen and Bergendoff, Consulting Engineers of New York who investigated the failure follows:

REPORT ON CHARLES W. CULLEN BRIDGE OVER INDIAN RIVER INLET

This report presents the results of studies made of the partial failure of the bridge on February 10, 1948. The studies include investigation of the failure and of repairs and reconstruction required to give a structure suitable for the conditions which obtain at this site.

Description

The bridge carries State Highway 14 across Indian River Inlet virtually at its mouth. The bridge provides a

roadway 24 feet wide and one sidewalk about 4 feet wide. It is 694 feet long and consists of a steel deck plate girder swing span 182 feet long, supported on three piers, and two trestle approaches each 256 feet long.

Bridge Failure

At about 8:45 on the morning of February 10th a portion of the south approach trestle adjacent to the south rest pier was carried out by the combined action of the wind, ice and tide. The parts carried out include 6 spans (116 lin. ft.) of trestle deck.

Based on information received from various sources, the following is a brief summary of events and conditions leading up to the failure.

For about a week prior to the failure there had been periods when ice was running in the Inlet. This apparently was flowing south from Delaware Bay and was being carried into the Inlet and to the bridge by incoming tide and wind. The amounts of such ice brought in by the tide were large enough to give concern as to the safety of the bridge and a number of inspections were made by engineers of the Highway Department but without finding anything to indicate danger of failure. Such flows of ice generally lodged against the east side of the bridge, piling up on the piles to heights of four or five feet, and forming an ice field east of the bridge. When the tide changed the ebb tide quickly carried this away from the bridge and out to sea.

On the morning of February 10th a similar flow of ice was carried into the Inlet with the tide aided by a north-east wind of approximately 30 miles per hour. It appeared to have no more effect on the bridge than had those of previous days, yet while the bridge tender was absent to report by telephone to the Department Engineer that there was no evidence of distress in the bridge, the failure occurred.

The failure occurred about three hours before high tide with water elevation at about an average of 7.0. There

was considerable wave action, the wave length being from 50 to 75 feet and its height about 6 feet, giving a crest elevation of about 10.0 feet. The ice was heavy, of a solid consistency. It was not in large-sized cakes but was churned up into a mass of an estimated thickness of 6 to 10 feet where it lodged against the bridge. At the time of the failure this ice extended across the whole Inlet though the principal flow of water was through the south portion of the Inlet.

At the time of the failure a light truck and an automobile were on the portion of the deck which failed. A member of the state maintenance crew saw the failure and reported that the truck, travelling south, had its front wheels south of Bent 22 when the deck failed. The truck overturned and landed on its top on the falling deck. The automobile went down with the deck and remained in an upright position, showing that the deck remained in a reasonably horizontal position. The fallen deck was carried inland by the ice and finally sank to the bottom about 250 feet west of the bridge. There were three lives lost at this time.

Soundings made soon after the failure show the following approximate depths of water below elevation zero:

North approach	15'
North rest pier	14' to 20'
Middle of north draw opening	13'
Pivot pier	20' to 25'
Middle of south draw opening	25' to 27'
South rest pier	26' to 32'
South approach	30' to 34'

In addition to destroying a part of the south approach trestle, the wind, ice and tide carried out also the greater part of the fender and draw protection still in place at that time. Some of the pile clusters had been carried out by previous storms. The ocean end of the draw protection for a length of about 40 feet had been previously destroyed when a storm carried a sunken barge into the Inlet and against this draw protection. At this time there remain in

place only 3 pile clusters, about one-third of the draw protection, the inland end, and a short length at the inland end of the fender at the north rest pier.

There follows after the above a technical discussion of the failure. This is on file with the Department and may be referred to at any time. However, it is well to note that in the technical discussion there is noted that no warning of failure could be expected and that failure would occur suddenly.

General Conditions at the Bridge Site

As made clear by the previous discussion, the principal cause of the failure was the flow of ice in the Inlet combined with the deep scour.

It is reported that the last previous similar flow of ice was in 1934, before the existing bridge was constructed, when a greater amount of heavier ice entered the Inlet. Such a flow of ice can occur only when there is an unusual period of cold weather producing large amounts of heavy ice in the Delaware River and Bay and which, when it is discharged into the ocean, is driven by northeast winds down the coast. Inasmuch as the prevailing winds at this season are northwesterly and westerly, this is a rather rare combination of conditions of infrequent occurrence.

At the time of the failure the principal flow of the Inlet was through the south approach, and this has been the region where maximum scour of the bottom has taken place. A few years ago the principal flow was through the north approach with water depths down to Elevation —23 or approximately 8 ft. lower than at the present time. Unless conditions in the Inlet are changed there can be no certainty as to the location in the future of the area of principal flow and maximum scour. It must be anticipated that the area of principal flow may be anywhere within the jetties and that this may be accompanied by scour down to depths such as those which now exist under the south approach.

Storms can be very severe at this site, with extremely high water elevations and considerable wave action, giving heavy pounding of all construction in the Inlet. It is reported that during a storm while the existing bridge was under construction, some waves passed over the construction trestle which had its top at about Elevation 12, and one wave even gave wash over the top of the pivot pier at Elevation 16.5. During a storm with an east wind, it is stated that the crest of the waves at high tide is generally from 1 to 3 feet above the tops of the steel pile jetties at the bridge site. These are at Elevation 10.7. Any part of the bridge within the Inlet must then be substantial in character if it is to withstand satisfactorily the battering of such storms.

Repair and Partial Reconstruction

The existing swing span will be retained without change.

The south rest pier base will be enlarged by driving steel sheet piling around it and about four feet clear from it so as to permit the driving of a new row of piles entirely around the pier. The steel sheet piling will be driven well below the bottoms of the existing pier and will be left in place so as to give protection against attack of teredo to the untreated timber piles of the existing pier. This sheet piling will also be used as a part of the new fender.

Two steel beam spans will be provided for the south approach to extend from the south rest pier a distance of about 194 feet. They will be supported on the south rest pier, on one new pier in the Inlet and on a second new pier about 28 feet south of the jetty. The existing trestle within this length together with the temporary trestle now being constructed to replace the portion of the approach which was destroyed will be removed.

The north approach trestle will remain in place with minor modifications. Even with modifications there can be



TEMPORARY BRIDGE REPAIRS—CHARLES W. CULLEN BRIDGE OVER INDIAN RIVER INLET
SUSSEX COUNTY—WINTER 1948

no definite assurance that the north trestle approach will stand up under the conditions which caused failure of the south approach, although it might well do so. There is no way to accurately determine the combined effect on a timber trestle of wind, ice, tide and wave action such as may be encountered in this Inlet. Such assurance can come only with a more permanent type of construction as proposed for the south approach.

The portions of the fenders and draw protection which now remain in the Inlet will be removed and new fenders and draw protection will be provided. This construction is much more substantial than that originally placed and we believe it will give good service under the conditions that exist in this Inlet.

The estimated cost of repair and reconstruction follows:

New South Approach Spans	\$ 94,616
Removal Existing Spans	10,000
Reconstruction South Rest Pier	69,620
New Pier in Inlet	64,860
New Pier South of Jetty	5,430
New Fenders and Draw Protection	98,680
Miscellaneous Repairs	31,700
	\$374,906
Engineering and Contingencies 20% abt.	75,094
TOTAL.....	\$450,000

Plans are being prepared based on the above plan and will be ready for the 1949 construction program.

The importance of this bridge to the area served makes it imperative that it not be closed to traffic during the summer months. In line with this decision an emergency contract was awarded to Thomas Earle and Sons for a temporary structure to replace the section of bridge washed out. This contract was completed and traffic was using the structure by May 1st, 1948. The cost of temporary repairs was \$34,290.42.

RIGHT OF WAY DIVISION

The accelerated pace of our construction work has naturally increased the activities of the Right-of-Way Division. During the year 351 options were obtained, 50 agreements were prepared, signatures were obtained on 307 deeds, 112 releases were obtained, 293 descriptions were written, 3 condemnations were necessary, 2 condemnations were called off, 22 plats were drawn, 3 borrow pits were secured, 4 buildings were moved and 6 buildings were demolished. In addition the Right-of-Way Division participated in a host of miscellaneous activities.

We have been engaged in the acquisition of the most difficult type of right of way; namely, narrow ribbons of land along existing highways. Many homes and businesses have been built along our highways and in practically all cases no allowance has been made for expansion of highway facilities. Such building practices eventually cost the taxpayers of the State untold thousands of dollars. Proper legislation would correct this condition.

The development of a modern highway network requires the planning of highways far in advance of actual construction. For example; we have plans for several dual highways that may not be fully constructed before 1960. In some cases existing alignment and existing highways are to be incorporated as part of the finished product, but in every case considerable additional right of way is necessary. Obviously funds are not available to purchase all of the land required, so we have adopted a policy of continually watching the lands involved and attempting to deal with those property owners who are planning some type of immediate building activity. In this manner we purchase only the land and do not later find ourselves in a position of having to purchase recently constructed building. This policy has paid dividends. However, we often find that we are not in a financial position to pay for property when such conditions as described above arise. It is very desir-

able to establish financial arrangements so that we may continue to pursue our adopted and highly successful policy.

In connection with right of way work, I wish to make the following recommendations:

1. That "set-back" legislation be proposed requiring all property owners to keep twenty-five feet (25') back of the highway right of way or easement line when building any type of a building.
2. That an appropriation of \$50,000 yearly be requested for the purchase of right of way for future construction.

