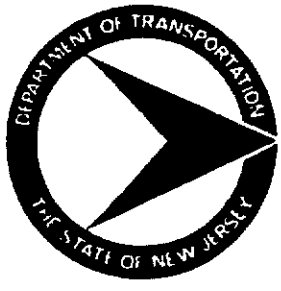
NEW JERSEY
DEPARTMENT OF TRANSPORTATION



STANDARD SPECIFICATIONS

FOR

ROAD AND BRIDGE CONSTRUCTION

1989

PLEASE BE ADVISED THAT THESE STANDARDS MAY *NOT* HAVE BEEN UPDATED TO THE CURRENT STANDARDS CONTAINED IN OUR METRIC VERSION.

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SECTION 101 - GENERAL INFORMATION

101.01 General. The titles and headings of the Sections, Subsections and Subparts herein are intended for convenience of reference and shall not be considered as having bearing on their interpretation.

Working titles which have a masculine gender, such as "workman" and "flagman" and the pronouns and adjectives "he", "his" and "him" are utilized in the Contract Documents for the sake of brevity, and are intended to refer to persons of either sex.

When a publication is specified, it refers to the most recent date of issue, including interim publications, prior to the date of the receipt of bids for the Project unless the issue as of a specific date or year is provided for.

101.02 Abbreviations.

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
API	American Pipe Institute
ASTM	American Society for Testing and Materials
AWPA	American Wood Preservers Association
AWWA	American Water Works Association
AWS	American Welding Society
CRSI	Concrete Reinforcing Steel Institute
EEI	Edison Electrical Institute
EPA	Environmental Protection Agency of the United States Government
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards, General Services Administration
IMSA	International Municipal Signal Association
IPCEA	Insulated Power Cable Engineers Association
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NJSA	New Jersey Statutes Annotated
MUTCD	Manual on Uniform Traffic Control Devices
OSHA	Occupational Safety and Health Administration
PCI	Prestressed Concrete Institute
SSPC	Steel Structures Painting Council
UL	Underwriters' Laboratories

101.03 Terms. When the following terms are used in the Contract Documents, the intent and meaning shall be as follows:

ACCEPTANCE. The term "Acceptance" means the formal written acceptance of the Project by the Commissioner of Transportation which has been completed in all respects in accordance with the Contract Documents.

ACCEPTANCE TESTING. Testing conducted by the Engineer to measure the degree of compliance to the Contract Documents.

ADDENDA. The term "Addenda" means the written or graphic documents issued prior to the opening of bids which clarify, correct or change Contract Documents.

ADVERTISEMENT. The public announcement as required by law, inviting bids for work to be performed or materials to be furnished.

AWARD. The term "Award" means the decision of the Department to accept the Proposal of the lowest responsible Bidder, subject to the execution and approval of a satisfactory Contract based thereon and bonds to secure the performance thereof, and such conditions as may hereinafter be specified or as may be specified or required by law.

BIDDER. The term "Bidder" means an individual, firm, partnership or corporation, or any acceptable combination thereof, acting directly or through a duly authorized representative, legally submitting a bid for the advertised work, and having been qualified to bid on the advertised work pursuant to the provisions of NJSA 27:7-35.1 *et seq*, and regulations issued thereunder.

BRIDGE. Any structure, other than a culvert, including supports, erected over a depression or an obstruction, as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of the structure of more than 20 feet between undercopings of abutments or extreme ends of openings for multiple boxes.

- Bridge length - The length of a bridge structure is the overall length measured along the line of survey stationing back to back of backwalls of abutments, if present, otherwise end to end of the bridge floor; but, in no case less than the total clear opening of the structure.
- Bridge width - The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom or curbs, or in the case of multiple height of curbs, between the bottoms of the lower risers or, if curbs are not used, between inner faces of parapet or railing.

BY OTHERS. The term "by others" refers to a person, firm or corporation other than the Contractor or its surety or persons, firms or corporations in a contractual relationship with the Contractor or the surety, such as a subcontractor, supplier, fabricator or consultant at any tier. "By others" shall include the Department or other public body.

CALENDAR DAY. Each and every day shown on the calendar.

CHANGE ORDER. The term "Change Order" means a written order issued by the Engineer to the Contractor after execution of the Contract authorizing one or more of the following:

- Changes in the Work.
- Adjustments in the basis of payment for the Work affected by the changes.
- Adjustments in the Contract Time.

COMMISSIONER. The term "Commissioner" means the Commissioner of Transportation of the Department of Transportation of the State of New Jersey, as created by law, acting directly or through his duly authorized representatives, such representatives acting within the scope of the particular duties delegated to them.

COMPLETION. The term "Completion" means Completion of the Work. Completion shall occur when:

- the Work has been satisfactorily completed in all respects in accordance with the Contract Documents;

- the Project is ready for use by the State to the degree required by the terms of the Contract, and;
- the Contractor has satisfactorily executed and delivered to the Engineer all documents, certificates and proofs of compliance required by the Contract Documents, it being understood that the satisfactory execution and delivery of said documents, certificates and proofs of compliance is a requirement of this Contract.

CONDITIONAL AWARD. The term "Conditional Award" means an Award, conditioned upon the later grant of approval by the Federal Government or such other State, governmental body or private party, or combination thereof. Where compliance with a Federal requirement or a requirement imposed as the result of the Project being a cooperative endeavor involving one or more states, governmental bodies, private parties, or a combination thereof, makes it not reasonably possible to award the Contract within the 30 working day period fixed by NJSA 27:7-33, the Department may, nevertheless, make a Conditional Award.

CONSTRUCTION OPERATIONS. Construction operations shall include site clearing, demolition, movement of utilities or other facilities and actual construction of any of the temporary or permanent structures, roadways or public improvements required by the Contract. The term shall not include mobilization, procurement and storage of materials and plant, providing engineering, Performance Bond and Payment Bond, surveys, working drawings, field offices, or other schedules, certificates, forms, or documents necessary prior to the performace of Work on Pay Items.

CONSTRUCTION ORDER. The term "Construction Order" includes Field Orders, Change Orders and Supplementary Agreements.

CONTRACT. The term "Contract" means the entire and integrated agreement between the parties thereunder and supersedes all prior negotiations, representations or agreements, either written or oral. The Contract Documents form the Contract between the Department and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to, the performance of the Work and the basis of payment.

CONTRACT DOCUMENTS. The term "Contract Documents" include: Advertisement for Proposal, Proposal, Certification as to Publication and Notice of Advertisement for Proposal, Appointment of Agent by Nonresident Contractors, Noncollusion Affidavit, Warranty Concerning Solicitation of the Contract by Others, Resolution of Award of Contract, Executed Form of Contract, Performance Bond and Payment Bond, Standard Specifications, Supplementary Specifications, Plans, Addenda or other information mailed or otherwise transmitted to the prospective bidders prior to the receipt of bids, Change Orders, Field Orders and Supplementary Agreements, all of which are to be treated as one instrument whether or not set forth at length in the form of Contract.

Note: As used in Sections 102 and 103 only, Contract Documents do not include Change Orders, Field Orders and Supplementary Agreements. As used in Section 102 only, Contract Documents also do not include Resolution of Award of Contract, Executed Form of Contract and Performance and Payment Bond.

CONTRACT TIME. The term "Contract Time" means the number of working days or calendar days including authorized adjustments allowed for Completion. When a specified completion date is shown in the Specifications in lieu of the number of working or calendar days, Completion shall be on or before

that date. Specified completion date and calendar day contracts shall be completed on or before the day indicated even when that date is a Saturday, Sunday or holiday.

CONTRACTOR. The term "Contractor" means the individual, partnership, firm, corporation, or any acceptable combination thereof contracting with the Department for performance of the prescribed Work. Throughout the Contract Documents the Contractor is referred to as if singular in number. The term "Contractor" means the Contractor or the Contractor's authorized representative.

COUNTY AND MUNICIPAL PROJECTS. Those projects carried out with County or Municipal Aid from the State, for which the County or Municipality, and not the State, is the contracting party.

CULVERT. Any structure not classified as a bridge which provides an opening to carry water under the roadway.

CURRENT CONTROLLING OPERATION OR OPERATIONS. The current controlling operation or operations is to be construed to include any feature of the Work, which, if delayed at the time in question, delays the overall time of Completion.

DAYS. Unless otherwise designated, days as used in the Contract Documents means calendar days.

DEPARTMENT. The term "Department" means the Department of Transportation of the State of New Jersey, as created by law.

DEPARTMENT LABORATORY. The term "Department Laboratory" means the main testing laboratory of the Department located at 999 Parkway Avenue, Trenton, New Jersey 08625 or such other laboratory as the Department may designate.

ENGINEER. The term "Engineer" means the State Transportation Engineer, as created by law, acting directly or through his duly authorized representatives, such representatives acting within the scope of the particular duties delegated to them.

Note: In order to avoid repetition, whenever the following words are used, it shall be understood as if they were followed by the words "to the Engineer" or "by the Engineer":

"acceptable, accepted, added, allowed, applied, approved, assumed, authorized, awarded, calculated, charged, checked, classified, computed, condemned, conducted, considered, considered necessary, contemplated, converted, deducted, deemed, deemed necessary, deleted, designated, determined, directed, disapproved, divided, documented, established, evaluated, examined, excluded, furnished, given, granted, included, incorporated, increased, indicated, inspected, insufficient, issued, made, marked, measured, modified, monitored, notified, observed, obtained, opened, ordered, paid, paid for, performed, permitted, provided, received, recorded, reduced, re-evaluated, rejected, removed, required, reserved, retested, returned, sampled, satisfactory, scheduled, specified, stopped, submitted, sufficient, suitable, supplied, suspended, taken, tested, unacceptable, unsatisfactory, unsuitable or used".

EQUIPMENT. All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction of the Work

EXTRA WORK. The term "Extra Work" means new and unforeseen work found essential to the satisfactory completion of the Project,as determined by the Engineer, and not covered by any of the various Pay Items for which there is a bid price or by combination of such items. Such work will be designated as Extra Work. In the event portions of such work are determined by the Engineer to be covered by one of the various Pay Items for which there is a bid price or combinations of such items, the remaining portion of such work will be designated as Extra Work. Extra Work also includes work specifically designated as Extra Work in the Contract Documents.

EXTREME WEATHER CONDITIONS. When, solely as a result of adverse weather, the Contractor is not able to work more than 15 days in any one month from April through November, inclusive, the Contractor is entitled to claim that his progress has been affected by extreme weather conditions during that month and may seek an extension of Contract Time consistent with the provisions of Subsection 108.11. The Contractor shall have no claim that his progress has been affected by extreme weather conditions during the months of December through March, inclusive.

FIELD ORDER. The term "Field Order" means a written order, signed by the Resident Engineer, requiring performance by the Contractor without negotiation of any sort.

HIGHWAY, STREET OR ROAD. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way (see Figure 101-1 on page 12).

HIS OWN ORGANIZATION. This term shall be construed to include only workmen customarily employed and paid directly by the Contractor and equipment owned or rented by him, with or without operators.

HOLIDAYS. The following days shall be considered holidays for use in determination of working days:

New Year's Day	Labor Day
Martin Luther King's Birthday	Columbus Day
Lincoln's Birthday	Presidential Election Day
Washington's Birthday	Veteran's Day
Memorial Day	Thanksgiving Day
Independence Day	Christmas Day

INSPECTOR. The Engineer's authorized representative assigned to inspect contract performance, methods and materials related to the Work both on and off the site of the Project.

INTERAGENCY ENGINEERING COMMITTEE. The committee formed with representation from the New Jersey Department of Transportation, the New Jersey Turnpike Authority, the New Jersey Highway Authority, and the Port Authority of New York and New Jersey to develop standardized construction specifications among the agencies.

INVITATION FOR BIDS. The Advertisement for Proposals for all work or materials on which bids are required. Such advertisement indicates the location of the Project and an estimated quantity of Work to be done or the character and quantity of the material to be furnished and the time and place of the opening of Proposals.

MAJOR AND MINOR PAY ITEMS. The term "Major Pay Item" means any Pay Item having an original contract value in excess of 10 percent of the Total Contract Price. The original contract value of a Pay Item equals the per unit

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price bid for said Pay Item multiplied by the estimated quantity of such item contained in the Proposal Form. All other Pay Items shall be considered "Minor Pay Items".

MATERIALS. Any substances specified for use in the construction of the Project.

MATERIALS QUESTIONNAIRE. The specified forms on which the Contractor shall notify the Engineer of the sources of materials he expects to use.

MEDIAN. That portion of a divided highway separating the paved sections, said paved sections including both the shoulders and the traveled way.

NOTICE TO PROCEED. The term "Notice to Proceed" means the written notice to the Contractor to begin Work.

PAVEMENT STRUCTURE. The combination of surface course and base course, and when specified, a subbase course, placed on a subgrade to support the traffic load and distribute it to the roadbed (see Figure 101-1 on page 12).

- Surface course - One or more layers of specified material of designed thickness on a base course or a subbase.
- Base course - One or more layers of specified material of designed thickness placed on the subgrade or subbase.
- Subbase - One or more layers of specified material of designed thickness placed on the subgrade.

PAY ITEM. The term "Pay Item" means a specifically described item of Work for which the bidder provides a per unit or lump sum price in the Proposal.

PERFORMANCE BOND AND PAYMENT BOND. The term "Performance Bond and Payment Bond" means the approved form of security, executed by the Contractor and his surety or sureties, guaranteeing complete performance of the Contract in conformity with the Contract Documents and the payment of all legal debts pertaining to the construction of the Project.

PLANS. The approved plans, profiles, typical sections, cross sections, working drawings and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions, quantities, and details of the work to be done.

PRECONSTRUCTION CONFERENCE. The initial project meeting conducted by the Regional Construction Engineer, normally held after Award of the Contract and prior to the start of Work. A separate utility preconstruction conference may be scheduled. The Contractor shall attend preconstruction conferences.

PRESIDING OFFICER. The Engineer or his designee in charge of receipt of bids. The Presiding Officer opens each meeting for the receipt of bids and declares when the receipt of bids has been closed.

PROFILE. The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline of the roadway. Profile grade means either the elevation or gradient of such trace according to the context. From this, cross section elevations are established based on the typical section.

PROJECT. The specific section of highway or other public improvement together with all appurtenances and construction to be performed thereon under the Contract. The Project may include work by others under other contracts.

PROPOSAL. The term "Proposal" means the offer of a bidder, properly signed and guaranteed, on the prepared form furnished by the Department, to perform the Work at the prices therein.

PROPOSAL BOND. The term "Proposal Bond" means the security furnished with a bid to guarantee that the bidder shall enter into the Contract if awarded the Contract.

PROPOSAL FORM. The term "Proposal Form" means the approved form on which the Department requires bids to be prepared and submitted for the Work.

RESIDENT ENGINEER. The term "Resident Engineer" means the field representative of the Engineer having direct supervision of the administration of the Contract.

RIGHT-OF-WAY (R.O.W.). A general term denoting all of the land, property or interest therein, usually in a strip, acquired for or devoted to transportation purposes or construction of a public improvement (see Figure 101-1 on page 12).

ROADBED. The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders (see Figure 101-1 on page 12).

ROADSIDE. A general term including:

- The areas between the outside edges of the shoulders and the right-of-way boundaries.
- The unpaved median areas between inside shoulders of divided highways.
- Areas within interchanges.
- Historic sites.
- Viewpoints.
- Scenic strips.
- Junkyard screening over which the State retains maintenance responsibilities.

ROADWAY. The portion of the highway, street or road within the limits of construction (see Figure 101-1 on page 12).

SHALL. Designates an obligation of the Contractor, unless otherwise indicated.

SHOULDER. The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses (see Figure 101-1 on page 12).

SIDEWALK. That portion of the roadway primarily constructed for the use of pedestrians (see Figure 101-1 on page 12).

SPECIALTY ITEMS. Such items shall be limited to work that requires highly specialized knowledge, craftsmanship or equipment not normally available among contractors qualified to bid on the Contract as a whole, and which are designated as "specialty items" in the Contract Documents.

SPECIFICATIONS. The term "Specifications" means the directions, provisions and requirements contained in the Standard Specifications, as supplemented by the Supplementary Specifications, and modified by Addendum or other information giving interpretations or revisions to them which, prior to the receipt of bids, are transmitted to prospective bidders.

STANDARD SPECIFICATIONS. The term "Standard Specifications" means this book of Standard Specifications.

STATE. The term "State" means the State of New Jersey.

STATE BUSINESS DAY. A calendar day, exclusive of Saturdays, Sundays, State-recognized legal holidays, and such other holidays or State office closings as declared by the Governor. The term "State Business Day" as used in the Contract Documents and the term "Working Day" as used in NJSA 27:7-31 and NJSA 27:7-33 are synonymous.

STRUCTURES. Bridges, culverts, inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains and other features which may be encountered in the work and not otherwise classed herein.

SUBCONTRACTOR. An individual, partnership, firm or corporation, or any acceptable combination thereof, to which the Contractor subcontracts part of the work pursuant to Subsection 108.02.

SUBGRADE. The surface of the roadbed upon which the first layer of the pavement structure and/or shoulder section is constructed (see Figure 101-1 on page 12).

SUBSTANTIAL COMPLETION. The term "Substantial Completion" means the point at which the performance of all work on the Project has been completed except landscaping items (including the planting of trees, shrubs, vines, ground covers and seedlings), final cleanup, and repair of unacceptable Work, and provided the Engineer has determined, in his sole discretion, that:

- the Project is safe and convenient for use by the public, and,
- failure to complete the work and repairs excepted above does not result in the deterioration of other completed work; and, provided further, that the value of landscaping work remaining to be performed, repairs and cleanup, is less than 2 percent of the Total Adjusted Contract Price.

SUBSTRUCTURE. All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, together with the backwalls, wingwalls and wing protection railings.

SUPERINTENDENT. The Contractor's authorized representative responsible for and in charge of the work. The Superintendent shall be authorized to receive all communications from the State.

SUPERSTRUCTURE. All of that part of a structure above the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, excluding backwalls, wingwalls and wing protection railing.

SUPPLEMENTARY AGREEMENT. The term "Supplementary Agreement" means a bilateral agreement between the Commissioner and the Contractor, executed on a Change Order form, setting forth the negotiated terms and conditions whereunder changes are to be accomplished, including negotiated adjustments in compensation and time of Completion. The Supplementary Agreement shall be conclusive as to all questions of compensation and extensions of Contract Time relative to the subject of the agreement excepting only those instances wherein the agreement recites specific exceptions.

SUPPLEMENTARY SPECIFICATIONS. The term "Supplementary Specifications" means specifications which are additions and revisions to the Standard Specifications. Supplementary Specifications govern over Standard Specifications.

SURETY. The corporate body bound with and for the Contractor, for the full and complete performance of the Contract and for the payment of all debts and obligations pertaining to the Work.

TESTING AGENCY. A privately owned facility capable of testing and evaluating component parts, or the whole, for certification of the composition or construction of the material or product.

TOTAL ADJUSTED CONTRACT PRICE. The term "Total Adjusted Contract Price" means the Total Contract Price as it is adjusted through the issuance of Change Orders and Field Orders and the calculation of as-built quantities.

TOTAL CONTRACT PRICE. The term "Total Contract Price" means the correctly determined summation of lump sum bids and products of all quantities for Pay Items shown in the Proposal multiplied by the unit prices bid.

TOWN, TOWNSHIP, CITY. A subdivision of the County used to designate or identify the location of the Project.

TRAVELED WAY. The portion of the roadway for the movement of vehicles exclusive of shoulders and auxiliary lanes (see Figure 101-1 on page 12).

UTILITY. A publicly, privately or cooperatively owned agency or agencies operated by one or more persons or corporations for public service. For purposes of this Contract railroads shall be considered utilities.

WILL. Designates an action to be taken by the State, the Department, the Commissioner, the Engineer or any authorized representative, unless otherwise indicated.

WORK. The term "Work" means the furnishing of all labor, services, materials, equipment, tools, transportation, supplies and other incidentals necessary or convenient to the successful completion by the Contractor of the construction described in the Contract Documents and the carrying out of all duties and obligations imposed by the Contract Documents on the Contractor.

WORKING DAY. Any calendar day, exclusive of:

- Saturdays, Sundays and holidays,
- days on which the Contractor is specifically required by the Supplementary Specifications to suspend construction operations, and
- days on which the Contractor is prevented by inclement weather or conditions resulting immediately therefrom adverse to the current controlling operation or operations, as determined by the Engineer, from proceeding with at least 75 percent of the normal labor and equipment force engaged on such operation or operations for at least 60 percent of the total daily time being currently spent on the controlling operation or operations.

Should the Contractor prepare to begin work at the regular starting time in the morning of any day on which inclement weather, or the conditions resulting from the weather, prevent the work from beginning at the usual starting time, and the crew is dismissed as a result thereof, and the Contractor does not proceed with at least 75 percent of the normal labor and equipment force engaged in the current controlling operation or operations for at least 60 percent of the total daily time being currently spent on the controlling operation or operations, the Contractor will not be charged for a working day whether or not conditions should change thereafter during said day and the major portion of the day could be considered to be suitable for such construction operations.

WORKING DRAWINGS. Stress sheets, shop drawings, diagrams, illustrations, schedules, performance charts, brochures, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, and any other supplementary plans or similar data which are prepared by the Contractor or any subcontractor, manufacturer, supplier or distributor, and which the Contractor is required to submit to the Engineer for approval.

101.04 Inquiries Regarding the Project. Inquries prior to bids regarding any discrepancy, error or omission, or concerning the intent or meaning of the Plans, Specifications, or other Contract Documents shall be directed to the Department as provided in the Supplementary Specifications. Contractors shall rely only upon written responses to their inquiries. Oral responses will be of no effect.

Figure 101-1

Figure 101-1

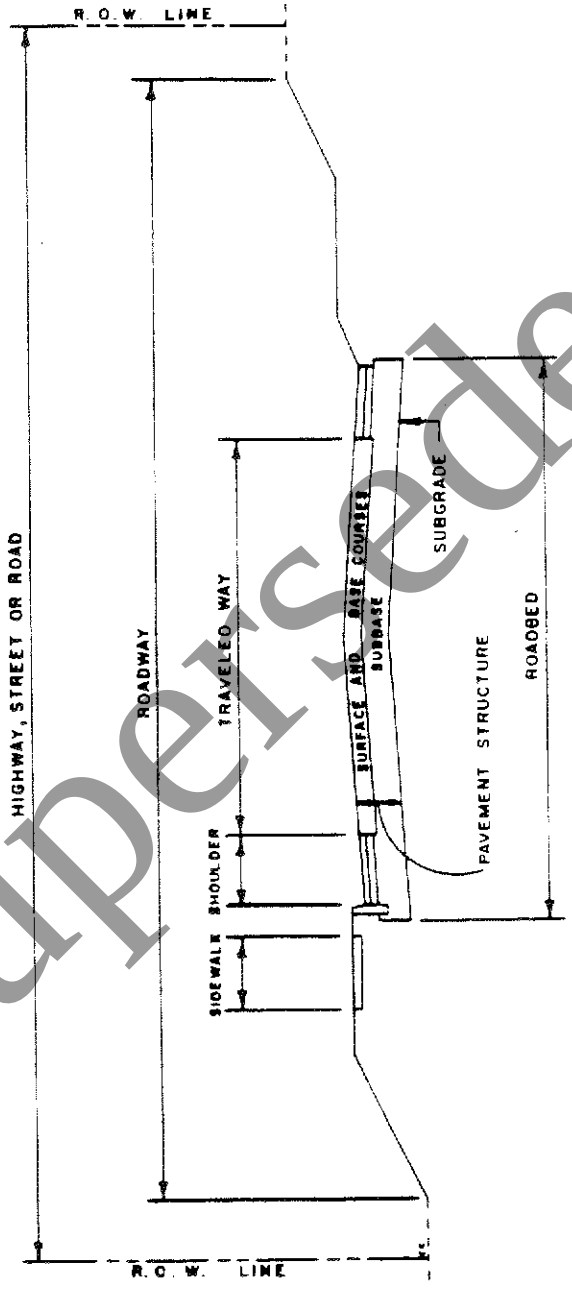

FIGURE 101-1

SECTION 102 - BIDDING REQUIREMENTS AND CONDITIONS

102.01 Prequalification of Prospective Bidders. Proposals will be received only from bidders who, prior to the delivery of the Proposal, have, as required by statute, submitted under oath, statements relating to their financial ability, adequacy of plant and equipment, organization and prior experience and other matters, on forms furnished by the Department; who have been prequalified in accordance with Regulations Covering the Classification of Prospective Bidders issued in accordance with NJSA 27:7-35.1 *et seq* and ownership as required by NJSA 52:25-24.2; and who at the time of delivery of Proposals have effective prequalification ratings of not less than the amounts of their respective bids.

102.02 Disqualification of Prequalified Prospective Bidders. The Department reserves the right to disqualify or refuse to receive a Proposal Form from a prospective bidder even though prequalified as required by Subsection 102.01 or reject a Proposal after having received same for any of the following reasons:

- Lack of competency or lack of adequate machinery, plant or other equipment.
- Uncompleted work which, in the judgment of the Department, might hinder or prevent the prompt completion of additional work, if awarded.
- Failure to pay, or satisfactorily settle, all bills due for labor, equipment or material on previous Contracts.
- Failure to comply with any prequalification regulations of the Department.
- Default under any previous contract.
- Unsatisfactory performance on previous or current contracts.
- Questionable moral integrity as determined by the Attorney General of New Jersey or the Commissioner.
- Failure to reimburse the State for monies owed on any previously awarded contracts including those where the prospective bidder is a party to a joint venture and the joint venture has failed to reimburse the State for monies owed.

102.03 Contents of the Proposal. Upon request, the Department will furnish prequalified prospective bidders with a Proposal Form. Informational copies are available. The Proposal Form states the location and description of the Project, shows the approximate estimate of the various quantities and kinds of Work to be performed and includes a schedule of Pay Items for which bid prices are invited. The Proposal Form and accompanying Supplementary Specifications state the number of days or date in which the Project must be completed, the amount of the Proposal Bond and the date, time and place of the opening of Proposals.

All papers bound with or attached to the Proposal Form are considered a part thereof and must not be altered and must be submitted with the Proposal.

Other Contract Documents are considered a part of the Proposal whether attached or not.

Prospective bidders are required to pay the Department the sum stated in the Specifications for each copy of the Proposal Form, Supplementary Specifications and each set of Plans.

102.04 Interpretation of Quantities in Bid Schedule. The quantities appearing in the bid schedule are approximate only and are prepared for the comparison of bids. Payment will be made only for the quantities of Work completed in accordance with the Contract. Such payment will be made at the original unit prices for the

quantities of Work accepted by the Engineer. The scheduled quantities of Work may be increased or decreased, or Pay Items may be eliminated in their entirety as hereinafter provided.

102.05 "If and Where Directed" Items. The Proposal Form may request bids on one or more Pay Items to be incorporated into the Project "if and where directed" by the Engineer. Such items may not be located on the Plans. The estimated quantities set out in the Proposal Form for such items are presented solely for the purpose of obtaining a representative bid price, but are not intended to indicate the Department's anticipation as to the quantities of such items which are to be actually incorporated into the Project. Depending on field conditions, such "if and where directed" items may or may not be incorporated into the Project and if incorporated may be many times the estimated quantity or only a fraction thereof.

Incorporation of such items shall only be made on written directions of the Engineer. In the absence of written directions, no such items shall be incorporated into the Project and if incorporated will not be paid for. The Engineer may order incorporation of such items at any location within the Project, and at any time during the Contract Time. Claims for additional compensation shall not be made because of any increase, decrease or elimination of such items, nor because of an increase or decrease in the amount of Work due to the field conditions encountered in incorporating such items into the Project.

102.06 Examination of Contract Documents and Site of Project. The bidder shall examine carefully the site of the proposed Project and the Contract Documents before submitting a Proposal. The submission of a bid is conclusive evidence that the bidder has made such examination and is fully aware of the conditions to be encountered in performing the Work and as to the requirements of the Contract Documents.

(a) Investigation of Subsurface and Surface Conditions. Where the Department has made investigations of subsurface conditions in areas where Work is to be performed under the Contract, or in other areas, some of which may constitute possible local material sources, such investigations are made only for the purpose of study, estimating and design. Where such investigations have been made, bidders may, upon written request, inspect the records of the Department as to such investigations subject to and upon the conditions set forth herein. Such inspection of records may be made at the Department of Transportation building, 1035 Parkway Avenue, Trenton, New Jersey, or at such other locations as directed in response to the written request.

Boring logs, if borings are taken, are part of the subsurface information made available. Such borings, which are taken solely for design purposes, were obtained with reasonable care and recorded in good faith. The soil and rock descriptions shown are determined by a visual inspection of samples from the various explorations unless otherwise noted. These samples are made available for non-destructive examination. The observed water levels and other water conditions indicated on the boring logs are as recorded at the time of the exploration. These levels and other conditions may vary considerably, with time, according to the prevailing climate, rainfall and other factors.

Boring logs may be inspected at the Bureau of Geotechnical Engineering, 1035 Parkway Avenue, Trenton, New Jersey 08625 or ordered through the Cashier of the Department, accompanied by a check for the proper amount drawn to the order of the New Jersey Department of Transportation.

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When contour maps were used in the design of the Project, the bidders upon written request may inspect such maps, and if available, they may obtain copies for their use.

The records of the Department's subsurface investigation are not a part of the Contract and are made available for inspection solely for the convenience of the bidder or Contractor. This investigation, while considered by the Department to be sufficient for design purposes in both scope and content, is not necessarily sufficient for construction purposes and is not keyed to the needs of the bidder and Contractor.

It is expressly understood and agreed that the Department assumes no responsibility whatsoever in respect to the sufficiency or accuracy of the subsurface investigations, the records thereof, or of the interpretations set forth therein or made by the Department in its use thereof other than as used to establish a design for the Project in its as-built condition. There is no warranty or guaranty, either express or implied, that the conditions indicated by such investigations or records thereof are representative of those existing throughout such areas, or any part thereof, or that unlooked-for developments may not occur, or that materials other than, or in proportions different from those indicated, may not be encountered.

The availability or use of information described in this Subsection is not to be construed in any way as a waiver of the above provisions and a bidder is cautioned to make such independent investigation and examination as he deems necessary to satisfy himself as to conditions to be encountered in the performance of the Work and, with respect to possible local material sources, the quality and quantity of material available and the type and extent of processing that may be required in order to produce material conforming to the requirements of the Contract Documents.

Information derived from such inspection of records of investigations or compilation thereof made by the Department or from the Consultant, or his assistants, does not relieve the bidder or Contractor from any risk or from properly fulfilling the terms of the Contract.

Moreover, New Jersey is a small, heavily populated State whose physical geography has received thorough examination. The bidder is charged with knowledge of the State's physical geography from publications prepared under the auspices of the Federal and State governments, educational institutions and others. Therefore, the bidder, in performing his site investigation, should be fully aware of the following publications and such others as may be listed in the Supplementary Specifications:

- Bulletin 50, Geologic Series, "The Geology of New Jersey" by H. Kummel, out of print, available generally as library reference material.
- Geologic Maps of New Jersey available through the New Jersey Department of Environmental Protection.
- Engineering Soils Survey of New Jersey, available through the Bureau of Engineering Research, College of Engineering, Rutgers University, New Brunswick, NJ 08903.

- Soil Surveys of Individual Counties prepared by the US Department of Agriculture, Soil Conservation Service, in cooperation with the New Jersey Agricultural Experiment Station and Cook College, Rutgers University, available through local Soil Conservation District Offices.

The bidder should also conduct such borings, soils tests and other subsurface investigations and obtain such expert advice on site conditions, both surface and subsurface, as is required for bidding and for the construction of the Project.

(b) *Right-of-Way Availability.* The bidder shall consider the effect on his work schedule of any delays in right-of-way availability as may be set forth under Subsection 108.12. The submission of a bid shall be considered conclusive evidence that the bidder has considered such delays and made allowance for them in the progress schedule.

(c) *Utilities.* The bidder shall consider the effect on his work schedule of Subsections 105.09 and 105.10. He shall make a diligent investigation of all utilities on the job site, including any necessary de-energization of power lines, and contact all utilities inquiring as to their planned operations and existing and proposed facilities prior to bidding.

(d) *Other Contractors.* The bidder shall examine the Project site and adjacent areas so as to be fully aware of other contractors working on or adjacent to the site. He shall become fully aware of the operations of such contractors before bidding and how their operations affect his progress. The bidder should also consider, and allow for in bidding, the right of the Department at any time to contract for and perform other or additional work on or near the Project, and the conditions and terms of this Contract relative thereto as set forth in Subsection 105.10.

(e) *Mass Diagram and Cross Sections.* The swell or shrinkage of excavated material and direction and quantities of haul or overhaul as and if shown on said mass diagram are for the purpose of design only, and in like manner as provided in Subpart (a) above, concerning furnishing information resulting from subsurface investigations, the Department assumes no responsibility whatever in the interpretation or exactness of any of the information shown on said mass diagram, and does not, either expressly or impliedly, make any guarantee of the same.

Similarly, the cross sections are not intended to be relied upon to accurately indicate the location or quantities of rock and soil. The bidder should independently make an investigation as to the location, quality, and quantity of rock and soil.

102.07 Preparation of Proposal. The bidder shall submit a Proposal on the forms furnished by the Department. The bidder shall specify a price in figures for each Pay Item. For lump sum items, the price should appear solely in the box provided for that lump sum item under the column designated as "Amounts". For unit price items the per unit price shall appear under the column designated "Unit Price" in the appropriate box and the product of the respective unit price and the approximate quantity for that item shall appear under the column designated "Amounts." The Total Contract Price is the sum of all figures shown in the column designated "Amounts" and shall appear at the location provided therefor. When the bidder intends to bid zero ($0.00) for a Pay Item, a "0" should appear in the "Unit Price" and "Amounts" columns for unit price items or in the "Amounts" column for lump sum items.

When the Proposal Form contains a choice to be made by the bidder, the bidder shall indicate his choice in accordance with the Specifications for that particular Pay Item or Items and thereafter no further choice will be permitted. The boxes provided in

the Proposal Form for the Pay Item or Items not chosen shall contain no entries in the "Unit Price" or "Amounts" columns. When the Proposal Form contains alternate Pay Items to be bid, the bidder shall provide prices for each of the alternate items in accordance with the Specifications. However, in developing the Total Contract Price only the lowest "Amount" for these lower alternate Pay Items shall be used.

Unless otherwise directed, the lower priced alternate Pay Item shall be constructed. However, if prices bid for alternate items are equal, the Department will notify the Contractor within 30 days after execution of the Contract as to which alternate shall be constructed.

All figures entered in the "Unit Price" and "Amounts" columns and the figure entered for the Total Contract Price shall be in ink or shall be typed.

The Proposal Form must be signed in ink by the bidder. If the bidder is an individual, his name and post office address must be shown; by a partnership, the name and post office address of each partnership member must be shown; as a joint venture, the name and post office address of each member or officer of the firms represented by the joint venture must be shown; by a corporation, the name of the corporation and the business address of its corporate offices must be shown.

102.08 Balanced Bids. The bidder shall prepare his bid so that it reflects under each Pay Item the actual cost which the bidder anticipates the performance of that particular item entails, together with a proportional share of the bidders anticipated profit, overhead and costs to perform work for which no Pay Item is provided. The Department will not consider any claim for additional compensation arising from the bid on an item, or group of items, inaccurately reflecting the cost of such work or containing a disproportionate share of the bidder's anticipated profit, overhead and other costs. The Contractor expressly waives the right to pursue such claims either before the Commissioner or under the terms of the New Jersey Contractual Liability Act.

102.09 Delivery of Proposals. Each Proposal should be submitted in a special envelope furnished by the Department. The blank spaces on the envelope shall be filled in correctly to clearly indicate its contents. When an envelope other than the special one furnished by the Department is used, it shall be of the same general size and shape and be similarly marked to clearly indicate its contents. The Proposal shall be mailed or hand carried to the Department at the address and in care of the official in whose office the bids are to be received. Proposals must be received prior to or at the time and at the place specified in the Advertisement. Proposals will not be accepted after the receipt of bids has been declared closed by the Presiding Officer.

Enclosed in the sealed envelope with the Proposal shall be submitted the following documents:

- The Proposal Bond as described in Subsection 102.10.
- An updated financial questionnaire on forms furnished by the Department, properly filled out, signed and notarized.

When the bidder submits Proposals for two or more Projects, a single updated financial questionnaire, submitted in a separate envelope, is acceptable in lieu of a separate questionnaire for each Project.

102.10 Proposal Bond. The Proposal when submitted shall be accompanied by a Proposal Bond satisfactory to the Commissioner, on the form furnished by the Department, for a sum of not less than 50 per cent of the Total Contract Price.

The Proposal Bond shall be properly filled out, signed and witnessed, and shall be furnished only by such surety company or companies authorized to do business in this State as are listed in the current US Treasury Department Circular 570 as of the date for receipt of bids for the particular Project.

The Proposal Bond shall be accompanied by a copy of the power of attorney executed by the surety company or companies. The power of attorney shall set forth the authority of the attorney-in-fact who has signed the bond on behalf of the surety company to bind the company and shall further certify that such power is in full force and effect as of the date of the bond.

102.11 Withdrawal of Proposals. A bidder may withdraw a Proposal after it has been submitted to the Department, provided the request for such withdrawal is received by the Department, in writing or by telegram, before the time set for opening Proposals.

Proposals shall not be withdrawn after the time designated for the public opening of such Proposal, except to exercise the option set out in the following:

- When Proposals for more than one project are to be opened at the same time, a bidder, at his option, may submit a written request to withdraw his Proposal for the second or succeeding project. The bidder shall notify the Department, in writing, of his intent to exercise this option before the time set for opening of Proposals. In such event, a short interval of time will be allowed between project Proposal openings to allow the bidder time to submit an executed Department of Transportation "Request for Withdrawal of Bid" form. Upon presentation of the executed form at the proper time, a bidder's Proposal will be returned to him unopened.