CONSTRUCTION

On previous occasions and in November and December of 1947 the Department approved construction programs covering contemplated work for the full 1948 construction season and partial coverage for the 1949 season.

The total program consists of twenty (20) Federal Aid Secondary, fifteen (15) Federal Aid Primary, two (2) Federal Aid Urban, five (5) State and eight (8) Suburban Community projects. The total program is hereinafter enumerated.

CONSTRUCTION PROGRAM

CONTRACT NUMBER	TITLE OF CONTRACT	MILEAGE
934	Selbyville to Sound Church	6.26
1013	State Road to Basin Corner	2.30
936	Marsh Road	3.75
753	Wesley Church to Bridgeville	3.89
940	Thru Houston	0.83
971	Shallerross Lake .....	.....
845	Dagsboro Cut-Off to Georgetown	10.25
978	Road No. 62 to Road No. 311 on U. S. No. 13	2.27
910	Naamans Creek Road	5.70
975	Island Bridge (Seaford) .....	.....
962	Cranston Heights to Basin Corner	4.08
939	Greenwood to Shawnee	8.65
425	Leipsic Bridge and Approaches	0.33
1002	County Road No. 391	4.29
965	Delmar to Laurel	7.55
677	Hockessin to Yorklyn	1.92
943	Blackbird to Fieldsboro	3.17

CONTRACT NUMBER	TITLE OF CONTRACT	MILEAGE
998	Frankford to Clarksville	5.51
541	Maryland Line to Kenton	6.89
665	Curtis Mill Bridge and Approaches	0.19
771	Milton to Jefferson Crossroads	3.80
844	Selbyville to Dagsboro Cutoff	8.58
854	Pennsylvania Avenue (Wilm.)	1.19
1022	Surface Treatment (New Castle County) .....	.....
874	Drawyers Fill (North)	0.19
1024	Surface Treatment (Sussex County) .....	.....
935	Ellendale to Milford	7.20
1023	Surface Treatment (Kent County) .....	.....
997	Belltown to Midway	2.67
1005	Little Mastens Corner to Felton	6.25
900	Lancaster Avenue (Wilmington)	1.73
903	H. & H. to Middletown	5.41
987	Camp Meeting Woods to Silver Lake	3.72
907	Limestone Road to Newark	2.95
882	Drawyers Bridge and Approaches	0.69
1009	Philadelphia Pike (Claymont to Pa. Line)	1.70
1006	Wyoming Mill to S. R. No. 8	2.62
933	Brandywine Boulevard	2.10
1011	Bridgeville By-Pass	2.46
878	Portsville to Laurel	3.03
1016	Milton to Overbrook	4.38
1008	Georgetown Airport Road	2.40
SD-20	North Street Extended (Seaford)	0.17
SD-15	Swanwyck	0.22
SD-19	Overlook Colony	0.18
SD-18	Stockdale (Wister Street)	0.11
SD-10	Hollyoak Terrace	0.37
SD-21	North Bellevue Manor	0.42
SD-16	Woodland Homes	0.40
SD-17	Westhaven	0.66
Total.....		143.43

The program is varied, consisting of 143.43 miles of reconstruction, new construction, widening, bridge, surface treatment, and suburban community work.

MISCELLANEOUS APPROPRIATIONS

In addition, by action of the General Assembly of 1947, the Department was directed to carry out certain projects under special appropriation. A table of these special projects follows:

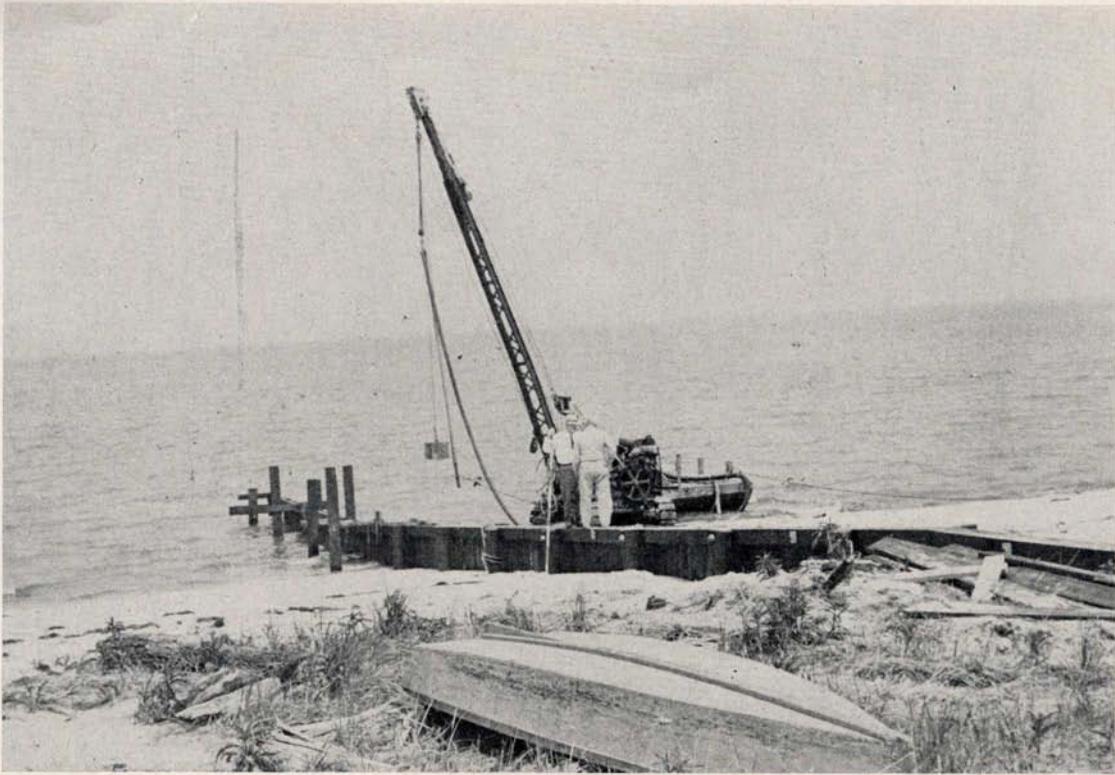
1.	Indian River Inlet Park	\$50,000
2.	Drainage at Selbyville School	10,000
3.	Rehoboth and Indian Bay Oyster Bed Survey	1,000
4.	Slaughter Beach Erosion Control	33,000
5.	Lewes Beach Erosion Control	10,000
6.	Tide Gate—Slaughter Neck Ditch	15,000

The Department engaged competent private engineers to undertake the oyster bed survey in the Rehoboth and Indian Bay. This work was satisfactorily completed in December of 1947.

In September of 1947 the Department awarded the contract for the remaining work under the legislative appropriations. A concrete culvert was constructed to handle the drainage problem at the Selbyville School. Seven timber groins were constructed at Slaughter Beach, two timber groins at Lewes Beach, and a tide-gate was built at Broadkill. All of this work was completed during the report period.

The Indian River Inlet Park project was also awarded during the month of September. The contract called for the construction of a concession building and a utility building. The two buildings are being constructed as part of a program to develop state lands around the Indian River Inlet as a recreational area. This initial development is in reality a trailer camp. The concession building will provide facilities for a restaurant, and the utility building will provide sanitary facilities for the tenants in the trailer camp, as well as for people enjoying the general area for recreational purposes. At the end of the report period the concession building was complete, and the utility building was approximately eighty percent complete. Plans were being formulated to open the Indian River Inlet Park on July 4th.

There is considerable interest in this latter project. For a number of years people of this state and neighboring states have enjoyed the fishing, swimming and general recreational activities that are common to the Indian River Inlet area. It is the rule rather than the exception to find some two to three hundred cars parked in the location over summer week-ends. Restaurant and sanitary facilities have been needed for a long time and the Indian River Inlet Park will provide these facilities for the enjoyment of all.



SHORE PROTECTION—SLAUGHTER BEACH—BUILDING GROINS

The post-war construction program as shown above, financed by State and Federal funds, and designated for correcting as rapidly as possible Delaware's highway deficiencies, was carried vigorously into the 1947-48 fiscal year. There were contracted during this last fiscal year 19 road construction projects, 4 bridge construction projects and 9 miscellaneous projects. Satisfactory prosecution of the program was made possible by the diligent efforts of the successful contractors and the extra efforts made by employees of the Department.