102.12 Combination or Conditional Proposals. If the Department so elects, Proposal Forms may be issued for projects in combination and/or separately, so that bids may be submitted either on the combination or on separate units of the combination. The Department reserves the right to make awards on combination bids or separate bids to the best advantage of the Department. Combination bids other than those specifically provided for in the Proposal Forms will not be considered. Separate contracts will be awarded for each individual Project included in the combination.

Conditional Proposals will be considered only when provided for in the Supplementary Specifications.

102.13 Acknowledgement of Revisions. When Addenda and other forms of notice giving revisions and interpretations of the Contract Documents are mailed or otherwise transmitted to prospective bidders, acknowledgement thereof must be made by the bidder. The acknowledgement shall be sent or hand delivered to the office and/or individual noted on the form, and must be received before the Proposal of the bidder concerned is opened. If the acknowledgement has not been received prior to the opening of bids, the bid envelope will be returned to the bidder unopened.

102.14 Public Opening of Proposals. Proposals will be opened and read publicly at the time and place indicated in the Advertisement or such other time and place as may be established by Addendum. Bidders, their authorized agents, and other interested parties are invited to be present.

102.15 Irregular Proposals. Proposals will be considered irregular and may be rejected for the following reasons:

1. If the Proposal is on a form other than that furnished by the Department; or, if the form is altered or any part thereof is detached or incomplete.
2. If the Proposal is not properly signed.
3. If the bid is not typed or in ink.
4. If there are unauthorized additions, conditional or alternate bids, or irregularities of any kind which may tend to make the Proposal incomplete, indefinite, or ambiguous as to its meaning.
5. If the bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award. The prohibition does

not exclude a reservation limiting the maximum gross amount of awards acceptable to any one bidder at any one bid letting. However, the Commissioner will make the selection of which Contract or Contracts are to be awarded to such bidder within the maximum gross amount reserved.

6. If the bidder makes an alteration of the "Unit Prices" or "Amounts" that have been included by the Department, unless otherwise directed by Addendum received prior to receipt of bids.
7. Subject to Subsection 103.01, if the Proposal does not contain a unit price for each Pay Item listed or a Total Contract Price. In the case of authorized alternate Pay Items unit prices must appear for such Pay Items except where the Proposal or Supplementary Specifications specifically states that the bidder need not provide a unit price for each authorized alternate Pay Item.
8. If the Proposal is not accompanied by the Proposal Bond as specified in Subsection 102.10.
9. If the Proposal is not accompanied by an acceptable updated Financial Questionnaire.
10. If acknowledgement of letters and other notices to prospective bidders, giving revisions of or amendments to the Contract Documents, have not been received as prescribed in Subsection 102.13.
11. If the Commissioner deems it advisable to do so in the interest of the State.

102.16 Disqualification of Bidders. Any of the following reasons may be considered as being sufficient for the disqualification of a bidder and the rejection of his Proposal:

1. More than one Proposal for the same work from an individual, firm, partnership, corporation, or combination thereof, under the same or different names. Reasonable grounds for believing that any individual, firm, partnership, corporation, or combination thereof, is interested in more than one Proposal for the work contemplated may cause the rejection of all Proposals in which such individual, firm, partnership, corporation, or combination thereof, is interested.
2. Evidence of collusion among bidders. Participants in such collusion will not be permitted to submit bids for future work of the Department until reinstatement as a qualified bidder by the Commissioner.
3. If any Pay Item bid price is obviously unbalanced. However, non-rejection of a bid on this basis shall not be deemed to be a determination by the Department that the bid is balanced.
4. Uncompleted work which, in the judgment of the Department, might hinder or prevent the prompt completion of additional work, if awarded.

SECTION 103 - AWARD AND EXECUTION OF CONTRACT

103.01. Consideration of Proposals. After the Proposals are opened and read, they are compared on the basis of the correctly determined summation of the correctly determined products of all the quantities for Pay Items shown in the Proposal multiplied by the unit prices bid together with the sums bid for lump sum Pay Items. The Total Contract Price resulting from such comparisons is available to the public upon request. Award will be made on the basis of the Total Contract Price.

In the event of a discrepancy between the unit price bid for any Pay Item and the extension shown for that item under the column of the Proposal Form designated "Amount," the unit price is to govern. Where a unit price is bid for a Pay Item, but no extension is provided, the Department will provide the extension based on the unit price bid and the estimated quantity for that Pay Item. Where an extension is provided by the bidder in the "Amount" column, but no unit price appears in the "Unit Price" column of the Proposal Form, the Department will provide the unit price by dividing the "Amount" figure provided by the bidder by the estimated quantity. Where no figure is provided by the bidder in both the "Unit Price" and "Amount" columns for one or more Pay Items, or where no figure is provided in the "Amount" column for one or more lump sum Pay Items, the Department will consider the amount bid to be zero ($0.00) for that item provided, however, that the Commissioner may reject such a bid if this result would be unconscionable and it is shown that the failure to include a bid price was an excusable mistake.

In the event a corporation not incorporated in the State of New Jersey is the lowest bidder, it shall be authorized to do business in New Jersey pursuant to NJSA 14A:15 *et seq*.

The Commissioner may reject any and all Proposals when he determines that it is in the public interest to do so. He reserves the right to waive technicalities or to advertise for new Proposals.

103.02 Award of Contract. The Award will be made to the lowest responsible bidder whose Proposal conforms in all respects to the requirements set forth in the Contract Documents. The Commissioner will award the Contract or reject all bids within 30 State business days after the bids are received.

The Commissioner may make a Conditional Award pending the approval of the Federal Government, another State governmental body or private party. Should the Contract not be awarded or conditionally awarded within 30 State business days, all bidders shall have the right to withdraw their bids. However, the Commissioner and the lowest responsible bidder and/or the second lowest responsible bidder can agree to extend the time within which the Commissioner may make an award or conditional award by mutual consent.

At the time of Award or Conditional Award to a bidder not a resident of the State of New Jersey, such bidder shall appoint, on the form furnished by the Department, a proper agent in the State of New Jersey on whom service can be made in event of litigation of any type arising under the Contract or as a result of performance of the Contract. Said agency shall remain in effect during the performance of the Contract and for 6 years following Acceptance.

The Award or Conditional Award is not binding upon the State until the Contract has been executed by the Commissioner, nor shall any work be performed on account of the proposed Contract until the prospective Contractor has been notified that the Contract has been executed by the Commissioner, and then only as provided in Subsection 108.03.

103.03 Cancellation of Award. The Department reserves the right to cancel an Award or Conditional Award at any time before the execution of said Contract by all parties without any liability against the Department.

103.04 Return of Proposal Bond. All Prooosal Bonds except those of the two lowest bidders will be returned within 3 State business days after receipt of bids.

The Proposal Bond of the lowest and next lowest bidders will be returned when the Contract and Performance Bond and Payment Bond have been executed and delivered in accordance with the provisions of Subsection 103.06, or, if not executed, when other disposition of the matter has been made by the Commissioner. However, when the Award or Conditional Award has been annulled due to failure of the bidder to whom award was made to execute and deliver the Contract and Performance Bond and Payment Bond, the Proposal Bond of such bidder shall become operative as provided in Subsection 103.07.

103.05 Performance Bond and Payment Bond. Within 10 State business days of the date of Award or Conditional Award, the bidder to whom the Contract has been awarded shall complete and deliver a Performance Bond and a Payment Bond on forms furnished by the Department.

Each bond shall be for a sum of not less than the Total Contract Price less the lump sum bid for the Pay Item "Performance Bond and Payment Bond" and shall be maintained by the Contractor until Acceptance. In the event of insolvency of the surety, the Contractor shall forthwith furnish and maintain, as above provided, other surety satisfactory to the Commissioner.

All alterations, extensions of Contract Time, extra and additional work, and other changes authorized by the Contract Documents may be made without securing the consent of the surety or sureties of the bonds.

The surety corporation bonds shall be furnished by only those sureties listed in the US Treasury Department Circular 570 and authorized to do business in the State. The bonds shall be accompanied by a certification as to authorization of the attorney-in-fact to commit the surety company and a true and correct statement of the financial condition of said surety company.

Payment for the Performance Bond and Payment Bond will be made on a lump sum basis or the actual cost whichever is lower and will be made only upon delivery of a paid bill.

Payment will be made under:

Pay Item	*Pay Unit*
Performance Bond and Payment Bond	Lump Sum

103.06 Execution and Approval of Contract. The Contract shall be signed by the successful bidder and returned, together with the Performance Bond and Payment Bond, within 10 State business days of the date of Award or Conditional Award. If the Contract is not executed by the Commissioner within 45 State business days following receipt from the bidder of the signed Contract and Performance Bond and Payment Bond, the bidder shall have the right to withdraw his bid without penalty. The Contract is not effective until it has been fully executed.

103.07 Failure to Execute Contract. Failure on the part of the bidder to whom the Contract has been awarded to execute and deliver the Contract as provided in Subsection 103.06 and the bonds as provided in Subsection 103.05 in the manner and within the time provided is just cause for annulment of the Award or Conditional Award and for the exclusion of the bidder from bidding on subsequent projects for such period as the Commissioner may deem appropriate. If the award is annulled for the above reasons, the Proposal Bond, as described in Subsection 102.10, shall become forfeited and the State may proceed to recover under the terms and provisions of the Proposal Bond. Award may then be made to the next lowest responsible bidder or the work may be readvertised and constructed under contract, or otherwise, as the

Department may decide. The successful bidder may file with the Commissioner a written notice, signed by the bidder or his authorized representative, specifying that the bidder refuses to execute the Contract. The filing of such notice has the same force and effect as the failure of the bidder to execute the Contract and furnish a Performance Bond and Payment Bond within the time hereinbefore prescribed.

SECTION 104 - SCOPE OF WORK

104.01 Intent. The intent of the Contract Documents is to describe a functionally complete and aesthetically acceptable Project to be constructed and completed by the Contractor in every detail in accordance with the Contract Documents. Any work that may be reasonably inferred from the Contract Documents as being required to produce the intended result shall be supplied whether or not specifically called for. Where the Contract Documents describe portions of the Work in general terms, but not in complete detail, it is understood that only the best construction practice is to prevail and only materials and workmanship of the first quality are to be used.

Only where the Contract Documents specifically describe a portion of the Project as being performed by others is the Work deemed not to constitute construction of the entire Project.

104.02 Changes. The Department reserves the right to make such alterations, deviations, additions to or omissions from the Contract Documents, including the right to increase or decrease the quantity of any Pay Item or portion of the Work or to omit any Pay Item or portion of the Work, and to require Extra Work as needed for the satisfactory completion of the Project. Such increases or decreases, alterations and omissions do not invalidate the Contract nor release the surety, and the Contractor agrees to accept the work as altered, the same as if it had been a part of the original Contract.

Changes which solely involve the increase or decrease in the quantity of Pay Items (not involving unit price adjustments pursuant to Subsection 104.05), the elimination of Pay Items, the adjustment of the estimated quantities in the Proposal as the result of as-built calculations, or minor changes in the work as provided in Subsection 104.03, may be effected by Field Order or Change Order, as determined by the Engineer. All other changes will be included in a Change Order which specifies, in addition to the work to be done, an adjustment of Contract Time, if any, and the basis of compensation for such work. A Change Order does not become effective until the Regional Engineer has approved the proposed Change Order submitted by the Resident Engineer.

Upon receipt of a Field Order or Change Order, the Contractor shall proceed with the ordered work. Where the changes involved require a Change Order, and a Change Order has not yet been issued, the Resident Engineer may direct, by Field Order, that the Contractor proceed with the desired work and the Contractor shall comply. In such cases, the Engineer will, as soon as practicable, issue a Change Order for such work.

When the compensation for an item of work is subject to adjustment under the provisions of Subsections 104.04 through 104.09 the Contractor shall, upon request, furnish the Engineer with adequate detailed cost data for such item of work. If the Contractor requests an adjustment in compensation for an item of work as provided in Subsection 104.05, such cost data shall be submitted with the request.

In addition to Field Orders and Change Orders, the terms and conditions relating to changes may be negotiated with the Contractor. If the Contractor signifies his acceptance of such terms and conditions by executing a Supplementary Agreement, and if such Supplementary Agreement is approved by the Regional Engineer and issued to the Contractor, payment in accordance with the provisions as to compensation and adjustments in the Contract Time therein set forth constitutes full compensation and a mutually acceptable adjustment of Contract Time for all work included therein or required thereby. The Contractor agrees that a proposed Supplementary Agreement which is not approved by the Regional Engineer or which is rejected by the Contractor shall have no effect and that neither may attempt to use it in any litigation which may result from this Contract.

No claim for additional compensation shall be made because of any such alteration, deviation, addition to, or omission from the Work required by the Contract, by reason of any variation between the approximate quantities in the Proposal and the quantities of Work as done, by reason of Extra Work, by reason of elimination of Pay Items, or by reason of changes in the character of Work except as allowed in this Section 104. Attention is directed to Subsections 102.08 and 107.27.

No claim for additional compensation or extension of Contract Time within the scope of this Section 104 will be allowed if asserted after Acceptance.

104.03 Minor Changes in the Work. The Resident Engineer has the authority to order minor changes in the Work not involving an adjustment to the unit or lump sum prices or quantities of Pay Items or an extension of Contract Time, and not inconsistent with the intent of the Contract Documents. Such changes may be effected by Field Order, are binding on the Department and the Contractor. Additional compensation or extension of Contract Time will not be allowed.

104.04 Procedure and Protest. A Field Order or Change Order may be issued at any time. Should the Contractor disagree with any terms or conditions set forth in a Field Order or a Change Order, he shall submit a written protest to the Engineer within 15 days after the receipt of such Field Order or Change Order on forms furnished by the Department. The protest shall state the points of disagreement, and, if possible, the specification references, quantities and costs involved. The protest shall be a specific, detailed statement of the points of disagreement, and the Engineer reserves the right to reject general protests. Rejected general protests which are not cured by the submission of a specific, detailed statement within 5 days of such rejection will not be considered. If a written protest is not submitted, payment will be made as set forth in the Field Order or Change Order and such payment constitutes full compensation for all work included therein or required thereby and also is conclusive as to any Contract Time adjustments provided for therein or in establishing that no Contract Time adjustment was warranted.

Protests related to work ordered by Field Order but as to which a Change Order is required, shall be made within 15 days after receipt of the Field Order. Subsequent issuance of the Change Order shall not be the basis for a protest except to the extent that the Change Order differs materially from the Field Order.

Where the protest concerning a Field Order or a Change Order relates to compensation, the compensation payable for all work specified or required by said Field Order or Change Order to which such protest relates, if later deemed appropriate by the Engineer, will be determined as provided in Subsections 104.05 through 104.08 and Subsection 109.03. The Contractor shall keep full and complete records of the cost of such work and shall permit the Engineer to have such access thereto consistent with Subsection 109.12, as may be necessary to assist in the determination of the compensation payable for such work.

Where the protest concerning a Change Order relates to the adjustment of Contract Time, the time to be allowed therefor, if later deemed appropriate, will be determined as provided in Subsection 108.11

104.05 Increased or Decreased Quantities. Increases or decreases in the quantity of a Pay Item will be determined by comparing the total as-built quantity of such item of work with the quantity contained in the Proposal therefor. In making such a comparison, quantities which are the subject of Supplementary Agreements or Change Orders for Extra Work will not be considered.

Minor Pay Items are not eligible for any adjustment in unit price regardless of how much the total as-built quantity varies from the quantity contained in the Proposal unless eligible for adjustment pursuant to Subsection 104.07.

If the total pay quantity of any Major Pay Item varies from the estimate contained in the Proposal by 25 percent or less, payment will be made for the quantity of work of said item performed at the unit price bid unless eligible for adjustment pursuant to Subsection 104.07.

If the total pay quantity of any Major Pay Item varies from the estimate contained in the Proposal by more than 25 percent, payment will be made in accordance with the following catagories:

(a) *Increases of More Than 25 Percent.* Should the total as-built quantity of any Major Pay Item exceed the estimate contained in the Proposal by more than 25 percent, the work in excess of 125 percent of such estimate will be paid for by adjusting the unit price, as hereinafter provided. Alternatively, the Contractor and Engineer may negotiate a Supplementary Agreement for such adjustment.

Such adjustment of the unit price is to be the difference between the unit price and the actual unit cost, which will be determined as hereinafter provided. If the costs applicable to such item of work include overhead, such overhead will be deemed to have been recovered by the Contractor by the payments made for the 125 percent of the Contract quantity for such item already paid, and in computing the actual unit cost, such overhead will be excluded. Subject to the above provisions, such actual unit costs will be determined in the same manner as if the work were to be paid for on a Force Account basis as provided in Subsection 109.03.

When the compensation payable for the number of units of an item of work performed in excess of 125 percent of the Engineer's estimate is less than $1,500 at the applicable unit price, the Engineer reserves the right to make no adjustment in said price if he so elects, except that an adjustment will be made if requested in writing by the Contractor.

(b) *Decreases of More than 25 Percent.* Should the total as-built quantity of any Major Pay Item be less than 75 percent of the estimate contained in the Proposal, an adjustment in compensation pursuant to this Subsection will not be made unless the Contractor so requests in writing. If the Contractor so requests, the quantity of said item performed will be paid for by adjusting the unit price as hereinafter provided, or at the option of the Engineer, payment for the quantity of the work of such item performed will be made on the basis of Force Account as provided in Subsection 109.03, provided, however, that in no case shall the payment for such work be less than that which would be made at the unit price bid. Alternately, the Contractor and Engineer may negotiate a Supplementary Agreement for such adjustment.

Such adjustment of the unit price is to be the difference between the unit price and the actual unit cost, which will be determined as hereinafter provided, of the total as-built quantity of the item, including overhead. Such actual unit cost will be determined in the same manner as if the work were to be paid for on a Force Account basis as provided in Subsection 109.03.

The payment for the total as-built quantity of such item of work is not to exceed the payment which would be made for the performance of 75 percent of the estimate contained in the Proposal for such item at the original unit price bid.

104.06 Eliminated Items. Should any Pay Item contained in the Proposal be found unnecessary for the proper completion of the Work, the Engineer may, upon written order to the Contractor, eliminate such item from the Contract. In such case compensation, if any is appropriate, will be made as provided in this Subsection.

If acceptable material is ordered by the Contractor for the eliminated item prior to the date of notification of such elimination and if orders for such material cannot be canceled, it will be paid for at the actual cost to the Contractor. In such case, the material paid for becomes the property of the State and the actual cost of any further handling will be paid for. If the material is returnable to the vendor and if the Engineer so directs, the material shall be returned and the Contractor will be paid for the actual cost or charges made by the vendor for returning the material. The actual costs of handling returned material will be paid for.

The actual costs or charges will be computed in the same manner as if the work were to be paid for as provided in Subsection 109.03. However, no profit will be allowed.

A reduction in the Contract Time may be made by the Engineer pursuant to Subsection 108.11, if appropriate.

104.07 Changes in Character of Work. If the Engineer determines that an ordered change in the Work materially changes the character of the work of a Pay Item or a portion thereof, and if the change substantially increases or decreases the actual unit cost of such changed item as compared to the actual or estimated actual cost of performing the work of said item in accordance with the Contract Documents originally applicable thereto, in the absence of a Supplementary Agreement or unprotested Change Order specifying the compensation payable, an adjustment in compensation will be made in accordance with the following:

- The basis of such adjustment in compensation is to be the difference between the actual unit cost to perform the work of said item or portion thereof involved in the change as originally planned and the actual unit cost of performing the work of said item or portion thereof involved in the change, as changed. Actual unit costs will be determined in the same manner as if the work were to be paid for as provided in Subsection 109.03, or such adjustment is as agreed to in a Supplementary Agreement. Any such adjustment is to apply only to the portion of the work of said item actually changed in character.
- At the option of the Engineer, the work on said item or portion of item which is changed in character will be paid for as provided in Subsection 109.03.
- If the compensation for an item of work is adjusted under this Subsection, the costs recognized in determining such adjustment and quantity involved will be excluded from consideration in making an adjustment for such item of work under the provision in Subsection 104.05.

Failure of the Engineer to recognize a change in character of the work at the time a Field Order or Change Order is issued does not relieve the Contractor of the duty and responsibility of filing a written protest within the 5 day limit as provided in Subsection 104.09.

104.08 Extra Work. The Department reserves the right to require Extra Work as needed for the satisfactory completion of the Project. Such work will be designated as Extra Work when it is determined by the Engineer that such work is not covered by any of the various items for which there is a bid price or by combinations of such items. In the event portions of such work are determined to be covered by some of the various items for which there is a bid price or combinations of such items, the remaining portion of such work will be designated as Extra Work. Extra Work also includes work specifically designated as Extra Work in the Contract Documents.

The Contractor shall do such Extra Work and furnish labor, material and equipment therefor upon receipt of a Change Order, Field Order, or Supplementary Agreement and in the absence of such he shall not perform, nor be entitled to payment for, such Extra Work.

Payment for Extra Work required pursuant to the provisions in this Subsection, will be made as provided in Subsection 109.03, or as agreed to in a Supplementary Agreement.

If the Contractor and the Engineer cannot agree on a Supplementary Agreement for Extra Work and the Engineer, in his sole discretion, deems it inadvisable to have such work completed on a Force Account basis as provided in Subsection 109.03, the Commissioner may elect to have such work completed by others, and the Contractor shall not interfere therewith nor have any claim for additional compensation as the result of such election.

104.09 Notification of Changes. The Contractor shall promptly report State conduct which he believes to constitute a change to this Contract. Except for changes identified as such pursuant to Subsections 104.02 and 104.03, the Contractor shall promptly notify the Engineer in writing, on forms provided by the Department, within 5 days from the date that the Contractor identifies any State conduct including actions, inactions, and written or oral communications, which the Contractor regards as a change to the Contract terms and conditions. In no event shall the Contractor begin work nor incur any expenses with relation to the claimed change prior to giving notice.

The notice shall state, on the basis of the most accurate information available to the Contractor:

1. the date, nature and circumstances of the conduct regarded as a change;

104.09

2. the name, function and activity of each State individual and official or employee involved in or knowledgeable about such conduct;
3. the identification of any documents and the substance of any oral communication involved in such conduct;
4. in the instance of alleged acceleration of scheduled performance or delivery, the basis for the Contractor's claim of accelerations;
5. in the instance of alleged Extra Work, the basis for the Contractor's claim that the work is extra;
6. the particular elements of Contract performance for which the Contractor may seek additional compensation under this Section 104 including:
    - what Pay Items have been or may be affected by the alleged change;
    - what labor or materials or both have been or may be added, deleted or wasted by the alleged change and equipment idled, added or required for additional time;
    - to the extent practicable, what delay and disruption in the manner and sequence of performance and effect on continued performance have been or may be caused by the alleged change;
    - what adjustments to contract price, delivery schedule, and other provisions affected by the alleged change are estimated.

Following submission of the notice, the Contractor shall diligently continue performance of this Contract to the maximum extent possible in accordance with the Contract Documents, unless such notice results in a direction of the Engineer, in which event the Contractor shall continue performance in compliance therewith, provided, however, that if the Contractor regards such direction itself as a change, notice shall be given as provided above. All directions, orders and similar actions of the Engineer will be reduced to writing and copies thereof furnished to the Contractor.

The Resident Engineer will promptly, and in any event within 10 days after receipt of notice, respond thereto in writing. In such response the Resident Engineer will either:

1. confirm that the conduct of which the Contractor gave notice constitutes a change and when necessary direct the mode of further performance,
2. revise or rescind any communication regarded as a change,
3. deny that the conduct of which the Contractor gave notice constitutes a change and when necessary direct the mode of further performance; or
4. in the event the Contractor's notice information is inadequate to make a decision under No. 1, 2 or 3 above, advise the Contractor as to what additional information is required, and establish the date by which it should be furnished and the date thereafter by which the Department will respond.

If the Engineer confirms that State conduct effected a change as alleged by the Contractor, and such conduct causes an increase or decrease in the cost of, or the time required for performance of any part of the Work under this Contract, whether changed or not changed by such conduct, an adjustment in compensation will be made in accordance with the provisions of this Section and the Contract will be modified in writing accordingly. In the case of drawings, designs or specifications which are defective and for which the State is responsible, the adjustment will be made to include the cost and extension of Contract Time for delay reasonably incurred

by the Contractor in attempting to comply with such defective drawings, designs or specifications before the Contractor identified, or reasonably should have identified, such defect. When the cost of property made obsolete or excess as a result of a change confirmed by the Engineer pursuant to this Subsection is included in the adjustment in compensation, the Engineer has the right to prescribe the manner of disposition of such property. Adjustments will not be made which include increased costs or extensions of Contract Time for delay resulting from the Contractor's failure to provide adequate notice or to continue performance as provided above. Any adjustments of Contract Time will be made pursuant to Subsection 108.11.

The failure of the Contractor to give notice pursuant to the provisions of this Subsection shall constitute a waiver of any and all claims and damages which could have been avoided or mitigated had such timely notice been given. Moreover, no action or inaction of any person shall constitute a waiver of the State's absolute right to receive written notice pursuant to this Subsection of an alleged claim.

104.10 Rights in and Use of Materials Found on the Work. The Contractor, with the approval of the Engineer, may use on the Project such stone, gravel, sand or other material determined suitable by the Engineer, as may be found in the excavation and will be paid both for the excavation of such materials at the corresponding unit price and for the Pay Item for which the excavated material is used except for the provisions for roadway excavation as provided in Subsection 202.14. He shall replace at his own expense with other acceptable material all of that portion of the excavated material which was needed in the embankments, backfills, approaches or otherwise. Charge for the materials so used will not be made against the Contractor. The Contractor shall not excavate or remove any material from within the highway location which is outside the grading limits, as indicated by the slope and grade lines, without written authorization. The Contractor will not be paid for the excavation so authorized and shall replace the excavated material at his own expense.

104.11 Final Cleanup. Before final inspection and Completion, borrow and local material sources and all areas occupied by the Contractor in connection with the Work shall be cleaned of all rubbish, excess materials, temporary structures and equipment, and all parts of the Work shall be left in an acceptable condition.

If the Contractor fails to complete final cleanup within the time stated in the Supplementary Specifications for the completion of the Contract or within such further time as may have been granted in accordance with the provisions of the Contract, the Contractor shall pay the State liquidated damages pursuant to Subsection 108.16.

Payment for final cleanup will be made on a lump sum basis.

Payment will be made under:

Pay Item	***Pay Unit***
Final Cleanup	Lump Sum

104.12 Value Engineering. The term proposal as used in this Subsection is construed to mean a Value Engineering proposal submitted by the Contractor for changing the Plans, Specifications or other requirements of the Contract.

(a) *Purpose and Scope.* The intent of Value Engineering is to share with the Contractor any cost savings generated on this Contract as a result of a proposal or proposals offered by the Contractor and approved by the Department. The purpose is to encourage the use of Contractor's ingenuity and experience in arriving at alternative, lower cost construction methods other than those reflected in the Contract Documents, by the sharing of savings resulting therefrom. The proposals contemplated are those that could produce a savings to the Department without, in the sole judgement of the Engineer, impairing essential functions and characteristics of the Project or a portion of the work involved. They include but are not limited to service life, stage construction, economy of operation, ease of maintenance, desired appearance and safety.

(b) *Submittal of Proposal.* Proposals will not be considered if submitted after monthly estimates amount to more than 50 percent of the Total Adjusted Contract Price. As a minimum, the following materials and information shall be submitted with each proposal plus any additional information requested by the Department:

1. A statement that the proposal is submitted as a Value Engineering proposal.
2. A description of the difference between the existing Contract requirements and the proposed change, and the comparative advantages and disadvantages of each, including considerations of service life, economy of operations, ease of maintenance, desired appearance and safety.
3. Complete plans, specifications and calculations showing the proposed revisions relative to the original Contract features and requirements.
4. A complete cost analysis indicating the final estimate costs and quantities to be replaced by the proposal, the new costs and quantities generated by the proposal, and the cost effects of the proposed changes on operational, maintenance and other considerations.
5. A specific date by which a Change Order or Supplementary Agreement adopting the proposal must be executed so as to obtain the maximum cost reduction during the remainder of the Contract. This date must be selected to allow the Department ample time, usually a minimum of 60 days, for review and processing a Change Order or Supplementary Agreement. Should the Department find that insufficient time is available for review and processing, it may reject the proposal solely on such basis. If the Department fails to respond to the proposal by the date specified, the Contractor shall consider the proposal rejected and shall have no claim against the State as a result thereof.
6. A statement as to the effect the proposal has on the Contract Time.
7. A description of any previous use or testing of the proposal on another Department project or elsewhere and the conditions and results therewith. If the proposal was previously submitted on another Department project, indicate the date, the project and the action taken by the Department.

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(c) *Conditions.* Proposals will be considered only after Award of Contract and only when all of the following conditions are met:

1. The Contractor is cautioned not to base any bid prices on the anticipated approval of a proposal and to recognize that such proposal may be rejected. In the event of rejection, the Contractor is required to complete the Contract in accordance with the Plans and Specifications at the prices bid.
2. All proposals, approved or not approved by the Department for use in this Contract, apply only to the ongoing Contracts or Contracts referenced in the proposal and become the property of the Department and shall contain no restrictions imposed by the Contractor on their use or disclosure. The Department will have the right to use, duplicate and disclose in whole or in part any data necessary for the utilization of the proposal. The Department retains the right to utilize any accepted proposal or part thereof on any other or subsequent Project without any obligation to the Contractor. This provision is not intended to deny rights provided by law with respect to patented materials or processes.
3. If the Department already has under consideration certain revisions to the Contract which are subsequently incorporated in a proposal, the Department will reject the Contractor's proposal and may proceed with such revisions without any obligation to the Contractor.
4. The Contractor shall have no claim against the Department for any costs or delays due to the Department's rejection of a proposal, including but not limited to development costs, anticipated profits or increased materials or labor costs resulting from delays in the review of such proposal.
5. The Engineer will determine as to whether a proposal qualifies for consideration and evaluation. The Engineer may reject any proposal that requires excessive time or costs for review, evaluation and/or investigations, or which is not consistent with the Department's design policies and basic design criteria for the Project.
6. The Engineer may reject all or any portion of Work performed pursuant to an approved proposal if he determines that unsatisfactory results are being obtained. The Engineer may direct the removal of such rejected Work and require the Contractor to proceed in accordance with the original Contract requirements without reimbursement for any Work performed under the proposal, or for its removal. Where modifications to the proposal are approved in order to adjust to field or other conditions, reimbursement is limited to the total amount payable for the Work at the Contract prices as if it were constructed in accordance with the original Contract requirements. Such rejection or limitation of reimbursement does not constitute the basis of any claim against the State for delay or for any other costs.
7. The proposal shall not be experimental in nature but shall have been proven to the Department's satisfaction under similar or acceptable conditions on another Department Project or at another location acceptable to the Department.

8. Proposals will be considered only if equivalent options are not already provided in the Contract Documents.
9. The proposal shall be made based on items of Work scheduled to be done by the Contractor. Anticipated cost savings based on revisions of utility relocations or other similar items to be done by others will not be considered. Proposals which may increase the cost of Work done by others will not be considered.
10. The savings generated by the proposal must be of sufficient significance to warrant review and processing.
11. If additional information is needed to evaluate proposals, this information must be provided in a timely manner otherwise the proposal will be rejected. Such additional information could include, where design changes are proposed, results of field investigations and surveys, design computations and field change sheets.

If the proposal is approved, the Contractor shall submit drawings, in ink, on polyester film such as Mylar or Herculene, 4 mils thick, matted on both sides except as follows:

- Structural drawings may be submitted in pencil.
- Electrical drawings may be matted on one side and may be submitted in pencil.
- Cross section sheets may be 3 mils thick and may be matted on one side.

Engineering calculations with appropriate signatures shall be submitted in an established and approved format.

Proposals will not be considered that change the types, thicknesses or joint designs of the pavement structures or the basic design of bridges, retaining walls, overhead sign supports or breakaway sign supports.

Note - The basic design of a bridge is defined as type of superstructure and substructure, span length type and thickness of deck, type of beam and arrangement, geometrics, width and underclearance.

(d) Payment. If the proposal is accepted, the changes and payment therefor will be authorized by Supplementary Agreement. Payment will be made as follows:

1. The changes will be incorporated into the Contract by adjustments in the quantities of Pay Items, agreed upon Extra Work items or by Force Account, as appropriate, in accordance with the Specifications.
2. The cost of the revised Work as determined from the aforementioned changes will be paid in accordance with Section 109. In addition to such payment, the Department will pay, under a separate pay item, 50 percent of the savings as reflected by the difference between the above payment and the cost of the related construction required by the original Contract Documents computed at Contract bid prices. However, the Department may disregard the Contract bid prices if such prices do not represent the value of the work to be performed or to be deleted.

3. The Department's costs for review and processing of the proposal will not be deducted from the savings.
4. The Contractor's costs for development, design and implementation of the proposal are not eligible for reimbursement.

SECTION 105 - CONTROL OF WORK

105.01 Authority of the Engineer. The Engineer will decide all questions which may arise as to the quality and acceptability of the Work and as to the rate of progress of the Work; all questions which may arise as to the interpretation of the Contract Documents; all questions as to the acceptable fulfillment of the Contract on the part of the Contractor, and all questions as to compensation. All questions as to the interpretation of the Contract Documents shall be submitted to the Resident Engineer in writing.

The Engineer has the authority to suspend the Work wholly or in part pursuant to Subsection 108.14 or 108.15 and to suspend partial payments under Subsection 109.05 due to the failure of the Contractor to correct conditions unsafe for the workmen or the general public, for failure to carry out provisions of the Contract or, for failure to carry out orders. The Engineer may also suspend the Work wholly or in part for such periods as deemed necessary due to unsuitable weather, for conditions considered unsuitable for the prosecution of the work or for any other condition or reason deemed to be in the public interest.

105.02 Communications. Unless otherwise directed, all communications with the Department shall be sent to the Resident Engineer. Where communications are directed to persons other than the Resident Engineer, a clear copy shall be sent to the Resident Engineer.

105.03 Plans and Specifications. The Plans consist of general drawings and show such details as are necessary to give a comprehensive idea of the construction contemplated. The Plans show details of all structures, lines, grades, typical cross sections of the roadway, location and design of all structures and a summary of items appearing on the Proposal Form. The Contractor shall keep one set of Plans available on the Project site at all times. All alterations affecting the requirements and information given on the Plans will be authorized in writing.

Omissions from the Plans or Specifications of details of Work which are manifestly necessary to carry out the intent of the Contract Documents, or which are customarily included, shall not relieve the Contractor from including such omitted details of Work, but they shall be included as if fully and correctly set forth and described.

Plans and Specifications will be furnished upon request at a charge in accordance with rates on file with the Department. The successful bidder receives one copy of the governing Standard Specifications and the number of sets of Plans specified below, without charge, upon Award if requested. However, not more than one free copy of the current Standard Specifications will be furnished any Contractor, regardless of repeated contract awards to him.

One copy of Supplementary Specifications and Addenda is furnished, without charge, with each set of the Plans. Additional copies of Supplementary Specifications and Addenda are available upon request, at a charge in accordance with the Departmental rate except that after Award, a maximum of five additional free copies will be furnished the successful bidder upon request.

Request for Plans, Specifications and Proposal Forms shall be directed to the Cashier of the Department, accompanied by a check for the proper amount drawn to the order of the New Jersey Department of Transportation. Requests for those items furnished without charge shall be directed to the Bureau of Construction Services.

Table of Plans Furnished Without Charge

Amount of Contract		Sets of
From More Than	To and Including	Plans
$ 0	$ 500,000	1
500,000	1,000,000	2
1,000,000	5,000,000	3
5,000,000	10,000,000	4
10,000,000	----------	5

105.04 Working Drawings. Working drawings shall be provided by the Contractor in accordance with this Subsection to adequately control the Work.

The Contractor shall review, approve, sign and submit, with reasonable promptness and in orderly sequence so as to cause no delay in his work or in the work of any other contractor, all working drawings required by the Contract Documents. Working drawings shall be properly identified. At the time of submission the Contractor shall inform the Engineer in writing of any deviation in the working drawings from the requirements of the Contract Documents. By approving and submitting working drawings, the Contractor thereby represents that he has determined and verified all field measurements, field construction criteria, materials, catalog numbers and similar data and has checked and coordinated each working drawing with the requirements of the Work and the Contract Documents.

The Engineer will review and approve working drawings with reasonable promptness, but only for conformance with the design concept of the Project and with the information given in the Contract Documents. The Engineer's approval of a separate item does not indicate approval of an assembly in which the item functions.

The Contractor shall make any corrections required by the Engineer and shall resubmit the required number of corrected copies of working drawings until approved. The Contractor shall direct specific attention in writing or on resubmitted working drawings to revisions other than the corrections requested by the Engineer on previous submissions.

The Engineer's approval of working drawings does not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents unless the Contractor has informed the Engineer in writing of such deviation at the time of submission and the Engineer has given written approval to the specific deviation, nor does the Engineer's approval relieve the Contractor from responsibility for errors or omissions in the working drawings.

The Contractor shall not order materials and do any work relating to said working drawings before their approval. The carrying out of the Work or the ordering of the materials before the approval of the drawings may constitute a cause for rejection of such Work or materials. Deviations from approved working drawings shall not be made without the written approval of the Engineer.

All costs for providing working drawings shall be included in the prices bid for the various Pay Items scheduled in the Proposal.

105.05 Conformity with Contract Documents. All Work performed shall be in conformity with the lines, grades, cross sections, dimensions and material requirements, including tolerances, if any, shown in the Contract Documents. The purpose of tolerances is to accommodate occasional minor variations from the middle portion of the tolerance range that are unavoidable for practical reasons. When a maximum or minimum value is specified, the production and processing of the material and the performance of the Work shall be so controlled that the Work shall not be preponderately of borderline quality or dimension. Although measurement, sampling and testing may be considered evidence of conformity, the Engineer will determine whether the Work deviates from the Contract Documents.

In the event the Engineer finds the Work not in conformance with the Contract Documents but that reasonably acceptable Work has been produced, he will determine if the Work is to be accepted and remain in place. In this event, the Engineer will document the basis of the acceptability of the Work and provide for an appropriate adjustment in the contract price for such Work as deemed necessary. If an appropriate adjustment cannot be negotiated, the Work shall be removed and replaced or otherwise corrected at no cost to the State.

In the event the Engineer finds the Work not in conformance with the Contract Documents, including tolerances, if any, resulting in an inferior or unsatisfactory product, the Work shall be removed and replaced or otherwise corrected at no cost to the State.

Neither the observations of the Engineer in his administration of the Contract, nor inspections, tests or approvals by persons other than the Contractor relieves the Contractor from his obligation to perform the Work in accordance with the Contract Documents.

105.06 Special Inspection, Testing or Approval. Whenever the Engineer considers it necessary or advisable to ensure the proper implementation of the Contract Documents, he has authority to require special inspection or testing of the Work in addition to that required elsewhere in the Contract Documents, whether or not such Work be then fabricated, installed or completed. However, neither the Engineer's authority to act under this Subsection, nor any decision made by him either to exercise or not to exercise such authority, creates a duty or responsibility of the Engineer to the Contractor, any subcontractor or any of their agents or employees performing any of the Work.

If after commencement of the Work the Engineer determines that any Work requires special inspection, testing or approval not provided for elsewhere in the Contract Documents he will perform such inspection, testing or approval using Department facilities, by contracting with others for such services, or by instructing the Contractor by Field Order to order such special inspection, testing or approval. If such special inspection or testing reveals a failure of the Work to comply with the requirements of the Contract Documents or, with respect to the performance of the Work, with laws, ordinances, rules, regulations or orders of any public authority having jurisdiction, the Contractor shall bear all costs thereof, including the Engineer's additional services made necessary by such failure. If tests reveal no such failure, the Department will bear such costs and a Supplementary Agreement will be negotiated.

105.07 Coordination of Plans, Specifications and Addenda. The Plans, the Standard Specifications, the Supplementary Specifications, Addenda and all other Contract Documents are essential parts of the Contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a functionally complete Project.

As the work progresses, it is anticipated that the Contractor shall frequently apply to the Resident Engineer relative to the interpretation and coordination of the Contract Documents. Such applications shall be in writing. Should it appear that the work to be done or any of the matters relative thereto are not sufficiently detailed or explained in the Contract Documents, the Contractor shall apply to the Engineer for such further explanations as may be necessary and shall conform to them as part of the Contract.

Both parties realize that in performing the Work, field conditions may require modifications in the Plans and quantities of Work involved. Work under all Pay Items must be carried out to meet these field conditions to the satisfaction of the Engineer and in accordance with his directions and the Contract Documents.

The Contractor shall not take any advantage of any apparent error or omission in the Contract Documents. In the event the Contractor discovers any discrepancy, error or omission in the Plans, Specifications or other Contract Documents, or if there is any doubt or question as to the intent or meaning of the Plans, Specifications or other Contract Documents, the Contractor shall immediately notify the Resident Engineer in writing. The Engineer will promptly make, in writing, such corrections and interpretations as deemed necessary.

105.08 Cooperation by Contractor. The Contractor shall give the Work the constant attention necessary to facilitate the progress thereof, and shall cooperate with the Engineer, his inspectors, and other contractors in every way possible.

When the Contractor is comprised of two or more persons, firms, partnerships, or corporations functioning on a joint venture basis, said Contractor shall designate in writing, before starting Work, the name of one individual who shall have the authority to represent and act for the joint venture.

The Contractor shall designate in writing before starting Work, a competent, English speaking superintendent capable of reading and thoroughly understanding the Contract Documents and thoroughly experienced in the type of construction being performed. Said superintendent shall have the authority to represent and act for the Contractor. An alternate to the superintendent, with equal authority, may also be designated.

Said superintendent or his alternate shall be present at the site of the Project at all times while Work is actually in progress on the Contract irrespective of the amount of Work subcontracted. He shall have full authority to execute orders or directions of the Engineer, without delay, and to promptly supply such materials, equipment, tools, labor and incidentals as may be required. When Work is not in progress and during periods when Work is suspended, arrangements, acceptable to the Engineer, shall be made for any emergency Work which may be required.

Whenever the superintendent or his alternate is not present on the site or at the location of any particular part of the Work where it may be desired to give direction, the Engineer may suspend all of the Work or the particular Work in reference until said superintendent or his alternate is present. Such suspension shall not be the basis of any claim against the State.

105.09 Cooperation with Utilities. Within the site of the Project there may be public utility structures, and notwithstanding any other clause or clauses of this Contract, the Contractor shall not proceed with his Work until he has made diligent inquiry at the offices of the Engineer, the utility companies and municipal authorities or other owners to determine their exact location. The Contractor shall notify, in writing, the utility companies and municipalities or other owners involved of the nature and scope of the Project and of his operations that may affect their facilities or property. Two copies of such notices shall be sent to the Engineer.

Attention of the Contractor is directed to the fact that the approximate locations of known utility structures and facilities that may be encountered within and adjacent to the limits of the Work are shown on the Plans. The accuracy and completeness of this information are not guaranteed by the State, and the Contractor is advised to ascertain for himself all the facts concerning the location of these utilities.

Electrical installations of the Department constructed either before or during the time of this Contract shall be considered a utility and all provisions of this Subsection shall be applicable. Plans showing the locations of such electrical facilities, particularly those underground, are on file with the Department and should be examined by the Contractor before performing any Work which would endanger these facilities.

The Contractor shall carry out his Work carefully and skillfully and shall support and secure utility structures so as to avoid damage to them. The Contractor shall satisfactorily maintain the flow in drains and sewers at all times. He shall not move without the owner's written consent any utility structures, and at the completion of the Work their condition shall be as safe and permanent as before. When utility structures, facilities or equipment are damaged by the Contractor, he shall notify their owners, who may cause the damage to be repaired at the Contractor's expense. If the cost thereof is not paid by the Contractor within 30 days after repairs have been completed, the Commissioner may retain an amount sufficient to cover the cost from any monies due or that may become due the Contractor. House service connections damaged by the Contractor shall be repaired by competent skilled mechanics.

Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals, railroad lines and all other utility appurtenances within the limits of the Project which are to be relocated or adjusted are to be moved by the owners at their expense, except as otherwise provided for in the Supplementary Specifications or as noted on the Plans.

The Contractor shall permit the owners of the utilities, or their agents, access to the Project site, in order to relocate or protect their facilities, and he shall cooperate with them in performing this Work.

The Contractor shall cooperate with the utility owners concerned and shall notify them not less than 10 days in advance of the time he proposes to perform any Work that may endanger or affect their facilities. He assumes the primary obligation of coordinating his activities with those of the utilities.

When the removal, relocation, de-energization, or replacement of utility structures or facilities not provided for in the Contract Documents is deemed not essential by the Engineer for carrying out the Project but is performed for the Contractor's convenience, the cost of such Work shall be borne by the Contractor. When such removal, relocation, de-energization or replacement is deemed essential by the Engineer for carrying out the Work of the Project, the cost is to be borne by the State or by the owner of the utility in accordance with Department policy.

All costs for protection and preservation of utilitites, and cooperation and coordination with their owners shall be included in the prices bid for the various Pay Items scheduled in the Proposal.

For the purpose of establishing the exact location of subsurface utilities, the Engineer may direct the excavation of test pits, and payment therefor will be made as provided in Section 207. Failure of the Engineer to direct the digging of test pits does not relieve the Contractor of his responsibilities regarding the protection and preservation of utilities.

Any utility facilities being constructed under this Contract are subject to inspection by the utility owner during construction, and the utility owner shall be given the opportunity to inspect material to be used in reference to the Specifications and plan details applying to such materials. The Contractor shall notify the utility owner 10 days in advance of the beginning of construction of the utility facilities.

It is understood and agreed that the Contractor has considered in his bid all of the permanent and temporary utility facilities in their present and/or relocated positions as shown on the Plans and as revealed by his site investigation, is cognizant of the limited ability of the State to control the actions of the utilities and in his bid has made allowance for the fact that additional compensation will not be allowed for any delays, inconvenience or damage sustained by him due to any interference from the said utility facilities or the operation of moving them.

In addition to the foregoing provisions, the following specific provisions relate to railroads only:

(a) Railroad Traffic and Property. Where the Project includes Work across, over, under or adjacent to railroad tracks or railroad right-of-way, the Contractor shall safeguard the traffic, tracks and appurtenances, and other property of the railroad affected by his work. He shall comply with the regulations of the railroad company relating to the Work, shall keep tracks clear of obstructions, shall provide barricades, warning signs, lights or other safety devices as required. Payment for such safety devices will be made in accordance with Section 110.

All Work done within the railroad company right-of-way is subject to the approval of the railroad company in matters affecting railroad property and the safety and operation of its trains. The safety and continuity of railroad operation shall be of the first importance and shall be at all times protected and safeguarded, and the Contractor, and any subcontractor, shall perform and arrange all pertaining construction Work accordingly.

All Work shall be regulated so as to avoid interruption of train movements and damage to the tracks and other facilities of the railroad company.

The Contractor shall give written notice to the railroad company concerned not less than 48 hours in advance of when he or his subcontractors shall start Work within the railroad company's right-of-way, or other Work which may affect railroad property, in order that necessary arrangements may be promptly made to protect railraod property.

The occupancy by the Contractor of any part of the railroad company's right-of-way shall be only with permission and according to the requirements of said railroad company.

The Contractor shall make his own arrangements with the railroad company for any such occupancy. Whenever Work within the railroad company's right-of-way may affect or involve the safety of the railroad company's facilities and/or movement of trains, the time and method of doing such Work shall first be submitted to and approved by the railroad company. Such approval does not release the Contractor from responsibility or liability for any

damage which the railroad company may suffer, or for which it may be held liable, by the acts of the Contractor or those of his subcontractors or his or their employees.

An operating track is fouled when any object is brought closer than 10 feet horizontally from the near rail of the tracks. Cranes, trucks, motor shovels or any other equipment are considered as fouling the tracks when working in such a position that failure of the same, with or without load, would obstruct the track.

Equipment of the Contractor to be used on and adjacent to the railroad company's right-of-way shall be in first class condition so as to fully prevent any failure that might cause delay in the operation of trains or damage to railroad facilities. His equipment is subject to railroad company inspection at all times and shall not stand or be put in operation adjacent to the track without first obtaining permission from the railroad company.

The railroad company may assign inspectors and/or engineers during the time the Contractor is engaged in Work on railroad property for the general supervision of construction operations to ensure adherence to the Contract Documents and applicable railroad company requirements, and to ensure the use of approved construction methods. The salary and expense of said inspectors and/or engineers and the cost of any other engineering services furnished by the railroad company will be paid directly to the railroad by the State at no cost to the Contractor.

(b) *Railroad Insurance.* The applicable insurance provisions are as specified in Subsection 107.23, Subpart *(f)*.

(c) *Railroad Protective Personnel.* When railroad employees are assigned to protection duties during the time Work is being performed on or adjacent to railroad right-of-way or facilities, the wages of said employees are to include the base rate, warranted overtime, and labor surcharges in accordance with the United States Department of Transporation, Federal Highway Administration, Program Manual, Volume 1, Chapter 4, Section 3.

The State will reimburse the railroad company for all necessary costs incurred for services by railroad protective personnel up to the amount specified in the Supplementary Specifications. All costs above this amount will be paid by the State but will be deducted from partial or final payments made to the Contractor, unless, in the opinion of the Engineer, it is established that such excess costs were caused by operations of the Contractor during any approved extension of Contract Time or by conditions beyond his control.

105.10 Cooperation Between Contractors. The Department reserves the right at any time to contract for and perform other or additional work on or near the Project site.

When separate contracts are let within the limits of the Project, or in areas adjacent thereto, the Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other contractors. Moreover, the Contractor assumes the positive obligation of cooperating with such other contractors and coordinating his activities with theirs. If there is a difference of opinion as to the respective rights of the Contractor and others doing work within the limits of or adjacent to the Project, the Engineer will decide as to the respective rights of the various parties involved in order to secure the completion of the State's work in general harmony and in a satisfactory manner. The decision of the Engineer is final and binding and is not cause for claims by the Contractor for additional compensation.

The Contractor shall assume all liability, financial or otherwise, in connection with his contract and hereby waives any and all claims against the Department for additional compensation that may arise because of inconvenience, delay, or loss experienced by him because of the presence and operations of other contractors working within the limits of or adjacent to the Project.

The Contractor shall arrange his Work and shall place and dispose of the materials being used so as not to interfere with the operation of the other contractors within the limits of the Project or adjacent thereto. He shall join his Work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

The Contractor is not responsible for damage to Work performed on the Contract or on other contracts within or adjacent to the site of the Project that may be caused by or on account of the work of other contractors. The Contractor is responsible for any damage done or caused by his Work or forces to the work performed by other contractors within or adjacent to the site of the Project and he shall repair or make good any such damage in a manner satisfactory to the Engineer and at no cost to the State.

The provisions of this Subsection also apply to utilities and their contractors working on the Project site or adjacent thereto.

105.11 Construction Stakes, Lines and Grades.

(a) For Projects with Construction Layout as a Pay Item. The Contractor shall provide all Work required in connection with the layout for construction of the Project, using the control points and data furnished by the Engineer.

The Contractor shall furnish all necessary qualified personnel and adequate equipment to preserve such controls throughout the duration of the Contract and shall lay out therefrom all of the lines and grades necessary for the complete construction of the Project.

The Contractor shall make all necessary computations to establish the exact position of all the Work from the control points which are shown on the Plans or furnished by the Engineer. All the work shall be referenced to baselines which the Contractor shall establish from the control points, reestablish when necessary and maintain throughout the life of the Contract so as not to delay the Engineer from making necessary preliminary, interim, and final measurements and from checking the Contractor's layout if he so desires.

The Department will lay out the work to be done by utility companies using the baselines established by the Contractor. The Engineer will notify the Contractor, in writing, not less than 5 days in advance of when the baselines shall be established.

The Contractor shall be responsible for the preservation of all control points furnished by the Department for his use in staking out the Work. If such control points are damaged, lost, displaced or removed, they shall be reset at no cost to the State.

The Contractor shall provide and maintain offset stakes from each main roadway baseline, from each ramp, jughandle, or turnaround baseline and from each local road baseline, at each station, and outside the limits of grading and construction.

Each stake shall be identified and marked to show the offset distance from the baseline and the Contractor shall furnish grade sheets showing the cut or fill to the finished profile lines with reference to the offset stakes. Grade sheets for construction of subbase and underlayer preparation shall also include calculations to establish the typical cross section from the profile

grade stake. The Contractor shall provide adequate and accurate offset lines during such construction that require occupation of the baseline points by construction operations.

The Contractor shall be responsible for maintaining the points he has established. Any error or apparent discrepancies found in the Plans or Specifications shall be called to the Engineer's attention in writing for interpretation prior to proceeding with the work.

The Contractor shall be responsible for the finished Work conforming to the lines and grades called for on the Plans, and he shall correct all errors caused by his personnel at no cost to the State.

Attention is directed to the need for caution in laying out and constructing storm drains or headwalls to ascertain that these items do not encroach on private property where easements have not been obtained.

Payment for construction layout will be made on a lump sum basis.

Note - The ratio of payment for construction layout to the lump sum price bid for construction layout shall be the same as the ratio of the Total Adjusted Contract Price exclusive of payment for construction layout, to the Total Contract Price exclusive of the price bid for construction layout.

Payment will be made under:

Pay Item	***Pay Unit***
Construction Layout	Lump Sum

(b) *For Projects without Construction Layout as a Pay Item.* The Engineer will set construction stakes establishing lines, and continuous profile grade in road work, and centerline and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances as deemed necessary, and will furnish the Contractor with all necessary information relating to lines, slopes and grades. These stakes and marks shall constitute the field control by and in accordance with which the Contractor shall establish other necessary controls and perform the Work.

The Contractor shall be held responsible for the preservation of all stakes and marks, and if any of the construction stakes or marks have been destroyed or disturbed by the Contractor, the cost of replacing them will be deducted from any monies due or that may become due the Contractor.

The Department will be responsible for the accuracy of lines, slopes, grades, and other engineering work which it provides.

The Contractor shall notify the Engineer, in writing, not less than 5 days in advance of when construction stakes are required. When possible, requests for engineering services shall include work for not less than 1 day.

105.12 Authority and Duties of Resident Engineer. As the direct representative of the Engineer, the Resident Engineer has immediate charge of the engineering details of the Project. The Resident Engineer is responsible for the administration of the Contract. This responsibility includes the authority to reject defective material and to suspend any or all of the Work in accordance with Subsections 108.14 and 108.15.

105.13 Duties of the Inspector. Inspectors employed by the Department are authorized to inspect all Work. Such inspection may extend to all or any part of the Work and to the preparation, fabrication or manufacture of the materials to be used. The inspector is not authorized to alter or waive the provisions of the Contract. The inspector is not authorized to issue instructions contrary to the Contract Documents, or

to act as foreman for the Contractor; however, the inspector has the authority to reject Work subject to confirmation by the Resident Engineer

105.14 Inspection of Work. Each part or detail of the Work is subject to inspection by the Engineer. The Engineer shall be allowed access to all parts of the Work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection. When the Engineer is in or about the site of the Work in the course of his employment, he is deemed conclusively to be an invitee of the Contractor. If the Contractor is not the owner of the place where fabrication, preparation or manufacture is in progress, the owner thereof shall be deemed to be the agent of the Contractor with respect to the obligation assumed hereunder. The Contractor or his agent shall be responsible for the payment of claims for injuries to the Engineer due to negligence on the part of the said Contractor or his agent.

At the direction of the Engineer, the Contractor, at any time before Acceptance, shall remove or uncover specified portions of the finished Work which the Engineer had previously inspected. After examination, the Contractor shall restore said portions of the Work to the standard required by the Contract Documents. Should the Work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as Extra Work; but should the Work so exposed or examined prove unacceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed, shall be at no cost to the State.

The Engineer may order any Work done without his inspection to be removed and replaced at the Contractor's expense. Payment for the Work will be made and the uncovering or removing, and the replacing of the covering or making good of the parts of the uninspected work will be paid for as Extra Work only if all of the following conditions are met:

- the Work removed, uncovered and/or replaced proves to have been acceptable in accordance with the Contract Documents; and
- the Contractor gave reasonable notice in writing to the Department that the uninspected work was to be performed; and
- the Contractor in performing the uninspected work did not do so in the face of a directive from the Department that such work not be performed.

Projects financed in whole or in part with Federal funds are subject to inspection at all times by the Federal agency involved or such other Federal agencies as the United States requires. Such inspection does not make the Federal Government a party to this Contract.

When any unit of government or political subdivision or any railroad is to pay a portion of cost of the Work covered by this Contract, its respective representatives shall have the right to inspect the Work. Such inspection does not make any such unit of government or political subdivision, or any such railroad a party to this Contract, and shall in no way interfere with the rights of either party hereunder.

The Contractor is responsible for carrying out the provisions of the Contract at all times and for control of the quality of the Work regardless of whether an authorized inspector is present or not. This obligation to perform the Work in accordance with the Contract Documents is not relieved by the observations of the Engineer in the administration of the Contract, nor by inspections, tests or approvals by others. Work not meeting the Contract requirements shall be made good and unsuitable Work

may be rejected, notwithstanding that such Work had been previously inspected and approved by the Department or that payment therefor has been included in a monthly estimate certificate.

105.15 Field Office. The Contractor shall provide and maintain in good condition one or more construction and survey field offices for the exclusive use of the Engineer at a location or locations approved by the Engineer.

The field office or offices shall be ready for use not later than 10 days after the date of mailing of the fully executed Contract to the Contractor and before construction operations begin, and shall be maintained until no longer required by the Engineer and then removed.

It is estimated that the field office or offices is required for 3 months after Completion.

Any building scheduled to be demolished under this Contract will not be permitted to be used as a field office.

The types of construction field offices are as follows:

Type A. Type A field office shall be of weatherproof construction located on or in the immediate vicinity of the Project, having a floor area of not less than 576 square feet and a ceiling height of not less than 7 1/2 feet, and having partitions and doors providing three communicating rooms, one with a floor area of not less than 288 square feet and two with a floor area of not less than 144 square feet each.

The field office shall be provided with sufficient natural and artifical light, and shall be adequately insulated, heated and air conditioned..

The field office shall have one or more clothes closets of ample size for maximum office requirements and all stairs shall have safety rails installed.

Sanitary conveniences suitable for use by male and female employees of the Department and conforming to the requirements of Subsection 107.10 shall be provided in the field office or offices, and shall be stocked with lavatory and sanitary supplies at all times during the life of the Contract.

Doors and windows shall be equipped with adequate locks and all keys shall be in the possession of the Engineer.

Adequate free parking shall be provided and maintained for the field office.

The office shall be equipped with the following for the exclusive use of the Engineer:

- One or more telephones, installed, as directed.
- Desk and chair for each room
- Drafting table with stool and sufficient drawers for standard size plans either attached to the table or in cabinet form, for each room.
- Tables and chairs for the use of 16 men.
- One supply cabinet,
- Two plan racks.
- Two fire-resistant, four-drawer, legal-size file cabinets with lock and two keys meeting fire underwriters' approval for not less than a 1-hour test.
- One Class ABC fire extinguisher or one Class A and one Class B fire extinguisher meeting fire underwriters' approval.
- Water cooler with bottled water.

105.15

- One electronic calculator, ten key, with trigonometric function capability, with printout tape.
- One electric typewriter, elite type, with 15-inch carriage.
- One compact copying machine, plain paper, with letter and legal size capacity.

Type B. Type B field office shall conform to the requirements for Type A except that it shall have a floor area of of not less than 432 square feet and shall be divided into two communicating rooms with a floor area of not less than 288 and not less than 144 square feet and equipped with tables and chairs for the use of 12 men.

Type C. Type C field office shall conform to the requirements for Type A except that it shall consist of one room having a floor area of not less than 288 square feet and shall be equipped with tables and chairs for the use of 8 men.

Type D. Type D field office shall conform to the requirements for Type A except that it shall have a floor area of not less than 720 square feet and shall be divided into four communicating rooms, one with a floor area of not less than 288 square feet and three with a floor area of not less than 144 square feet each and equipped with tables and chairs for the use of 20 men.

Type E. Type E field office shall conform to the requirements for Type A except that it shall have a floor area of not less than 864 square feet and shall be divided into four communicating rooms, two with a floor area of not less than 288 square feet each and two with a floor area of not less than 144 square feet each and equipped with tables and chairs for the use of 24 men.

Type F. Type F field office shall conform to the requirements for Type A except that it shall have a floor area of not less than 1008 square feet and shall be divided into five communicating rooms, two with a floor area of not less than 288 square feet each and three with a floor area of not less than 144 square feet each and equipped with tables and chairs for the use of 28 men.

The types of survey field offices are as follows:

Type S. Type S field office shall conform to the requirements specified above for Type A except that it shall be one room and shall have a floor area of not less than 144 square feet and shall be equipped with tables and chairs for the use of 4 men, one plan rack and one fire-resistant, four-drawer, legal-size file cabinet with lock and two keys meeting fire underwriters' approval for not less than a 1-hour test.

Type T. Type T field office shall conform to the requirements specified above for Type S except that it shall have a floor area of not less than 288 square feet and shall be equipped with tables and chairs for the use of 8 men.

In lieu of the field office or offices specified above, the Contractor may provide equivalent office space, equipment and facilities subject to approval of the Engineer.

Setting up the field office or offices shall consist of furnishing the office complete with furniture, equipment, electricity, water, heating, air-conditioning, sanitary facilities and lavatory supplies.

Maintenance of the field office or offices, for the time required, shall consist of maintaining the furniture, equipment and utilities, providing lavatory supplies, janitorial and waste disposal services weekly, and snow removal services. Maintenance of the field office shall also include the monthly rent.

Payment for setting up the field office of the various types will be maoe by the number of each.

Payment for maintenance of the field office of the various types will be made for each month or fraction thereof that the field office is required except that payment will not be made for any month or fraction thereof for which the Contractor is assessed liquidated damages in accordance with Subsection 108.16.

Payment for telephone service will be made based on the actual cost as evidenced by paid bills from the telephone company. An estimated amount to cover these reimbursements has been included in the Proposal.

Payment will be made under:

Pay Item	*Pay Unit*
Field Office Type ____Set-up	Unit
Field Office Type ____Maintenance	Month
Telephone Service	Lump Sum

105.16 Removal of Unacceptable and Unauthorized Work. All Work which does not conform to the requirements of the Contract is unacceptable unless otherwise determined acceptable under the provisions in Subsection 105.05.

Unacceptable Work, whether the result of poor workmanship, use of defective materials, damage through carelessness or any other cause, found to exist prior to Acceptance, shall be removed immediately and replaced in an acceptable manner at no cost to the State.

Work shall not be done without lines and grades having been given by the Engineer or the Contractor as provided under Subsection 105.11. Work done contrary to the instructions of the Engineer, work done beyond the lines shown on the Plans, except as herein specified or any Extra Work done without authority is considered as unauthorized and will not be paid for under the provisions of the Contract. Work so done may be ordered removed or replaced at no cost to the State.

If the Contractor fails to comply promptly with any order of the Engineer made under the provisions of this Subsection, the Engineer will have authority to cause unacceptable Work to be removed and/or replaced by others and to deduct the costs thereof from any monies due or that may become due the Contractor.

105.17 Load Restrictions. Within the limits of the Project the operation of equipment of such weight or so loaded as to cause damage to structures or the roadway or to any other type of construction will not be permitted. Hauling of materials over the base course or surface course under construction shall be limited as directed. No loads will be permitted on a concrete surface course, base course, or structure before the expiration of the curing period. In no case shall legal load limits be exceeded when equipment is used for hauling to and from the Project site unless permitted in writing by the Director of Motor Vehicles. The Contractor shall be responsible for all damage done by his hauling equipment.

The Department will monitor the Contractor's observance of the legal load limits in accordance with the following:

- For trucks with weigh tickets, a certified weigh ticket shall be furnished with each load.
- For trucks without weigh tickets that are hauling material for items of 5000 cubic yards or more, a list of trucks and their motor vehicle classifications shall be furnished prior to the start of work and shall be updated at the start of each construction season thereafter. A certified weigh ticket showing the gross weight shall be furnished with the first load for each truck for each item. The Resident Engineer shall be notified in advance so that the first load can be documented by measurements and photographs.

- For concrete delivery trucks, a list of trucks including the certified tare weight and the maximum cubic yard load for each shall be furnished prior to the start of work and shall be updated at the start of each construction season thereafter.

Any truck found to be in excess of the legal load limit may have that load of material rejected for use on the Project.

105.18 Automatically Controlled Equipment. Whenever equipment is required to be operated automatically under the Contract and a breakdown or malfunction of the automatic controls occurs, the equipment may be operated manually or by other methods only for the remainder of the working day on which the breakdown or malfunction occurs, provided this method of operation produces results which otherwise meet the Specifications.

105.19 Maintenance During Construction. Except as provided for below, the Contractor shall be responsible for maintenance within the Project limits until Acceptance pursuant to Subsection 105.23. This maintenance shall consist of continuous and effective work prosecuted day by day, with adequate equipment and forces to the end that the roadway is kept in satisfactory condition at all times.

In the case of a Contract requiring the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.

On any section opened to traffic, whether provided for in the Contract Documents or opened as directed, any damage to the roadway due to the Contractor's operations shall be repaired at no cost to the State.

The Contractor shall not be responsible for removal of ice or snow from sections of roadways opened to traffic or for damage to the Project caused by the operation of snow plows or other snow removal or de-icing operations carried on by others under the supervision or direction of the Department or of the various Counties and Municipalities.

The Contractor shall not be responsible for mowing unless an item for mowing is scheduled in the Proposal Form.

The Engineer may direct the Contractor to construct bituminous concrete patch in accordance with Section 402 in order to maintain sections of traveled way and shoulders in a smooth riding condition at all times including seasonal shutdowns. Payment for bituminous concrete patch will be made in accordance with Section 402 except for those areas which are damaged by the Contractor's operations.

Except as provided for above, all costs for maintenance during construction shall be included in the various Pay Items scheduled in the Proposal.

105.20 Failure to Maintain Roadway. If the Contractor at any time fails to comply with the provisions of Subsection 105.19, the Engineer will immediately notify the Contractor of such noncompliance. If the Contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer may proceed to maintain the Project and the entire cost of this maintenance will be deducted from any monies due or that may become due the Contractor.

105.21 Partial Acceptance. If at any time during the prosecution of the Project the Contractor completes a unit or portion of the Project, such as a structure, an interchange, or a section of road or pavement, he may request the Engineer to make final inspection of that unit. If the Engineer finds upon inspection that the unit has been satisfactorily completed in compliance with the Contract, he may accept that unit as being completed and the Contractor may be relieved of the responsibility of doing

further Work on or maintaining that unit or portion of the Project. The Engineer reserves the right to reject the request made by the Contractor, if he determines that the unit or portion of the Project should not be the subject of a partial acceptance.

Such partial acceptance shall in no way void or alter any of the terms of the Contract, including Subsections 107.22 and 107.23, nor shall it be construed as relieving the Contractor of full responsibility for making good defective work or materials found at any time before Acceptance pursuant to Subsection 105.23.

105.22 Substantial Completion. When the Contractor determines that the Work is substantially complete, the Contractor shall prepare a written notice thereof for submission to the Engineer listing the items remaining to be completed or corrected. The failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents. If the Engineer determines that the Work is substantially complete, he will then prepare a letter which states the date of substantial completion and establishes a reasonable time within which the Contractor shall complete the planting of trees, shrubs, vines, ground covers, and seedlings, perform the final cleanup and the repair of unacceptable Work, which time may be prior to Contract Time as modified. The letter will be submitted to the Contractor for his prompt compliance therewith.

If, however, the inspection discloses that the Work is not substantially completed to his satisfaction, the Engineer will give the Contractor the necessary instructions for completion and correction of same, and the Contractor shall immediately comply with and execute such instructions. Upon completion and correction of the Work, the Contractor shall re-notice the Engineer and another inspection will be made.

105.23 Completion and Acceptance. Upon receipt by the Engineer of written notice from the Contractor that the Work has reached Completion and is ready for final inspection and Acceptance, the Engineer will promptly make such inspection. When he finds the Work to be in compliance with the Contract, he will promptly issue a Certificate of Completion stating that, to the best of his knowledge, information and belief, and on the basis of observations and inspections, the Work has been completed in accordance with the terms and conditions of the Contract. If, however, the final inspection discloses that the Work has not reached Completion, the Engineer will give the Contractor the necessary instructions for the correction of deficiencies, and the Contractor shall immediately comply with and execute such instructions. Upon correction of the deficiencies the Contractor shall re-notice the Engineer and another inspection will be made. This procedure is to be repeated until a Certification of Completion is issued.

At the request of the Contractor, the Engineer may issue a Certificate of Completion without receiving all required documents, certificates or proofs of compliance. The Contractor's request must satisfactorily establish that the Contractor could not reasonably and in good faith provide some of the required documents, certificates or proofs of compliance at a time contemporaneous with Completion and with the Project being ready for use by the State to the degree contemplated by the Contract. In such instances where a Certificate of Completion is issued, the Contractor shall expeditiously attempt to provide the exempted document, certificate or proofs of compliance. Final payment will not be made, however, until all such documents, certificates and proofs of compliance have been satisfactorily executed and delivered to the Engineer.

The Certificate of Completion is issued establishing Completion as of the date of the notice or re-notice from the Contractor. If the Commissioner concurs in the Certificate of Completion, the Contractor will be notified of Acceptance and the date thereof.

After Acceptance, the Contractor is relieved of the duty of maintaining and protecting the Work as a whole, and is not required to perform any further Work thereon. In addition, the Contractor is relieved of his responsibility for damage to the Work which may occur after Acceptance. However, nothing herein shall be construed to limit the provisions of Subsections 107.22, 107.23, 107.26 and 109.14.

SECTION 106 - CONTROL OF MATERIAL

106.01 Source of Supply and Quality Requirements. All materials for the Project shall be furnished by the Contractor and shall be new, unless otherwise specifically prescribed in the Contract Documents. The materials shall conform to the requirements of the Contract Documents and shall be from approved sources. Only materials which have been approved by the Engineer shall be used.

Materials will not be approved from firms and individuals suspended or debarred by the Department or included in the Report of Suspensions, Debarments and Disqualifications of Firms and Individuals as maintained by the Department of the Treasury, Division of Building and Construction, Bureau of Contractor Prequalification.

Promptly after the execution of the Contract, the Engineer shall be notified on Materials Questionnaire Forms furnished by the Department, of the sources of materials expected to be used during the 6 month period thereafter. Such notice shall be received by the Engineer no later than 10 days prior to the shipment of materials from a previously approved source and no later than 30 days prior to the shipment of materials from a source not previously approved, except that, with the Engineer's consent, shipments of materials from approved stocks may be permitted to be made 3 days after notice to the Engineer. For materials which are not required until more than 6 months after the execution of the Contract, such notice shall be received by the Engineer no later than 30 days prior to the date that such materials need to be ordered so that they are available for the Project at the proper time.

Within 12 hours after receiving a shipment of materials, the Engineer shall be notified of the kind, size, quantity and location thereof.

In any item of construction, the sources, brands or types of materials shall not be changed without the consent of the Engineer. Request for such changes shall be filed with the Engineer the number of days in advance of such changes as required above. The request shall state the name and address of the owner, the location of the proposed source, the method of shipment, and the intended use of the material. This information shall be furnished whenever an order is placed for materials.

The foregoing provisions shall apply with regard to requests by subcontractors for the sources of the materials they propose to use, such requests to be submitted through the Contractor.

The notice provisions of this Subsection shall not be so construed as to relieve the Contractor of his obligation to ensure that all materials required for the construction of the Project shall be available at the time and place necessary for their incorporation into the Work in order that the completion date set forth in Subsection 108.10 is met. If any doubt exists as to the timely availability of any material, the Engineer shall be

immediately informed, in writing, of the potential problem and of the action to be taken to guaranty the availability of such material. Stockpiles of materials whose availability is or may be problematical shall be established at an early date.

106.02 Local Material Sources. Possible sources of local materials may be designated on the Plans or described in the Supplementary Specifications. The quality of material in such deposits may be acceptable in general, but the Contractor shall determine for itself the amount of equipment and work required to produce a material meeting the requirements of the Contract Documents. It shall be understood that it is not feasible to ascertain from samples the limits or quantity for an entire deposit, and that variations shall be considered as usual and are to be expected. The Engineer may order procurement of material from any portion of a deposit and may reject portions of the deposit as unacceptable.

The Department may acquire and make available to the Contractor the right to take materials from the sources designated on the Plans or described in the Supplementary Specifications together with the right to use such property as may be specified, for plant site, stockpiles and hauling roads.

If the Contractor desires to use material from sources other than those designated, he shall acquire the necessary rights to take materials from the sources and shall pay all costs related thereto, including any which may result from an increase in length of haul. All costs of exploring and developing such other sources shall be borne by the Contractor. The use of material from other than designated sources is not permitted until such preliminary samples as may be required by the Engineer have been obtained and tested at the expense of the Contractor. Additional samples may be required of the Contractor for inspection and testing by the Engineer prior to approval of and authorization to use the source.

When material deposits are not described in the Supplementary Specifications or where those designated provide insufficient material, the Contractor shall provide sources of acceptable material. When these sources are provided by the Contractor, the Department assumes the cost of processing samples to determine the suitability of the material except as in Subsection 106.03.

Unless otherwise permitted, borrow pits and quarries occupied by the Contractor or his subcontractor or suppliers exclusively for this Project shall be so excavated that water does not collect and stand therein. Sites from which material has been removed shall be left in a neat and presentable condition before Completion. Where practicable, all pits and quarry sites shall be located so that they are not visible from the highway.

106.03 Materials, Inspections, Tests and Samples.

(a) General. All materials will be inspected, tested and approved before incorporation in the Work. Unapproved materials may be used only with written permission of the Engineer. In the absence of such written permission, unapproved materials will not be paid for and shall be removed at no cost to the State.

All materials being used are subject to inspection, testing or rejection at any time prior to Acceptance. Samples will be taken by a representative of the Department. Results of tests, made with the Department Laboratory's apparatus and conforming to the requirements specified in the prescribed methods of tests, are official and copies of test results will be furnished upon request.

Testing will be performed in accordance with AASHTO or ASTM methods of tests or in accordance with specified Departmental test methods as described in Section 990.

Nothing in this Subsection shall be construed to limit the right of the Engineer to order special inspection or tests as provided in Subsection 105.06.

Except as otherwise provided, all materials will be tested at the expense of the State.

Manufacturers supplying pipe under the Contract shall provide all facilities necessary to carry out the tests required by the Specifications, at their own expense.

Certain materials as specified will be accepted on the basis of Certifications of Compliance in accordance with Subsection 106.04.

The required number of samples and rate of sampling or Certifications of Compliance for the various materials are as specified in the respective methods of test or in the Subsections applicable to that particular material or Pay Item.

Additional samples shall be required whenever in the opinion of the Engineer additional tests are required to determine the quality and suitability of materials for their respective uses.