There were no major changes made in construction methods or practices and Tabulation No. 1, showing information relative to the contracts awarded during the period covered by this report, is herewith presented:

TABULATION I
TABULATION OF CONTRACTS AWARDED JULY 1, 1947 TO JUNE 30, 1948

Contract Number	Location	Total Bid Price	Date of Award	Contractor	Type of Construction
541	Maryland Line to Kenton	\$184,681.55	5/26/48	James Julian Elsmere, Delaware	C. C. Widening and Asphalt Surface
665	Curtis Mill Bridge and Approach	169,413.50	9/18/47	James Julian Elsmere, Delaware	Reinforced C. Ridged Frame Bridge and 20' C. C. Pavement
677	Hockessin to Yorklyn	227,530.60	6/15/48	Wilson Contracting Co. State Road, Delaware	20' C. C. Pavement
753	Wesley Church to Bridgeville	65,331.75	2/2/48	Delmarva Asphalt Co. Seaford, Delaware	Stabilized and Surface Treated Roadway
771	Milton to Jefferson Cross Road	49,425.50	9/17/47	Walter Roach & Son Georgetown, Delaware	Stabilized and Surface Treated Roadway
807	Trailer Park Buildings.....	59,900.00	10/25/47		
833-A	North Shore Groins	24,700.00		Coast Construction Co.	Seven Timber Groins
844	Selbyville to Dagsboro Cutoff	427,552.60	7/7/47	James Julian Elsmere, Delaware	Bituminous Resurface
845	Dagsboro to Georgetown...	468,046.60	1/19/48	George & Lynch Wilmington, Delaware	C. C. Widening and Hot Asphalt Resurface
854	Pennsylvania Avenue	265,103.40	8/11/47	Olivere Paving & Const. Co., Wilmington, Del.	58' Sheet Asphalt Pavement

TABULATION I

TABULATION OF CONTRACTS AWARDED JULY 1, 1947 TO JUNE 30, 1948 — (Continued)

Contract Number	Location	Total Bid Price	Date of Award	Contractor	Type of Construction
934	Selbyville to Sound Church via Williamsville	230,911.70	12/31/47	James Julian Elsmere, Delaware	Waterbound Macadam, Widening and Hot Mix Asphalt
935	Ellendale to Milford	355,336.00	5/26/48	George & Lynch Wilmington, Delaware	C. C. Widening and Hot Mix Resurface
936	Marsh Road	192,546.00	2/2/48	Standard Bitulithic Co. New York City	C. C. Widening and Hot Mix Resurface
939	Greenwood to Shawnee.....	232,417.65	7/2/47	George & Lynch Wilmington, Delaware	Bituminous Resurfacing
940	Thru Houston	48,748.75	2/9/48	Standard Bitulithic Co. New York City	C. C. Widening and Hot Mix Asphalt Resurface
943	Blackbird to Fieldsboro.....	125,447.00	7/7/47	Wilson Contracting Co. New Castle, Delaware	Bit. Resurfacing
965	Delmar to Laurel	311,828.75	6/9/48	Standard Bitulithic Co. New York City	C. C. Widening Bitumin- ous Resurface and Bridge Floor
971	Road 52 Shallcross Lake...	15,645.00	10/25/47	George & Lynch Wilmington, Delaware	Conc. Dam and Roadway
975	Island Bridge	8,768.00	1/6/48	Sussex Contractors, Inc. Rehoboth, Delaware	New Structure under present bridge

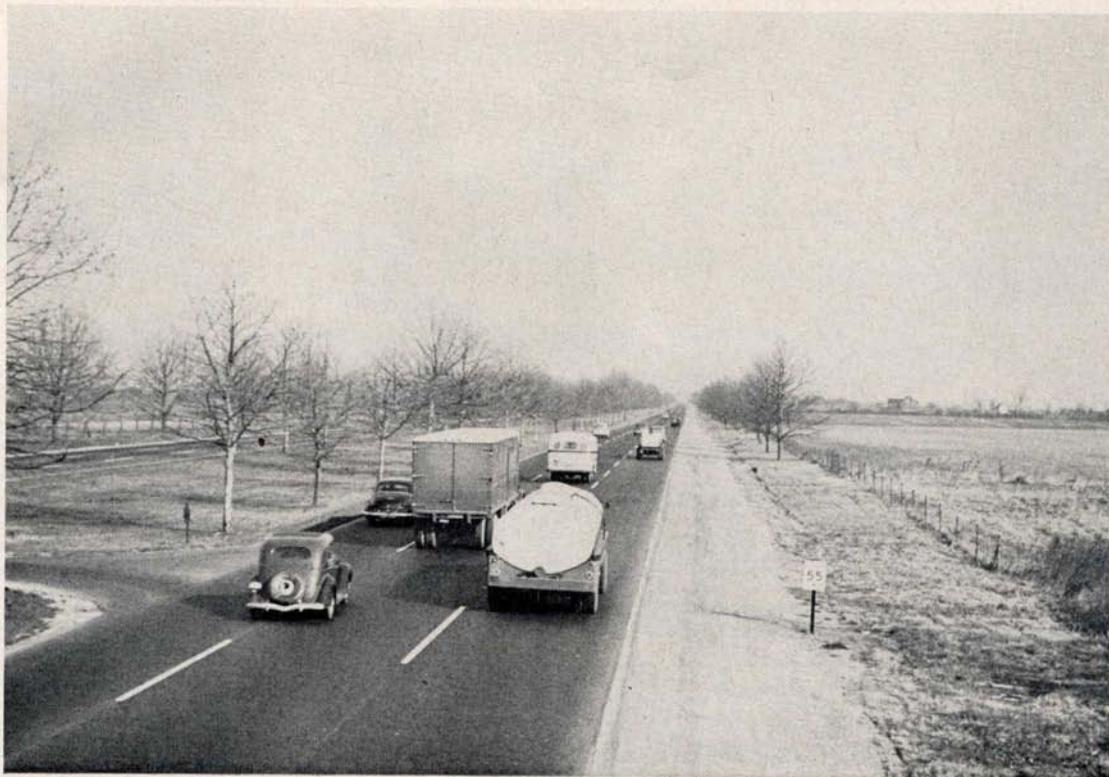
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TABULATION I
TABULATION OF CONTRACTS AWARDED JULY 1, 1947 TO JUNE 30, 1948 — (Continued)

Contract Number	Location	Total Bid Price	Date of Award	Contractor	Type of Construction
978	Road No. 62 to Road No. 311	44,837.00	7/2/47	Standard Bitulithic Co. New York City	3" Bit. Resurface
900	Lancaster Avenue	465,511.00	6/15/48	Olivere Paving & Construction Co., Wilmington, Delaware	38' and 42' Sheet Asphalt Pavement
910	Naaman's Road	284,601.85	4/5/48	Standard Bitulithic Co. New York City	C. C. Widening and Hot Mix Asphalt Resurface
986	Selbyville School Drainage	10,614.00	9/12/47	Pleasanton & Edgell Dover, Delaware	Drainage Facilities
991	Tide Gate—Slaughter Neck Ditch	14,665.00	9/12/47	George & Lynch Dover, Delaware	Tide Gate
998	Frankford to Clarksville.....	164,650.50	5/26/48	Old Line Construction Co. Chestertown, Maryland	C. C. Widening
1013	State Road to Basin Corner	127,885.00	12/30/47	James Julian Elsmere, Delaware	5' C. C. Widening and 36' Hot Mix Asphalt Surface
1020-A	Repairs to Indian River Inlet Bridge	34,290.42	3/10/48	Thomas Earle & Son Philadelphia, Penna.	Timber temporary repairs to Bridge
1022	Surface Treatment New Castle County	194,040.00	6/7/48	Asphalt Service Company Baltimore, Maryland	Bituminous Resurface

TABULATION I
TABULATION OF CONTRACTS AWARDED JULY 1, 1947 TO JUNE 30, 1948 — (Continued)

Contract Number	Location	Total Bid Price	Date of Award	Contractor	Type of Construction
1024	Surface Treatment Sussex County	175,365.50	6/7/48	Delmarva Asphalt Co. Seaford, Delaware	Bituminous Resurface
1023	Surface Treatment Kent County	118,646.53	6/7/48	W. M. McIntosh Harrisburg, Penna.	Bituminous Resurface
MC-2	Fuel Oil Requirements.....	.126	6/21/48	John R. Hitchens, Inc.	
1021	Gasoline Requirements .....	.0075	6/21/48	Atlantic Refining Company	
	Total.....	\$5,098,446.00		(Exclusive of Fuel Oil and Gasoline Requirements)	



STATE ROAD TO BASIN CORNER (U. S. 13 AND 40) RESURFACING AND WIDENING

From the tabulation it is found that 32 contracts were awarded during the year. Of this total Federal Aid Contracts amounted to \$4,441,811, and State contracts reached the sum of \$656,635, exclusive of gasoline and fuel oil requirements.

Particular attention should be called to the amount of work awarded during the period. In the 1946-47 year eleven (11) contracts were awarded totalling \$1,589,649. During this report period thirty-two (32) contracts were awarded totalling \$5,098,446 for an increase of 191% in contracts and 221% in dollar value. In addition it is estimated that another six (6) contracts will be awarded before the end of 1948 construction season totalling an estimated \$2,500,000.

The type of construction was varied and included the reconstruction of portions of our primary network, the construction and reconstruction of portions of our secondary network, an extensive surface treatment program on our secondary system and the rebuilding of several bridges.

The most noteworthy part of the construction program is the fact that by the end of the construction, the reconstruction of the older southbound section of the dual highway between Dover and Wilmington, U. S. No. 113 from Selbyville to north of Frederica and U. S. No. 13 between Delmar and Dover (except Laurel to Seaford) will have been completed. This practically completes a program conceived before the War and started in 1944. Generally the reconstruction consisted of widening and patching the existing concrete pavement, resurfacing with three (3) to four (4) inches of hot-mix asphaltic concrete, widening bridges and culverts and other miscellaneous work.

The completion of this work will provide riding comfort and enjoyment to thousands of motorists and will permit the Department to extend the scope of activity to other much-needed improvements.



ATLANTIC OCEAN AT REHOBOTH BEACH—ICE ON SHORE—WINTER 1948

WINTER DAMAGE

Within the fiscal year most unusual winter weather was encountered and the subsequent damage done to the roads and streets during the spring thaw can be safely classed as the severest encountered in any year since 1935, and has been classed as the severest in the history of the Department by many "veteran employees."

The damage as reported by the Division Engineers is presented herewith in tabulation form:

NEW CASTLE COUNTY

	Mileage	Type of Repair	Estimated Cost of Work
City Streets .....	.....	Patch	\$12,000
Suburban Streets	5.0	Rebuild	75,000
Concrete Pavement	0.38	Patch	30,000
Macadam Pavement	4.00	Rebuild	93,000
Surf. Tr. Roads	20.0	Rebuild	90,000
Earth Roads	30.0	Stabilized	36,000
Total.....			\$336,000

KENT COUNTY

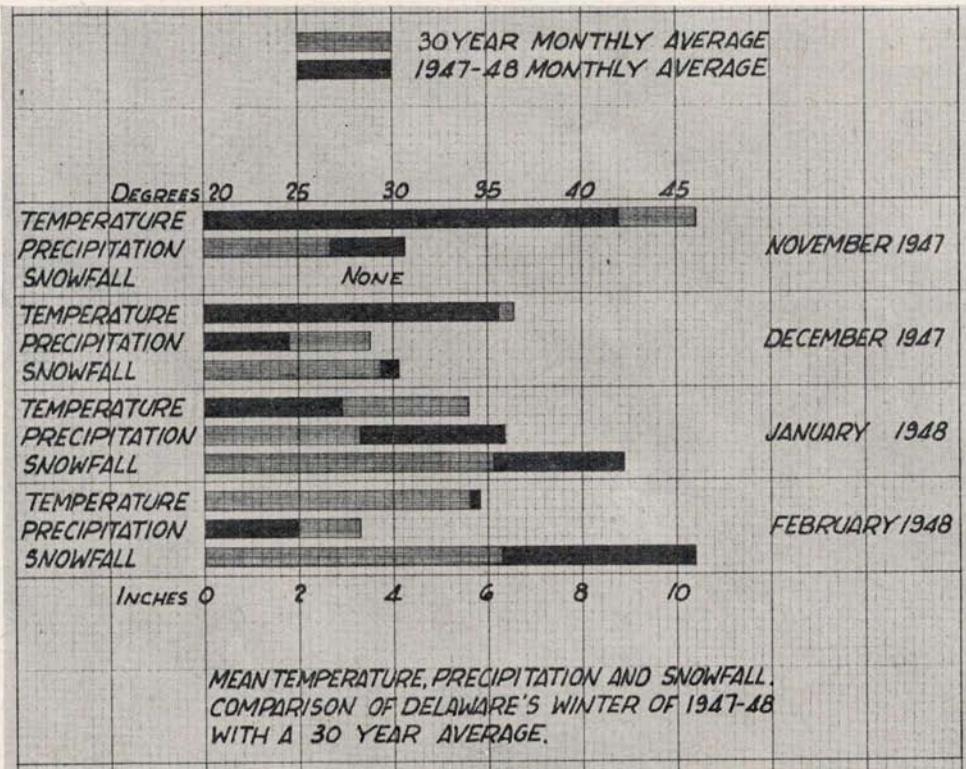
Concrete Pavement	1.8	Resurface	\$20,924
Surf. Tr. Roads	15.00	Rebuild	67,500
Surf. Tr. Roads	15.00	Retreat	15,000
Earth Roads	104	Stabilized	220,000
Total.....			\$323,424

SUSSEX COUNTY

Surf. Tr. Roads	40.65	Rebuilt	\$113,390
Earth Roads	92.50	Stabilized	145,106
Total.....			\$258,496

THREE COUNTY TOTALS

New Castle	\$336,000
Kent	323,424
Sussex	258,496
\$917,920	



After reviewing the above tabulations it is readily seen that damage was caused to our highways by the severe winter conditions, which is conservatively estimated to be more than \$900,000.

The state-wide expenditure for maintenance during the fiscal year was \$1,600,000, and, since this sum was insufficient to maintain satisfactorily all roads within the State, such an unusually heavy demand as the winter damage could not be borne by the regular appropriations as set by Legislative action. It was therefore necessary to allocate funds, originally intended for matching Federal Aid, to the maintenance divisions for use in repairing the winter damage.

COST OF DAMAGE

The cause of damage is related specifically to the adverse conditions during the winter season 1947-48. To illustrate this relation see Figure I.

In analyzing the data it is found that during the seventy-seven or seventy-eight year period, as covered by the Baltimore Weather Bureau records, the winter season just past was more severe in temperatures, precipitation, and snowfall than in any period previously recorded.

The month of January was particularly interesting from a comparative view because of the following reasons:

- (1) There were but five years; 1937, 1936, 1932, 1915, and 1892, during which time there was more precipitation recorded for the month.
- (2) There were but seven years: 1940, 1920, 1918, 1912, 1904, 1893, and 1888, during which time the average temperature was lower than the average temperature recorded for the month.
- (3) The stream flow average fifty percent below normal over a large section of the Eastern United States because of the severe freeze over the

streams. Further, run-off was reported to be the record low for January at five (5) gaging stations scattered over the same areas.

- (4) The most important fact found, when studying the Weather Bureau's statistics, was that during the entire seventy-eight year period no single January had so much precipitation with such low average temperatures. Since the combination of low temperature and moisture is directly responsible for the damage encountered, it can be quickly seen why highways suffered such severe damage.

To explain just how such combinations affect the composition of subgrades and roadway surfaces, a discussion on this subject is herewith added.

Briefly, frost heaving occurs in certain soils when water freezes in the form of layers or lenses which grow at the expense of unfrozen water supplied by gravity or capillarity from a free water source. Under prolonged freezing, the growth of these layers causes an upheaval of the roadway surface or pavement.

When the temperature rises above the freezing point, thawing starts at the surface and progresses downward. This action liberates a large quantity of water which has been accumulated in the form of ice layers. The still-frozen under soil prevents the water from escaping with the result that the soil immediately below the pavement temporarily provides little or no support. Unless the roadway surfacing possesses sufficient "Bridging strength" failures in the form of breakage and displacement occur. This condition is known as the "frost boil" and is distinct from the frost heave.

It is therefore seen that whether or not "frost heaves" or "frost boils" occur depends upon the quantity of moisture present in adverse soils and the temperatures prevailing over any given length of time.



WINTER DAMAGE TO CONCRETE HIGHWAY NEAR MIDDLETOWN—NEW CASTLE COUNTY



WINTER DAMAGE TO FLEXIBLE PAVEMENT NEAR MT. PLEASANT—NEW CASTLE COUNTY



WINTER DAMAGE 1948—EARTH ROAD—KENT COUNTY



THIS PICTURE SHOWS THE TYPICAL FAILURE OF A SURFACE TREATED ROAD. IT SHOULD BE NOTED THAT THE ROAD HAD GOOD CROSS SECTION AND WAS APPARENTLY DRAINED; HOWEVER, LOSS OF SUPPORTING VALUE OF THE SUB-GRADE CAUSED COMPLETE FAILURE OF THE ROADWAY SURFACE.

PERSONNEL

Administrative and Technical Employees

My report covering the 1946-47 year stressed the fact that the Department is seriously handicapped by the lack of technically trained and supervisory personnel. This shortage is directly reflected in delays and often in the quality of work performed. No material change has occurred in this field.

Adequate, competent and trained personnel is a prime prerequisite to the successful operation of any organization, whether it be government or private industry. Today's market is highly competitive. Employers have a choice; they either must enter the competition or they take what is left. To have a successful and competent organization employers must adopt modern personnel practices and policies. They must offer fair wages; they should have adequate retirement and disability plans; they should have training programs; in government they must have employment practices free from politics and they must provide economic security through continuity of service.

The Department has recognized several of these factors and the State Administration has made a start toward the provision of proper legislation in several other fields. Within budgetary limitations wages have been increased. This action has resulted in material improvement. It has raised the morale of the employees and permitted the employment of a few young engineers, however, we are still not in a position to compete with industry. The State Legislature, in 1945, enacted a retirement and disability plan and, while it contains certain inequities, it is reasonable to expect that improvements will be made during the ensuing years.

It is obvious that strides have been made in the right direction, but reasonable wages and a retirement and disability plan are useless without some assurance of continuity of service.

We have embarked upon a program of visiting nearby engineering colleges to discuss highway engineering as a career and to encourage highway employment upon graduation. Do you have a Civil Service Plan or a plan that offers economic security? Representatives of government cannot answer such questions truthfully when assurance of continuity of service is lacking.

Maintenance Employees

The entire maintenance organization rests on manpower—on the workers and the foremen who man it. Its efficiency will depend largely on the quality of its morale, and the ability of the Department to hold together, year after year, an organization of skilled and seasoned men. Some highway departments have been notably successful in doing this; others have found to their sorrow, that the cost of compromising on fundamental questions of personnel policy is high, and must be paid in the end.

The maintenance worker and the maintenance foreman, like the highway engineer, are interested in adequate pay, in good working conditions, in vacations and in security. The highway department that offers these advantages will secure incalculable advantages for the citizens of its respective state and good will for itself as well.

Even though some strides have been made forward within the past year, there is left much to be desired insofar as maintenance is concerned. First, there has been insufficient money allocated the maintenance organization to satisfactorily make any progress in improving maintenance problems that have mounted by leaps and bounds. The manpower has steadily decreased during the past number of years. The following tabulation will show the average number of maintenance employees on the Department's payroll since the fiscal year 1935-1936.