(b) *Sampling and Field Testing of Soil Aggregates.* The sampling and field testing of soil aggregates shall conform to the general requirements for sampling and testing specified in Section 901, and with the following requirements provided, however, that the following requirements shall govern where there is any conflict or inconsistency between them.

The Contractor shall determine initially, by means of proper sampling and laboratory tests, that soil aggregate materials from proposed sources conform to the specifications requirements. Written notice of the proposed sources of soil aggregate materials, as well as the results of the sampling and testing, shall be given the Engineer by the Contractor after the initial determination as specified above, and not less than 10 days prior to the time of their intended use. The Engineer may sample and test materials representative of that portion of the source intended to be used.

Approval by the Engineer of a proposed source of any aggregate materials does not constitute approval of materials delivered to the site of the Work from that source but shall be deemed as permission to select and use materials from that source only so long as they conform to the Specifications. The Contractor shall progressively determine for himself by proper sampling and laboratory tests, while the sources are in use, that materials selected from approved sources conform to the Specifications. Should the source contain oversize material, the Engineer may require the Contractor to eliminate such oversize material.

The final and governing determination of conformance or nonconformance with the Contract Documents will be made based on sampling and testing of the materials after they have been placed in accordance with the Contract Documents. All materials in place in the Work which do not conform to the Contract Documents shall be removed and replaced with materials which do conform thereto, or their deficiencies shall be corrected. For those materials subject to density testing, conformance shall include compliance with the density requirement. After the initial corrective action has been taken, the Engineer will take an additional sample and if necessary, one check sample. If the materials still do not conform to the requirements of the

Contract Documents after additional corrective action, the Contractor shall supply the Engineer with a gradation of the in-place material showing the size of sample, all calculations, final gradation, name of person performing the test, date and location of sample taken. Further testing will not be performed by the Engineer until the Contractor certifies that the rejected material has been corrected. After this certification, the Engineer will analyze one additional sample and if this sample does not meet the Contract Documents, the material shall be removed.

The Contractor shall excavate test pits and provide such facilities as the Engineer may require in order to properly sample the source and shall, if the source is approved, remove any overburden which would contaminate the material intended for use on the Project. If soil aggregate materials are obtained by dredging, the Contractor shall provide safe and adequate water transportation for the Engineer to and from the dredges or other boats and shall cooperate with the Engineer in every reasonable way to expedite inspection and sampling of the materials. The cost of such work, facilities and transportation, in connection with sampling by the Engineer at the proposed source of soil aggregate materials, and the initial and progressive sampling and testing of materials at their sources performed by the Contractor, shall be included in the prices bid for the various Pay Items scheduled in the Proposal.

Sampling and testing of aggregates which meet the Specifications and are used in the Work will be performed without cost to the Contractor.

The cost of sampling and testing by the Engineer of soil aggregates which do not conform to the Specifications for gradation and density and the cost of sampling and testing of soil aggregates which do conform to the Specifications but are not used in the Work shall be paid to the State by the Contractor at Departmental rates. Such costs may be recovered by the State from any monies due or that may become due the Contractor.

106.04 Certification of Compliance. Materials or assemblies as specified will be accepted on the basis of Certificates of Compliance stating that such materials or assemblies fully comply with the requirements of the Contract. The form of Certificates of Compliance must be approved by the Engineer.

Materials or assemblies used on the basis of Certificates of Compliance may be sampled and tested at any time and if found not to be in conformity with the Contract requirements, will be rejected whether in place or not. The Contractor shall require the manufacturer or supplier to furnish four copies of Certificates of Compliance with each delivery of materials, components and manufactured items that are acceptable by certification. One copy shall be furnished to the Resident Engineer, two copies shall be furnished to the Department Laboratory and one copy shall be retained by the Contractor.

Certificates of Compliance are to contain the following information:

- Project to which the material is consigned.
- Name of the Contractor to which the material is supplied.
- Kind of material supplied.
- Quantity of material represented by the certificate.
- Means of identifying the consignment, such as label marking, seal number, etc.
- Date and method of shipment.
- Statement that the material has been tested and found in conformity with the pertinent Contract requirements stated in the certificate.

- Signature of a person having legal authority to bind the supplier.
- Signature attested to by a notary public or other properly authorized person.

Payments will not be made for materials specified to be accepted on the basis of Certificates of Compliance until the Engineer has received the required Certificate of Compliance.

106.05 Plant Inspection. The Engineer may undertake the inspection of materials at the source. Manufacturing plants may be inspected periodically for compliance with specified manufacturing methods. Material samples may be obtained for laboratory testing for compliance with materials quality requirements. This may be the basis for the acceptability of manufactured lots as to quality.

In the event plant inspection is undertaken, the following conditions shall be met:

- The Engineer will have the cooperation and assistance of the Contractor and the producer with whom he contracted for materials.
- The Engineer will have full entry at all times to such parts of the plant as may concern the manufacture or production of the materials being furnished.
- If required by the Engineer, the Contractor shall arrange for approved office space for the use of the inspector; such space to be located conveniently in or near the plant.
- Adequate safety measures shall be provided and maintained. It is understood that the Department reserves the right to retest all materials which have been tested and accepted at the source of supply after the same have been delivered and to reject all materials which, when retested, do not meet the requirements of the Contract Documents.

106.06 Materials Field Laboratory. The Contractor shall provide and maintain in good condition a materials field laboratory, including enclosure, for the exclusive use of the Engineer at a location approved by the Engineer. Provisions for this item shall be deferred until the Engineer gives notification that this item is required.

The materials field laboratory shall be ready for use not later than 10 days after the date of such notification and shall be maintained until no longer required by the Engineer and then shall be removed.

Testing will not be conducted until the materials field laboratory is ready for use.

It is estimated that the materials field laboratory is required for 1 month after Completion.

Any building scheduled to be demolished under this Contract will not be permitted to be used as a materials field laboratory.

The materials field laboratory shall be of weatherproof construction located on or in the immediate vicinity of the Project, having a floor area of not less than 280 square feet and a ceiling height of not less than 7 1/2 feet.

The materials field laboratory shall be provided with sufficient natural and artifical light, and shall be adequately insulated, heated and air conditioned to maintain temperatures between 68 to 80 degrees F.

The materials field laboratory shall have one or more clothes closets of ample size for the maximum office requirements and all stairs shall have safety rails installed.

Sanitary conveniences suitable for use by male and female employees of the Department and conforming to the requirements of Subsection 107.10 shall be provided in the materials field laboratory and shall be stocked with lavatory and sanitary supplies at all times during the life of the Contract.

Doors and windows shall be equipped with adequate locks and all keys shall be in possesion of the Engineer.

Adequate free parking shall be provided and maintained for the materials field laboratory.

1. The materials field laboratory shall be equipped with the following for the exclusive use of the Engineer:
   - One or more telephones, installed, as directed.
   - Three desks and six chairs.
   - Work bench not less than 2 1/2 by 10 feet and two stools.
   - Shelves and supply cabinets.
   - Plan rack of sufficient size to hold 15 sets of plans.
   - One fire-resistant, four-drawer, legal-size file cabinet with lock and two keys meeting fire underwriters approval for not less than a 1-hour test.
   - One Class ABC fire extinguisher or one Class A and one Class B fire extinguisher meeting fire underwriters' approval.
   - Water cooler with bottled water.
   - One electronic calculator with printout tape.
   - One electric typewriter, elite type, with 15-inch carriage.
   - One compact copying machine, plain paper, with letter and legal size capacity.
   - One 12-inch diameter, minimum, exhaust fan or other means of removing excess heat, dust and fumes.
   - Minimum of four, 3-prong electrical outlets, having a minimum of two 20 amp-120 volt circuits.
   - Two gas stoves, each having at least 2 burners.
   - Commercially bottled gas or gas supplied by a public utility company with at least two connections located as directed.
   - Display area, approximately 3 by 4 feet, for mounting control charts.
   - Sink with hot and cold running water having adequate pressure and equipped with two drainboards and a drain-disposal system capable of handling elutriable material.
   - Metal stand to hold sieves used in washing elutriable material.
   - Wheelbarrow.
   - Shovels, scoops, and pick for sampling soil aggregates and concrete.
   - Telephone answering machine.
   - Equipment and testing apparatus conforming to that listed in AASHTO T 11, T 27, T 99, T 119, T 152, T 180, and T 248.
2. Enclosure. A weathertight room or enclosure shall be adjacent to the materials field laboratory, capable of being secured, with concrete floor area of not less than 450 square feet and ceiling height of not less than 7 1/2 feet. It shall be provided with sufficient natural and artifical lighting and shall be adequately insulated, heated and air-conditioned to maintain temperatures between 60 and 80 degrees F. It shall be equipped with a minimum of two 12-inch diameter exhaust fans or other means of removing excess heat, dust and fumes, a minimum of three 3-prong electrical outlets having a minimum of two 20 amp - 120 volt circuits, and a 7-day temperature recording device capable of producing a permanent record of the room temperature.

A cube of concrete, weighing a minimum of 200 pounds and measuring approximately 10 x 10 x 24 inches with a 1 x 10 inch square steel plate fastened to the top, shall be erected on a firm foundation in the enclosure at a location approved by the Engineer.

Located in the enclosure shall be a sounddampening and dustproof cabinet constructed of at least 3/4 inch plywood or other suitable material and of sufficient size to house a large mechanical sample shaker.

Located in the enclosure, on an outside wall, shall be a second cabinet constructed of at least 3/4 inch plywood or particle board and 1/8 inch lead plate. The second cabinet is to be used to house a nuclear density gauge and must be securable and have a door equipped with a heavy-duty lock with two keys provided. Before this cabinet is constructed, its exact location, materials to be utilized for its construction, locking system, etc are subject to approval by the Engineer.

Doors and windows of the enclosure shall be equipped with locks and all keys shall be in the possession of the Engineer.

A sufficient number of water tanks shall be provided, deep enough to fully submerge 12-inch concrete cylinders in an upright position.

Setting up the materials field laboratory shall consist of furnishing the laboratory and enclosure complete with furniture, equipment, electricity, water, heating, air-conditioning, sanitary facilities and lavatory supplies.

Maintenance of the materials field laboratory, for the time required, shall consist of maintaining the furniture, equipment, and utilities, providing lavatory supplies, janitorial and waste disposal services weekly, and snow removal services. Maintenance of the materials field laboratory shall also include the monthly rent.

Payment for setting up the materials field laboratory will be made by the number of units.

Payment for maintenance of the materials field laboratory will be made for each month or fraction thereof that the materials field laboratory is required except that payment will not be made for any month or fraction thereof in which the Contractor is assessed liquidated damages in accordance with Subsection 108.16.

Payment will be made under:

Pay Item	*Pay Unit*
Materials Field Laboratory Set-up	Unit
Materials Field Laboratory Maintenance	Month

Payment for telephone service will be made in accordance with Subsection 105.15.

106.07 Foreign Materials. The attention of the Contractor is particularly directed to NJSA 52:32-1 and NJSA 52:33-1 *et seq* which prohibit on any public work the use by the Contractor or subcontractors of farm products or materials produced or manufactured outside of the United States. Exceptions to this prohibition are allowed upon a finding by the Commissioner that its enforcement would be inconsistent with the public interest, or where the cost of enforcing the prohibition would be unreasonable, or where the material in question is not of a class or kind mined, produced or manufactured in the United States in commercial quantities and of a sufficient quality. Findings by the Commissioner allowing an exception to this prohibition will be included by the Department in the Contract Documents.

If the Commissioner finds that in the performance of the Contract there has been a failure to comply with the provision contained in the Contract Documents relative to foreign materials, he is to make his findings public, including therein the name of the Contractor obligated under the Contract, and no other contract for the construction,

alteration or repair of any public work in this State will be awarded to such Contractor, or to any partnership, association or corporation with which such Contractor is associated or affiliated, within a period of 3 years after such finding is made public.

Where the use of foreign materials is allowed in the performance of this Contract, such materials shall be furnished in accordance with the following requirements:

- Materials manufactured, produced or mined outside the United States shall be delivered to approved locations within the State unless otherwise permitted, where they shall remain until sampling and testing can be completed.
- The Contractor shall, at no cost to the State, arrange for any required testing which the Department is not equipped to perform. All testing shall be performed within the State and is subject to witnessing by the Engineer.
- Each lot of foreign material shall be accompanied by a Certificate of Compliance prepared in accordance with Subsection 106.04. In addition, certified mill test reports shall be attached to the Certificate of Compliance for those materials for which mill test reports are required and shall clearly identify the lot to which they apply.
- Structural materials requiring mill tests reports will be accepted only from those foreign manufacturers who have previously established to the satisfaction of the Engineer the adequacy of their in-plant quality control to assure delivery of uniform material in conformance with Contract requirements.
- Adequacy of quality control shall be established, at the option of the Engineer, by either submission of detailed written proof of adequate control, or through an in-plant inspection by the Engineer.
- Structural materials will not be accepted which cannot be identified with mill test reports and Certificates of Compliance. On Federal Aid projects, the Contractor's particular attention is directed to the Federal statutes and regulations promulgated thereunder by the Federal Highway Administration which establish the Buy America requirements applicable to the Project. The Contractor must comply with these requirements in addition to those provided under applicable State law.

106.08 Storage of Materials. Materials shall be stored to assure the preservation of their quality and fitness. Stored materials, even though approved before storage, may again be inspected prior to their use on the Project. Stored materials shall be located so as to facilitate their prompt inspection. With the approval of the Engineer, portions of the right-of-way may be used for storage purposes and for the placing of the Contractor's plant and equipment, but any additional space must be provided by the Contractor at his expense. Private property shall not be used for storage purposes without written permission of the owner or lessee. Copies of such written permission shall be furnished to the Engineer prior to storage. Storage sites shall be restored to their original condition at no cost to the State.

106.09 Handling Materials. Materials shall be handled to assure the preservation of their quality and fitness. Aggregates shall be transported from the storage site to the Project site in tight vehicles constructed to prevent loss or segregation of materials after loading and measuring in order that there shall be no inconsistencies in the quantities of materials intended for incorporation in the Project as loaded, and the quantities actually received at the place of operations.

106.10 Unacceptable Materials. All materials, whether in place or not, which do not conform to the requirements of the Contract Documents shall be considered as unacceptable and such materials will be rejected and shall be removed immediately from the site of the Work unless otherwise directed. Rejected material, the defects of which have been corrected, shall not be used until approval has been given.

106.11 Department Furnished Material. The Contractor shall furnish all materials required to complete the Work, except those specified to be furnished by the Department. Material furnished by the Department will be delivered or made available at the points specified in the Supplementary Specifications.

The cost of handling and placing the materials after they are delivered or made available shall be considered as included in the Work for the Pay Item in connection with which they are used.

The Contractor is to be responsible for all material delivered to him and deductions will be made from any monies due or that may become due the Contractor to make good any shortages and deficiencies, from any cause whatsoever, and for any damage which may occur after such delivery, and for any demurrage charges.

106.12 Substitutes or "Or Equal" Items. Whenever materials or equipment are specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular supplier, the naming of the item is intended to establish the type, function and quality required. Unless the name is followed by words indicating that no substitution is permitted, materials or equipment of other suppliers may be accepted if sufficient information is submitted by the Contractor to allow the Engineer to determine that the material or equipment proposed is equivalent or equal to that named. Requests for review of substitute items of material or equipment will not be accepted from anyone other than the Contractor. If the Contractor wishes to furnish or use a substitute item of material or equipment, the Contractor shall make written application to the Engineer for approval thereof certifying that the proposed substitute performs adequately the functions and achieves the results called for by the general design, is similar and of equal substance to that specified and is suited to the same use as that specified. The application shall state that the evaluation and approval of the proposed substitute does not prejudice the Contractor's achievement of completion on time. It shall also state whether or not approval of the proposed substitute for use in the Work requires a change in any of the Contract Documents (or in the provisions of any other direct Contract with the State for Work on the Project) to adapt the design to the proposed substitute and whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty. All variations of the proposed substitute from that specified shall be identified in the application and available maintenance, repair and replacement service shall be indicated. The application shall also contain an itemized estimate of all costs that result directly or indirectly from approval of such substitute, including costs of redesign, all of which will be considered in evaluating the proposed substitute. The Engineer may require the Contractor to furnish additional data about the proposed substitute.

If a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents, the Contractor may furnish or utilize a substitute means, method, technique, sequence or procedure of construction which is acceptable, if the Contractor submits sufficient information to allow the Engineer to determine that the substitute proposed is equivalent to that indicated or required by the Contract Documents. The procedure for review by the Engineer is to be similar to that described in the previous paragraph.

The Engineer is to be allowed a reasonable time within which to evaluate each proposed substitute. The Engineer will be the sole judge of acceptability, and no substitute shall be ordered, installed or utilized without either a Construction Order or an approved working drawing. If approval is given, it is on the condition that the Contractor is fully responsible for producing work in conformity with Contract requirements. If, after trial use of the substituted materials, equipment, means, method, technique, or sequence or procedure of construction, the Engineer determines that the work produced does not meet Contract requirements, the Contractor shall discontinue the use of the substitute and shall complete the remaining work with the specified materials, equipment, means, method, technique, or sequence or procedure of construction. The Contractor shall remove the deficient work and replace it with work as specified, or take such other corrective action as the Engineer may direct. Changes will not be made in the basis of payment for the pay items involved nor in the Contract Time as a result of authorized substitutes. The Engineer may require the Contractor to furnish at no cost to the State a special performance guarantee or other surety with respect to any substitute. The Engineer will document the time required by the Department in evaluating proposed substitutions and in making changes in the Contract Documents. When the Engineer determines that a proposed substitute is unacceptable, the Contractor shall reimburse the Department for the cost of evaluating each proposed substitute.

When the Contract Documents permit the use of more than one type of material, equipment or product, only one type is to be used throughout the Project.

SECTION 107 - LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.01 Legal Jurisdiction. This Contract shall be construed and shall be governed in accordance with the Constitution and laws of the State of New Jersey.

The State in entering into this Contract does not waive its Sovereign Immunity, except as provided in the New Jersey Contractual Liability Act, NJSA 59:13-1 *et seq*. The rights or benefits provided the Contractor in this Contract which exceed those provided under that Act and the obligations established under this Contract which vary from those under the Act are contractual in nature and shall not be deemed to expand the waiver of Sovereign Immunity as set forth in that Act.

107.02 Notice of Potential Claim. The various notice provisions set forth in this Contract are contractual obligations assumed by the Contractor in executing the Contract. Any required notice shall be given only on forms provided by the Department. All forms shall be completed in their entirety and signed by the Contractor. Incomplete forms will be rejected and of no effect. Submission of completed notice forms acceptable to the Engineer constitutes compliance with the notice requirements of the New Jersey Contractual Liability Act if such notices are given within the time limits established by that Act, NJSA 59:13-5.

The Contractor agrees that the only evidence of compliance with NJSA 59:13-5 shall be the filing of said forms with the Engineer and that he shall not claim that any other documents sent or delivered to the Department or any of its officers or employees satisfies this notice requirement.

The Contractor understands that he shall be forever barred from recovering against the State if he fails to give notice of any act, or failure to act, by the Engineer, or the happening of any event, thing or occurrence in accordance with NJSA 59:13-5 and on the forms required by this Subsection.

107.03 Laws to be Observed. The Contractor shall keep fully informed of all Federal, State and local laws, ordinances, and regulations and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any manner affect those engaged or employed on the Work, or which in any way affect the conduct of the Work. The Contractor shall at all times observe and comply with, and shall cause his agents and employees to observe and comply with, all such laws, ordinances, regulations, orders, and decrees; and shall protect and indemnify the State and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by himself or his agents or employees, subcontractors of any tier, suppliers or materialmen. If any discrepancy or inconsistency is discovered between the Contract Documents and any such law, ordinance, regulation, order or decree, the Contractor shall immediately report the same to the Engineer in writing.

107.04 Federal Aid. In all contracts in which the Federal Government participates financially, which contracts are designated as Federal Aid Contracts, the Contractor shall conform in all respects to the requirements contained in the applicable Federally required contractual provisions which are included as part of the Contract Documents for contracts so designated. When any such Federal provisions are in conflict with any other provisions of this Contract, the Federal provisions prevail and take precedence and be of force over and against any said conflicting provisions as contained in the other Contract Documents.

107.05 Permits, Licenses and Taxes. The Contractor shall procure all permits, grants and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the due and lawful prosecution of the Work except where the Department has procured such permits, grants or licenses for temporary or permanent construction. The Contractor shall advise the issuing agency or party of his proposed operations and obtain their cooperation and such supplemental permission as may be necessary. Before submitting his bid the Contractor should obtain from the Department all available information on the permits, grants and licenses he has obtained. Charges incurred by the Contractor for permits, grants and licenses in connection with the Work shall be paid by the Contractor and shall be included in the prices bid for the various Pay Items scheduled in the Proposal.

Before the Contractor performs dredging or channel excavation within tidal waterways for the procurement of materials, or performs therein other work of his own, when such work is not part of the permanent or temporary Work provided for in the Contract, he shall advise the US Army Corps of Engineers, US Coast Guard, and the New Jersey Department of Environmental Protection, Division of Marine Services and Division of Water Resources of his intended work. If the waterway is not navigable, he shall notify the Division of Water Resources only. The Contractor shall procure all necessary permits for such work from the above named agencies having jurisdiction and interest and shall comply with their rules and regulations in the performance of the above mentioned work.

Prior to submitting a bid based on utilizing hydraulically procured soil aggregate materials, bidders shall assure themselves that the New Jersey Department of Environmental Protection will issue a permit to dredge such materials.

NJSA 54:32B-9 provides that any sale or service to the State of New Jersey, or any of its agencies, instrumentalities, public authorities, public corporations (including a public corporation created pursuant to agreement or compact with another State) or political subdivisions where the State is the purchaser, user or consumer, is not subject to the sales and use taxes imposed under the Sales and Use Tax Act. NJSA 54:32B-8 provides that sales of materials, supplies or services made to contractors, subcontractors or repairmen for exclusive use in erecting structures, or building on, or otherwise improving, altering or repairing real property of the above listed bodies are exempt from the tax on retail sales imposed by the Sales and Use Tax Act. The exemption provided under NJSA 54:32B-8 is conditioned on the person seeking such exemption qualifying therefor pursuant to the rules and regulations and upon the forms prescribed by the New Jersey Division of Taxation. The required form, "Contractor's Exemption Purchase Certificate" (Form No. ST-13), can be obtained by writing or calling the New Jersey Division of Taxation, Tax Information Services (TIS), CN 269, Trenton, New Jersey 08625 or any New Jersey Division of Taxation Regional Office.

107.06 Patented Devices, Materials and Processes. If any design, device, material, or process covered by letters of patent or copyright is used in the work, the Contractor shall provide for such use by suitable legal agreement with the patentee or owner. The Contractor shall assume all costs arising from the use of patented materials, equipment, devices, or processes used on or incorporated in the Work. The Contractor shall defend, indemnify and save harmless the State, any affected third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the State for any costs, expenses, and damages which it may be obliged to pay by reason of an infringement, at any time during the performance of or after Acceptance.

107.07 Discrimination in Employment on Public Works. Pursuant to NJSA 10:2-1, the Contractor agrees that:

- In the hiring of persons for the performance of work under this Contract or any subcontract hereunder, or for the procurement, manufacture, assembling or furnishing of any such materials, equipment, supplies or services to be acquired under this Contract, the Contractor, subcontractor or any person acting on behalf of such Contractor or subcontractor shall not, by reason of race, creed, color, national origin, ancestry, marital status or sex, discriminate against any person who is qualified and available to perform the work to which the employment relates;
- The Contractor, subcontractor or any person acting on his behalf shall not , in any manner, discriminate against or intimidate any employee engaged in the performance of Work under this Contract or any subcontract hereunder, or engaged in the procurement, manufacture, assembling or furnishing of any such materials, equipment, supplies or services to be acquired under such Contract, on account of race, creed, color, national origin, ancestry, marital status or sex;
- There may be deducted from any monies due the Contractor under this Contract, a penalty of $50.00 for each person for each calendar day during which such person is discriminated against or intimidated in violation of the provisions of the Contract; and

- This Contract may be canceled or terminated by the Department, and any monies due the Contractor under this Contract may be forfeited, for any violation of this Subsection occurring after notice to the Contractor from the Department of any prior violation of this Subsection.

107.08 Affirmative Action and Minority or Disadvantaged Business Enterprises. It is the public policy of the State of New Jersey and of the United States that no individual, group, firm or corporation working on or seeking to work on a public works project should be discriminated against on the basis of age, race, creed, color, national origin, ancestry, marital status or sex. To this end, Affirmative Action and Minority or Disadvantaged Business Enterprise Programs have been developed. The Affirmative Action and Minority or Disadvantaged Business Enterprises regulations and requirements applicable to this Contract are contained in the Supplementary Specifications for this Project. Any conflicts between these regulations and requirements and the other provisions of the Contract Documents shall be resolved by the Engineer to further the above stated public policy.

107.09 Restoration of Surfaces Opened by Permit. The right to construct or reconstruct any utility service in the highway or street or to grant permits for same, at any time, is hereby expressly reserved by the Department for the public utilities and proper authorities of the municipality in which the work is done and the Contractor shall not be entitled to any damages either for the digging up of the street or for any delay occasioned thereby

When an individual, firm, or corporation is authorized through a duly executed permit from the Department, the Contractor shall allow parties bearing such permits, and only those parties, to make openings in the highway. When ordered by the Engineer, the Contractor shall make all necessary repairs due to such openings and such necessary work will be paid for as Extra Work or as specifically provided elsewhere in the Contract Documents.

107.10 Sanitary, Health, and Safety Provisions. The Contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of his employees and for State field offices and materials field laboratory as may be necessary to comply with the requirements of the State and local health departments, or of other bodies or tribunals having jurisdiction.

The Contractor shall observe all rules and regulations of the Federal, State and local health officials. Attention is directed to Federal, State and local laws, rules and regulations concerning construction safety and health standards. The Contractor shall not require any worker to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his health or safety.

The Contractor shall admit, without delay and without the presentation of an inspection warrant, any inspector of the Occupational Safety and Health Administration or other legally responsible agency involved in safety and health administration upon presentation of proper credentials.

107.11 Public Convenience and Safety. The Contractor shall at all times so conduct the Work as to assure the least possible obstruction to traffic. The safety and convenience of the general public and the residents along the highway and the protection of persons and property shall be provided for by the Contractor as specified under Section 110.

Precaution shall be exercised at all times for the protection of persons and property. The safety provisions of applicable laws, OSHA regulations, building and construction codes, and the rules and regulations of the New Jersey Department of Labor shall be observed.

107.12 Railway Highway Provisions. If the Contract Documents require that materials be hauled across the tracks of any railway, the Department will arrange with the railway for any new crossings required or for the use of any existing crossings. If the Contractor elects to use crossings other than those designated, he shall make arrangements for the use of such crossings.

Construction work performed on or near railroad right-of-way shall be performed in accordance with Subsections 105.09 and 105.10.

107.13 Construction Over or Adjacent to Navigable Waters. All Work over, on or adjacent to navigable waters shall be so conducted that free navigation of the waterways is not interfered with and that the existing navigable depths are not impaired except as allowed by permit issued by the US Coast Guard and/or the US Army Corps of Engineers, as applicable.

107.14 Barricades and Warning Signs. The Contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient lights, danger signals, signs and other traffic control devices in accordance with Section 110, and shall take all necessary precautions for the protection of the Work and safety of the public.

107.15 Use of Explosives. When the use of explosives is necessary for the prosecution of the Work, the Contractor shall exercise the utmost care not to endanger life or property, including new Work. The Contractor shall be responsible for all damage resulting from the use of explosives.

A preblasting meeting will be scheduled by the Engineer with the Office of Safety Compliance. The Contractor shall attend the preblasting meetings. No blasting will be permitted prior to the preblasting meeting.

Explosives shall be stored safely under lock and key. The storage places shall be marked plainly **DANGEROUS EXPLOSIVES**. The storing and handling of explosives and highly inflammable materials shall conform to the regulations of the Office of Safety Compliance, Mines and Explosives, New Jersey Department of Labor, and to local regulations relating thereto. Proper means shall be used to avoid blasting damage to public and private property. Flagmen shall be provided, when necessary, who shall warn and keep traffic from the danger area, and all persons within the danger area shall be warned and given time to withdraw.

107.16 Protection and Restoration of Property Markers and Land Monuments. The Contractor shall be responsible for the preservation of all public and private property markers and shall protect carefully from disturbance or damage all land monuments and property markers until the Engineer has referenced their location. Monuments and markers shall not be moved until directed.

107.17 Forest Protection. In carrying out Work within or adjacent to State or National Forests or Parks, the Contractor shall comply with all regulations of the State Fire Warden, State Division of Parks and Forestry, or other authority having jurisdiction, governing the protection of forests and the carrying out of work within forests, and shall observe all sanitary laws and regulations with respect to the performance of work in forest areas. The Contractor shall keep the areas in an orderly condition, dispose of all refuse, obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks and other structures in accordance with the requirements of the Division or such other authority.

The Contractor shall take all reasonable precautions to prevent forest fires and shall require his employees and subcontractors, both independently and at the request of Forestry officials, to do all reasonably within their power to prevent and assist in preventing forest fires and to make every possible effort to notify a Forestry official at the earliest possible moment of the location and extent of any fire seen by them.

107.18 Opening Sections of Project to Traffic. Opening sections of the Project to traffic prior to Completion may be desirable or may be necessary due to conditions inherent in the Work, changes in the Contractor's work schedule, or conditions or events unforeseen at the time the Project was bid. Such openings shall be made only when so directed by the Engineer. Under no condition shall such openings constitute Acceptance or a part thereof, or a waiver of any provisions of the Contract.

The Contract Documents indicate, insofar as possible, which sections are to be opened prior to Completion. The Contractor shall make no claim for and shall have no right to additional compensation or extension of Contract Time for opening sections of the Project to traffic as indicated in the Contract Documents, or resulting from partial acceptance or changes in the Contractor's work schedule, or for reasons which are due to the fault of the Contractor or any other party, including utilities.

Additional compensation or extension of Contract Time for completion of other items of Work on sections of the Project opened to traffic for reasons other than those indicated in the preceding paragraph will be made as provided in Subsection 109.03 or in a Supplementary Agreement.

If the Contractor is dilatory in completing shoulders, drainage structures, or other features of the work, the Engineer may so notify him in writing and establish therein a reasonable period of time in which the work is to be completed. If the Contractor is dilatory, or fails to make a reasonable effort toward completion in this period of time, the Engineer may then order all or a portion of the Project opened to traffic. On such sections which are so ordered to be opened, the Contractor shall conduct the remainder of his construction operations so as to cause the least obstruction to traffic and shall make no claim for and shall have no right to additional compensation or extension of Contract Time.

On sections of the Project opened to traffic whether indicated in the Contract Documents or not, maintenance of the roadway shall be in accordance with Subsection 105.19.

107.19 Independent Contractor. The relationship of the Contractor to the State is that of an independent contractor, and said Contractor, in accordance with its status as an independent contractor, covenants and agrees that it shall conduct itself consistent with such status, that it shall neither hold itself out as nor claim to be an officer or employee of the State by reason hereof. The Contractor shall not, by reason hereof, make any claim, demand or application to or for any right or privilege applicable to an officer or employee of the State, including, but not limited to, worker's compensation coverage, unemployment insurance benefits, social security coverage, or retirement membership or credit.

107.20 Third Party Beneficiary Clause. It is specifically agreed between the parties executing this Contract that no provision of this Contract is intended to make the public or any member thereof a third party beneficiary hereunder, or to authorize anyone not a party to the Contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of the Contract.

It is the further intent of the Commissioner and the Contractor in executing this Contract that no individual, firm, corporation or any combination thereof, which supplies materials, labor, services or equipment to the Contractor for the performance of the Work becomes thereby a third party beneficiary of this Contract. The Commissioner and the Contractor understand that such individual, firm, corporation, or combination thereof, has no right to bring an action in the courts of this State against the State, by virtue of this lack of standing and also by virtue of the provisions of the New Jersey Contractual Liability Act, NJSA 59:13-1, *et seq*, which allows suit against the State in contract only on the basis of express contracts or contracts implied in fact.

107.21 Assignment of Contract Funds and Claims. The Contractor shall not transfer or assign to any party any contract funds, due or to become due, or claims of any nature it has against the State, without the written approval of the Engineer having first been obtained. The Engineer, in his sole discretion, considering primarily the interests of the State, may grant or deny such approval.

107.22 Risks Assumed by the Contractor. The Contractor assumes the following distinct and several risks, whether they arise from acts or omissions, whether negligent or not, of the Contractor, its subcontractors, suppliers, materialmen, employees, agents and all others working for the Contractor on the Project, of the State, or of third persons, or from any other cause, and whether such risks are within or beyond the control of the Contractor described in Subparts *(a)* through *(c)* below. Excepted from this assumption of risks are only those risks which arise from solely affirmative acts done by the State subsequent to the execution of the Contract with actual and willful intent to cause loss, damage and injury.

(a) Risks of Loss or Damage to the Permanent Construction. Until Acceptance, the Contractor shall bear the risk of loss or damage to the permanent construction, temporary construction and to materials, whether or not he has received payment for such construction or materials under Subsection 109.05, 109.06 or 109.07. The Contractor shall take every precaution against injury or damage to any part of the construction or to materials by the action of the elements or from any other cause, whether arising from the execution or the nonexecution of the Work. The Contractor shall promptly repair, replace, and make good any such damage or loss without cost to the Department. However, the Contractor shall not bear such risk of loss or damage which arises from acts of war or floods, tidal waves, earthquakes, cyclones, tornadoes, hurricanes or other cataclysmic natural phenomenon.

The Contractor shall, in furtherance of the above paragraph, but not by way of limitation, at his expense, provide suitable drainage for the Project and erect such temporary structures where necessary to protect the Work from damage. The risks for failure to take such actions shall be assumed by the Contractor.

In case of suspension of the Work from any cause whatever, the Contractor shall continue to be responsible for the Project as provided above and shall take such precautions as may be necessary to prevent damage to the Project, provide for drainage and shall erect any necessary temporary structures, signs, or other facilities. During such period of suspension of the Work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings furnished under this Contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury. If ordered by the Engineer, the Contractor shall properly store, during such suspension of the Work, materials which have been partially paid

for or furnished by the Department. The Department will be entitled to the possession of such materials, and the Contractor shall promptly return the same to the Project site when requested. The Contractor shall not dispose of any of the materials so stored except on written authorization. The Contractor shall be responsible for the loss of or damage to such materials.

(b) *Risks of Claims on Account of Injury, Loss or Damage.* The risk of claims, just or unjust, by third persons made against the Contractor or the State, on account of injuries (including wrongful death), loss or damage of any kind whatsoever arising or alleged to arise out of or in connection with the performance of the Work (whether or not actually caused by or resulting from the performance of the Work) or out of or in connection with the Contractor's operations or presence at or in the vicinity of the construction site or State premises, whether such claims are made and whether such injuries, damages and loss are sustained at any time both before and after Acceptance.

(c) *Risk of Loss to Property of Those Performing the Work.* The risk of loss or damage to any property of the Contractor, and of claims made against the Contractor or the State for loss or damage to any property of subcontractors, materialmen, workmen and others performing the Work, and to lessors, occurring at any time prior to completion of removal of such property from the construction site or the State's premises, or the vicinity thereof.

The Contractor shall indemnify and save harmless the State against all claims described in Subparts *(b)* and *(c)* above and for all expense incurred by the State in the defense, settlement or satisfaction thereof including expenses of attorneys. If so directed, the Contractor shall at his own expense defend against such claims, in which event he shall not, without obtaining express advance permission from the State, raise any defense involving in any way jurisdiction of the tribunal, immunity of the State, governmental nature of the State, or the provisions of any statutes respecting suits against the State.

The provisions of this Subsection are also for the benefit of all officers, agents and employees of the State so that they have all the rights which they would have under this Subsection if they were named at each place above at which the State is named, including a direct right of action against the Contractor to enforce the foregoing indemnity except, however, that the State may at any time in its sole discretion and without liability on its part cancel the benefit conferred on any of them by this Subsection, whether or not the occasion for invoking such benefit has already arisen at the time of such cancelation.

Neither Acceptance nor the making of final payment releases the Contractor from his obligations under this Subsection. Moreover, neither the enumeration in this Subsection nor the enumeration elsewhere in this Contract of particular risks assumed by the Contractor or of particular claims for which it is responsible shall be deemed:

- to limit the effect of the provisions of this Subsection or of any other provision of this Contract relating to such risks or claims,
- to imply that the Contractor assumes or is responsible for risks or claims only of the type enumerated in this Subsection or in any other provision of this Contract, or
- to limit the risks which the Contractor would assume or the claims for which the Contractor would be responsible in the absence of such enumerations.

The Contractor expressly understands and agrees that any insurance protection required by the Contract, or otherwise provided by the Contractor, in no way limits the Contractor's responsiblity to defend, indemnify and save harmless the State as herein provided. Such insurance requirements are designed to provide greater assurance to

the State that the Contractor is financially able to discharge his obligations under this Subsection and as to the risks assumed elsewhere in this Contract and are not in any way construed as a limitation on the nature and extent of such obligations.

107.23 Insurance. The Contractor shall procure and maintain at his own expense, until Acceptance and at all times thereafter when the Contractor may be correcting, removing or replacing defective work or completing plantings, insurance for liability for damages imposed by law and assumed under this Contract, of the kinds and in the amounts hereinafter provided, with insurance companies authorized to do business in the State. Before commencing the Work, the Contractor shall furnish to the Department a certificate or certificates of insurance together with declaration pages, in form satisfactory to the Department, showing that he has complied with this Subsection. Insurance binders are not acceptable as a form of insurance certificate. All of the policies of insurance required to be purchased and maintained and the certificates, declaration pages or other evidence thereof shall contain a provision or endorsement that the coverage afforded is not to be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to the Engineer by certified mail. All certificates, notices or declaration pages shall be mailed to the Regional Construction Engineer whose name and address is included in Subsection 101.04 of the Supplementary Specifications. Upon request, the Contractor shall furnish the Department with a certified copy of each policy itself, including the provisions establishing premiums.