**AVERAGE NUMBER OF EMPLOYEES
BI-WEEKLY PAYROLL**

FISCAL YEAR	NEW CASTLE	KENT	SUSSEX	TOTAL
1936-1937	126	167	252	545
1937-1938	170	196	235	601
1938-1939	163	228	231	622
1939-1940	145	174	206	525
1940-1941	120	154	270	554
1941-1942	109	121	171	401
1942-1943	90	121	119	330
1943-1944	87	117	172	376
1944-1945	98	119	120	337
1945-1946	106	131	131	368
1946-1947	114	136	146	396
1947-1948	123	124	142	389

A study of the tabulation will show that the necessary employees are not presently employed to perform all items of maintenance up to the standards established before World War II. Further, unless a substantial increase in maintenance funds is allocated, there is no prospect of improving the overall maintenance operations.

One most important point, which cannot be overlooked in the maintenance organization is the lack of trained capable supervisory employees. There is a serious need for young engineers in this division of the Department, but unless they can be offered starting salaries comparable to other engineering organizations, and job security, they are not going to be interested in the highway maintenance.

Modern highway transportation is big business. Millions of dollars of public funds are being handled yearly. We are entering an era when an ever increasing amount of money should be available. These funds must be expended wisely and the work performed must be managed and supervised by men who are trained and experienced in the highway field. The citizens of Delaware have through the years been blessed with a fine highway network. They expect past standards to be continued. This can only be accomplished by establishing highway engineering as a career. To accomplish this end some type of Civil Service legislation should be enacted.

Employees Pension Act

In 1945 the Legislature passed "The Delaware State Employees' Pension Act." The Act was liberalized by amendments during the 1947 session. The Act is unique in the fact that it is non-contributory insofar as employees are concerned. The State pays the full costs. At the present time, twelve former employees of the Department are enjoying the privileges of this Act. Eleven have retired under the age clause, and one under the disability provision.

During the first three years of operation under the Act, a number of cases have come to our attention which are not wholly equitable. In order to remove some of the most glaring inequities, I wish to recommend that the following items be considered as amendments to the present Act:

1. That provision be made for retirement calculations on the basis of gross salary received from the State instead of base salary.
2. That disability pensions be permitted after fifteen years of service instead of twenty-five years.
3. That the maximum permissible retirement be increased above the present \$150.00 per month.
4. That the minimum pension be increased above the present allowable \$50.00 per month.
5. That service with the County Levy Court prior to 1935 be counted the same as State service as long as there were no interruptions between the County service and the State service.
6. That all types of interruptions of service during the war years be permitted as allowable interruptions.
7. That employees who were working for the State at the time the original Act was passed, be permitted to continue working past age 70 in order to acquire the minimum fifteen years of service that would permit their retirement.

8. That employees be permitted to pick any five years of their service for the purpose of calculating the amount of pension.

MAINTENANCE

General

In this period of mounting costs and increased demands on the highway plant the maintenance organization and highway policies affecting maintenance stand in the front line. Here is a field where decisions are vital to those who travel over the highways and to those who manage them.

The maintenance organization is the little known group who is actually the pulse of highway transportation. From what the men making up the organization do and the way they do it, the public judges the efficiency of the Highway Department. This gives them an important role in public relations in addition to their many regular duties. No wonder that maintenance is considered a hard and important job. It is steadily growing harder and more important.

The average highway user does not realize the extent of maintenance operations and he cannot therefore understand that maintenance must become one of the most formidable items in the cost of operating a highway system. According to latest statistics highway maintenance costs have increased by a total of eighty-six (86) percent since the year 1935.

Three main factors account for these mounting costs—general price trends, increased traffic requirements and worn out and obsolete highways.

Each of us in personal life has experienced the effect of the shrinkage of the dollar's value; therefore, no general explanation of this item is felt necessary other than to say that an attempt is being made to meet the situation through a wider use of equipment and the concentration of efforts on the more essential features of maintenance.



NEW EQUIPMENT PURCHASED FROM WAR ASSETS ADMINISTRATION FOR USE IN MAINTENANCE

The second factor in rising maintenance costs is greater demand of traffic, both in number of vehicles and in heavier loads. During the war years, when railroads were loaded to capacity, shippers turned to the highways for freight shipping. This was found to be both convenient and economical; therefore, when the emergency ended, shippers continued using trucks.

To illustrate this point, the following information is taken from actual surveys made within the State.

The tractor truck-semi trailer type of commercial vehicle, which is the type carrying the heavy weights on our highways, has doubled in frequency since 1941.

In 1941 the average maximum axle load of loaded vehicles was 15,256 pounds while in 1948 this figure had increased to 18,389, an increase of 20 percent.

Again, in 1941 the average total weight of loaded vehicles was 32,149 pounds while in 1948 this figure had increased to 39,818, or an increase of 24 percent.

The frequency per 100 vehicles of axles over 18,000 pounds has increased from 15 to 73 or 500 percent. It is seen that there are now almost five times as many axles in tractor trucks semi-trailer over 18,000 pounds as there were in 1941. The design of new highways is controlled mainly by this data and further, the rate of deterioration of existing highways is definitely dependent upon the same conditions.

Finally, in 1941, out of 3191 commercial vehicles checked in the study, there was not one vehicle over a gross weight of 45,000 pounds. In 1948, out of 3863 commercial vehicles checked, 20 percent were found to exceed the same gross weight figure.

Nationally, truck traffic is increasing more rapidly than any other type of highway transportation. Movement of goods by truck in 1947, is estimated at 85 million tons miles, 17 percent more than 1946 and 46 percent above the 1941 total.

Truck registration rose from 4,859,244 in 1941, to approximately 6,500,000 in 1947, an increase of nearly 34 percent. Further, trucks are carrying heavier loads than in pre-war years. The average load hauled by all types of trucks increased from 3.18 tons in 1941, to 4.36 tons in 1947, an increase of 37 percent.

Worn out and obsolete highways are the third factor. Roads adequate in the early days of the automobile cannot meet present day requirements and must be strengthened. Many roads that stood the pounding of the war years must also be rebuilt. There will be no saving of money by postponing this new construction, for maintenance charges increase in direct ratio to deterioration. Eventually a point is reached where maintenance costs are exorbitant, while the road's value to the public grows less and less in spite of the efforts of the repair crews.

Plant and Equipment

In an effort to decrease costs and and to improve the efficiency of the maintenance operations, increased mechanization has been undertaken. This practice was adopted since it has been established by actual records that costs can be cut by the careful study and adaption of power-driven units.

The total amount expended state wide for Plant and Equipment during the fiscal year was \$223,606. Of this total, the sum of \$21,209 was utilized in the purchase of Surplus Construction Equipment from the War Assets Administration.

The following tabulation will show the surplus equipment obtained and its purchase price:

Caterpillar No. 212 Grader	\$2,058
Adams No. 412 Grader	2,267
Galion No. 101D Grader	2,028
International TDR-18 Bull Dozer	4,205
Unit Model 1020 Mobile Crane	8,800
Buckeye Ditching Machine Model 12	1,851
Total.....	\$21,209

Other than normal maintenance and operation costs, no large expenditure has been made on any piece of equipment even though it has been in operation for a period greater than one year. The entire purchase saved a sum of approximately \$31,000 based upon Government acquisition cost, and further, has increased the efficiency of the Department.

The coming fiscal year will again show a large outlay for Plant and Equipment since several years will be required to bring the equipment up to standard. Also, each piece of equipment purchased is considerably higher in initial cost which means that the maintenance equipment dollar has only a fraction of its former value.

Snow Removal and Ice Control

Since snow removal and ice control have become items of foremost importance, within regular maintenance operations, greater emphasis is placed upon the work yearly.

In an effort to perform more satisfactorily these operations in New Castle County, Radio Telephones were installed in seventeen pieces of prime equipment. The installations permitted contact between headquarters and the operator of the unit at all times. By such control, it was possible to eliminate "stand-by" sanding crews at each bad hill and permitted the use of a very few crews to perform normal sanding operations over a wide area.

TABULATION III
SNOW REMOVAL AND ICE CONTROL

COUNTY	FISCAL YEAR 1939-40	FISCAL YEAR 1940-41	FISCAL YEAR 1941-42	FISCAL YEAR 1942-43	FISCAL YEAR 1943-44	FISCAL YEAR 1944-45	FISCAL YEAR 1945-46	FISCAL YEAR 1946-47	FISCAL YEAR 1947-48
New Castle	\$22,242.79	\$20,260.03	\$11,011.16	\$21,075.98	\$18,383.81	\$39,443.57	\$30,553.61	\$49,578.15	\$60,866.54
Kent	19,529.27	9,570.96	6,787.65	4,937.30	4,432.73	3,266.13	8,318.34	13,007.78	21,797.22
Sussex	16,662.59	6,919.05	5,298.91	3,168.62	2,671.05	1,244.92	8,062.61	6,775.90	33,069.91
Total.....	\$58,595.65	\$36,750.04	\$23,097.72	\$29,181.90	\$25,487.59	\$43,954.62	\$46,934.56	\$69,361.83	\$115,733.67

It would be difficult to say just how much was saved by using such service; however, with the knowledge that a smaller number of crews was used and further with the knowledge that the units could be dispatched immediately to any bad location, the cost of this equipment is justified.

Another illustration, even though intangible insofar as actual savings is concerned, is herewith presented.

One of the largest Walters Trucks was plowing heavy snow one night within the Mount Cuba vicinity, when transmission trouble developed. The driver contacted headquarters and reported his experience.

By radio telephone, a mechanic in his service truck and another heavy truck approximately five miles away were contacted. The mechanic and the heavy truck reached the disabled vehicle within an extremely short period of time and after disconnecting the drive shafts, towed it into the garage. Immediately upon arriving at the garage the heavy truck returned to its snow plowing schedule and mechanics prepared to find out just what was wrong with the Walters transmission.

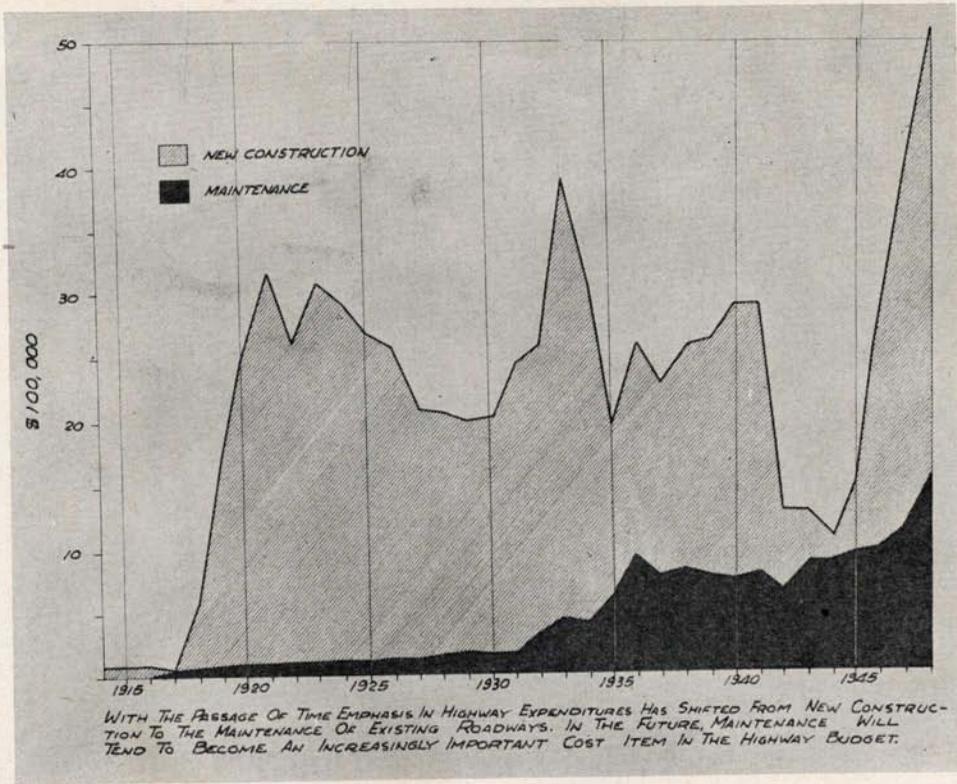
Within three hours, from the time the driver reported his trouble, his truck was in the garage, the transmission cover plate removed, new parts placed therein and he was back on his regular route plowing snow. Such service is most valuable even though it cannot be measured in actual dollars and cents savings.

It was stated, in the report covering the last fiscal year, that state-wide expenditures for both snow removal and ice control were the highest since 1935.

Tabulation Number III will show that the past fiscal year surpassed the amount previously spent by a very large degree. This expenditure was necessary because of the severity of the winter and which has been described under the heading "Winter Damage."

Highway System

The State Highway Department is responsible for maintenance of all public roads within the State with the



exception of certain streets within incorporated limits and certain streets in private or suburban developments. The mileage as maintained and the various classifications have been presented in another section of this report, but to eliminate references, are shown herewith:

MILEAGE OF STREETS AND HIGHWAYS

System	New Castle	Kent	Sussex	Totals
State—Primary	327.15	273.65	414.47	1,015.27
State—Secondary	467.48	729.99	1,392.92	2,590.39
Urban—Extensions	46.49	46.55	55.28	148.32
Developments	137.33	5.54	8.18	151.05
Totals.....	978.45	1,055.73	1,870.85	3,905.03

* 40% of private development mileage not maintained by State Highway Department.

The maintenance of the roads and streets included in the above tabulation during the past several years has presented an administrative problem of unprecedented magnitude. Rising costs have continued to shrink the value of the maintenance dollar, while the advancing age of the existing pavements continues to increase the maintenance requirements. The problems imposed by these conditions have had to be approached with limited maintenance appropriations.

As reported in the Annual Report to the State Highway Department, prepared during 1947, there are 942 miles of paved highways within the state of which 703 miles are concrete. Of this total concrete, 85 per cent is now twenty years old, and thirty per cent is actually between the ages of twenty-five and thirty years.

To and including the construction season of 1948, there have been reconstructed but 107 miles of these old pavements; therefore it is quite evident that approximately 500 miles are requiring more and more maintenance each year. With these known conditions, the maintenance problem is going to greatly increase until the cycle of reconstruction has been completed.

The total maintenance expenditures during "Pre-War" and "Post-War" years compared with construction expenditures are shown in Figure 14.

Roadside

During the year, this item of maintenance has not been up to the standards of the past years. While it is true that the main highways were neatly kept, the rural roads did not, in general, get the attention they should have received.

There is but one reason for this showing and it is touched upon briefly in the report covering the activities of the Department during the fiscal year 1946-1947. Specific reference is made to the fact that all three maintenance divisions were forced to use their allotted money on only the critical items of operations; therefore, the weekly savings accumulated when not mowing rural roads were used on items like surface patching of old concrete highways.

This practice is not desirable but when insufficient funds are provided, certain items of lessor importance must be curtailed.

Traffic Service

Following the pattern described in the last report, a continued effort has been made to improve this important phase of maintenance. The marking of streets and highways with standard signs for the control, safety and expedition of traffic movement is a necessary and integral part of a transportation system.

Adequate traffic signs are of great assistance to the vehicle operators and are therefore an important and valuable means of safeguarding and expediting traffic. Cost of traffic service is shown in Figure 16.

FIGURE 16
TRAFFIC SERVICE COSTS

County	1939-40	1940-41	1941-42	1942-43	1943-44	1944-45	1945-46	1946-47	1947-48
New Castle	\$34,495.59	\$38,210.01	\$39,887.41	\$34,182.39	\$34,572.96	\$33,567.55	\$37,530.42	\$45,534.10	\$54,944.91
Kent	8,238.41	10,445.04	12,009.78	14,100.43	12,502.39	13,243.70	18,329.44	17,254.17	17,926.34
Sussex	6,425.68	10,375.71	6,377.53	11,498.87	6,435.53	5,512.76	12,828.23	14,580.11	12,765.88
Total.....	\$49,159.68	\$59,030.76	\$58,274.72	\$59,781.69	\$53,510.88	\$52,324.91	\$68,628.09	\$77,368.38	\$85,637.13



WINTER DAMAGE TO EARTH ROAD IN KENT COUNTY

Secondary System

In the Department's concern over problems of traffic congestion on main highways and in urban communities, it has not forgotten the transportation difficulties that handicap a large part of the state's rural population.

It is known that all-weather roads in the Country put an end to part time rural isolation. They bring the farmer's mail to his gate. They carry his family to the theater and to Church on Sundays. His youngsters may ride over them daily on the way to school. They cut the cost of transporting farm produce, and lower the prices consumers pay for food. They increase the value of his farmland.

Some of the benefits resulting from improvement of country roads are capable of fairly precise calculation. Some of the values created, such as the enlargement of educational opportunities, cannot be computed in terms of dollars and cents.

With the realization of these facts as presented above, the Department has embarked upon a program of converting dirt roads with reasonable traffic to hard surface roads. In fact, at the present time 48% of all Delaware's rural highways are hard surfaced. It ranks fourth in the nation being outranked only by three more densely populated states of Connecticut with 67%—Rhode Island with 55%—New Jersey with 49%.

During the coming fiscal year, the Department will improve by contract or by its own forces approximately 50 miles of earth roads. Further, this mileage should increase yearly if funds continue to be available for this type of work.

It would seem appropriate to point out two conditions that have specific bearing on the construction of this type of secondary roads.

In the past roads selected for improvement have been brought up to a standard where they would serve traffic year-round under average winter conditions. Such a policy

has been selected in order that a higher mileage might be constructed with a minimum expenditure. During normal winters these roads have given very satisfactory service; however, when a combination of unusual precipitation and heavy freezing is encountered very costly repairs are necessary. The past winter was an example of such conditions and by referring to the winter damage section of this report it can be seen that of the estimated \$900,000 winter damage, \$775,000 represented damage to roads of the lower classification.

With increasing demands being made for rural "hard surface roads" the policy as previously described seems the most logical solution. Nevertheless, it should be pointed out that this low type construction will serve traffic all year-round only during the average winter seasons and when unusual conditions are encountered heavy maintenance expenditures will be a necessity on sections of these roads.

Last year, I pointed out that each mile of earth classification which was improved into the surface treated classification would add an additional \$200.00 per mile per year over present costs. The construction and improvement of the secondary roads from earth to hard surface types result in additional maintenance requirements and the budget must be increased in proportion to the number of miles built.

Maintenance Suburban Communities

For many years the New Castle Division has been maintaining approximately 90 miles of streets within the suburban communities of that County. In general, these streets were cheaply constructed and were not designed to meet modern suburban traffic.

Within the past few years, the residents of several communities have petitioned for sanitary sewers and several contracts have been undertaken by the New Castle Levy Court. When these sewers were placed the streets were of necessity torn up for a major portion of their width and length.

It is therefore becoming evident that some long range plan will have to be established in order that finances will be available for the complete restoration of these streets as sewers and other utilities are installed.

The problem is most complex and is one that will have to be given consideration before a satisfactory program can be reached.