The types of insurance and minimum limits of liability are as follows:

(a) Comprehensive General Liability Insurance. The minimum limit of liability shall be $5,000,000 per occurrence as a combined single limit for bodily injury and property damage. In the event that an annual aggregate applies to this policy, said aggregate shall be at least $10,000,000.

The above required Comprehensive General Liability policy shall name the State, its officers and employees as additional named insureds.

The coverage to be provided under this policy shall be at least as broad as that provided by the standard, basic, unamended and unendorsed comprehensive general liability coverage forms currently in use in the State of New Jersey, which shall not be circumscribed by any endorsement limiting the breadth of coverage. Moreover, such policy shall be endorsed so as to delete any exclusions applying to property damage liability arising from underground hazards relating to underground utilities, explosion and collapse of foundations.

The insurance policy shall be endorsed to include contractual liability coverage; premises/operations coverage; products/completed operations coverage; broad form property damage coverage; independent contractors coverage and personal injury coverage. In addition, the Contractor shall maintain completed operations insurance for at least 2 years after final payment and furnish the Engineer with evidence of continuation of such insurance at final payment and 1 year thereafter.

Umbrella coverage with the same terms and conditions as the primary underlying coverage (following form) will be acceptable in lieu of the higher aggregate limit provided the umbrella policy is in the minimum amount of $10,000,000 and provided said umbrella policy contains a clause stating that it takes effect (drops down) in the event the primary aggregate is impaired or exhausted.

The Contractor shall provide documentation from the insurance company which indicates the cost of naming the State, its officers and employees as named insureds.

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(b) *Comprehensive Automobile Liability Insurance.* The policy shall cover owned, nonowned and hired vehicles with minimum limits of liability in the amount of $5,000,000 per occurrence as a combined single limit for bodily injury and property damage.

(c) *Owner's and Contractor's Protective Insurance.* A separate Owner's and Contractor's Protective Policy shall be provided with the same minimum limits as specified for Comprehensive General Liability Insurance in Subpart *(a)* above. The policy is to be written for the benefit of the "State of New Jersey, its officers and employees" and they are to be named as the insured. The Contractor shall provide documentation from the insurance company which indicates the cost of the Owner's and Contractor's Protective Insurance Policy.

(d) *Worker's Compensation and Employer's Liability Insurance.* Worker's Compensation Insurance shall be provided in accordance with the requirements of the laws of this State and shall include an all states endorsement to extend coverage to any state which may be interpreted to have legal jurisdiction. Employer's Liability Insurance shall be provided with the following minimum limits:

- $100,000 each accident
- $100,000 Disease each employee
- $500,000 Disease aggregate limit

(e) *Marine Liability Insurance.* The Contractor or the subcontractor engaged in marine operations shall procure and maintain Marine Liability Insurance with protection and indemnity coverage with a minimum limit of liability of $1,000,000 per occurrence.

(f) *Railroad Insurance.* In addition to any other forms of insurance or bonds required under the terms of the Contract Documents, the Contractor or subcontractor engaged in work within or adjacent to railroad right-of-way shall procure and maintain insurance for such railroads for both bodily injury and property damage with the same minimum limits as specified for Comprehensive General Liability Insurance in Subpart *(a)* above in the following types:

1. Contractor's Public Liability and Property Damage Liability Insurance.
2. Contractor's Protective Public Liability and Property Liability Insurance, if any part of the Work is performed by subcontractor.
3. Railroad Protective Public Liability and Property Damage Liability Insurance in accordance with Federal Highway Administration Program Manual, Volume 6, Chapter 6, Section 2, Subsection 2.

A copy of the program manual and form of insurance policy may be obtained upon request to the Bureau of Construction Services.

The original policy of No. 3 and certificates of Nos. 1 and 2 above must be furnished to and approved by the railroad company before the Contractor will be permitted on railroad property. Policies, certificates, notices of cancellation or changes etc. are to be sent by the Contractor directly to the engineering officer of the railroad. The Contractor and his insurance representative must reconcile all policy requirements to the satisfaction of the railroad and the Engineer. The requirements of this paragraph are in addition to the general requirements of this Subsection.

The Supplementary Specifications contain an estimate of the percentage of the Project cost located within or adjacent to the railroad right-of-way. The ratio is given for informational purposes only and in no way affects or disturbs whatever laws, regulations, etc., that now apply relative to the amount of risk or coverage.

Insurance coverage in the minimum amounts set forth herein shall not be construed to relieve the Contractor for liability in excess of such coverage, nor does it preclude the State from taking such other actions as are available to it under any other provisions of this Contract or otherwise in law.

All proof of insurance submitted to the State shall clearly set forth all exclusions and deductible clauses. The Engineer may allow certain deductible clauses which he does not consider excessive, overly broad, or harmful to the interests of the State. Standard exclusions will be allowed provided they are not inconsistent with the requirements of this Subsection. Allowance of any additional exclusions is at the discretion of the Engineer. Regardless of the allowance of exclusions or deductions by the Engineer, the Contractor shall be responsible for the deductible limit of the policy and all exclusions consistent with the risks he assumes under this Contract and as imposed by law.

In the event that the Contractor provides evidence of insurance in the form of certificates of insurance, valid for a period of time less than the period during which the Contractor is required by the terms of this Contract to maintain insurance, said certificates are acceptable, but the Contractor shall be obligated to renew its insurance policies as necessary and to provide new certificates of insurance so that the State is continuously in possession of evidence of the Contractor's insurance in accordance with the foregoing provisions.

In the event the Contractor fails or refuses to renew its insurance policy, or the policy is canceled, terminated, or modified so that the insurance does not meet the requirements of this Subsection, the State may refuse to make payment of any further monies due under this Contract or refuse to make payment of monies due or coming due under other contracts between the Contractor and the State. The State may use monies retained under this paragraph to renew the Contractor's insurance for the periods and amounts referred to above. Alternately, the State may default the Contractor and direct the surety to complete the Project. During any period when the required insurance is not in effect, the Engineer may suspend performance of the Contract. If the Contract is so suspended, additional compensation or extension of Contract Time is not due on account thereof.

107.24 Personal Liability of Public Officials. In carrying out any of the provisions of the Contract, or in exercising any power or authority granted to them by or within the scope of the Contract, there is to be no liability upon the Commissioner, Engineer or their authorized representatives, either personally or as officials of the State, it being understood that in all such matters they act solely as agents and representatives of the State.

107.25 Recovery of Monies by the State. Whenever it is provided in the Contract Documents that the State, Department, or Engineer is to withhold or deduct money from any monies due or that may become due the Contractor, or that the Contractor is to pay or return monies for any reason, or that the State, Department or Engineer can charge against the Contractor certain costs, assessments or fines, or that the State, Department or Engineer can recover any sum for any reason from the Contractor, it is understood that the State has available to it any monies due or that may become due the Contractor under this Contract and on other contracts between the Contractor and the Department. Such other contracts shall include joint ventures in which the Contractor is a participant but only to the extent of its participation. The right to recover against the Contractor as herein provided is in addition to and does not affect the right of the State to seek recovery against the Contractor or surety under the Contract bonds or as otherwise allowed by the law.

107.26 No Waiver of Legal Rights. Notwithstanding any other provision of this Contract, for a period of 3 years after Acceptance, all estimates and payments made pursuant to Section 109, including the Final Certificates and Final Payment, are subject to correction and adjustment for clerical or other errors in the calculations involved in the determination of quantities and payments. The Contractor and the Department agree to pay to the other any sum due under the provisions of this Subsection, provided, however, if the total sum to be paid is less than $100, payment will not be made.

A waiver on the part of the Department of any breach of any part of the Contract is not to be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the Contract, shall be liable to the Department at any time both before and after Acceptance for latent defects, fraud, such gross mistakes as may amount to fraud, or actions affecting the Department's rights under any warranty or guaranty.

107.27 Limitations of Liability. In any event, whether under the provisions of this Contract, as a result of breach of Contract, tort (including negligence) or otherwise, the State will not be liable to the Contractor for any special, consequential, incidental or penal damages including, but not limited to, loss of profit or revenues, loss of rental value for contractor-owned equipment, damages to associated equipment, cost of capital or interest of any nature.

107.28 Environmental Protection. The Contractor shall comply with all applicable Federal, State and local laws and regulations, and all conditions of permits controlling pollution of the environment. Necessary precautions shall be taken to prevent pollution of streams, lakes, ponds, wetlands, groundwater and reservoirs with fuels, oils, bitumens, chemicals or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

(a) Control of Dust and Dirt Pollution. The Contractor shall employ construction methods and means that keep flying dust to the minimum and shall provide for the laying of water on the Project and on roads, streets and other areas immediately adjacent to the Project limits, wherever traffic or buildings that are occupied or in use, are affected by such dust caused by his hauling or other construction operations. The materials and methods used for water laying are subject to approval. If calcium chloride is used, the rate of application shall be approximately 1.5 pounds per square yard. The cost of carrying out the foregoing provisions shall be included in the prices bid for the various items in the Contract.

The Contractor shall provide for prompt removal from existing roadways of all dirt and other materials that have been spilled, washed, tracked or otherwise deposited thereon by his hauling and other operations whenever the accumulation is sufficient to cause the formation of mud, interfere with drainage, damage pavements or create a traffic hazard.

In order to minimize tracking of dirt and other materials onto existing roadways, a construction driveway shall be constructed at locations where vehicles exit a work site.

The construction driveway shall consist of a layer of broken stone which shall be a minimum 4 inches thick and 100 feet long where practical and of sufficient width to serve the intended purpose. The broken stone shall be 2 1/2 inch nominal size and shall conform to the quality requirements of Subsection 901.04. The driveway shall be maintained by top dressing with additional stone and shall be removed when no longer required.

Construction driveway will be measured by the ton.
Payment will be made under:

Pay Item	*Pay Unit*
Construction Driveway	Ton

(b) *Control of Noise and Air Pollution.* The Contractor shall employ all possible methods to minimize noise and dust pollution caused by drilling, blasting, excavation and hauling operations. These shall include, but shall not necessarily be limited to, use of dust collection devices or water injectors on drilling units.

All construction equipment powered by an internal combustion engine shall be equipped with a properly maintained muffler. Air-powered equipment shall be fitted with pneumatic exhaust silencers. Air compressors shall meet EPA noise emission standards.

Stationary equipment powered by an internal combustion engine shall not be operated within 150 feet of noise sensitive sites without portable noise barriers placed between the equipment and the noise sensitive sites. Noise sensitive sites include residential buildings, motels, hotels, schools, churches, hospitals, nursing homes, libraries and public recreation areas. Portable noise barriers shall be constructed of plywood or tongue and groove boards with a noise absorbant treatment on the interior surface (facing the equipment). Powered construction equipment shall not be operated before 8 AM or after 8 PM within 150 feet of a noise sensitive site.

All methods and devices employed to minimize noise and dust pollution are subject to the daily approval of the Engineer.

(c) *Historic Places.* The Contractor will not be permitted to use as a disposal site or obtain borrow excavation from locations eligible for or listed on the State or National Registers of Historic Places. Copies of the State and National Registers of Historic Places are available from the Department's Bureau of Environmental Analysis.

(d) *Disposal Sites Beyond Project Limits.* Material shall not be disposed of beyond the Project limits until the Resident Engineer has approved the location of the disposal site and received a copy of the soil and sediment control plan certified by the soil conservation district in accordance with NJSA 4:24-39 *et seq.*

(e) *Borrow Pits.* Material shall not be excavated from a borrow pit beyond the Projects limits until the Resident Engineer has received a copy of the soil and sediment control plan certified by the soil conservation district in accordance with NJSA 4:24-39 *et seq.*

SECTION 108 - PROSECUTION AND PROGRESS

108.01 Assignment. The performance of the Contract may not be assigned, except upon the written consent of the Commissioner. Consent will not be granted to any proposed assignment which would relieve the original Contractor or his surety of their responsibilities under the Contract nor will the Commissioner consent to any assignment of a part of the Work under the Contract.

108.02 Subcontracting. Subject to the provisions of this Subsection and to the consent of the Commissioner, Work may be subcontracted except that the item mobilization or any part thereof shall not be subcontracted. It is understood, however,

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that any consent of the Commissioner for the subcontracting of any Work of the Contract in no way relieves the Contractor from his full obligations for all Work under the Contract, nor the surety of its obligations under the bond. The Contractor shall at all times give his personal attention to the fulfillment of the Contract and shall keep the Work under control. The Contractor shall be responsible for all work of subcontractors which work shall conform to the provisions of the Contract Documents. The consent to the subcontracting of any part of the Work is not to be construed as an approval of the said subcontract or of any of its terms, but is to operate only as an approval of the Contractor's request for the making of a subcontract between the Contractor and his chosen subcontractor.

The Contractor shall perform with his own organization contract work amounting to not less than 50 percent of the Total Contract Price, except that any Pay Items designated as "Specialty Items" in the Contract Documents may be performed by subcontract and the amount of any such "Specialty Items" so performed may be deducted from the Total Contract Price before computing the amount of work required to be performed by the Contractor with his own organization. Where an entire item is subcontracted, the value of Work subcontracted will be determined based on the Pay Item bid price. When a portion of a unit price item is subcontracted, the value of Work subcontracted will be determined by the unit price bid in the Proposal except when a portion of a sign support structure is subcontracted, the provisions for a lump sum item govern. When a portion of a lump sum item or an item which includes specialty work is subcontracted, the value of Work subcontracted will be determined based on the estimated cost of the Work to be subcontracted as determined from the breakdown of cost submitted by the Contractor.

Application for subcontracting any part of the Work shall be made by the Contractor on forms furnished by the Department. That form, fully completed, in quadruplicate, all with original signatures, shall be furnished to the Regional Construction Engineer. The Contractor shall attach to that form a certified copy of the executed subcontract between the Contractor and the subcontractor. The copy of the subcontract will be used in the review of the application.

After review of the application, the consent of or rejection by the Commissioner of the subcontracting will be provided to the Contractor in writing. Prior to the receipt of this written consent from the Commissioner, Work shall not be performed on the Project under the subcontract.

Subcontracting will not be permitted to firms and individuals suspended or debarred by the Department or included in the Report of Suspensions, Debarments and Disqualifications of Firms and Individuals as maintained by the Department of the Treasury, Division of Building and Construction, Bureau of Contractor Prequalification.

Where the value of the Work to be subcontracted is $200,000 or more, subcontracting will be permitted only to subcontractors prequalified with the Department. Moreover, where one subcontractor has pending, and as yet incompleted, Work on more than one Department project, the aggregate value of which exceeds $200,000, such subcontractor must be prequalified with the Department.

Subcontracting of landscape items will be permitted only to subcontractors holding a landscape prequalification rating with the Department regardless of the value of the subcontract.

Subcontracting of those electrical items which require electricians will be permitted only to subcontractors who are licensed electricians in the State of New Jersey regardless of the value of the subcontract.

The subcontractor shall look only to the Contractor for the payment of any claims of any nature whatsoever arising out of said subcontract and the subcontractor agrees, as a condition of the Commissioner's consent to the making of said subcontract, that the subcontractor shall make no claims against the Commissioner or his agents or employees for any Work performed or thing done by reason of said subcontract, or for any other cause that may arise by reason of the relationship created between the Contractor and subcontractor by the subcontract.

Additionally, the Contractor shall give assurances, prior to the Commissioner's giving of his consent, that when minimum wage rates are specified they shall apply to labor performed on all subcontracted Work.

The Commissioner will not consent to the making of any subcontract unless the proposed subcontractor furnishes a statement to the effect that said subcontractor is acquainted with all of the provisions of the Contract.

108.03 Commencement of Work. Upon execution of the Contract by the Commissioner, a fully executed copy thereof together with a Notice to Proceed will be provided to the Contractor. Receipt of the executed Contract and Notice shall constitute the Contractor's authority to enter upon the site of the Work, provided the Contractor has, prior thereto, submitted to the Engineer, and he has accepted, the insurance certificates required under Subsection 107.23 and a preconstruction conference has been held. Construction operations shall not begin until the Contractor has supplied, and the Engineer has accepted, the progress schedule and other certifications, forms, schedules and any other information required by the Contract Documents and has established a field office as required by Subsection 105.15.

Construction operations shall begin within 25 days of the date the Contract is executed by the Commissioner. Said twenty-fifth day is the first day of the Contract Time. Failure of the Contractor to begin construction operations within 25 days for any reason shall constitute a Contractor delay. Failure to begin construction operations within 40 days shall constitute a default for which the Commissioner may take whatever action that is deemed appropriate under the Contract.

Should the Contractor begin Work prior to the execution of the Contract by the Commissioner, such Work shall be considered as having been done at his own risk and as a volunteer. In no event, however, shall the Contractor work at the Project site prior to execution of the Contract by the Commissioner unless proof of insurance has been provided in accordance with Subsection 107.23. In the event the Commissioner decides to reject the Contract, the Contractor shall at his expense do such Work as is necessary to leave the site in an approved condition. If any of the Work done prior to the Commissioner's rejection affects any existing road or highway, the Contractor shall at his expense restore it to its former condition or the equivalent thereof, as approved. However, all Work done in accordance with the Contract Documents prior to its execution by the Commissioner will, if the Commissioner executes the Contract, be considered authorized Work and will be paid for as provided in the Contract.

The Contractor is not entitled to additional compensation or extension of Contract Time for any delay, hindrance, or interference caused by or attributable to commencement of Work prior to the twenty-fifth day following execution of the Contract by the Commissioner.

The Contractor shall give the Resident Engineer at least 24 hours advance notice in writing of his intention to start construction operations.

108.04 Progress Schedule and Prosecution of the Work. At or prior to the preconstruction conference, the Contractor shall furnish, for approval, a progress schedule showing the order in which the Contractor proposes to prosecute the

Work, the dates on which he shall start the various work stages, operations and principal items of Work including procurement of materials and plant, the quantity and kinds of equipment and character of the labor force and the contemplated dates for completing the same. The progress schedule shall clearly outline the intended maintenance of traffic, pollution control measures and such other information as required by the Contract Documents or as deemed appropriate for the Project.

Construction operations shall not begin until the above schedule has been approved. Five working days will required for review and approval of progress schedules for projects having a duration of 2 years or less with 2 additional working days for each year or part thereof in excess of 2 years. Once the progress schedule has been approved, the Contractor shall not deviate therefrom without first notifying the Engineer in writing.

(a) Staging. The Contractor shall schedule the Work using such procedures and staging as may be specified in the Contract Documents. Work designated as part of separate stages may be performed simultaneously where provided by the Contract Documents or where approved.

When the Contract Documents provide for staging or specific procedures, the Contractor may, prior to submitting a progress schedule, present for written approval of the Engineer, a detailed, written alternate staging plan or procedure which incorporates the requirements of the Department. As a condition of the Engineer's reviewing the alternate staging plan or procedure, the Contractor agrees that he is not entitled to additional Contract Time or compensation arising from possible delays to construction due to the time spent in reviewing the Contractor's staging plan or procedure, regardless of whether the Department accepts or rejects it. If such staging plan or procedure is approved in writing, the Contractor may then prepare a progress schedule consistent with the approval.

(b) Prosecution of the Work. The Contractor shall provide sufficient materials, equipment and labor to guarantee the completion of the Project in accordance with the Contract Documents and within the time set forth under Subsection 108.10.

If the Contractor falls 10 percent by time behind the submitted schedule, the Contractor shall submit a revised schedule for approval.

Should the prosecution of the Work be discontinued for any reason, the Contractor shall notify the Engineer, in writing, prior to discontinuing work and at least 24 hours in advance of resuming operations.

The Contractor shall arrange and prosecute the Work so that each successive construction operation at each location shall follow the preceding operation as closely as the requirements of the various types of construction permit.

Work which closes or alters the use of existing roadways shall not be undertaken until adequate provisions, conforming to the requirements of Section 110, have been made by the Contractor and approved.

The Engineer may revise stage construction and maintenance of traffic, if deemed necessary, due to unforeseen circumstances which may arise during construction.

Compensation for additional expense to the Contractor and allowance of additional time for completion of the Work shall be as set forth in a Change Order or Supplementary Agreement or in accordance with Subsections 108.11 and 109.03.

When possible, the construction of subsurface structures adjacent to traffic shall be performed while traffic is being diverted from such areas. If traffic must be maintained in such area, the Work shall be done expeditiously in stages, as approved, and with minimum interference with traffic.

Subsurface structure excavation adjacent to traffic shall not remain open overnight unless adequately protected by approved safety devices.

The Contractor shall proceed with the Work of demolition of the various buildings identified with a demolition number as and when they become available for demolition. If any of the buildings to be demolished is not available for demolition at the time the Contractor begins Work on the Project, the Contractor shall arrange and prosecute his Work so as to temporarily defer his Work in the vicinity of such building and complete such Work when the building is made available for demolition.

Operations adjacent to traffic shall be confined to only one side of the traffic at any one time unless otherwise specified in the Contract Documents.

Concrete curbs constructed adjacent to flexible base and surface courses shall be completed, cured and backfilled before such flexible base and surface courses are constructed.

Underground structures for traffic signals shall be constructed, except for pressure detector installations, prior to completion of the intersecting road.

(c) *Intent, Responsibility and Time.* Scheduling of construction is the responsibility of the Contractor. Therefore, it is the Contractor's responsibility to determine the most feasible order of Work commensurate with the Contractor's abilities and the Contract Documents. The requirement for the progress schedule is included to assure adequate planning and execution of the Work, to assist the Engineer in appraising the Contractor's compliance with the Contract Documents and to evaluate progress of the Work. The progress schedule will be used for determining extensions or reductions of Contract Time pursuant to Subsection 108.11.

It is not intended that the Engineer, by approving the progress schedule, agrees that it is reasonable in all respects or that following the progress schedule can result in timely completion of the Project. The parties agree that the progress schedule is not a part of the Contract.

If, in the preparation of the progress schedule, the Contractor reflects a completion date different than that specified under Subsection 108.10, this in no way voids the date set therein. The date as specified in that Subsection governs. Where the progress schedule reflects a completion date earlier than that specified as the Contract Time, the Engineer may approve such schedule with the Contractor specifically understanding that no claim for additional Contract Time or compensation shall be brought against the State as the result of failure to complete the work by the earlier date shown on the progress schedule.

(d) *Acceleration and Default.* If, in the opinion of the Engineer, the Contractor falls behind his progress schedule, and cannot complete the Work within the time prescribed under Subsection 108.10, as modified pursuant to Subsection 108.11, the Contractor shall take such steps as may be necessary to improve his progress. The Engineer may require him to increase the number of shifts, begin overtime operations, work extra days including weekends and holidays, supplement his construction plant or all of the foregoing, and to submit for approval such supplementary schedule or schedules, as may be deemed necessary to demonstrate the manner in which the agreed rate of progress shall be regained all at no cost to the State.

Failure of the Contractor to comply with the requirements of the Engineer under this Subpart is grounds for the determination that the Contractor is not prosecuting the Work with such diligence as to ensure completion within the time specified. Upon such determination, the Engineer may terminate the Contractor's right to proceed with the Work or any separable part thereof in accordance with Subsection 108.17.

(e) Types of Progress Schedules. All progress schedules shall comply with the foregoing provisions of this Subsection. Regardless of the type of progress schedule used, the Contractor shall supply the Resident Engineer with a weekly work schedule indicating his planned work, subcontractors' planned work, the dates when materials are to be delivered and a forecast of lane closings.

The progress schedule shall be one of the following depending on whether the progress schedule is a Pay Item or not.

(1) When the Progress Schedule is a Pay Item. The progress schedule shall be prepared by the Critical Path Method (CPM) or a comparable network system conforming with the requirements hereinafter prescribed.

The network shall include, as a minimum, one activity for each discrete component part of each Pay Item scheduled in the Proposal. The Engineer may allow grouping of similar Pay Items. The system shall consist of network diagrams and accompanying mathematical tabulations as described hereinafter.

Diagrams shall show the order and interdependence of activities and the sequence and quantities in which the Work is to be accomplished. The basic concept of network scheduling shall be followed to show how the start of a given activity is dependent on the completion of preceding activities and how its completion may affect the start of following activities. No activity duration shall be longer than 20 working days without prior approval. The critical path shall be distinguished from other paths on the network. The network diagram shall include the following:

- activity description
- activity duration (work days)
- critical path denoted
- event nodes numbered
- all restraints noted
- all network dummies
- slack or float for each activity
- work days calendar which extends for the length of the Contract plus 25 percent additional time

In addition to construction activities, network activities shall include the submittal and approval of samples of materials and working drawings, and the fabrication of special materials. It shall include all documents and proofs of compliance required by the Contract Documents for Completion.

All activities of the Department that affect progress and any special Contract required dates shall be shown.

The mathematical tabulation of the network diagram shall include a tabulation of each activity shown on the detailed network diagram.

The following information shall be furnished as a minimum for each activity on this tabulation:

- event nodes numbered
- activity description
- estimate duration
- earliest start date (calendar date)
- earliest finish date (calendar date)
- latest start date (calendar date)
- latest finish date (calendar date)
- Contractor's intended start date
- Contractor's intended completion date
- slack or float for each activity
- quantities involved on each activity based on Contractor's intended start and completion dates
- percentages of activity completed
- critical path activities denoted

This mathematical tabulation can be either a computer printout or one manually prepared with a column for each of the above requirements. The Contractor shall update the mathematical tabulation on a monthly basis and shall provide the Engineer with updated copies along with any revisions to the network diagrams on the day the monthly Engineer's Estimate is prepared. The updated tabulations shall reflect the current status of activities as outlined on the network diagram. If any delays have occurred, these shall be noted for time consideration, the updated tabulation sheet shall reflect all changes in dates, durations and float time.

Conditions may develop which require network logic revisions to the original diagram. If during the progress of the Work, major changes develop which necessitate changes in the original plan, the Contractor shall make such changes so as to depict the current mode of operation and shall provide the Engineer with a revised network diagram.

Payment for the accepted progress schedule will be made on a lump sum basis for the schedule completed as specified including all necessary updating. Twenty-five percent of the lump sum bid will be paid upon approval of the initial submission with the balance paid upon approval of updates at a prorated sum based upon the number of anticipated updates to be submitted during the Contract Time.

Payment will be made under:

Pay Item	***Pay Unit***
Progress Schedule	Lump Sum

(2) *When the Progress Schedule is Not a Pay Item.* The progress schedule may be of the bar chart or similar type acceptable to the Engineer as to form and substance. The schedule shall be in a suitable scale as to indicate the percentage of work scheduled for completion at any time. The progress schedule shall include, as a minimum, one activity for each Pay Item provided, however, that the Engineer may require and the Contractor shall provide for certain Pay Items, a breakdown of each discrete component part to be

included in the Progress Schedule. The Contractor shall include in the progress schedule, or in a separate submission, a schedule of working drawing submissions. The Contractor shall update the progress schedule when conditions have changed such to invalidate the current schedule.

All costs for furnishing and updating the progress schedule shall be included in the prices bid for the various Pay Items scheduled in the Proposal.

108.05 Mobilization. Mobilization shall consist of preparatory work and operations, necessary for the movement of personnel, equipment, supplies and incidentals to the Project site, and other work performed or costs incurred prior to beginning Work.

Payment for mobilization will be made on a lump sum basis regardless of the fact that the Contractor may have, for any reason, shut down his work on the Project or moved equipment away from the Project and back again.

Payment will be made in accordance with the following schedule:

- when 5% of the Work is completed - 25% of the amount bid for mobilization or 2.5% of the Total Contract Price, whichever is less, will be paid
- when 10% of the Work is completed - 50% of the amount bid for mobilization or 5% of the Total Contract Price, whichever is less, will be paid
- when 15% of the Work is completed - 75% of the amount bid for mobilization or 7.5% of the Total Contract Price, whichever is less, will be paid
- when 20% of the Work is completed - 100% of the amount bid for mobilization or 10% of the Total Contract Price, whichever is less, will be paid
- upon completion of all Work on the Project, payment for the amount bid for mobilization in excess of 10% of the Total Contract Price will be made.
- the percentage of Work completed shall be the total of payments earned compared to the Total Contract Price. The total of payments earned excludes the amount paid for this item and the amount paid for materials furnished but not incorporated into the Work in accordance with Subsection 109.06, as shown on the monthly estimates of the approximate quantities of Work done, prepared in accordance with Subsection 109.05.

Payment will be made under:

Pay Item	***Pay Unit***
Mobilization	Lump Sum

When mobilization is not a Pay Item, all costs for the Work shall be included in the prices bid for the various Pay Items scheduled in the Proposal.

108.06 Limitation of Operations. The Contractor shall conduct the Work at all times in such a manner and in such sequence to assure the least interference with traffic. He shall have due regard for the location of detours and for the provisions for handling traffic. The Engineer may require the Contractor to finish a section on which Work is in progress before Work is started on any additional sections if the opening of such section is essential to public convenience.

108.07 Character of Workmen, Methods and Equipment. The Contractor shall at all times employ sufficient labor and equipment for prosecuting the several classes of Work to full completion in the manner and time required by the Contract Documents.

All workmen shall have sufficient skill and experience to perform properly the Work assigned to them. Workmen engaged in special Work or skilled Work shall have sufficient experience in such Work and in the operation of the equipment required to perform the Work satisfactorily.

Any person employed by the Contractor or by any subcontractor who, in the opinion of the Engineer, does not perform his Work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Engineer, be removed promptly by the Contractor or subcontractor employing such person, and shall not be again employed in any portion of the Work without approval. Should the Contractor fail to remove such person or persons as required above, or fail to furnish suitable and sufficient personnel for the proper prosecution of the Work, the Engineer may suspend the Work by written notice until compliance with such orders.

Except for regularly retired employees, the Contractor and his subcontractors shall not, without the written consent of the public employer of such person, engage on a full, part-time or other basis, during the period of the Contract, any of the professional or technical personnel of the New Jersey Department of Transportation or of any State, county or municipality, who are or have been at any time during the period of the Contract or for 30 days prior to Award, in the employ of such public agency.

All equipment which is proposed to be used on the Work shall be of sufficient size and in such mechanical condition as to meet requirements of the Work and to produce a satisfactory quality of Work. Equipment used on any portion of the Project shall be such that its use results in no damage to the roadway, adjacent property or other highways.

Use of equipment will not be permitted that is owned and/or operated by firms and individuals suspended or debarred by the Department or included in the Report of Suspensions, Debarments and Disqualifications of Firms and Individuals as maintained by the Department of the Treasury, Division of Building and Construction, Bureau of Contractor Prequalification.

When the methods and equipment to be used by the Contractor in accomplishing the construction are not prescribed, the Contractor is free to use any methods or equipment that accomplishes the Work. When the use of certain methods and equipment is specified, such methods and equipment shall be used unless otherwise authorized in accordance with Subsection 106.12.

108.08 Working Site. Except as otherwise provided, any space that the Contractor may require for plant, equipment, storage or other purposes in addition to that available at the site of the Project, shall be procured by the Contractor and the cost thereof shall be included in the prices bid for the various Pay Items scheduled in the Proposal. In the event of default as set forth in Subsection 108.17, the Commissioner has the right to take over and occupy such space, or cause it to be occupied, for the purpose of completing the Project, at the Contractor's expense. If leased, the lease shall contain a provision that in event of default by the Contractor the lease may be assigned to the State or its nominee at their election. The Contractor agrees in event of said default, that he shall make such assignment.

The Contractor shall not use the decks of any completed bridges, or the areas including slopes under any completed bridges, as working sites or storage areas for materials or equipment.

108.09 Unusual Site Conditions. The Contractor shall promptly, and before such conditions are disturbed, notify the Resident Engineer in writing, on forms provided by the Department, of previously unknown physical conditions at the site of an unusual nature or differing materially from those ordinarily encountered and generally recognized as inhering in Work of the character provided for in this Contract. The Engineer will promptly investigate the conditions, and if he determines that such conditions are unusual, that they could not have been discovered by the Contractor through employing the high standard of care required under Subsection 102.06 and that they cause an increase or decrease in the cost of, or the time required for, performance of any part of the Work under this Contract, an adjustment, as appropriate, will be made in the Contract Time pursuant to Subsection 108.11 and in compensation to the Contractor pursuant to Subsections 104.02, 104.03, 104.05, 104.06, 104.08, 109.03 and 109.04.

Claims arising from unusual site conditions are barred unless the Contractor has given the required notice prior to disturbing such conditions.

108.10 Time of Completion. The Contractor shall complete all or any portion of the Project called for under the Contract in all parts and requirements within the time or times for completion of the Contract set forth in the Supplementary Specifications. All time limits stated in the Contract Documents are of the essence of the Contract.

When the Contract Time is on a working day basis, the Engineer will furnish the Contractor a weekly statement showing the number of days charged to the Contract for the preceding week and the number of days specified for Completion. The Contractor is allowed 1 week in which to file a written protest, on forms provided by the Department, setting forth in what respect said weekly statement is incorrect. Otherwise, the statement is deemed to have been accepted by the Contractor as correct.

When the Contract Time is on a calendar day basis, it shall consist of the number of calendar days stated in the Contract counting from the date set forth in the Notice to Proceed in accordance with Subsection 108.03, including all Saturdays, Sundays, holidays and non-work days.

When the Contract Time is a specified completion date, that is the date on which the Contract shall reach Completion.

108.11 Extensions and Reductions of Contract Time. Where appropriate under the provisions of this Subsection, extensions or reductions to the Contract Time may be provided by Change Order, however, such extensions or reductions will be allowed only to the extent that the increase or decrease in the Work or delays of the types indicated below affect current controlling operations and the overall Completion. Increases or decreases in Work or such delays which do not affect the overall Completion are not to be the basis for reduction or extension of Contract Time. Extensions of Contract Time will not be granted under this Subsection where it is determined that the Contractor could have avoided the circumstances which give rise to his requesting such extension.

If the Contractor is delayed in completion of the Work by reason of changes made under Subsection 104.02, or by failure of the Department to acquire right-of-way, or by any act of other contractors consistent with Subsection 105.10, or due to the discovery of archeological finds consistent with Subsection 108.13, or the discovery of hazardous substances, or by any act of the Engineer or of the Department not contemplated by the Contract, an extension of Contract Time commensurate with the delay in overall completion of the Contract thus caused will be granted and the Contractor is relieved from any claim for liquidated damages or engineering and inspection charges.

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Additionally, the Contractor may be granted an extension of Contract Time and not assessed with liquidated damages or the costs of engineering and inspection for any portion of the delay in overall completion of the Work beyond the time provided in Subsection 108.10 caused by the following reasons:

- acts of civil or military authorities, war or riot;
- fire;
- floods, tidal waves, earthquakes, cyclones, tornadoes, hurricanes or other cataclysmic natural phenomemon (except on working day contracts);
- extreme weather conditions (see paragraph a. below) (except on working day contracts);
- epidemics or quarantine restrictions;
- strikes or labor disputes beyond the control of the Contractor which prevent work on the construction operations which are critical to the completion of the Project;
- shortages of materials (see paragraph b. below) or freight embargoes;
- acts of the State in its sovereign capacity;
- failure of the Engineer to furnish interpretations of the Contract Documents (see paragraph c. below).

Extension of Contract Time for the reasons set forth in this Subsection 108.11 will not be granted unless the Contractor has notified the Engineer in writing of the causes of delay within 15 days from the beginning of any such delay on forms provided by the Department. The Engineer will ascertain the facts and extent of the delay, and his findings thereon will be final and conclusive.

a. Extensions of Contract Time for extreme weather conditions will be granted in accordance with the following chart:

Number of Days the Contractor's Work is Limited to in One Month As the Result of Adverse Weather Conditions	Extension of Contract Time Allowable
16-31	0
15	1
14	2
13	3
12	4
11	5
10	6
9	7
8	8
7	9
6	10
5	11
4	12
3	13
2	14
1	15
0	16

In utilizing the above chart, the Engineer will:

- consider days on which an extension is granted under the category above "floods, tidal waves, earthquakes, cyclones, tornadoes, hurricanes or other cataclysmic natural phenomenon," as days on which the Contractor's work is limited as the result of adverse weather conditions;
- consider days for which an extension is granted under the categories above for causes other than "floods, tidal waves, earthquakes, cyclones, tornadoes, hurricanes or other cataclysmic natural phenomenon" as days on which the Contractor worked and was unaffected by adverse weather conditions; and
- make the above calculation based on the full 30 or 31 days in the calendar month as being days on which the Contractor could have worked without regard to Saturdays, Sundays and holidays.

b. Extensions of Contract Time will not be granted for a delay caused by a shortage of materials unless the Contractor furnishes:

- documentary proof that he has diligently made every effort to obtain such materials from all known sources within reasonable reach of the Work and,
- further proof in the form of a supplementary progress schedule, as required in Subsection 108.04, that the inability to obtain such materials when originally planned, did, in fact, cause a delay in completion of the Contract which could not be compensated for by revising the sequence of the Contractor's operations. The term "shortage of materials," applies only to raw and fabricated materials, articles, parts or equipment which are standard items and does not apply to materials, parts, articles or equipment which are processed, made, constructed, fabricated or manufactured to meet the specific requirements of the Contract. Only the physical shortage of materials and not the cost of materials will be considered.

c. Extensions of Contract Time will not be granted for failure of the Engineer to furnish interpretations of the Contract Documents until 20 days after receipt of such demand in writing as required by Subsections 105.01 and 105.07, and not then unless such request for an interpretation of the Contract Documents is reasonable and made in good faith, and the failure to respond was unwarranted.