SUBURBAN COMMUNITIES

This year marked the third year of street construction under the provisions of the Suburban Road Act. Although the results to date have been encouraging, high costs and other miscellaneous factors are slowing the program down.

At the close of the last report year, freeholders in five communities in upper New Castle County were in the process of determining by referenda whether or not they wanted the proposed street improvements. Freeholders in Westwood Manor, Carrcroft and Rolling Park voted favorably for street improvements in their communities, while the freeholders in Hamilton Park and Roselle turned down sidewalk projects.

Construction and bond bids were opened by the New Castle County Levy Court on August 12th, 1947 for the suburban communities voting favorably at the referendum. Low bids for the contract ranged from 11% under to 14% over estimates. All contracts were awarded the low bidders and the last contract was under way by the early part of September. The Rolling Park contract was completed during the fall months. However, it became necessary to carry over a few items of work on the Carrcroft and Westwood Manor contracts into the 1948 construction season. Both of the carry-over contracts were completed in the early spring.

The three contracts constituted 1.26 miles of street construction. Construction costs per front foot of property ranged from \$1.44 to \$4.91. Construction costs per mile

ranged from \$14,000.00 to \$41,000.00. The total construction costs for the three contracts, was \$40,318.22. This compares with six contracts for a total cost of \$122,249.29 during the previous year.

By the end of October 1947, seven new petitions were in hand, all seven were for street improvements, and were from the communities of Overlook Colony (Commonwealth Avenue), Stockdale (Wister Street), North Bellevue Manor, Woodland Homes, Westhaven, Swanwyck and North Street Extended, near Seaford.

Plat maps, surveys, plans, specifications and estimates were prepared during the winter months and submitted to the New Castle County Levy Court by June. In the interim period difficulties were encountered in the suburban community of Overlook Colony (Commonwealth Avenue), and Swanwyck. The freeholders of Overlook Colony (Commonwealth Avenue), requested that their petition be dropped. The freeholders in Swanwyck requested that their petition be held in abeyance subject to having the petition amended as a result of a request by the developers of the area. By the end of the report period information had not been submitted to the Sussex County Levy Court on North Street Extended (Seaford). It is presently planned to hold the latter project over until the 1949 construction year.

By the end of the report year the New Castle County Levy Court was preparing to hold the referenda for the suburban community project in New Castle County.

Changing conditions and the continued high cost of construction are affecting the operation of the Suburban Road Act, and it is now obvious that additional changes in the law are necessary. In the last annual report reference was made to the opposition being encountered by corner property owners. This opposition is continuing and is recognized to be a hardship in many cases. The people of the suburban communities generally agree that some relief should be allowed the corner property owners.

Section 8 of the Suburban Road Act states in part—“that if the estimated cost of said improvement or improvements submitted by the Department shall exceed ten percent of the assessed value of all properties in said suburban communities, as reflected by the books of the Board of Assessment for the county in which said suburban community is situated, then said Levy Court shall not be authorized to proceed with the issuance of bonds as proved in this Act.” The assessed value of most properties are still on a pre-war basis. In addition there are a considerable number of vacant lots in many of the suburban communities. Although the residents and lot owners in a suburban community may be in favor of improvements, the combination of the two before mentioned factors make improvements impossible as long as Section 8 contains the ten percent feature.

The biggest problem arises as a result of the some eighty miles of suburban streets that were taken over by legislative action from the county in 1935. Improvements are badly needed in the greater majority of communities in this category, yet, since the Department has the responsibility for maintenance of these streets, the local residents are very reluctant to initiate any type of project that is going to cost them money. Up to the present time we have not been able to develop any interest in the Suburban Road Act in communities in which we are maintaining streets.

I wish to recommend to the Department the following legislative program regarding the Suburban Road Act.

1. That the law be amended so that corner property owners will pay full value for the frontage of their property abutting the improved street, and fifty percent of the sideage of their property abutting the improved street;
2. That the law be amended to delete the 10% feature in Section 8.
3. That the possibility of State Aid in suburban road construction be explored.

SUBURBAN COMMUNITY CONSTRUCTION—PETITIONS RECEIVED IN 1947
CONSTRUCTION UNDERTAKEN IN 1947

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Community	Miles of Construction	Estimated Cost	Amount of Bond Issue	Bond Issue Interest Rate	Low Bid Price	Final Construction Cost	Property Front Foot	Construction Cost per Front Foot
Carreroft	0.286	\$11,834.80	\$12,500.00	1.375	\$11,853.00	\$11,764.36	2,398	\$4.91
Westwood Manor	0.754	30,116.54	30,000.00	1.375	27,785.00	25,435.54	7,440	3.42
Rolling Road	0.220	3,244.50	3,500.00	1.375	3,705.00	3,118.32	2,173	1.44
Totals	1.260	\$45,195.84	\$46,000.00		\$43,343.00	\$40,318.22	12,011	Av. \$3.36

RECOMMENDATIONS

Highway Research

Improved engineering and construction practices through research is a reasonable expectation. Certain it is that opportunities for improvement are not lacking. Faced with the loss of these opportunities for improvement, the Delaware State Highway Department should stop and examine this challenge.

The Division of Tests is basically a materials testing and a quality control group and therefore progress is practically nil in any fundamental research toward the solution of current design and construction problems. The present organizational set up of the Division of Tests permits only two to three months of the year to be devoted to the countless problems in design, construction and maintenance that are continually plaguing the Department.

It is with these "lost opportunities for improvement" and their consequent savings in dollars and cents that the following recommendation is offered for serious consideration: A nucleus of a future full-time, small research group be formed, as soon as possible, and a fundamental research program toward the solution of our current design, construction and maintenance problems be launched at once.

RECOMMENDATIONS

New Construction

I have reviewed and studied very carefully our construction needs and I wish to recommend, for your consideration and subsequent action, the following list of contracts for which the 1948 construction program may be selected. In order that we may proceed in a workmanlike manner it is essential that the program be selected at an early date.

NEW CASTLE COUNTY

Title of Contract	Type of Construction	Federal Aid System	Mileage
Cranston Heights to Basin Corner	Reconstruction	Primary	4.07
Phila. Pike (Claymont to Pa. Line)	Reconstruction	Primary	1.70
Brandywine Boulevard	New Construction	Secondary	1.97
Newark to Limestone Road (B)	New Construction	Primary	2.32
Augustine Bridge	Repairs and Repainting	None .....	..
Third Street Bridge	Repairs and Fender System	None .....	..
Seventh Street Bridge	Repairs and Repainting	None .....	..
Taylor's Bridge	New Bridge	Secondary .....	..
Talley Road Bridge	New Bridge	None .....	..
Middletown to Summit Bridge	Reconstruction	Primary	7.37
Newport Pike (Boxwood Road to Broom Street)	New Construction	Primary	1.40
Baynard Boulevard-Wilmington-(Washington St.- Concord Ave.)	New Construction	Urban	0.70
Summit Bridge to Tybouts Corner	Reconstruction	Primary	7.25
Lancaster Pike (Ext.)	Grading	Primary	2.30
duPont Road (Maryland Avenue-Kennett Pike)	Reconstruction	Secondary	2.88
Glasgow Station to Newark	New Construction	Secondary	5.60
Drawyers Bridge and Approaches	New Construction	Primary	0.70
Wilmington Avenue (Elsmere)	New Construction	Primary	0.50
Concord Pike (Baynard Blvd. to Murphy Road)	New Construction	Primary	2.41
Concord Pike (Murphy Road to Talleyville)	New Construction	Primary	2.90
Philadelphia Pike (Wilmington to Bellevue Road)	Reconstruction	Primary	1.90
Philadelphia Pike (Bellevue Road to Claymont)	Reconstruction	Primary	2.49
Marsh Road (Washington Street Extended to Gov. Printz)	Reconstruction	Secondary	0.93
Bellevue Road (Philadelphia Pike to Gov. Printz Boulevard)	Reconstruction	Secondary	0.56
Silverside Road (B. & O. R. R.-Philadelphia Pike)	Reconstruction	Secondary	0.93
Carpenter Station Bridge	New Construction	Secondary .....	..
Rockland Road	New Construction	Secondary	1.20
Newark to Christiana	Reconstruction	Primary	4.73

NEW CASTLE COUNTY—(Continued)

Title of Contract	Type of Construction	Federal Aid System	Mileage
Christiana to Hares Corner	Reconstruction	Primary	3.19
Kings College to New Castle	New and Reconstruction	Secondary	6.43
Maryland Line to State Road (East Bound Dual)	Reconstruction	Primary	9.90
Fieldsboro to St. Georges Bridge	Reconstruction	Primary	7.78
St. Georges Bridge to Black Cat	Reconstruction	Primary	9.14
Lincoln Street (Wilmington)	New Construction	Urban	1.37
Ridge Road (Naamans Road to Pennsylvania Line)	Reconstruction	Primary	0.22
Lancaster Pike (Ferris Road to Greenhill Avenue)	New and Reconstruction	Primary	1.38
Middletown to Odessa	New Construction	Primary	3.19
Blackbird to Walker School	New Construction	Secondary	2.69
Maryland Line to Newark (State Route No. 2)	Reconstruction	Secondary	2.68
Maryland Line to Newark (State Route No. 273)	Reconstruction	Primary	1.96
Newark to Maryland Line (State Route No. 896)	Reconstruction	Secondary	3.19
Fieldsboro to Middletown	New Construction	Secondary	1.13
Kennett Pike	Reconstruction	Primary	4.48
			115.54