Except where specifically provided in the Contract Documents, the Contractor shall not make any claim for damages or additional compensation for any delay in or hindrance to the performance of this Contract occasioned by any act or omission to act by the State or any of its representatives, or for any of the reasons enumerated in this Subsection and agrees that any such claim shall be fully compensated for by an extension of Contract Time to complete performance of the Work.

Extensions of Contract Time will not be granted due to delays caused by, or in any way related to, the financial condition of the Contractor, subcontractors, sub-subcontractors, materialmen, fabricators or suppliers. The Contractor and his surety assume full responsibility for ensuring that the financial condition of any of the above does not delay completion of the Contract.

If as a result of modifications made under Subsection 104.02, 104.05, 104.06 or 108.09, the Work required is reduced or altered so that the time required for the overall Completion is reduced, the Engineer may reduce the Contract Time provided

under Subsection 108.10. The Engineer will ascertain the facts and the extent of the reduction and his findings thereon are final and conclusive.

It is the intention of the above provisions that the Contractor or surety is not relieved of liability for liquidated damages or engineering and inspection charges for any period of delay in Completion in excess of that expressly provided for in this Subsection.

108.12 Right-Of-Way Delays. If, through the failure of the Department to acquire right-of-way, the Contractor sustains losses which could not have been avoided by the judicious handling of forces, equipment and plant, or performance of the Work is delayed, compensation for such loss and an extension of Contract Time may be granted in accordance with the provisions of Subsection 108.14.

The term "failure to acquire right-of-way" includes all right-of-way related delays of any nature, not solely those related directly to acquisition, from the date of execution of the Contract until its Acceptance, whether arising from events, or failure of the Department to act, occurring either before or after execution of the Contract.

The Supplementary Specifications indicate rights-of-way which have not been secured prior to construction and the approximate anticipated dates of availability.

108.13 Archeological Findings. When excavating operations encounter prehistoric remains or artifacts of historical or archeological significance, the operations shall be temporarily discontinued in that area. The Engineer will consult archeological authorities and determine the disposition of the remains or artifacts.

The Contractor agrees to make no claim for additional payment or for an extension of Contract Time because of any delays in the progress or alteration of the prosecution of the Work due to such discontinuance of the work or removal of any such remains or artifacts for the first 10 days of such delay. Thereafter and beginning on the eleventh day, compensation for such delay and an extension of Contract Time will be considered in accordance the provisions of Subsection 108.14.

108.14 Suspension of Work for Convenience of the State. The Engineer may order the Contractor in writing to suspend, delay, or interrupt all or any part of the Work for such period of time as he may determine to be appropriate for the convenience of the State.

If the performance of all or any part of the Work is, for any period of time, suspended, delayed, or interrupted by an act of the Engineer in the administration of this Contract, or as provided under Subsection 108.12 or 108.13, an adjustment will be made for any increase in the cost of performance of the Work, excluding profit, necessarily and directly caused by such suspension, delay, or interruption pursuant to Subsection 109.04, and where appropriate, an extension of Contract Time may be granted as specified in Subsection 108.11. However, adjustment will not be made under this Subsection for any suspension, delay, or interruption to the extent that performance would have been so suspended, delayed, or interrupted by any other cause, including the fault or negligence of the Contractor, or that such adjustment is provided for or excluded under any other provision of this Contract.

The failure of the Engineer to consider the Work suspended and to allow for an adjustment in the compensation or in the Contract Time shall not bar recovery under the foregoing provisions, provided the Contractor gives written notice to the Engineer within 10 days of the start of the alleged suspension. The failure of the Contractor to give such notice pursuant to the provisions of this Subsection shall constitute a waiver of any and all claims and damages which would have been avoided or mitigated had such timely notice been given. Such written notification shall be submitted on forms provided by the Department.

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108.15 Temporary Suspension of Work. The Engineer has the authority to suspend the Work wholly or in part, for such period as deemed necessary, due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the Work, or for such time as deemed necessary due to the failure on the part of the Contractor to carry out orders given, or to perform any provision of the Contract. The Contractor shall promptly comply with the written order of the Engineer to suspend the Work wholly or in part. The suspended Work shall be resumed when conditions are favorable and methods are corrected, as ordered or approved in writing.

In the event that a suspension of Work is ordered as provided above, and should such suspension be ordered by reason of the failure of the Contractor to carry out orders or to perform any provision of the Contract; or by reason of weather conditions being unsuitable for performing any item or items of Work, which Work, in the sole opinion of the Engineer, could have been performed prior to the occurrence of such unsuitable weather conditions had the Contractor diligently prosecuted the Work when weather conditions were suitable; the Contractor, at his expense, shall do all the Work necessary to provide a safe, smooth, and unobstructed passageway through the construction area for use by public traffic during the period of such suspension. In the event that the Contractor fails to perform the Work above specified, the Department will perform such Work and the cost thereof will be deducted from any monies due or that may become due the Contractor. In the event that a suspension of Work is ordered by the Engineer due to unsuitable weather conditions, and, in the sole opinion of the Engineer, the Contractor has prosecuted the Work with energy and diligence prior to the time that operations were suspended, the cost of providing a smooth and unobstructed passageway through the Work will be paid for as Extra Work as provided in Subsection 109.03, or, at the option of the Engineer, such Work will be performed by the Department at no cost to the Contractor.

If the Engineer orders a suspension of all of the Work or a portion of the Work which is the current controlling operation or operations, due to unsuitable weather or to such other conditions as are considered unfavorable to the suitable prosecution of the Work, the days on which the suspension is in effect are not considered working days on working day contracts. If a portion of Work at the time of such suspension is not a current controlling operation or operations, but subsequently does become the current controlling operation or operations, the determination of working days will be made on the basis of the then current controlling operation or operations. Similarly on calendar day and specified completion date contracts, extensions of Contract Time will be granted only if the suspension affects the overall completion of the Contract and the other requirements of Subsection 108.11 are satisfied.

If a suspension of Work is ordered by the Engineer due to the failure on the part of the Contractor to carry out orders given or to perform any provision of the Contract, the days on which the suspension order is in effect are to be considered working days if such days are working days within the meaning of the definition set forth in Subsection 101.03. On calendar day and specified completion date contracts, extensions of Contract Time will not be granted due to such suspension.

The Contractor shall have no claim for additional compensation as a result of suspension ordered for the reasons set forth in this Subsection, except as to the costs of providing a smooth and unobstructed passageway consistent with the above provisions.

108.16 Failure to Complete on Time. The Contractor and the Department recognize that delay in Completion results in damage to the State in terms of the effect of the delay on the use of the Project, upon the public convenience and economic development of the State, and also results in additional cost to the State for engineering, inspection and administration of the Contract. Because this damage is difficult or impossible to estimate, the parties agree that if the Contractor fails to complete the Contract within the time stated in the Supplementary Specifications, or within such further time as may have been granted in accordance with the provisions of the Contract, the Contractor shall pay the State liquidated damages in accordance with the following schedule in lieu of the above stated actual damage. Such liquidated damages shall be paid for each and every day, as hereinafter defined that he is in default on time to complete the Contract.

Schedule of Liquidated Damages for Each Day of Overrun in Contract Time

Original Contract Amount		Liquidated Damages	
From More Than	To and Including	Calendar Day	Working Day
$ 0	$ 500,000	$ 300	$ 420
500,000	1,000,000	400	560
1,000,000	2,000,000	500	700
2,000,000	5,000,000	700	880
5,000,000	10,000,000	1000	1400
10,000,000	15,000,000	1200	1680
15,000,000	20,000,000	1375	1925
20,000,000	25,000,000	1500	2100
25,000,000	50,000,000	1880	2600
50,000,000	75,000,000	2300	3200
75,000,000	----------	2600	3600

The days in default mentioned above are the number of calendar days in default when the time for Completion is specified on the basis of calendar days or a specified completion date, and are the number of working days in default when the time for Completion is specified on the basis of working days.

The Commissioner may elect, upon substantial completion of the Project, to waive liquidated damages and, in lieu thereof, require the Contractor to pay the State's costs for engineering, inspection and administration (including overhead) between the date of substantial completion or such subsequent date as the Commissioner may determine and the date as established by the Certificate of Completion. The Contractor hereby waives the right to challenge this election by the Commissioner on the grounds that such costs exceed the amount of liquidated damages established by the above schedule.

The Commissioner will recover said damages by deducting the amount thereof from any monies due or that may become due the Contractor, or from the Contractor or from his surety.

108.17 Default and Termination of Contractor's Right to Proceed. If the Contractor:

- fails to begin the Work under the Contract within the time specified in Subsection 108.03, or
- fails to perform the Work with sufficient workmen and equipment or with sufficient materials to assure its completion within the Contract Time specified, or any extension thereof, or

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- fails to complete the Contract within the Contract Time specified, as extended, or
- performs the Work unsuitably or neglects or refuses to remove materials or to again perform such Work as may be rejected as unacceptable and unsuitable, or
- discontinues the prosecution of the Work, or
- fails to resume Work which has been discontinued within a reasonable time after notice to do so, or
- becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency, or
- allows any final judgment to stand against him unsatisfied for a period of 10 days, or
- makes an assignment for the benefit of creditors, or
- fails to acquire or maintain the required insurance, or
- fails to comply with Contract requirements regarding minimum wage payments, or disadvantaged business enterprises or equal employment opportunity requirements, or
- is a party to fraud, or
- for any other cause whatsoever, fails to carry out the Work in an acceptable manner,

the Engineer will give written notice to the Contractor and surety of such delay, neglect or default, demanding the elimination of such cause for default.

If the Contractor or surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Commissioner has, upon written notification from the Engineer of the fact of such delay, neglect or default and the Contractor's failure to comply with such notice, full power and authority without violating the Contract, to declare the Contractor in default and notify him to discontinue the Work. The declaration of default will be in writing and given to the Contractor and surety. The Department may appropriate any or all materials and equipment on the site as may be suitable and acceptable and may direct the surety to complete the Contract or may enter into an agreement for the completion of the Contract according to the terms and provisions thereof with another contractor or the surety, or use such other methods required for the completion of the Contract, including completion of the Work by the Department.

The Contractor and surety are not relieved of the assessment of liquidated damages under Subsection 108.16 on account of the Contractor's default.

All costs and charges incurred by the Department, together with the cost of completing the Work, will be deducted from any monies due or that may become due the Contractor and surety. If such expense exceeds the sum which would be available from such monies, then the Contractor and the surety shall be liable and shall pay to the Department the amount of such excess.

The rights and remedies of the State are in addition to any other rights and remedies provided by law or under this Contract and the Bonds.

If, after notice of default under the provisions of this Subsection, it is determined for any reason that the Contractor was not in default or that the delay was excusable, the rights and obligations of the parties are the same as if the notice of termination had been issued pursuant to Subsection 108.18.

Where the Department's default of the Contractor pursuant to the provisions of this Subsection is found by a court to be legally improper, the Contract will be treated as if terminated for convenience pursuant to Subsection 108.18 and such termination is to be compensated for in accordance with provisions of that Subsection 108.18.

108.18 Termination of Contract. The Commissioner may, by written order, terminate the Contract or any portion thereof for convenience after determining that for reasons beyond the Contractor's control, the Contractor is unable to proceed with or complete the work as contracted for, or that termination is in the public interest.

Upon receipt of an Order of Termination for convenience, the Contractor shall not proceed with any item of work which is not specified in the Order of Termination. The Contractor shall complete all items of work specified in the termination order. Such work shall include punch list items and all work necessary to ensure the safety of the public, to properly secure existing work already constructed or partially constructed, and to secure the Project site. This work so ordered shall be performed in accordance with the Contract Documents, and may include items of work not in the original contract. The Contract shall be considered substantially complete upon completion and acceptance of all items of work specified in the Order, except punch list items. After completion of the punch list items and all documents required by the Contract, the Contract shall terminate upon issuance of a Final Certificate and payment. The Commissioner reserves the right to declare in default a contractor who fails to carry out the conditions set forth in an Order of Termination for convenience.

When the Commissioner orders termination of the Contract for convenience, all completed items of work as of that date will be paid for at the Contract bid price. Payment for partially completed work will be paid for at agreed prices or by Force Account methods described in Subsection 109.03 provided, however, that such payment does not exceed the bid price of the Pay Item under which the Work was performed. Items which are eliminated in their entirety by such termination will be paid for only to the extent provided in Subsection 104.06. Payment for new items, if any, will be made either at agreed prices or paid for by Force Account methods described in Subsection 109.03.

Materials obtained by the Contractor for the Work but which have not been incorporated therein may, at the option of the Engineer, be purchased from the Contractor at actual cost delivered to a prescribed location, or otherwise disposed of as mutually agreed.

Within 60 days of the effective termination date, the Contractor shall submit claims for additional costs actually incurred not covered above or elsewhere in these Specifications. Such claims may include such cost items as reasonable mobilization efforts, overhead expenses attributable to the Project terminated, subcontractor costs not otherwise paid for, actual idle labor cost if Work is stopped in advance of the termination date, and guaranteed payments for private land usage as part of original Contract. Costs which are prohibited under Subsection 107.27 and anticipated profits on work not performed are not allowed.

The Commissioner may also, by written order terminate the Contract or any portion thereof for cause after determining that reasons for default as stated in Subsection 108.17 exist. The decision whether to terminate for cause or declare the Contractor in default will be made in the sole discretion of the Commissioner acting in the best interest of the State. Prior to the issuance of an Order of Termination for cause, the Engineer will give wirtten notice to the Contractor and surety of the causes for the proposed termination. The notice shall demand the elimination of such causes.

If the Contractor or surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Commissioner may terminate the Contract for cause.

The Order of Termination for cause will terminate the Contractor's right to proceed with any items of work except as specified in the termination order. Such work will include punch list items and all work necessary to ensure the safety of the public, to properly secure existing work already constructed or partially constructed, and to secure the job site. This work so ordered shall be performed in accordance with the Contract Documents and may include such items of work not in the original Contract. Substantial Completion shall occur when all work specified in the termination order, except for punch list items is complete and accepted by the Engineer. After the completion of all punch list items and all documents required by the Contract, the Contract shall terminate upon issuance of a Final Certificate and payment.

When the Commissioner orders termination of the Contract for cause, all completed items of Work as of that date will be paid for at the Contract bid price. Payment for partially completed work will be made either at agreed prices or by Force Account methods described in Subsection 109.03 provided, however, that such payment does not exceed the bid price of the Pay Item under which the Work was performed. Items which are eliminated in their entirety by such termination will be paid for only to the extent provided in Subsection 104.06. Payment for new items, if any, will be made either at agreed prices or paid for by Force Account methods described in Subsection 109.03. No other costs will be allowed the Contractor. Profit and overhead not included in the bid price for Pay Items for work completed or partially completed will not be allowed except that profit and overhead on Force Account work may be paid consistent with Subsection 109.03.

In terminating a Contract for cause, the Department does not waive its right to sue the Contractor for any costs incurred by the Department as a result of the termination, including the additional costs of completing the Project. The Commissioner reserves the right to declare in default a contractor who fails to carry out the conditions set forth in an Order of Termination for cause.

Where the Department's termination of the Contract for cause pursuant to the provisions of this Subsection is found by a court to be legally improper, the termination of the Contract for cause will be treated as if it had been a termination for convenience and such termination is to be compensated for in accordance with the provisions of this Subsection governing terminations for convenience.

In terminating a Contract for convenience or cause pursuant to this Subsection:

- The Contractor shall make cost records available consistent with Subsection 109.12 to the extent necessary to determine the validity and amount of each item for which it seeks compensation;
- The Contractor shall not be relieved of contractual responsibilities for the Work completed, nor shall the surety be relieved of its obligations for and concerning any just claim arising out of the Work performed;
- The Contractor shall, if so directed by the Engineer, remove promptly any or all of his equipment and supplies from the site of the Project or other property of the State. If the Contractor fails to remove the equipment and supplies as directed, the Engineer may remove such equipment and supplies at the expense of the Contractor.

SECTION 109 - MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities. Measurements will be made in accordance with United States standard measure.

The method of measurement and computations to be used in determination of quantities of Work performed under the Contract are those methods generally recognized as conforming to good engineering practice.

Longitudinal measurements for area computations are made horizontally and deductions are not made for individual fixtures having an area of 9 square feet or less. Transverse measurements for area computations are the neat dimensions shown on the Plans or ordered in writing by the Engineer.

All items which are measured by the linear foot, such as pipe culverts, underdrains, etc are measured parallel to the base or foundation upon which such items are placed.

In computing volumes of excavation, the average end area method is used.

The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing is measured in decimal fractions of inches.

Materials measured by volume in the hauling vehicle are measured at the point of delivery. Vehicles for this purpose may be of any size or type acceptable to the Engineer, provided that the body is of such shape that the actual contents may be readily and accurately determined. Bituminous distributors shall be calibrated as described in Subsection 402.03.

Volumes of bituminous materials, of the types and grades specified, are determined by measuring the material in the calibrated hauling vehicle both prior to and after discharge. The gross gallons delivered are converted to the volume at 60 degrees F based on the temperature, in degrees F, of the material discharged and the temperature-volume correction factors in the applicable tables of Subsection 904.06.

When requested by the Contractor and approved by the Engineer, in writing, material specified to be measured by the cubic yard may be weighed and such weights converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined and shall be agreed to by the Contractor before such method of measurement of pay quantities is used.

Net certified scale weights or weights based on certified volumes in the case of rail shipments will be used as a basis of measurement, subject to correction when bituminous material has been lost from the car or the distributor, wasted, or otherwise not incorporated in the Work.

When bituminous materials are shipped by truck or transport, net certified weights or volume subject to correction for loss or foaming, may be used for computing quantities.

The term "lump sum" when used as a basis of payment means complete payment for the Work of that item and that item will not be measured.

When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gauge, unit weight, section dimensions, etc, such identifications are considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

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Whenever the phrase "quantity in the Proposal" is used hereinafter in this Subsection, it is construed to mean the quantity in the Proposal adjusted for Change Orders.

When the quantity in the Proposal is specified to be the pay quantity, either the Engineer or the Contractor may cause the quantity to be measured. If such a request is made by the Contractor, it shall be accompanied by drawings, calculations or other information indicating that the quantity in the Proposal is not correct.

For Type 1 Pay Items designated below, if the measured quantity is less than 5 percent different from the quantity in the Proposal, payment will be made based on the quantity in the Proposal and, if the measurement was requested by the Contractor, the Contractor is required to pay the State the cost of measurement. If the measured quantity is 5 percent or more different from the quantity in the Proposal, payment will be made based on the measured quantity and there is no charge for measurement.

For Type 2 Pay Items designated below, if the measured quantity is less than 10 percent different from the quantity in the Proposal, payment will be made based on the quantity in the Proposal and, if the measurement was requested by the Contractor, the Contractor is required to pay the State the cost of measurement. If the measured quantity is 10 percent or more different from the quantity in the Proposal, payment will be made based on the measured quantity and there is no charge for measurement.

When the Contractor is required to pay for measurement of quantities, the following rates apply:

Type 1 Pay Items	**Charge per Unit of Measure**
Roadway Excavation, Unclassified	$ 0.05 per cubic yard when cross sections are not required
Roadway Excavation, Unclassified	$ 0.12 per cubic yard when cross sections are required
Subbase	$ 0.32 per cubic yard
Soil Aggregate Base Course	$ 0.32 per cubic yard $ 0.13 per square yard
Dense Graded Aggregate Base Course	$ 0.32 per cubic yard $ 0.13 per square yard

Type 2 Pay Items	**Charge per Unit of Measure**
Concrete Base Course	$ 0.13 per square yard
Concrete Base Course, Reinforced	$ 0.13 per square yard
Concrete Surface Course	$ 0.13 per square yard
Concrete Surface Course, Reinforced	$ 0.13 per square yard
Bridge Approach Slabs	$ 0.13 per square yard
Bridge Approach Transition Slabs	$ 0.13 per square yard
Concrete in Structures,	
Culverts	$ 2.10 per cubic yard
Footings	$ 1.60 per cubic yard
Retaining Walls	$ 2.10 per cubic yard
Concrete in Substructures,	
Abutment Walls	$ 2.10 per cubic yard
Pier Columns and Caps	$ 2.10 per cubic yard
Pier Shafts	$ 2.10 per cubic yard

Concrete in Superstructure.	
Deck Slabs	$ 3.20 per cubic yard
Sidewalks	$ 1.60 per cubic yard
Parapets	$ 0.32 per linear foot
Reinforcement Steel in Structures	$ 0.01 per pound
Reinforcement Steel in Structures, Epoxy Coated	$ 0.01 per pound
Bituminous Concrete Sidewalk	$ 0.64 per square yard
Concrete Sidewalk	$ 0.64 per square yard
Concrete Sidewalk, Reinforced	$ 0.64 per square yard
Bituminous Concrete Island	$ 0.64 per square yard
White Concrete Island	$ 0.64 per square yard

Note: When calculating the cost of measurement, pay quantities are rounded off to the nearest whole number.

109.02 Scope of Payment. The Contractor shall receive and accept the compensation provided for in the Contract as full payment for furnishing all labor, materials, tools, equipment and incidentals necessary to the completed Work, and for performing all Work contemplated and embraced under the Contract in a complete and acceptable manner; also, except where specifically provided elsewhere in the Contract Documents, for all risk, loss, damage, or expense of whatever character arising out of the nature of the Work or the prosecution thereof, or for the action of the elements, or for any unforeseen difficulties which may be encountered during the prosecution of the Work until Acceptance; also, except where specifically provided elsewhere in the Contract Documents, for all expenses incurred in consequence of the suspension or discontinuance of the Work as provided in the Contract.

Payment for a Pay Item in the Proposal includes all the compensation that will be made for the work of that item as described in the Contract Documents unless the "Basis of Payment" clause provides that certain work essential to that item will be paid for under another pay item.

109.03 Force Account Payment. Where the Contractor and the Engineer cannot negotiate a Supplementary Agreement for Extra Work, or for Work designated for force account payments elsewhere in the Contract Documents, the Department may require the Contractor to do such Work on a force account basis to be compensated as provided in this Subsection.

The total costs for labor, materials, equipment, bonds, insurance and tax as provided below, together with applicable markups constitute full compensation for all direct and indirect costs (including overhead), and profit, and are deemed to include all items of expense not specifically designated.

When Work paid on a force account basis is performed by forces other than the Contractor's organization, the Contractor shall reach an agreement with such other forces as to the distribution of payments made by the State for such Work. Additional payment therefore will not be made by reason of the performance of the Work by a subcontractor or other forces.

It is understood that force account payments pursuant to the terms of this Contract are contractual in nature only, and are not to be used for any other purpose. More specifically, but not by way of limitation, the force account provisions of this Contract are not to be used to prove damages in a court of law in an action for breach of contract pursuant to the provisions of the New Jersey Contractual Liability Act.

(a) *Labor.* For all necessary labor and foremen in direct charge of the specific operations, whether the employer is the Contractor, subcontractor or another, the Contractor shall receive the rate of wage (or scale) actually paid as shown in its certified payrolls for each and every hour that said labor and foremen are actually engaged in such Work.

The Contractor shall receive the actual costs paid to, or in behalf of, workmen by reason of health and welfare benefits or other benefits, when such amounts are required by collective bargaining agreements or other employment contracts generally applicable to the classes of labor employed on the Work.

(b) *Bond, Insurance and Tax.* For bond premiums, property damage, liability, and workmen's compensation insurance premiums, unemployment insurance contributions and social security taxes on the force account work, the Contractor shall receive the actual incremental cost thereof, necessarily and directly resulting from the force account work. The Contractor shall furnish satisfactory evidence of the rate or rates paid for such bond, insurance, and tax.

(c) *Materials.* The Department reserves the right to furnish such materials as it deems advisable, and the Contractor shall have no claims for costs and markup on such materials.

Only materials furnished by the Contractor and necessarily used in the performance of the Work will be paid for. The cost of such materials shall be the cost to the purchaser, whether Contractor, subcontractor or other forces from the supplier thereof, together with transportation charges actually paid by him, except as the following are applicable. Sales tax will not be paid on materials which qualify for an exemption under the Sales and Use Tax Act and the regulations issued thereunder, regardless of whether the exemption is utilized.

1. If a cash or trade discount by the actual supplier is offered or available to the purchaser, it shall be credited to the State notwithstanding the fact that such discount may not have been taken.
2. If materials are procured by the purchaser by any method which is not a direct purchase from and a direct billing by the actual supplier to such purchaser, the cost of such materials is the price paid to the actual supplier as determined by the Engineer plus the actual costs, if any, incurred in the handling of such materials.
3. If the materials are obtained from a supply or source owned wholly or in part by the purchaser, the cost of such materials shall not exceed the price paid by the purchaser for similar materials furnished from said source on Pay Items or the current wholesale price for such materials delivered to the job site, whichever price is lower.
4. If the cost of such materials is, in the opinion of the Engineer, excessive, then the cost of such material is deemed to be the lowest current wholesale price at which such materials are available in the quantities concerned delivered to the job site, less any discounts as provided in No. 1 above.
5. If the Contractor does not furnish satisfactory evidence of the cost of such materials from the actual supplier thereof, the cost will be determined in accordance with No. 4 above.

(d) *Equipment and Plant.*

(1) *Contractor Owned Equipment and Plant.* The hourly rates for Contractor owned equipment and plant will be determined from the

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applicable volume of the Rental Rate Blue Book (referred to hereafter as the "Blue Book"), published by Nielsen/DATAQUEST, Inc. of Palo Alto, California.

The Blue Book will be used in the following manner:

a. The hourly rate will be determined by dividing the monthly rate by 176. The weekly, hourly and daily rates will not be used.

b. The number of hours to be paid for will be the number of hours that the equipment or plant is actually used on a specific force account activity.

c. The current revisions will be used in establishing rates. The current revision applicable to specific force account work is as of the first day of work performed on that force account work and that rate applies throughout the period the force account work is being performed.

d. Area adjustment will not be made. Equipment life adjustment will be made in accordance with the rate adjustment tables.

e. Overtime shall be charged at the same rate indicated in paragraph a. above.

f. The estimated operating costs per hour will be used for each hour that the equipment or plant is in operation on the force account work. Such costs do not apply to idle time regardless of the cause of the idleness.

g. Idle time for equipment will not be paid for, except where the equipment has been held on the Project site on a standby basis at the request of the Engineer and but for this request, would have left the Project site. Such payment will be made at one half the rate established in paragraph a. above.

h. The rates established above include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs, overhaul and maintenance of any kind, depreciation, storage, overhead, profits, insurance, all costs (including labor and equipment) of moving equipment or plant on to and away from the site, and all incidentals.

i. Operator costs will be paid only as provided in Subpart *(a)* of this Subsection.

All equipment shall, in the opinion of the Engineer, be in good operating condition. Equipment used by the Contractor shall be specifically described and be of suitable size and suitable capacity required for the work to be performed. In the event the Contractor elects to use equipment of a higher rental value than that suitable for the Work, payment will be made at the rate applicable to the suitable equipment. The equipment actually used and the suitable equipment paid for will be made a part of the record for force account work. The Resident Engineer will determine the suitability of the equipment. If there is a differential in the rate of pay of the operator of oversize or higher rate equipment, the rate paid for the operator is to be that for the suitable equipment.

In the event that a rate is not established in the Blue Book for a particular piece of equipment or plant, the Engineer will establish a rate for that piece of equipment or plant that is consistent with its cost and use in the industry.

The above provisions apply to the equipment and plant owned directly by the Contractor or by entities which are divisions, affiliates, subsidiaries or in any other way related to the Contractor or its parent company.

(2) *Rented Equipment and Plant.* In the event that the Contractor does not own a specific type of equipment and must obtain it by rental, the Contractor shall inform the Resident Engineer of the need to rent the equipment and of the rental rate for that equipment prior to using it on the Work. The Contractor will be paid the actual rental for the equipment for the time that the equipment is actually used to accomplish the Work, provided that rate is reasonable, plus the cost of moving the equipment on to and away from the job. The Contractor shall provide a copy of the paid receipt or canceled check for the rental expense incurred.

(e) *Profit.* Profit shall be computed at 10 percent of the following:

- Total material cost (bare cost - FOB).
- Total direct labor cost (actual hours worked multiplied by regular hourly rate).

(f) *Overhead.* Overhead costs for force account payments made pursuant to a Change Order which grants an extension of Contract Time in accordance with Subsection 108.11 are to be computed at 15 percent of the following:

- Total material cost (bare cost - FOB).
- Total direct labor cost (actual hours worked multiplied by regular hourly rate).

Percentage for overhead costs will not be allowed for force account payments made pursuant to a Change Order not granting an extension of Contract Time, but specific extraordinary overhead expenses such as the hiring of additional supervisory personnel or the use of special minor equipment (as defined below) which the Contractor has to purchase specifically for the force account may be allowed. In such instances the Contractor will be paid only the reasonable costs of such extraordinary overhead expenses provided the Engineer has agreed to such costs prior to their being incurred.

Overhead is defined to include the following:

- All salaries and expenses of executive officers, supervising officers or supervising employees;
- All clerical or stenographic employees;
- All charges for minor equipment, such as small tools, including shovels, picks, axes, saws, bars, sledges, lanterns, jacks, cables, pails, wrenches, etc., and other miscellaneous supplies and services;
- All drafting room accessories such as paper, tracing cloth, blueprinting, etc.

(g) *Records.* The Contractor shall maintain his records in such a manner as to provide a clear distinction between the direct costs of Work paid for on a force account basis and the costs of other operations.

From the above records, the Contractor shall furnish the Engineer completed daily force account work reports for each day's work to be paid for on a force account basis. Said daily force account work reports shall be signed by the Contractor and submitted daily. The daily force account work reports shall be detailed as follows:

- Name, classification, date, daily hours, total hours, rate and extension for each laborer and foreman.
- Designation, dates, daily hours, total hours, rental rate (including a copy of the Blue Book pages used), and extension for each unit of machinery and equipment.
- Quantities of materials, prices and extensions.
- Transportation of materials.
- Cost of property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions, bonds and social security tax.

Material charges shall be substantiated by valid copies of vendor's invoices. Such invoices shall be submitted with the daily force account work reports, or if not available, they shall be submitted with subsequent daily force account work reports. Should said vendor's invoices not be submitted within 60 days after the date of delivery of the material, or within 15 days after the Completion, whichever occurs first, the Department reserves the right to establish the cost of such materials at the lowest current wholesale prices at which said materials are available, in the quantities concerned delivered to the location of Work less any discounts provided in Subpart *(c)*, No. 1 above.

The Engineer will compare his records with the completed daily force account work reports furnished by the Contractor and make any necessary adjustments. When these daily force account work reports are agreed upon and signed by both parties, said reports become the basis of payment for the work performed, but do not preclude subsequent adjustment based on a later audit by the Department.

The Contractor's cost records pertaining to work paid for on a Force Account basis shall be open to inspection or audit by representatives of the Department, during the life of the Contract and for a period of not less than 3 years after Acceptance thereof, and the Contractor shall retain such records for that period. Where payment for materials or labor is based on the cost thereof to forces other than the Contractor, the Contractor shall ensure that the cost records of such other forces are open to inspection and audit by representatives of the Department on the same terms and conditions as the cost records of the Contractor. If an audit is to be commenced more than 60 days after Acceptance, the Contractor is provided a reasonable notice of the time when such audit is to begin. In case all or a part of such records are not made so available, the Contractor understands and agrees that any items not supported by reason of such unavailability of the records will not be allowed, or if payment therefore has already been made, the Contractor shall refund to the Department the amount so disallowed.

109.04 Payment for Contractor's Expenses During Delays. If the Engineer finds that the Work was delayed on the entire Contract or any part thereof, because of conditions beyond the control and without the fault of the Contractor for causes as to

which the provisions of the Contract authorize compensation, the Contractor will be paid his expenses during that period of delay by Change Order in the following manner:

(a) Labor. For all necessary nonproductive labor and foremen in direct charge of specific operations who must remain on the Project during such periods of delay due to collective bargaining contracts or other reasons approved by the Engineer, the Contractor is to receive the prevailing rate of wage as shown in its certified payrolls. The Contractor is also to receive the actual costs paid to, or in behalf of, workmen by reason of health and welfare benefits, pension fund benefits or other benefits, when such amounts are required by collective bargaining agreements or other employee contracts generally applicable to the classes of labor employed on the Work.

(b) Bond, Insurance and Tax. For bond premiums, property damage, liability, and workmen's compensation insurance contributions and social security taxes during the period of delay, the Contractor is to receive the actual incremental cost thereof necessarily and directly resulting from the delay. The Contractor shall furnish satisfactory evidence of the rate or rates paid for such bond, insurance and tax.

(c) Equipment. For any idle machinery or special equipment other than small tools which must remain on the Project site, with approval of the Engineer, during delays, the Contractor is to receive compensation at one-half the rate calculated pursuant to Subsection 109.03, Subpart *(d)*. Should the Engineer determine that it is not necessary for machinery or equipment to remain on the Project during delays, the Contractor is to receive transportation costs to remove the machinery or equipment and return it to the Project at the end of the delay period.

The time for which such compensation will be paid is the actual normal working time during which such delay condition exists, which in no case exceeds 8 hours in any one day.

The days for which compensation will be paid are the calendar days, excluding Saturdays, Sundays and holidays, during the existence of such delay.

(d) Miscellaneous. The Contractor further receives an amount equal to 10 percent of the sum of the above items which is full compensation for overhead, general superintendence or other costs attributed to the delay for which no specific allowance is herein provided. Payment under the Subsection constitutes full compensation for all items of expense related to such delay.

(e) Profit. Profit is not allowed under this Subsection.

(f) Records. Payment will not be made for delays until the Contractor has furnished the Engineer with duplicate itemized statements of the cost as hereinabove specified detailed as follows:

- Name, classification, date, daily hours, total hours, rate and extension for each laborer and foreman.
- Designation, dates, daily hours, total hours, rental rate, and extension for each unit of machinery and equipment.
- Transportation costs.
- Cost of bonds, property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions, and social security tax.

The Engineer will compare his records with completed daily reports furnished by the Contractor and make any necessary adjustments. When these daily reports are agreed upon and signed by both parties, said reports become the basis of payment for the expenses incurred, but do not preclude subsequent adjustment based on a later audit by the Department.

The Contractor's cost records pertaining to expenses under this Subsection shall be open to inspection or audit by representatives of the Department during the life of the Contract and for a period of not less than 3 years after Acceptance thereof, and the Contractor shall retain such records for that period. Where payment for materials, equipment or labor is based on the cost thereof to forces other than the Contractor, the Contractor shall make every reasonable effort to ensure that the cost records of such other forces are open to inspection and audit by representatives of the Department on the same terms and conditions as the cost records of the Contractor. Payment for such cost may be deleted if the records of such third parties are not made available to the Department's representatives. If an audit is to be commenced more than 60 days after Acceptance, the Contractor is to be provided with a reasonable notice of the time when such audit is to begin. In case all or a part of such records are not made so available, the Contractor understands and agrees that any items not supported by reason of such unavailability of the records will not be allowed, or if payment therefor has already been made, the Contractor shall refund to the Department the amount so disallowed.

109.05 Partial Payments. Monthly estimates will be made of the approximate quantities of Work satisfactorily performed in accordance with the Contract Documents during the preceding month. Partial payments on account of such monthly estimate will be made based on the prices bid in the Proposal or as provided by Field Order, Change Order or Supplementary Agreement. The Contractor is also to be paid under the monthly estimates for materials delivered in accordance with Subsection 109.06.

Pay Items which are on a lump sum basis will not be measured. However, payment for such items will be included in partial payments consistent with the provisions of the Subsection describing the Work under the lump sum pay item. Where the method of payment is not described under the Subsection describing the Work of the lump sum pay item, partial payment will be made based on an approximation of the proportionate value of the Work satisfactorily performed to date.

Partial payment will not be made when the monthly estimate shows the total Work and delivered materials payable since the preceding monthly estimate to be less than $1000.00, unless the Contractor requests in writing that such payment be made.

From the total amounts ascertained as payable, an amount equivalent to 5 percent of the amount due on the first 50 percent of the Total Adjusted Contract Price will be deducted and retained pending substantial completion. On the remaining 50 percent of the Total Adjusted Contract Price, no percentage of the partial payments is withheld as retainages.

Such estimate or payment will not be made when, in the judgment of the Engineer, the Work is not proceeding in accordance with the Contract Documents or following the Commissioner giving the Contractor and surety notice of delay, neglect or default under Subsection 108.17.

Such estimate or payment shall not be construed to be an approval of any defective or improper Work. The Engineer upon determining that any payment under a previous monthly estimate was improper or unwarranted for any reason may deduct the amount of such payment from the subsequent monthly estimate and partial payments made to the Contractor.

The Department will deduct from any monthly estimate and payment and/or the final payment such amounts as are required to be deducted pursuant to provisions of the Contract Documents.

109.06 Materials Payments. The monthly estimates and payments made on account thereof may also include, when authorized by the Engineer, an amount equal to the actual cost of materials furnished but not incorporated into the Work, provided, however, that such amount does not exceed 85 percent of the bid price for the Pay Item into which the material is to be incorporated, and the quantity allowed does not exceed the corresponding quantity estimated in the Contract Documents. Before including payments for such materials in an estimate, the Engineer must be satisfied that:

- the materials have been properly stored and protected along or upon the site or have been stored at locations owned or leased by the Contractor or the Department within the State except that structural steel may be stored outside the State with the approval of the Engineer, and
- the materials have been inspected and appear to be acceptable based upon available supplier's certification and/or materials test reports, and
- the Contractor has provided the Department with an invoice or bill of sale sufficient to show the price paid for the materials and a fully executed Department form "Release of Liens for Materials Stored for Incorporation in Department of Transportation Project," and
- the materials, if stored on property not belonging to the State, are fenced in with access limited to the State and the Contractor and the fenced-in materials are clearly identified in large letters as being without encumbrances and for use solely on this Project, and
- when such materials are stored in a leased area, the lease is made out to the Contractor and provides that it shall be canceled only with the written permission of the Engineer.