KENT COUNTY

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Title of Contract	Type of Construction	Federal Aid System	Mileage
Little Mastens Corner to Felton	New Construction	Secondary	6.25
Camp Meeting Woods to Silver Lake	Reconstruction	Primary	3.73
Wyoming Mill to S. R. No. 8	New Construction	Secondary	2.62
Leipsic Bridge and Approaches	New Construction	Secondary	0.33
Kenton to Pleasanton's Garage	Reconstruction	Primary	6.13
Burrsville to Harrington	Reconstruction	Primary	9.48
S. of Woodside to Camden	Reconstruction	Primary	4.56
Marydel to Pearson's Corner	Reconstruction	Primary	6.15
Tilghmans Corner to Hazletville	Reconstruction	Secondary	4.96
Marklands Corner to South Leipsic	Reconstruction	Secondary	3.29
Hartly to Dover	Reconstruction	Primary	9.66
Smyrna to Woodland Beach	Reconstruction	Secondary	6.08
Walnut Street, Milford	Reconstruction	None	0.65
Whiteleysburg to Felton	Reconstruction	Secondary	9.85
Commerce Street, Smyrna	Reconstruction	Primary	1.11
State Street, Dover	Reconstruction	Primary	3.17
Division Street, Dover	Reconstruction	Primary	0.84
Mill Creek Road, Smyrna	New Construction	Secondary	1.24
Farmington to Harrington	New Construction	Secondary	4.20
Barbers Corner, Hazel School	New Construction	Secondary	10.13
Felton to Woodside	New Construction	Secondary	4.24
Slaughter Station	New Construction	Secondary	2.66
Willow Grove to Hazletville	New Construction	Secondary	2.98
Maryland Line to Flemings Corner	New Construction	Secondary	6.77
Canterbury to Dover	Grading	Primary	5.70
Harrington to Frederica	Widening	Secondary	7.29
Maryland Line to Pleasanton Garage	Reconstruction	Secondary	7.78
Harrington to Milford	Reconstruction	Primary	7.28
Sandtown to Tilghman's Corner	New Construction	None	4.07
Barratt's Chapel to Canterbury	New Construction	None	5.85

KENT COUNTY—(Continued)

Title of Contract	Type of Construction	Federal Aid System	Mileage
Little Creek Bridge	New Construction	Secondary .....	..
Mahon's Ditch Road	New Construction	None	3.73
Magnolia to Barkers Landing	New Construction	Secondary	1.40
Barkers Landing Bridge	Repairs	Primary .....	..
Washington Street Bridge (Milford)	Repairs	None .....	..
Bridge No. 14-A	Repairs	Secondary .....	..
Bridge No. 227-A	New Bridge	None .....	..
Bridge No. 439-A	New Bridge	None .....	..
Bridge No. 306-A	New Bridge	None .....	..
			154.18

SUSSEX COUNTY

Title of Contract	Type of Construction	Federal Aid System	Mileage
Milton to Overbrook	New Construction	Secondary	4.38
Georgetown Airport Road	New Construction	Secondary	2.07
Indian River Inlet Bridge	New Construction	Primary .....	..
Cedar Creek Bridge	New Construction	None .....	..
Laurel to Seaford	Reconstruction	Secondary	6.83
Georgetown to Laurel	Reconstruction	Primary	13.63
Laurel to Mission	Reconstruction	Primary	12.41
Maryland Line at Sharptown to Laurel	Reconstruction	Primary	7.40
Harbeson to Route No. 24	Reconstruction	Secondary	8.35
Hardscrapple to Concord	Reconstruction	Secondary	4.21
Bridgeville By-Pass	New Construction	Primary	2.46
Argo's Store to Slaughter Beach	Reconstruction	Secondary	3.63
Milton to Waples Pond	Reconstruction	Secondary	2.52
Harbeson to Milton	Reconstruction	Secondary	5.28
Harman's School to Oak Orchard	Reconstruction	Secondary	2.06
Dagsboro to Shaft Ox	Reconstruction	Secondary	5.69
Seaford to Atlanta	Reconstruction	Secondary	5.83
Maryland Line to Portsville	New Construction	Secondary	5.30
County Roads Nos. 387 and 381	New Construction	Secondary	4.45
Sound Camp to Roxana	Reconstruction	Secondary	3.91
Gravel Hill to Milton	New Construction	Secondary	4.39
Wainwrights School to Oak Grove	Reconstruction	Secondary	3.46
Seaford to Ross Station	Reconstruction	Secondary	2.61
(Line Road) Delmar to Road No. 66	Reconstruction	Secondary	3.46
Dagsboro to Piney Neck	New Construction	None	3.08
Shingle Point to Milton	Reconstruction	Secondary	4.57
Greenwood to Kent Line	Reconstruction	Secondary	2.46
Mispillion Light House Road	New Construction	Secondary	1.04
Hopkins Corner to Route No. 14	New Construction	Secondary	4.26
Mission to Shortly	New Construction	Secondary	4.47

SUSSEX COUNTY—(Continued)

Title of Contract	Type of Construction	Federal Aid System	Mileage
County Roads No. 552-No. 553-(No. 547)-(No. 553-A)	New Construction	Secondary	6.08
Johnson Store to Bayard	New Construction	Secondary	1.71
Susan Beach Corner to Horsey's Church	New Construction	Secondary	4.79
Greenwood to U. S. No. 113	Reconstruction	Secondary	7.45
County Road No. 277	New Construction	Secondary	4.49
County Road No. 527 and No. 524	New Construction	None	6.46
Frankford to Clarksville	Surfacing	Secondary	6.00
County Roads Nos. 308, 309 and 310	New Construction	None	1.89
County Road No. 550	New Construction	None	2.02
Good Hope School Bridge	Repairs	None	..
Mill Creek Bridge	New Bridge	None	..
Assawoman Canal Bridge (Ocean View)	Redeck Bridge	Primary	..
Famy's Branch Bridge	New 19' Span	None	..
Tantrough Branch Bridge	Repairs	None	..
			175.10

THE DELAWARE MEMORIAL BRIDGE

The following chronology gives the important steps taken in the development and progress of The Delaware Memorial Bridge:

- May 4, 1939—Delaware Legislation approved authorizing and directing the State Highway Department to investigate the legal, engineering and financial problems relating to the construction of a highway crossing of the Delaware River.
- Jan. 21, 1941—Report of the Delaware State Highway Department to the Governor and members of the State Legislature relative to the legal, engineering and financial problems involved in the construction of a Delaware River highway crossing.
- Apr. 18, 1945—Delaware legislation approved authorizing the State Highway Department to construct, operate and maintain a highway crossing over the Delaware River.
- Apr. 19, 1945—Delaware legislation approved authorizing the State Highway Department to issue revenue bonds to defray the cost of construction of a highway crossing over the Delaware River.
- Apr. 23, 1945—Delaware legislation approved naming the Delaware River crossing "The Delaware Memorial Bridge" in dedication to those Delaware and New Jersey men and women who gave their lives in World War II.
- Mar. 14, 1946—New Jersey legislation approved permitting cooperation between New Jersey and Delaware in respect to real estate acquisition in New Jersey for the Delaware River Crossing and its New Jersey approach and grant-

ing the consent of New Jersey to the construction, operation and maintenance of this crossing.

May 2, 1946—Howard, Needles, Tammen & Bergendoff selected as Consulting and Designing Engineers.

July 13, 1946—Congressional franchise approved for the construction, operation and maintenance of a highway bridge over the Delaware River below Wilmington by the State of Delaware through its State Highway Department.

Aug. 22, 1946—Application made by the State of Delaware to the Chief of Engineers and the Secretary of War for the establishment of navigation clearances and for permission to build the Delaware River Bridge below Wilmington.

Nov. 13, 1946—Public hearing held in Wilmington by a joint Army and Navy Board to consider the application by the State of Delaware for a War Department permit to build the Delaware River Bridge below Wilmington.

Mar. 15, 1947—Formal permit issued to the State of Delaware for the construction of the Delaware River Bridge below Wilmington, permit being signed by the Chief of Engineers, the Secretary of War and the Secretary of Navy.

April 5, 1947—Amended Delaware legislation approved authorizing the State Highway Department to establish the "Delaware Crossing Division," issue \$40,000,000 of revenue bonds and make expenditures for certain preliminary activities.

Following the amended legislation authorizing the issue of \$40,000,000 of revenue bonds, approved on April 5, 1947, immediate steps were taken to proceed with the final design of the structure.

In June, 1947 a contract was awarded for taking soundings and borings along the proposed location, and the work was carried to an early completion.

The preparation of plans and specifications proceeded rapidly and on January 6, 1948 bids were received on Contract No. 2—Tower Piers and Anchorage Foundations. The weakness of the bond market at the time made it necessary to delay the awarding of this contract. However, arrangements for the sale of the entire \$40,000,000 bond issue were consummated on June 8, 1948 and the award for the revised contract was made to Merritt-Chapman & Scott Corporation of New York City on the same day.

Thus at the end of the fiscal period to which this report applies, the coming period, July 1, 1948 to June 30, 1949, can be looked forward to as the beginning of the actual construction of this long-looked-for project.

In closing this report, I wish to express my sincere appreciation to the Chairman of the Highway Department, Mr. F. V. duPont and to the members of the Department for their excellent advice and council during the past year.

To the employees of the Department who have made the carrying out of a large construction program possible, I extend my thanks for their loyalty and their willing and capable assistance.

Respectfully submitted,

W. A. McWILLIAMS
Chief Engineer