The Contractor assumes full responsibility for the safe storage and protection of the materials and nothing in this Subsection alters the provisions of Subsections 107.22 and 107.23. If materials paid for under this Subsection are damaged, stolen or prove to be unacceptable, the payment made therefor shall be deducted from subsequent estimates and payments.

Payment for materials as provided in this Subsection shall not be deemed to be an approval of such materials, and the Contractor shall be responsible for and must deliver to the site and properly incorporate in the Work only those materials that comply with the Contract Documents.

Payment for living or perishable plant materials will not be made until they are planted.

The Contractor shall pay any and all costs of handling and delivering materials to and from the place of storage to the Project site, as well as any storage rental. Any taxes levied by any government against the materials shall be borne by the Contractor.

109.07 Payments Following Substantial Completion. Following substantial completion of the Contract in accordance with Subsections 101.03 and 105.22, partial payments to the Contractor will be made only upon certification by the Contractor to the Department, on forms supplied by the Department, that all subcontractors have been paid in the same proportion that the Contractor has been paid. Should the certification or claims filed with the Department by subcontractors on the Project indicate that a subcontractor has not been paid in the same proportion as the

Contractor has been paid by the Department, the Department will withhold from the Contractor's partial payments following substantial completion, an amount equal to that in dispute. In no event, will the Department continue to withhold the disputed sum beyond 100 days following Acceptance or after final payment, whichever is later. The Contractor shall have the opportunity to challenge the subcontractor's claim as being frivolous. Such disputes shall be submitted in writing to the Regional Engineer, and his determination as to whether the subcontractor's claim is frivolous is final. Department Procedure 3.118 will be followed. Copies of the procedure are available from the Engineer.

In the first estimate following substantial completion, the Department will reduce retainages to 2 percent of the Total Adjusted Contract Price. If retainages are held in cash withholdings, the reduction is to be accomplished by payment under the next partial payment. If retainages are held in bonds, the Department will authorize a reduction in the escrow account. However, if subcontractor claims filed pursuant to this Subsection are in excess of the amount due the Contractor under the pending estimate and the anticipated balance the Contractor is to receive upon payment of the Total Adjusted Contract Price, said retainages are to remain consistent to the amount in dispute.

109.08 Bonds Posted in Lieu of Retainages. The Contractor may elect to deposit negotiable bonds of the State of New Jersey or any of its political subdivisions which have been approved by the Commissioner in an escrow account to secure release of all or a portion of the retainage held under the provisions of Subsection 109.05. Such account shall be established under the provisions of an escrow agreement to be entered into between the Contractor, the Department and a bank located in the State of New Jersey which is an authorized depository of the State of New Jersey and which has a trust department.

The agreement forms and a list of approved bonds may be obtained from the Bureau of Construction Services.

The par value or market value of said bonds, whichever is lower, must be equal to the amount of money being released to the Contractor.

109.09 Payment Following Acceptance. After Acceptance as provided in Subsection 105.23, the Engineer will make an estimate of the total amount of Work done under the Contract and the Department will make a final monthly payment. The Department will pay the balance thereon found to be due after deduction of all previous payments and such further amounts as the Engineer determines to be necessary and proper under the Contract (including those required under Subsection 109.07) pending issuance of the Final Certificate and payment thereon. Retainages are released with this estimate except where the Engineer determines to continue to retain them under the provisions of Subsections 109.07 and 109.10.

109.10 As-Built Quantities. Following Completion, the Resident Engineer will finalize as-built quantities for all Pay Items and Extra Work which has been authorized and incorporated into the Project. When such as-built quantities are completed, they are incorporated into a proposed Final Certificate. The Contractor assumes the positive obligation of assisting the Resident Engineer wherever possible in the preparation of such as-built quantities.

The Resident Engineer may from time to time, prior to Completion, prepare as-built quantities and incorporate these quantities into monthly estimate certificates through an appropriate Field Order or Change Order. Such interim as-built quantities are subject to recalculation following Completion. However, nothing contained in these Specifications shall be construed to place on the Engineer the obligation of providing

the Contractor with as-built quantities for the Work performed prior to the issuance of the proposed Final Certificate, nor to provide more than rough, approximate quantities of the Work done for use in the preparation of monthly estimates.

Should it appear to the Engineer at the time of Acceptance, that the calculation of as-built quantities might result in the Contractor being obliged to return money to the State, the Engineer may refuse to release retainages pending issuance of the proposed Final Certificate. Where the estimate reveals that an overpayment has been made, the Contractor shall immediately return the amount of the overpayment. If the Contractor fails to remit the overpayment, the Department will avail itself of other funds held on other projects with the same Contractor or against the retainages, and then if necessary proceed against the Contractor or his surety. Where the proposed Final Certificate reveals that no overpayment has been made, the Contractor shall be entitled to payment thereunder and the release of retainages, but the Contractor shall have no claim of any kind for additional compensation as a result of the Engineer's decision to withhold retainages or other monies pending issuance of the proposed Final Certificate.

109.11 Final Payment and Claims. The Final Certificate shows the total amount payable to the Contractor, including therein an itemization of said amount segregated as to Pay Item quantities, Extra Work and any other basis for payment, and also shows therein all deductions made or to be made for prior payments and as required pursuant to the provisions of the Contract Documents. All prior estimates and payments are subject to correction in the Final Certificate.

Within 60 days after said Final Certificate has been issued to the Contractor, the Contractor shall either submit to the Engineer a written acceptance of the Final Certificate without exception or a written acceptance of the Final Certificate with exception or reservation. The Contractor's failure to submit any written acceptance within said 60 days will be construed as an acceptance of the Final Certificate without exception or reservation. Final payment will be made to the Contractor in the amount set forth in the Final Certificate and the Contract will be complete as of the date on which such payment is issued. Failure of the Contractor to accept the tendered Final Payment shall not affect Completion of the Contract.

If the Contractor submits to the Engineer his written acceptance of the Final Certificate without exception or reservation, the acceptance shall contain a release signed by the Contractor in the following form:

In consideration of the above payment I hereby release the State of New Jersey, Commissioner of Transportation, the Department, their agents, officers and employees from all claims and liability of whatsoever nature for anything done or furnished or in any manner growing out of the performance of the Work.

Upon receipt of such written approval and release, the State will pay the entire sum due thereunder as provided by the New Jersey Prompt Payment Act, NJSA 52:32-32 *et seq.*, and the Contract will be complete as of the date on which that payment is issued.

If the Contractor submits to the Engineer his written acceptance of the Final Certificate conditioned with exception or reservation, the acceptance shall contain a release signed by the Contractor in the following form:

In consideration of the above payment I hereby release the State of New Jersey, Commissioner of Transportation, the Department, their agents, officers, and employees from all claims and liability of whatsoever nature for anything done or furnished or in any manner growing out of the performance of the Work except for _____.

The reservation shall state the specific amounts of the claims being reserved. Failure to state specific amounts shall result in a waiver of such claims. The Contractor can reserve only those claims properly filed with the Engineer pursuant to Subsection 107.02 and not previously resolved. The Contractor waives all claims for which the required notice has not been filed.

If the Contractor conditions his acceptance of the Final Certificate, he shall submit with his conditional release information sufficient to enable the Regional Engineer to determine the facts or contentions involved in the reserved claims. The claims filed by the Contractor shall be in sufficient detail to enable the Regional Engineer to ascertain the basis and amount of said claims. As a minimum, the following information must accompany each claim:

1. A detailed factual statement of the claim providing all necessary dates, locations and items of work affected by the claim, and
2. the date on which facts arose which gave rise to the claim, and
3. a copy of the Notice form filed for the specific claim by the Contractor pursuant to Subsection 107.02, and
4. the name, function, and activity of each State individual, official or employee involved in or knowledgable about such claim, and
5. the specific provisions of the Contract which support or mitigate against the claim and a statement of the reasons why such provisions support or mitigate against the claim, and
6. if the claim relates to a decision of the Engineer which the Contract leaves to the Engineer's discretion or as to which the Contract provides that the Engineer's decision is final, the Contractor shall set out in detail all facts supporting his contention that the decision of the Engineer was fraudulent or capricious or arbitrary or is not supported by substantial evidence, and
7. the identification of any documents and the substance of any oral communications relating to such claim, and
8. a statement as to whether the additional compensation or extension of Contract Time sought is based on the operation of the provisions of the Contract or an alleged breach of contract, and
9. if an extension of Contract Time is sought, the specific days for which it is sought and the basis for such claim, and
10. if additional compensation is sought, the exact amount sought and a breakdown of that amount into the following categories:
    - Direct Labor
    - Direct Materials
    - Job Overhead
    - Overhead (general and administrative)
    - Subcontractor's Work
    - Other categories as specified by the Contractor.

Failure to provide all requested information within the time specified will result in rejection of a claim.

The Contractor may request an additional 30 days to provide additional information regarding the claims which he reserved in his acceptance, but all information must be submitted to the Regional Engineer within 90 days of the issuance of the Final Certificate.

The Regional Engineer will review the information submitted by the Contractor and attempt to resolve the reserved claims within 30 days, unless that time period is extended by agreement between the parties.

If the parties agree to a resolution of the reserved claims and execute a Supplemental Agreement confirming the terms of the resolution, the Regional Engineer will issue an Amended Final Certificate which will include all sums previously included in the Final Certificate as well as the additional payment being made on the claims. Within 30 days, the Contractor shall submit to the Engineer his acceptance or rejection of this Amended Final Certificate. If the Contractor wishes to accept the Amended Final Certificate, such acceptance shall contain an unconditional release as described above which releases all claims. If the Contractor wishes to reject the Amended Final Certificate, written notice of his rejection shall be given to the Regional Engineer. If the Contractor rejects the Amended Final Certificate, final payment will be made in the amount set forth in the Final Certificate. Payment will be made pursuant to the terms of the New Jersey Prompt Payment Act, NJSA 52:32-32 *et seq.* and the Contract will be complete as of the date such payment is issued. Failure of the Contractor to accept the tendered final payment shall not affect the Completion of the Contract.

The Contractor's failure to submit any written acceptance or rejection of the Amended Final Certificate within said 30 days will be construed as a rejection of the Amended Final Certificate, and final payment will be made to the Contractor in the amount set forth in the Final Certificate. Payment will be made pursuant to the terms of the New Jersey Prompt Payment Act, NJSA 52:32-32 *et seq.*, and the Contract shall be complete as of the date such final payment is issued. Failure of the Contractor to accept the tendered final payment shall not affect the Completion of the Contract.

If the Regional Engineer determines after review of the claims that no further payment is warranted except for the sum indicated in the Final Certificate, he will so advise the Contractor in writing. The State will pay the sum indicated in the Final Certificate. The Contract will be complete as of the date of issuance of such payment.

At the election of the Contractor upon Completion of the Contract, the decision of the Regional Engineer may be reviewed by the Department's Claims Committee under procedures established by the Department. The Contractor's election to have his claims reviewed by that Committee shall not alter the time at which the Contract is complete as established by this Subsection, or prevent the running of the limitation period established by the New Jersey Contractual Liability Act, NJSA 59:13-5, for the purpose of bringing a lawsuit against the State. The Contractor, within 30 days of Completion of the Contract, shall notify the Secretary of the Department's Claims Committee in writing of his desire to have the decision of the Regional Engineer reviewed by the Committee. The Contractor shall send a copy of this notice to the Regional Engineer who will forward to the Claims Committee all information previously submitted by the Contractor in support of his claims. The failure of the Contractor to provide the written request for review within said 30 day period shall bar review by the Claims Committee.

109.12 Audits. All claims filed are subject to audit at any time following the filing of such claim, whether or not such claim is part of a suit pending in the courts of this State pursuant to the New Jersey Contractual Liability Act. The audit may be performed by the State or by an auditor under contract with the Department. The audit may begin on 10 days notice to the Contractor or his subcontractor. The Contractor, subcontractor or supplier shall provide adequate facilities, which are acceptable, for such audit during normal business hours. The Contractor, subcontractor, or supplier shall make a good faith effort to cooperate with the auditors. Failure of Contractor, subcontractor, or supplier to maintain and retain sufficient records to allow the Department's auditor to verify all or a portion of such claim to the books and records of the Contractor, subcontractor, or supplier shall constitute a waiver of such claim and shall bar any recovery thereunder.

As a minimum, the auditors shall have available to them the following documents:

a. Daily time sheets and foreman's daily reports.
b. Union agreements.
c. Insurance, welfare and benefits records.
d. Payroll registers.
e. Earnings records.
f. Payroll tax forms.
g. Material invoices and/or requisitions.
h. Material cost distribution worksheet.
i. Equipment records (list of company equipment, rates, etc.)
j. Vendors', rental agencies', and subcontractors' invoices.
k. Subcontractors' payment certificates.
l. Canceled checks (payroll and vendors).
m. Job cost report.
n. Job payroll ledger.
o. General ledger.
p. Cash disbursements journal.
q. Financial statements for all years reflecting the operations on this Project.
r. Income tax returns for all years reflecting the operations on this Project.
s. Depreciation records on all company equipment whether such records are maintained by the company involved or, its accountant, or others.
t. If a source other than depreciation records is used to develop costs for the Contractor's internal purposes in establishing the actual cost of owning and operating equipment, all such other source documents.
u. All documents which reflect the Contractor's actual profit and overhead during the years this Project was being performed and for each of the 5 years prior to the commencement of this Project.
v. All documents related to the preparation of the Contractor's bid including the final calculations on which the bid was based.
w. All documents which relate to each and every claim together with all documents which support the amount of damages as to each claim.
x. Worksheets used to prepare the claim establishing the cost components for items of the claim including but not limited to labor, benefits and insurance, materials, equipment, subcontractors and all documents which establish the time periods, individuals involved, the hours and the rates for the individuals.

109.13 Contractor's Compliance With NJSA 34:11-52.25 *et seq*. Before the proposed Final Certificate will be issued, the Contractor and subcontractors shall furnish the Engineer with written statements in form satisfactory to the Comptroller of the Department certifying to the amounts then due and owing from the Contractor and subcontractors filing such statement to any and all workmen for wages due on account of the Contract, setting forth therein the names of the persons whose wages are unpaid and the amount due to each respectively, which statement shall be verified by the oath of the Contractor or subcontractor, as the case may be, that he has read such statement subscribed by him, knows the contents thereof, and that the same is true of his own knowledge, provided, however, that nothing herein shall impair the right of the Contractor to receive Final Payment because of failure of any subcontractor to comply with provisions of this Subsection.

109.14 Warranty Against Defective Work. In addition to any other rights or remedies the Department may have against the Contractor, its officers, employees, agents, subcontractors, fabricators and suppliers under other provisions of the Contract Documents or as are otherwise allowed in law or equity, the following rights, remedies and obligations are imposed by this Subsection:

a. On all Projects, all subcontractors', manufacturers', fabricators' and suppliers' warranties, express or implied, respecting any work or materials shall, at the direction of the Engineer, be enforced by the Contractor for the benefit of the State. The Contractor shall obtain any warranties which subcontractors, manufacturers, fabricators and suppliers would give in normal commercial practice. If directed, the Contractor shall require any such warranty to be executed in writing to the Department. The Engineer may direct the Contractor to undertake litigation to enforce any warranty. Litigation directed to be brought during the life of the Contract and until 1 year following Acceptance (whether actually instituted within this period or not) shall be at the Contractor's expense. Litigation directed to be instituted after 1 year following Acceptance is at the Department's expense.

b. On all Projects funded in whole or in part without FHWA participation, the Contractor warrants that work performed conforms to the Contract requirements and is free of any defect of equipment, material or design furnished, or workmanship performed by the Contractor or any of his subcontractors, fabricators or suppliers at any tier. Such warranty shall continue for a period of 1 year following Acceptance. Under this warranty, the Contractor shall remedy at his own expense any such failure to conform or any such defect. In addition, the Contractor shall remedy at his own expense any damage to State owned or controlled real or personal property, when that damage is the result of the Contractor's failure to conform to Contract requirements or any such defect of equipment, material, workmanship, or design. The Contractor shall also restore any work damaged in fulfilling the terms of this clause. The Contractor's warranty with respect to work repaired or replaced hereunder shall run for one year from the date of such repair of replacement.

The Engineer will notify the Contractor in writing of the discovery of any failure, defect, or damage. Should the Contractor fail to remedy any failure, defect or damage described in the paragraph above, within 45 days after receipt of notice thereof, the Engineer will have the right to replace, repair, or otherwise remedy such failure, defect, or damage at the Contractor's expense.

A Project is funded in part without FHWA participation where a portion of the work such as a section of roadway, a structure or other appurtenance is paid for exclusively without FHWA funds, even where other portions of the Project receive FHWA participation. The warranty applies only to the non-FHWA funded portions of such Projects.

c. Notwithstanding any other provision of this Subsection, unless such a defect is caused by the negligence of the Contractor or his subcontractors, fabricators or suppliers at any tier, the Contractor shall not be liable for the repair of any defects of material or design furnished by the Department nor for the repair of any damage which results from any such defect in Department furnished material or design.

109.15 Affidavit Concerning Gifts to Department of Transportation Employees, etc. The Contractor shall not give any gifts of any nature, nor any gratuity in any form whatsoever, nor loan any money or anything of value to any Department employee, or relative or agent of any Department employee. The Contractor shall not rent or purchase any equipment or supplies of any nature whatsoever from any Department

employee, or relative or agent of any Department employee. Similarly, such gifts, gratuities, loans, rentals or purchases shall not be given to or made from any agent of the Department during the period of time that such agent is performing any function related in any way to the Project. Before receiving final payment, the Contractor shall execute, under oath, an affidavit, on forms provided by the Department, swearing that it has given no such prohibited gift, gratuities or loans nor made any such prohibited rentals or purchases.

SECTION 110 - TRAFFIC CONTROL

110.01 Maintaining and Protecting Traffic. When vehicular or pedestrian traffic or both are to be maintained within the scope of the Project, the Contractor shall plan and carry out the Work to provide for the safe and convenient passage of such traffic.

When the construction involves improvement of an existing roadway, the roadway shall be kept open to traffic unless otherwise approved or shown on the Plans.

The portion of the Project which is opened to traffic shall be kept in such condition that traffic is adequately accommodated. Temporary approaches or crossings and intersections, and access to trails, roadways, businesses, parking lots, residences, garages, and farms shall be provided and maintained in a safe condition. The owners of adjoining properties shall be given a written notice at least 3 days prior to the beginning of any Work which interferes with the owners' normal passage.

Equipment or machinery having crawler tracks or other treads that mar or damage pavements shall not move over or operate from newly constructed or existing pavements unless precautions are taken to prevent damage.

Any damage to newly constructed or existing pavements within the limits of the Project or adjacent thereto, which in the opinion of the Engineer was caused by the Contractor's operations, shall be repaired as directed, at the Contractor's expense or the repairs will be made by the Department and the cost of such repairs will be deducted from any monies due or that may become due the Contractor.

Any restrictions of required traffic lane widths or diversion of traffic at any time are subject to approval.

Except as necessary during actual working hours and then only with approval, equipment, materials, personnel or employee vehicles shall not occupy any traveled way, shoulder, median or sidewalk area within or adjacent to the Project that is open to traffic.

If approved, State property adjacent to the traveled way and shoulders may be used for storage of equipment and materials provided the equipment and materials are placed behind barriers or impact attenuators or are stored more than 30 feet from the traveled way. The barriers and impact attenuators must be approved prior to installation. Furnishing, placing and removing the barriers and impact attenuators shall be at no cost to the State.

Work which closes or alters the use of existing roadways shall not be undertaken until adequate temporary or permanent provisions for traffic have been approved.

Where it is necessary for pedestrians to cross or walk within the limits of the Project, temporary sidewalks shall be provided, maintained and removed as directed.

Construction above vehicular or pedestrian traffic shall not be performed unless there is explicit provision therefor in the Supplementary Specifications or specific written permission by the Engineer. Subject to such provision or permission, necessary devices and means to protect such traffic from falling construction materials and other objects and from painting operations shall be provided at no cost to the State during the time that construction is performed above traffic. The precautions to be taken for the protection of traffic are subject to approval.

Prior to beginning a seasonal shutdown or any other prolonged Work stoppage or when Work is suspended in accordance with Subsection 108.14 or 108.15, all excavated areas within the traveled way or adjacent thereto shall be brought to a grade compatible with the existing traveled way or to finished grade, as approved.

110.02 Detours. Approval of the Engineer and consent of the local authorities having jurisdiction shall first be obtained for rerouting traffic over detours that are not shown on the Plans. All necessary arrangements shall be made with such authorities regarding the establishment, maintenance and repair of such detours, the regulation and direction of traffic thereon, and signing. Adequate directional and detour signs, acceptable to the local authorities, shall be furnished and erected at the locations where such authorities may direct. All Work in connection with such detours shall be at no cost to the State.

Any detours used exclusively for hauling materials and equipment shall be constructed and maintained at no cost to the State.

110.03 Stage Construction. The Engineer shall be notified 1 month in advance of a tentative date for establishing new traffic patterns. This date shall be finalized 10 working days prior to the establishment of the new traffic patterns resulting from stage construction and 15 working days prior to the establishment of a detour for the closing of any roadways.

Existing roadways that are proposed to be dead-ended or abandoned shall not be closed to traffic until adequate temporary or permanent provisions for traffic have been approved.

110.04 Traffic Control Coordinator. Prior to the start of construction operations, the Contractor shall assign a supervisory-level employee to be the Traffic Control Coordinator. The Resident Engineer shall be notified as to the name and method of contacting the Traffic Control Coordinator on a 24-hour basis.

The Traffic Control Coordinator shall perform daily inspections, including weekends and holidays, with some inspections at night, and take all corrective action to ensure compliance with the Traffic Control Plan and other approved standards. The Engineer shall be advised of the schedule of these inspections and be given the opportunity to join in the inspection. In addition, the duties of the Traffic Control Coordinator shall include, but shall not be limited to, the responsibility for ensuring the following:

- Set-up and removal of all traffic control devices in accordance with the Contract Documents.
- Correction of deficiencies of traffic control devices within 2 hours of discovery or notification by the Engineer.
- Repositioning traffic control devices displaced by traffic or construction equipment.
- Covering or uncovering signs as appropriate.
- Repairing and/or replacing damaged traffic control devices.
- Replacing batteries, light bulbs, control panels and other electrical components.
- Keeping all traffic control devices clean.
- Adding fuel and oil to power units for traffic control devices.
- That all contractor equipment and vehicles are properly stored and parked so as not to create a traffic hazard.
- Properly storing traffic control devices when not in use.

- That all excavations or drop-offs greater than 2 inches deep are eliminated, covered or otherwise protected during non-working periods.

Separate payment will not be made for Traffic Control Coordinator but all costs thereof shall be included in the various Pay Items scheduled in the Proposal.

110.05 Traffic Control Devices. Traffic control devices need not be new but must be in good condition as approved. Traffic control devices, other than those shown on the Plans, shall conform to the Manual on Uniform Traffic Control Devices.

Prior to beginning construction, traffic control devices shall be placed where shown on the Plans or directed by the Engineer. Traffic control devices shall be kept clean and maintained in good condition until no longer required for the Project at which time they shall be disposed of.

(a) Construction Signs. Construction sign G20-1 shall be located at the limits of the Project as the first order of Work for construction signs for projects longer than 2 miles.

When construction signs conflict with existing signs, the existing signs shall be covered.

When construction signs are no longer required, they shall be removed. If they are temporarily not required, such as overnight, they shall be either temporarily removed or covered. Signs covered from view of the traveling public shall be completely covered with opaque material securely fastened so that it does not blow in the wind. Burlap shall not be used.

(b) Construction Barriers. Construction barriers shall be provided with reflectors. The reflectors shall consist of 6 inch wide by 12 inch high reflective sheeting, Type II, as specified in Subsection 916.04, mounted on a plastic or 0.080 inch aluminum support attached to the top of the construction barrier at 100 foot intervals except that on curves with a radius less than 1910 feet, the interval shall be 50 feet and on the flared portion of the construction barrier, the reflectors shall be omitted when other traffic control devices are used to delineate travel paths.

Reflective sheeting shall be yellow when the construction barrier is to the left of traffic and silver (white) when the construction barrier is to the right of traffic. Reflectors which are lost or damaged shall be replaced at no cost to the State.

Precast concrete curb used for construction barrier shall be constructed in accordance with Section 605. If sections of curb become broken or otherwise unacceptable for use, they shall be replaced at no cost to the State.

Precast concrete curb used for construction barrier may be used for permanent barrier, if approved, and will be measured for payment once for construction barrier and again when used as permanent barrier as specified in Section 605.

Beam guide rail used for construction barrier shall be constructed in accordance with Section 612 and shall be set at locations and removed and reset at new locations as directed. Components that do not remain serviceable shall be replaced at no cost to the State. Beam guide rail scheduled for permanent installation shall not be used for construction barrier.

(c) Lighting. Lights shall conform to the requirements of the Institute of Traffic Engineers Standards for Flashing and Steady-Burning Barricade Warning Lights. The color of the light emitted shall be amber. The lens shall not be less than 7 inches in diameter including a retro-reflector ring of approximately 1/2 inch width around a minimum of 300 degrees of the periphery. When a circuit of more than 50 volts is used, the lights shall be equipped with an Underwriters' Laboratory approved ground-fault circuit interrupter.

Storage batteries or other bulk power sources, not part of a monolithic flasher unit, shall be located as far as practicable from the traveled way and at ground level. Lights with self-contained batteries shall not weigh more than 7 pounds and, when located on traffic control devices, shall be securely fastened with the lens 36 inches above ground level.

Steady burning lights shall have one or two lens directional faces. They shall have a minumum beam candlepower of 2 candelas and shall be kept lighted from dusk to dawn and when adverse atmospheric conditions cause the ambient light to be less than 20 foot-candles.

Low intensity flashing warning lights shall have one or two lens directional faces. They shall have a minimum intensity of 4 candelas. They shall flash at a rate of 55 to 75 flashes per minute and the flash duration shall be 10 percent of each flash cycle. Low intensity flashing warning lights shall be kept lighted from dusk to dawn and when adverse atmospheric conditions cause the ambient light to be less than 20 foot-candles.

High intensity flashing warning lights shall have a one lens directional face. They shall have a minimum effective intensity of 35 candelas. The lights shall flash at a rate of 55 to 75 flashes per minute and the flash duration shall be 8 percent of each flash cycle. High intensity flashing warning lights shall be kept lighted 24 hours a day.

Illuminated flashing arrows shall be non-reflective, black, aluminum or wooden boards equipped with battery operated amber lights. The minimum mounting height shall be 7 feet above the traveled way from the bottom of the board. Boards shall be mounted on substantial, approved supports of such construction that they have good stability and do not topple or they may be mounted on a small two-wheeled towing trailer. In no case shall they be mounted on a vehicle other than the specified trailer, unless that vehicle is equipped with a truck mounted impact attenuator such as manufactured by Energy Absorption System Inc, One IBM Plaza, Chicago, Illinois 60611.

The 2 by 4 foot boards shall be equipped with 4-inch low intensity lights and the arrow panel message shall be comprehensible by a driver from a distance of 1/2 mile on a sunny day or a clear night. The lights shall flash in unison at a rate of 40 flashes per minute and the flash duration shall be 50 percent of each flash cycle. Light intensity shall be not less than 7000 candelas. The 2 by 4 foot boards shall only be used during the hours from dusk to dawn.

The 4 by 8 foot boards shall be equipped with 6-inch high intensity lights and the arrow panel message shall be comprehensible by a driver from a distance of 1 mile on a sunny day or a clear night. The lights shall flash in unison at a rate of 30 flashes per minute and the flash duration shall be 50 percent of each flash cycle. Each light shall have a minimum peak intensity of 8800 candelas and shall be equipped with a photoelectric cell that shall automatically reduce the peak intensity to 1500 candelas when ambient light level drops to 5 foot-candles. The 4 by 8 foot boards may be used 24 hours a day as required.

The lighting system shall have solid state controls, polarity and surge protected and contained in a lockable control box.

110.06 Traffic Control Plan. The Traffic Control Plan provides for the treatment of conditions caused by or encountered during the work on the Project. The Work shall be performed in accordance with the Traffic Control Plan.

110.07 Traffic Directors. Traffic directors shall be trained flaggers, in good physical condition including sight and hearing, mentally alert, and shall have a courteous but firm manner, neat appearance and a sense of responsibility for the safety of the public. Traffic directors shall wear an orange or fluorescent orange garment such as a shirt, jacket of vest. This garment shall be reflectorized for nighttime operations with reflective material that shall be orange in color. When controlling traffic, traffic directors shall be equipped with **STOP/SLOW** paddles and shall follow the procedures stipulated for flaggers in the Manual on Uniform Traffic Control Devices.

Where local ordinance requires, traffic directors shall be uniformed police officers. A uniformed police officer shall operate traffic signals when manual control of the signals is required.

110.08 Method of Measurement. The quantity of traffic control devices measured by the linear foot, number of each or unit basis is the maximum quantity required to be in service at one time in accordance with traffic control requirements.

Barricades of the various types will be measured by the linear foot.

Breakaway barricades will be measured by the number of units.

Construction barriers of the various kinds and types will be measured by the linear foot.

Construction signs of the various sizes will be measured by the number of each.

Construction identification signs of the various sizes will be measured by the number of each.

Delineator guide posts, drums, traffic cones and vertical panels will be measured by the number of units.

Illuminated flashing arrows of the various sizes will be measured by the number of each.

Lights of various kinds, except for the lighting system used for nighttime operations, will be measured by the number of each.

Temporary sidewalk will be measured by the square yard.

Traffic directors will be measured by the man-hour.

110.09 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Barricades, Type ____	Linear Foot
Beam Guide Rail, Construction Barrier	Linear Foot
Breakaway Barricades	Unit
Construction Signs, ____" x ____"	Unit
Construction Identification Signs, ____' x ____'	Unit
Delineator Guide Posts	Unit
Drums	Unit
High Intensity Flashing Warning Lights	Unit
Low Intensity Flashing Warning Lights	Unit
Illuminated Flashing Arrows, ____' x ____'	Unit
Steady Burning Lights	Unit
Precast Concrete Curb, Construction Barrier, Type ____	Linear Foot
Temporary Sidewalk	Square Yard
Traffic Cones	Unit
Traffic Directors	Man-hour
Vertical Panels	Unit

Payment for traffic control devices which are on a unit or linear foot basis will be made at 50 percent of the Contract bid price upon delivery, placement and approval with the balance prorated over the duration of the Contract.

Separate payment will not be made for relocating traffic control devices as required or as directed.

CONTENTS

SECTION 200 - EARTHWORK

SECTION 201 - CLEARING SITE

201.01 Description. This work shall consist of clearing of the site, removal of bridges, culverts and other structures, removal of pipes, inlets and manholes, removal of sidewalks, driveways, curbs and gutters, sealing of abandonded wells, and demolition of buildings except for items which are to be removed in accordance with the work of other Sections.

MATERIALS

201.02 Materials. Materials shall conform to the following Subsections:

Snow Fence	907.04
Waterproofing	919.05

CONSTRUCTION

201.03 Clearing Site. Before excavation or embankment construction is begun in any area, the site of the Project shall be cleared within the limits of construction. The ground surface shall be cleared of all trees, brush, weeds, roots, matted leaves, small structures, debris and other objectionable material, vegetation and growth.

Tree stumps may remain extending not more than 1 foot above the ground surface except that the stumps shall be grubbed out where the subgrade in fills or the finished grade in cuts is less than 3 1/2 feet from the ground surface, and shall be grubbed out within 5 feet of any structure or pipes and ducts.

Trees, shrubs and other landscape features within the limits of construction which do not interfere with the Project and are designated for preservation shall not be removed but shall be protected during the progress of the work.

Every necessary precaution shall be taken to prevent damage or injury to existing trees, plants and other vegetation that are to remain within or adjacent to the Project.

At locations adjacent to operations performed by motorized equipment, a 4-foot high snow fence shall be erected and maintained around all trees, shrubs and areas containing vegetation which are to be preserved.

Depressions in excavation areas which are below finished subgrade elevation resulting from grubbing operations shall be backfilled and compacted to finished subgrade in accordance with Subsection 203.09.

All slopes of cuts, embankments, ditches, channels, waterways and all structures, both old and new, shall be cleared of all brush, hedge, weeds, heavy vegetation and other objectionable material or growth. Clearing shall extend to a maximum of 8 feet beyond the top of slopes of roadway excavation and 5 feet beyond the top of slopes of ditches and channels except that such additional clearing shall not be done outside right-of-way limits.

RFD mail boxes shall be removed and shall be reset at locations acceptable to the owners and the Resident Engineer and in accordance with postal regulations.

Street and road signs shall be removed and shall be reset at the exact locations and in the manner acceptable to the public authorities having jurisdiction thereof.

201.04 Removal of Bridges, Culverts and Other Structures. Bridges, culverts and other structures in use by traffic shall not be removed until arrangements have been made to accommodate the traffic.

The substructures of existing structures shall be removed down to at least 3 feet below the natural stream bottom and those parts outside of the stream shall be removed down to a least 2 feet below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits of a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure.

Steel bridges and wood bridges, which are to be salvaged for the Department as provided for in the Supplementary Specifications, shall be dismantled without unnecessary damage. Steel members shall be match marked unless such match marking is waived. Salvagable material shall be removed in sections or pieces and shall be stored at specified places within the Project.

Blasting or other operations necessary for the removal of an existing bridge or structure, which may damage new construction, shall be completed prior to placing the new work.

Damages to any portion of an existing structure scheduled to remain shall be repaired at no cost to the State.

201.05 Removal of Pipe, Inlets and Manholes. Excavation for the removal of existing pipe, inlets and manholes shall be in accordance with Subsection 207.04. Backfill shall be made with excavated material in accordance with Subsection 203.09. The Engineer may direct compaction to be in accordance with Subsection 203.10 except that the frequency of measurements may be increased.

Pipe and debris from removal of drainage structures shall be disposed of in accordance with Subsection 201.09. Inlet and manhole castings shall be disposed of unless they are to be used on the Project.

201.06 Removal of Sidewalks, Driveways, Curbs and Gutters. Concrete sidewalks, driveways, curbs and gutters, designated for removal, shall be disposed of in accordance with Subsection 201.09.

201.07 Sealing of Abandoned Wells. Abandoned wells within the limits of clearing site shall be filled and sealed as follows:

- Dug wells shall be filled in accordance with Subsection 203.06.
- Drilled wells shall be sealed in accordance with the rules and regulations of NJAC 7:9-9.1 *et seq.*

If an alternate method is proposed to seal the abandoned wells, written approval shall be secured from the New Jersey Department of Environmental Protection, Division of Water Resources, and from the Engineer.

201.08 Demolition of Buildings. Demolition operations shall be confined to the limits of the existing right-of-way.

A list of occupied properties and vacation dates will be provided in Subsection 108.12 of the Supplementary Specifications.

All buildings to be demolished shall be demolished in place.

Materials and debris shall not be placed or stored within the limits of any existing street. The parking, loading and operation of trucks on existing highways or streets shall be governed by existing laws, ordinances and regulations.

The Department reserves the right to eliminate any item of building or structure demolition from the Contract at any time in accordance with Subsection 104.02.

The Department does not assume any responsibility for the condition of the various buildings or loss of fixtures, equipment, materials, or other objects between the submittal of the Proposal and the time of actual possession of the buildings.

All materials including fixtures, equipment, debris and rubbish shall be removed, as it accumulates, and not stored on the Project. Personal property belonging to owners or tenants and materials to be used in backfilling may remain.

Sale of materials shall not be conducted within the limits of the Project.

Where buildings have been removed by others, any remaining utility services shall be disconnected and terminated by making arrangements for such disconnection. Foundation walls and steps shall be removed to ground level. All detached buildings and all fixtures, wood and debris shall be removed from the area.

(a) *Safety Regulations.* Barricades, steady burning lights, flashing warning lights, warning signs and KEEP OUT signs shall be furnished, erected and maintained at places and locations where the placing of protective devices are warranted or in accordance with Subsection 107.14.

Suitable barriers shall be erected and maintained around all operations and all openings in the ground, as long as such operations and openings constitute a hazard or dangerous condition.

Footway shelter platforms and outlookers shall be erected, lighted, and maintained as required by law or directed.

Dust which may result from any demolition operation, especially that which may result from the use of chutes, shall be prevented or controlled.

(b) *Utility Disconnections.* Prior to the demolition of any building, arrangements shall be made for the disconnection and termination of all water, sewer, gas, electric, telephone, cable television and other facilities that are connected to the building, in conformance with the requirements of the municipalities and companies owning or controlling them.

When only a portion of an occupied structure is to be demolished, demolition and related operations shall be conducted in such a manner as not to interrupt the service to the portion of the structure which is not to be demolished. Where it is necessary to reconnect any facilities to the undemolished portion of the structure, such reconnection shall be made permanent.

The municipalities and companies concerned shall be notified, in writing, when such disconnections, terminations or reconnections are required, and the work shall be performed in accordance with their standard practices and requirements and under their supervision, or arrangements shall be made for the work to be performed with their forces.

(c) *Rodent Control and Extermination.* Prior to beginning any demolition operations, a qualified sanitarian shall conduct a survey for evidence of current rat activity and shall initiate a control program by a certified pest control operator if the survey indicates that it is necessary.

The application of exterminating materials shall conform to NJAC 7:30 *et seq.*

At least 10 days before beginning demolition of any structure, the pest control operator shall begin to rid the structure and adjacent areas within the limits of the Project of any rats or their carcasses and to prevent their migration to other adjacent areas.

Where there is no competing water supply, liquid anticoagulant baits can be used at the discretion of the certified pesticide applicator.

Toxic bait in the form of 1 pound paraffinized block shall also be placed in each manhole or inlet of storm or combination drains located on the same street as the building to be demolished and within the same block, including the entire intersections of the nearest cross streets. Bait shall be placed in suitable locations within the drainage structures, as determined by the pest control operator. The bait block shall be fastened in its location with wire.

All toxic bait in structures or drains shall be inspected and renewed as necessary on the fourth or fifth day after initial baiting.

All visible carcasses of rats shall be removed and disposed of to the satisfaction of the Engineer.

The pest control operator shall submit a signed statement after the initial treatment and each follow-up inspection reporting the amount and type of bait placed in each location and stating the visible results obtained from the rat control program.

Note - The pest control operator must be aware of the antidote noted on the rodenticide label.

(d) *Demolition Operations.* Before beginning demolition operations, wells, cesspools, and outbuildings within the areas to be cleared shall be pumped out and cleaned in a sanitary manner and, after being disinfected as may be required by the health authorities, shall be backfilled to adjacent ground level, as specified in Subpart *(e)* below.

Wells, cisterns, cesspools, and other openings in the ground outside the area to be cleared shall be maintained without hindrance to their functioning. All well casings shall be securely and permanently capped as specified in Subsection 201.07 and pipes leading into or out of of the well shall also be cut off and capped.

Where the portion of a Department-owned property outside the area to be cleared and adjacent thereto has been abandoned, wells and other openings located thereon which constitute a hazard or dangerous condition shall be covered or backfilled.

Small structures and appurtenances outside the area to be cleared shall be removed if specifically designated for demolition or removal.

Adjacent buildings shall be left in a safe condition and shall not be defaced, marred, or jeopardized in any way and any damage done to them shall be repaired or restored to the satisfaction of the Engineer at no cost to the State.

Only methods of demolition which ensure that all phases of demolition are confined within the limits of the demolition areas and without hazard to adjacent properties or to the public will be permitted. Under no circumstances shall any structure be set afire.

Chimneys, common to adjacent properties, are not to be demolished and shall not be disturbed other than to give them the necessary support for their continued stability. If necessary, they shall be repointed and capped.

Demolition of buildings having more than 3 floors shall be restricted to horizontal operations, one floor of each structure to be demolished at a time. The demolition of any structure or structures, except for the stripping of its fixtures, shall be progressive from top to bottom, one floor at a time. However, bay- or sectional-type or other demolition techniques may be considered, provided a detailed plan, including the structural framework of the building, is submitted and approved prior to start of operations. Each shall be removed in such a manner that the integrity and support of adjacent bays or sections is maintained.

Where a portion of a building is to be demolished, the remaining part shall be shored, braced and supported in such a manner that the integrity and support of all remaining walls, floors, roofs and their supporting members are maintained and continued in such a way that all shoring, bracing, and support shall be outside the right-of-way line. The remaining portion of such a partially demolished building shall be boarded up and sealed on the right-of-way line, and such new closure and its connections to the remaining portion of the severed building shall be weatherproof. Material for such closure shall consist of adequately braced studding of 2 by 4 inch timbers placed no more than 16 inches apart with wood facing, or equal, nailed to the studding and without any

holes appearing therein. The wood facing shall be covered with two layers of smooth-finished, 65 pounds per roll, roofing material conforming to ASTM D 224 and having an overlap of not less than 4 inches.

(e) *Backfilling.* Backfilling of all subsurface areas including cellars shall conform to Subsection 203.09 and the following:

- Additional materials required for backfilling shall be furnished at no cost to the State. The quality, nature and source of additional material required for backfilling shall be in accordance with Section 203. The selection of material shall be approved before use.
- The Engineer may direct compaction to be in accordance with Subsection 203.10 except that the frequency of measurements may be increased.
- All operations in connection with backfilling and grading shall be performed and completed in such manner to ensure proper drainage. Prior to placing the first layer, existing cellar floors and other surfaced areas shall be broken into pieces having areas of not more than 4 square feet with well-defined cracks through the full depth of the floors, or holes of not less than 1 square foot area shall be made through the floors on approximately 10-foot centers to provide vertical drainage. Cellar floors of wood shall be removed.
- Party wall foundations against which backfill material is to be placed shall first be cleaned, pointed and waterproofed with two coats of asphalt or tar.
- Cellars and all other subsurface spaces shall be backfilled and leveled to the adjacent ground elevation.
- The ground surface shall be graded, if necessary, to eliminate water pockets.

201.09 Disposal of Materials and Debris. Materials and debris accumulated by clearing site, demolition of buildings, removal of bridges, culverts and other structures shall be removed and disposed of at sites provided outside of State right-of-way and out of sight, during all seasons, of any State highway.

Written permission shall be obtained from the property owner on whose property the materials are to be placed. A copy of the agreement shall be furnished to the Resident Engineer.

COMPENSATION

201.10 Method of Measurement. Clearing site, including bridges and other structures will not be measured and payment will be made on a lump sum basis.

Demolition of buildings will not be measured and payment will be made on a lump sum basis.

Sealing of abandoned wells will be measured by the number of units.

201.11 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Clearing Site	Lump Sum
Clearing Site, Bridge (Description)	Lump Sum
Clearing Site, Structure (Description)	Lump Sum
Demolition of Buildings	Lump Sum
Sealing of Abandoned Wells	Unit

Payment for demolition of buildings will be reduced accordingly by the deletion of any building as listed in the Supplement for Analysis of the Lump Sum Price Bid attached to the Proposal.

Payment for clearing site in excess of the amount shown in the following table will not be made until Completion.

Total Contract Price		
From More Than	To and Including	Amount
$ 0	$ 100,000	$ 4,000
100,000	500,000	18,000
500,000	1,000,000	35,000
1,000,000	2,000,000	70,000
2,000,000	3,000,000	105,000
3,000,000	4,000,000	140,000
4,000,000	5,000,000	175,000
5,000,000	6,000,000	205,000
6,000,000	7,000,000	235,000
7,000,000	8,000,000	265,000
8,000,000	9,000,000	295,000
9,000,000	10,000,000	325,000
10,000,000	- - -	(see Note)

Note - Amount will be determined by increasing $325,000 by $25,000 for each $1,000,000, or fraction thereof, in excess of $10,000,000.

Separate payment will not be made for the removal of pipe, inlets and manholes, and removal of sidewalk, driveways, curb and gutters unless otherwise provided in the Supplementary Specifications.

SECTION 202 - ROADWAY EXCAVATION

202.01 Description. This work shall consist of stripping, excavation for the roadway and the construction of embankments with excavated material.

202.02 Classification.

(a) Roadway Excavation, Earth. Earth excavation consists of the excavation of all materials except rock.

(b) Roadway Excavation, Rock. Rock excavation consists of the excavation of boulders more than 1 cubic yard in volume and rock in ledge formations which cannot be excavated except by drilling or drilling and blasting.

(c) Roadway Excavation, Unclassified. Unclassified excavation consists of the excavation of all materials of whatever character encountered.

(d) Roadway Excavation, Regulated Waste. Roadway excavation of regulated waste consists of the excavation and disposal of materials classified in the Rules of the Solid Waste Administration, New Jersey Department of Environmental Protection, in accordance with the rules and regulations of NJAC 7:26-1 *et seq.*

Classification of regulated waste will be provided in the Supplementary Specifications or established by the Engineer.

(e) Wet Excavation. Wet excavation consists of the excavation of muck, mud, unstable materials and all other materials and objects encountered, of whatever nature, that cannot be excavated by ordinary dry excavation methods and equipment.

(f) *Removal of Concrete Base and Concrete Surface Courses.* Removal of concrete base and concrete surface courses consists of the excavation of reinforced and nonreinforced concrete courses including any overlaying surface courses.

(g) *Removal of Bituminous Concrete Overlay.* Removal of bituminous concrete overlay consists of the removal of bituminous concrete, block and brick surfaces from reinforced and nonreinforced concrete bases.

CONSTRUCTION

202.03 Stripping. Stripping operations shall not begin until the areas to be stripped have been determined by the Engineer. Vegetation and underlying soil shall be stripped off to a depth of not less than 4 inches and not more than 6 inches below the existing ground surface. Stripped material which is or may be made suitable for use as topsoil shall be stored. Topsoil shall not be stored in areas where it interferes with surface drainage or with the conservation of trees, shrubs and other vegetation that are to remain.

Stripped topsoil in excess of the quantity required for the Project shall be stored at specified locations for future use of the State.

202.04 Excavation. Excavation operations shall not begin until the Department has taken cross sections of those areas which have been stripped and of those areas cleared in accordance with Section 201 but which are not designated to be stripped. Construction operations shall be scheduled to provide time to take the required sections.

Excavation operations shall be conducted so that material outside of the limits of slopes is not disturbed.

Widening of cuts or varying the slopes according to the stability of the material excavated may be permitted.

Obliteration of old roads shall include filling of all ditches and rough grading to restore approximately the original contour of the ground or to produce a pleasing appearance by forming natural, rounded slopes.

Excavation shall be carried out in such a manner that the grade throughout the work is kept drained at all times. A plowed furrow, 6 inches deep, shall be cut in the existing ground surface, approximately 4 feet outside the slope line at the top of excavation, and turned toward the excavation. A plowed furrow is not required in areas where ditches are to be constructed outside the top of excavation slopes. Side ditches or gutters emptying from cuts to embankments or otherwise shall be so constructed as to avoid damage to embankments by erosion.

Excavated material shall not be deposited outside the limits of construction without written authorization.

Materials from roadway excavation meeting the requirements of Subsection 901.09 may be used for constructing items using soil aggregates. Notification shall be given in writing not less than 5 working days prior to use and the work shall be arranged so that all tests and measurements may be made.

When excavation to the finished graded section results in a subgrade or slopes of unstable soil, material shall be removed and the area backfilled with excavated material obtained from the Project, borrow excavation or from subbase material, as directed. The backfill shall be placed and compacted in accordance with Subsection 203.07 or 208.05.

All unstable material shall be used in embankments, as directed, or disposed of in accordance with Subsection 202.12.

202.05 Rodent Control In Dump Areas. Prior to beginning any excavation operations within the limits of dump areas, one of the following rodent control programs shall be effected by a certified pest control operator:

- Fumigant. The pest control operator shall treat all visible rodent burrows with chloropicrin, as per label instructions, not more than 1 week before excavating that particular area.
- Toxic Bait. The pest control operator shall place toxic bait over the area at least 5 days and not more than 14 days before excavating that particular area.

The application of exterminating materials shall conform to NJAC 7:30 *et seq.*

The type of toxic bait shall be determined by the pest control operator. The bait shall be placed either in tamperproof bait stations or in areas inaccessible to pets or children as determined by the pest control operator.

The treated area shall be checked daily for a minimum of four follow-up inspections. The toxic bait shall be renewed on each inspection as necessary to restore the bait to its original amount.

All visible carcasses of rats shall be removed and disposed of by the pest control operator at the time of placing or inspecting the toxic bait.

The pest control operator shall submit a signed statement after the initial treatment and after each follow-up inspection reporting the type of anticoagulant, the form, the location and the amount of bait placed, and the visible results of the rat control for each treatment.

Note - The pest control operator must be aware of the type of antidote noted on the rodenticide label.

202.06 Excavation In Rock Areas. Maximum usage shall be made of the excavated rock in embankments.

The portions of roadway that are below grade shall be brought to grade with material from the excavation except that rock fines, granular material or subbase material shall be used beneath the pavement structure areas. Boulders extending beyond the prescribed limits of excavation may be removed entirely. Any space created outside the prescribed limits by such boulder removal shall be refilled and compacted as specified in Subsection 203.09.

Care shall be taken that undrained pockets shall not be left in the surface of the rock.

After completing the excavation of each lift of rock slope construction and before beginning the next lift, the completed slopes shall be scaled to remove any loose rock fragments.

The Engineer will examine all rock slopes during the excavation to identify possible unstable conditions and to determine the need for stabilization. Whatever assistance and equipment are necessary for such examination shall be provided.

If it is determined that in-place stabilization is required, rock bolting or other stabilization techniques shall be used as directed. Payment for the technique used for stabilization will be made at the appropriate unit prices or in accordance with Subsection 104.02.

When a Pay Item is included for rock excavation, the earth cover shall be removed in advance of the rock in order that measurements of its surface may be taken. Earth cover need only be removed to the extent that its removal is practical, in the opinion of the Engineer, with equipment being used to perform the roadway excavation.

202.07 Blasting Operations. Before drilling and blasting, any existing overburden to the top of rock shall be removed.

Handling explosive materials and conducting blasting operations shall be in accordance with all of the safety regulations of the State of New Jersey regarding explosives. Only standard explosives, blasting agents, detonating cord, delays, blasting caps and other blasting accessories prepared and packaged by explosive manufacturing firms will be permitted.

All necessary precautions in drilling and blasting operations shall be exercised in order to preserve the rock remaining in the prescribed finished slope in a natural undamaged condition. Controlled blasting techniques, presplitting, shall be used for forming highway rock cut slopes. The purpose of controlled blasting is to minimize blast damage to the rock backslope to help ensure long term stability.

(a) Blasting Plan. A blasting plan shall be submitted not less than 2 weeks prior to commencing drilling and blasting operations and prior to each subsequent shot thereafter. The blasting plan shall contain the full details of the drilling and blasting patterns and controls to be used for both the controlled and production blasting. The blasting plan shall contain the following minimum information:

- Station limits of proposed shot.
- Plan and section views of proposed drill pattern including free face, burden, blasthole spacing, diameters and angles, lift height, and subdrill depth.
- Loading diagram showing type and amount of explosives, primers, initiators, and location and depth of stemming.
- Manufacturers' data sheets for all explosives, primers, and initiators to be employed.
- Initiation sequence of blastholes including delay times and delay system.

The blasting plan submittal is for quality control and record keeping purposes. A review of the blasting plan does not relieve responsibility for the accuracy and adequacy of the plan when implemented in the field.

(b) Blasting Test Sections. Prior to commencing full-scale blasting operations, the adequacy of the proposed blasting plan shall be demonstrated by drilling, blasting, and excavating short test sections, up to 100 feet in length, to determine which combination of method, hole spacing, and charge works best. Additional test sections may be directed when field conditions warrant.

Requirements for controlled and production blasting operations shall apply to the blasting carried out in conjunction with the test shots.

Drilling ahead of the test shot area will not be permitted until the test section has been excavated and the results evaluated. If the results of the test shots are unsatisfactory, revised methods shall be adopted to achieve the required results. Unsatisfactory test shot results include an excessive amount of fragmentation beyond the indicated lines and grade, excessive flyrock, or violation of other requirements.

If at any time during the progress of the work, the methods of drilling and blasting do not produce the desired result of a uniform slope and shear face, within the tolerances specified, drilling, blasting, and excavating in short sections, not exceeding 100 feet in length, will be required until a technique is arrived at that produces the desired results.

(c) Safety. The entire blast area shall be observed for a minimum of 5 minutes following a blast to guard against rock fall before commencing work in the cut.

The Engineer will prohibit or halt the blasting operations if it is apparent that through the methods being employed, the required slopes are not being obtained in a stable condition or the safety and convenience of the traveling public is being jeopardized.

(d) Methods of Drilling and Blasting.

(1) Presplitting. Presplitting is a method for constructing a shear plane along a specified cut slope through the controlled use of explosives and accessories in properly aligned and spaced drill holes.

After the overburden and weathered rock have been removed, slope holes for presplitting shall be drilled along the line and in the plane of the cut slope. The slope holes shall be not less than 2 1/2 inches and not more than 3 inches in diameter. Operations shall be controlled to ensure that the drill holes do not deviate from the plane of the slope by more than 6 inches and do not deviate within the plane of the slope by more than 6 inches.

The drilling equipment used to drill the presplit holes shall have mechanical devices affixed to that equipment to accurately determine the angle at which the drill steel enters the rock. Presplit hole drilling will not be permitted if these devices are either missing or inoperative. The spacing of the slope holes shall not exceed 36 inches on centers and shall be adjusted as required to produce a uniform and stable shear plane between slope holes. Auxiliary holes, which are identical to the slope holes but are not loaded with explosives, may also be required, under certain conditions, to produce a uniform and stable shear plane.

The length of the slope holes may extend to the full depth of the cut, to a maximum of 50 feet, if hole alignment is maintained. Otherwise, slope holes shall be drilled and blasted in lifts. If presplitting is accomplished in lifts, an offset of not more than 6 inches will be permitted to accommodate the drill head and the lifts shall be so arranged that the toe of the finished cut slope coincides with the toe of slope.

Drill hole conditions may vary from dry to filled with water.

Prior to the placing of explosives or blasting agents, it shall be determined that the hole is free of obstructions for its entire depth.

The maximum diameter of explosives used in presplit holes shall not be greater than one half the diameter of the presplit hole and shall not touch the side of the hole.

Only standard explosives manufactured especially for presplitting shall be used in presplit holes, unless otherwise approved. Bulk ammonium nitrate and fuel oil (ANFO) shall not be loaded in the presplit holes.

The amount of explosives used in the presplit hole shall produce the shearing without causing overbreak. The top of the load shall be far enough below the collar to avoid overbreak at the surface. The detonator cord downline shall extend from the collar to the bottom of the bore hole and from the collar to the detonator trunkline or electric blasting caps. The explosive charge shall be primed in accordance with the recommendations of the manufacturer of the commercial explosive or blasting agent.

If fractional portions of standard explosive cartridges are used, they shall be firmly affixed to the detonating cord in such a manner that the cartridges do not slip down the detonating cord nor bridge across the hole. Spacing of fractional cartridges along the length of the detonating cord shall not exceed 30 inches center to center and shall be adjusted to give the desired results.

Continuous column cartridge type of explosives used with detonating cord shall be assembled and affixed to the detonating cord in accordance with the explosive manufacturer's instructions, a copy of which shall be furnished to the Resident Engineer.

The bottom charge of a presplit hole may be larger than the line charges but shall not be large enough to cause overbreak. The top charge of the presplitting hole shall be placed far enough below the collar, and reduced sufficiently, to avoid overbreaking and heaving.

The upper portion of all presplit holes, from the topmost charge to the hole collar, shall be stemmed. Stemming materials shall consist of drill cutting or 3/8-inch clean stone chips.

It is not necessary to stem below the topmost charge unless it is determined that the rock is very seamy and incompetent, in which case, full stemming in such zones may be required.

Presplit holes may be detonated instantaneously or on short delays between each hole. Such delay detonating shall not exceed 25 milliseconds between holes. In any case, all presplit holes shall be detonated prior to the detonation of any production holes.

Presplitting shall extend a minimum of 50 feet ahead of the production blasting limits, but shall not extend more than 100 feet beyond the exposed presplit face.

(2) *Production Blasting.* Production blasting is a method of drilling and blasting to produce a high degree of fragmentation of the rock mass to be excavated.

The adjacent line of production holes inside the presplit lines shall be drilled in such a manner as to avoid damage to the presplit face. If necessary, the first line of production holes may be drilled parallel to the presplit face to reduce overbreak of this face.

Hole diameter, spacing, delay patterns, explosives, blasting agents, and other variables may be varied to obtain fragmentation acceptable to the Engineer, provided that the existing presplit face is not damaged.

202.08 Removal of Concrete Base and Concrete Surface Courses. Equipment which involves the use of a ball, weight or punch shall not be used in the breaking or removal of concrete within 5 feet of a transverse joint or within 3 feet of any structure or pavement which is to remain in place. The concrete within such restricted areas shall be broken or removed in such a manner as not to damage the adjacent joint structure, pavement or other structure which is to remain. Where a partial slab is to be removed, a vertical saw cut shall be made full depth. If any existing transverse expansion joint is damaged by the work to such an extent that it no longer serves its function, such joint shall be removed and replaced.

Joint areas and overlaying bituminous layers shall be saw cut full depth and replaced with bituminous-stabilized base course.

Wherever feasible, broken concrete shall be placed in the lower portion of Zone 3 embankment and spread out in layers with the pieces lying flat and not arching with the spaces between pieces filled with earth. Compaction shall be in accordance with Subsection 203.09. If such use is not possible, the broken concrete shall be disposed of in accordance with Subsection 202.12.

202.09 Milling of Bituminous Concrete. Milling of bituminous concrete consists of the removal of bituminous concrete surface and base courses to the prescribed depth, profile and cross slope.

(a) Equipment. The milling machine shall be a self-propelled planing, grinding or cutting machine, with variable operating speeds, capable of removing bituminous concrete without the use of heat.

The milling machine shall be equipped with automatic grade controls. The reference system may be either stringline or ski type. If a ski type reference system is used, it shall be a minimum 20-foot ski. Use of the automatic grade controls is required except at intersections and other locations where it is not practical.

Teeth in the milling drum that become dislodged, broken or unevenly worn shall be replaced immediately with teeth of the same length as the remaining teeth in that row.

(b) Construction Requirements. A test strip of approximately 500 square yards shall be constructed within the proposed limits of milling prior to commencement of the milling operations. The test strip shall be used to determine the machine and drum speeds of operation which can produce the proper surface texture and, when profile milling is called for, to determine the cutting depth required to remove ruts and transverse corrugations.

Prior to the start of milling operations, a meeting shall be held with the Resident Engineer to determine the method of grade control, the length of each milling pass, the method of traffic control to be used, and the side of the traveled way from which milling shall begin.

The milling operation may begin when the above criteria have been established and approved. The machine shall be operated at the speeds and cutting depth determined during the test strip milling. Test strips shall be constructed for each milling machine used. If the area to be milled is less than 2500 square yards, a test strip may not be required.

The milling operation, including removal of the milled material, shall be carried out in a manner that prevents dust and other particulate matter from escaping into the air, in accordance with Subsection 107.28, Subpart *(a)*.

If the milled material is to be recycled, the milling equipment shall be operated in such a manner as to produce milled material which passes a 2 1/2 inch sieve. The area of milling shall be cleared of all debris and power broomed to remove fine particles prior to milling. Before brooming, earth berms shall be removed, as necessary, within the area to be milled to prevent soil and grass from contaminating the milled material. Disposal of debris and earth shall be in accordance with Subsections 201.09 and 202.12.

Provisions shall be made for removal of any water that may be trapped due to the milling operation, such as by lateral saw cuts into the shoulder area. In the event that all milled areas which are opened to traffic have not been milled to a flush surface by the end of the work day, the longitudinal edges of the milled area exceeding 1 1/2 inches high shall be sloped and a smooth transition shall be provided at the transverse edges.

Bituminous concrete below the specified level of milling that becomes dislodged or delaminated shall be removed and replaced with bituminous concrete in accordance with Section 404 at no cost to the State.

The surface of the milled area shall be swept clean prior to being opened to traffic and prior to the subsequent construction or resurfacing stage. Sweepings shall be disposed of in accordance with Subsections 201.09 and 202.12.

The milled area opened to traffic before resurfacing shall be free from gouges, continuous grooves, ridges and delaminated areas and shall have a uniformly textured appearance consisting of discontinuous longitudinal striations which shall not deviate more than 1 inch in 200 feet from a line parallel to the center of the traveled way and shall not exceed 3/8 inch depth. The milling shall provide a skid resistance not less than that of the original surface prior to milling and shall permit passage of traffic at the posted speed limit without vehicle operators experiencing impaired directional control.

Areas to be milled which are not accessible to the milling machine shall be removed by other equipment.

The use of milling machines is not permitted on bridge decks when bituminous concrete is removed to its full depth.

202.10 Wet Excavation. Wet excavation shall be performed so that it assures removal down to firm bottom within the lateral limits.

After the excavation of any area, all material that enters the wet excavation area by sloughage not caused by the operations shall be included in wet excavation.

If a slope failure should develop during wet excavation adjacent to an existing roadway, such operations shall cease immediately. Limits of wet excavation shall be determined and backfilling shall be started at once. When it has been determined that the failure has stabilized, wet excavation shall be resumed at a rate and by a method to be determined by the Engineer.

In order to determine that the entire depth of material has been removed down to firm bottom, the bottom of the wet excavation area shall be tested, at frequent intervals as the excavation progresses, by taking soundings or samples or by other tests. The Department may take borings and samples in order to determine if there is any wet excavation material remaining below the bottom of or entrapped within the embankment.

When the wet excavation has been completed to firm bottom, notification shall be given to the Resident Engineer that the wet excavation areas at such locations are available for measurement.

Adequately equipped boats shall be provided at each location where excavation is in progress.

Wet excavation material trapped within or under the backfill embankment or between the new and an existing embankment so as to cause visible areas in the embankment or to be detrimental to the stability of the embankment, roadway, or structures, the entrapped material and the overlying Zone 2 material shall be removed and all such excavated areas shall be backfilled with Zone 2. Additional compensation will not be made for such excavation and backfilling.

All areas of wet excavation outside the embankment slope area but within the wet excavation limits shall be backfilled with Zone 2 material to the level of the adjacent original ground or meadow level. Payment for the backfill material will be made as provided for in Section 204. Areas of wet excavation outside the specified wet excavation limits shall be refilled with Zone 2 material to adjacent original ground level at no cost to the State.

Wet excavation shall be disposed of in accordance with Subsection 202.12 for excess material.

202.11 Partial Wet Excavation. Partial wet excavation shall be in accordance with Subsection 202.10 except that removal shall be to a prescribed elevation. Wet excavation shall be performed using such equipment and methods as to permit removal of material to the prescribed elevation without disturbing the material below that elevation. If the methods and equipment being used disturb material below the specified elevation, such operations shall immediately cease. Alternate methods and equipment shall be proposed and, subject to approval, the work may resume.

202.12 Disposal of Excess or Unusable Material. Excess excavation material may be permitted to be used to widen or flatten slopes of embankments, to fade embankments into cuts, or to be placed in such other locations or disposed of.

Excess rock excavation or broken concrete may be permitted to be used along slopes adjacent to streams for slope protection.

Excess material not used as specified above and unusable material shall be disposed of at sites provided outside of State right-of-way and out of sight, during all seasons, of any State highway.

Written permission shall be obtained from the property owner on whose property the materials are to be placed. A copy of the agreement shall be furnished to the Resident Engineer.

202.13 Disposal of Regulated Waste. Regulated waste shall be disposed of at sites provided outside of State right-of-way and out of sight, during all seasons, of any State highway.

Written permission shall be obtained from the property owner on whose property the material is to be placed. A copy of the agreement shall be furnished to the Resident Engineer.

COMPENSATION

202.14 Method of Measurement. Stripping will be measured by the acre.

Roadway excavation of the various kinds will be measured by the cubic yard except roadway excavation, unclassified will not be measured and payment will be made for the quantity in the Proposal adjusted for Change Orders except as provided for in Subsection 109.01.

If roadway excavation materials are used to construct items of soil aggregates and the final quantities result in an excess of roadway excavation materials, the volume of excavation will be reduced by the volume of soil aggregate constructed. If the final quantities result in borrow excavation material required to complete the embankments, a volume of borrow material shall be furnished, at no cost to the State, equal to the volume of soil aggregate constructed, or equal to the volume of material required to complete the embankment, whichever is less.

Wet excavation will be measured by the cubic yard.

Presplitting will be measured by the square yard.

Removal of concrete base or concrete surface course and the removal of only the bituminous concrete overlay will be measured by the square yard.

Joint removal, including adjacent concrete courses, will be measured by the square yard.

Milling of the various depths and kinds will be measured by the square yard.

The depth of the completed milling when measured from the original surface to the top of the high spots of the textured surface shall be equal to the prescribed depth of cut except for profile milling for which the depth of cut shall be only that necessary to remove the bituminous concrete above the bottom of wheelpath ruts and transverse corrugations while producing a smooth profile and cross section.

202.15 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Stripping	Acre
Roadway Excavation, Earth	Cubic Yard
Roadway Excavation, Rock	Cubic Yard
Roadway Excavation, Unclassified	Cubic Yard
Roadway Excavation, Regulated Waste	Cubic Yard
Wet Excavation	Cubic Yard
Presplitting	Square Yard
Removal of Bituminous Concrete Overlay	Square Yard
Removal of Concrete Base Course and Concrete Surface Courses	Square Yard
Joint Removal	Square Yard
Milling, _____" Depth	Square Yard
Milling, _____" Average Depth	Square Yard
Milling, Variable Depth	Square Yard
Profile Milling	Square Yard

Separate payment will not be made for bituminous-stabilized base course replacement for joint removal.

SECTION 203 - EMBANKMENT

203.01 Description. This work shall consist of the construction of embankments and the preparation of the area on which the embankments are placed.

203.02 Embankment. Zones of embankment are defined as follows:

- Zone 1 is the sand blanket placed on swamps, marshes and other unstable ground in connection with the formation and consolidation of embankment by the vertical drain method or by the sand blanket method.
- Zone 2 in swamp embankment constructed by the wet excavation and backfill method is that part of the embankment extending upward from the lower limit of the wet excavation to the elevations specified.

  Zone 2 also includes such volume of Zone 2 material that may be placed on swamp or marsh surface, in channels and other critically soft areas, prior to placing the Zone 1 sand blanket. In swamp embankment constructed by the vertical drain method or by the sand blanket method, Zone 2 is that portion of the embankment extending upward from the top of Zone 1 to elevations or heights as specified or upward from the swamp surface prior to placing Zone 3 when Zone 1 is not proposed or used.
- Zone 3 in swamp embankment is that embankment above Zone 2. Zone 3 also includes all other areas of embankment constructed on firm ground.

Zone 3 embankment shall be constructed of soil or rock materials or a combination of these materials obtained from the work specified in Sections 202, 204, 205, 206 and 207. These materials shall be free from stumps, roots, weeds, sod, rubbish, garbage and any other material that may decay.

MATERIALS

203.03 Materials. Borrow Excavation for embankments shall conform to Table 203-1. Soil aggregate materials shall conform to Subsection 901.09.

Table 203-1 Gradation Designations of Embankment Materials

Embankment Materials	Designation
Borrow Excavation, Zone 1	I-7
Borrow Excavation, Zone 2	I-11
Borrow Excavation, Zone 3	(Notes 1 & 2)
Borrow Excavation, Zone 2 and Zone 3 (Hydraulically Placed)	I-12
Borrow Excavation, Bridge Foundation (Underwater Area)	I-9 (Note 2)
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Borrow Excavation, Selected Material	I-13
Porous Fill	I-9
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Drainage Windrow	(Note 3)

Note 1 - Material shall be composed of soil aggregate or soil aggregate and rock. The portion of material passing the 4-inch sieve shall contain not more than 35 percent by weight of material passing the No. 200 sieve. When composed of soil aggregate and rock, the proportion of soil aggregate shall not be less than that required to fill all rock voids. When embankments are to be constructed outside the right-of-way in areas where the State has purchased slope rights to construct embankments on existing areas, the top 30 inches shall be constructed with excavated material from the Project or with borrow material, neither of which shall contain stones, broken concrete or similar objects larger than 2 inches in any dimension.

Note 2 - When piles for structures are to be driven, the maximum size aggregate shall be 2 inches. Borrow Excavation, Bridge Foundation (Underwater Area) shall be placed in the dry and compacted in accordance with Subsection 204.03.

Note 3 - The material for drainage windrows shall be broken stone, washed gravel or blast furnace slag conforming to Subsection 901.04, 901.05 or 901.06 and the aggregate size shall be No. 7 or No. 8 as shown in Subsection 901.21, Table 901-1.

EQUIPMENT

203.04 Equipment. Compaction shall be accomplished with one or more of the following:

- Pneumatic-Tire Roller. Pneumatic-tire rollers shall be of the self-propelled type consisting of two axles equipped with pneumatic tires mounted so as to completely cover the area to be compacted in a single pass. The wheels on at least one axle shall oscillate vertically, either singly or in pairs. The roller shall have a width of not less than 5 feet. Wobble-wheel rollers will not be permitted. The wheels shall be equipped with smooth, wide-tread compactor

tires of equal size and diameter, capable of producing a uniform, ground-contact pressure on a level, unyielding surface through a range of 60 to 95 pounds per square inch on all wheels. Operating tire contact pressure shall be maintained by the use of ballast, and tire inflation pressure combinations shall not exceed the recommendations of the Tire and Rim Association Incorporated for the applicable tire size and ply rating.

All tires shall be uniformly inflated so that their respective tire pressures do not vary more than 5 pounds. Charts and tabulations shall be furnished showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the tires used.

- Dynamic Compactor. The compactor shall be a vibratory roller or vibratory pad-type compactor capable of operating at the optimum frequency of vibration required for the size and type of compactor used and for the type of material being compacted. Vibratory pad-type compactors shall be used only when access with a vibratory roller is not practical. Vibratory rollers shall be equipped with a readily visible instruction plate containing the manufacturer's recommended operating frequency, amplitude and roller speed. A calibrated vibrating reed tachometer shall be provided with each roller to permit a mechanical check of the roller vibration control system.
- Sheepsfoot Roller. The tamping type or sheepsfoot roller shall consist of one or more cylindrical sections having studs or feet projecting not less than 6 1/2 inches from the surface and developing a load of not less than 200 pounds per square inch of bearing surface when a complete row of tampers is in contact with a level surface.
- 50-Ton Compactor. The compactor shall consist of four pneumatic-tire wheels mounted on a rigid steel frame. The wheels shall be evenly spaced in one line across the width of the roller and shall be arranged in such a manner that all wheels carry approximately equal loads when operated over an uneven surface. The maximum spacing between adjacent wheels shall not exceed the tire width. The tires shall be capable of operating at inflation pressures ranging from 50 to 90 pounds per square inch. Charts and tabulations shall be furnished showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the tires used.

  The compacting equipment shall have a body suitable for ballast loading with such capacity that the gross load may be varied from 25 to 50 tons. Ballast to obtain the required weight shall consist of ingots, concrete blocks, sand bags, or other material, with a uniform, known unit weight, so that the total weight of the ballast used can be determined at all times.
- Three-Wheel 10-Ton Steel Roller. Three-wheel rollers shall be smooth-faced power rollers, weighing not less than 10 tons and having a load of not less than 330 pounds per inch of width of roller surface when all wheels are in contact with a level surface. The load requirements apply to the rear wheels.

CONSTRUCTION

203.05 Construction Requirements.

(a) Preparation of Embankment Areas. The ground surface shall not be frozen and shall be free from quantities of snow, ice and mud when a subsequent layer is placed.

When the embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when the embankment is to be built a portion at a time, the slope against which the embankment is to be placed shall be benched continuously as the

embankment is brought up in layers. Benching shall be a minimum of 6 feet in width in order to integrate the new embankment with the existing slope. Material cut out shall be recompacted along with the new embankment.

In areas outside proposed pavement limits, the following shall apply:

- Where the final grade of fill is to be less than 15 inches above existing bituminous or concrete material, the existing material shall be removed and the area shall be graded and compacted in accordance with Subsection 203.09.
- Where the final grade of fill is to be from 15 inches to 3 feet above existing bituminous or concrete material, the concrete shall be broken into pieces of not more than 4 square feet and the bituminous shall be scarified.

(b) *Placement.* Embankment placed under water or on wet and unstable ground shall be constructed by end-dumping methods. End-dumping shall be used only to such an elevation that permits the use of compacting equipment. The remainder of the embankment shall be placed and compacted as specified in Subsection 203.07 for Zone 3 embankment. End-dumping shall not be started until the suitability of the surface on which the embankment is to be placed has been approved. When interrupted for a period of 24 hours or more, dumping shall not be done until suitability of the surface has been re-approved.

In the construction embankments, starting layers shall be placed in the deepest portion of the fill, and, as placement progresses, layers shall be constructed approximately parallel to the finished pavement grade line.

During construction of the embankment, when practicable, construction equipment, both loaded and empty, shall be routed over the layers with the travel distributed evenly over the entire width of the embankment. Cemented soil aggregations shall be broken up into smaller pieces and incorporated with other material in the layer.

The work of roadway excavation, embankment and borrow excavation shall be timed and arranged so that space is reserved in the embankment for excavated earth and rock.

(c) *Drainage and Stability.* Embankment shall be constructed so that adequate surface drainage shall be provided at all times. The center of the roadbed shall be constructed higher than the sides and the surface shall be kept uniformly graded and compacted.

To facilitate compaction and drainage of the embankment, sufficient blade graders or other equipment shall be used to keep the embankment smooth and free from ruts during construction.

If, in the opinion of the Engineer, the embankment construction would be adversely affected by the moisture content of the existing or embankment soil being either excessive or deficient, embankment construction shall not continue until the moisture content is reduced or increased, to produce the necessary compaction.

Embankments shall be stable and any portion shall be replaced which has become displaced or unstable due to carelessness or negligence.

(d) *Rock in Embankments.* Rock shall not be placed in embankments without approval.

Rock shall be placed, in general, to form the base of embankments for the full width of the cross section. Rock shall also be placed on side slopes where indicated or where directed.

Excess rock placed on the side slopes of completed embankments need not be compacted unless directed.

Rock shall be placed in uniform, loose layers not exceeding in depth the approximate average size of the larger rock, but limited to a maximum depth of 36 inches. Oversize rock shall be reduced in size until it can be incorporated readily in a 36-inch layer. However, rock shall not be dumped in final position, but shall be distributed by blading or dozing in a manner that ensures proper placement in the embankment so that voids, pockets, and bridging are reduced to a minimum. The top layer and sides of all rock embankments shall be limited to a maximum of 12 inches with all voids filled with smaller pieces, spalls or granular material. The rock embankment shall not be constructed above an elevation 2 feet below the finished subgrade. The balance of the embankment shall be composed of material other than rock, smoothed and placed in layers not exceeding 8 inches in loose thickness, and compacted as specified in Subsection 203.07.

Before rock is placed on compacted embankment constructed of earth, the existing embankment surface shall be sloped from the centerline to the sides at the rate of approximately 1 inch to the foot and the surface of the embankment shall be thoroughly compacted.

When rock and earth embankment material are placed at the same time, the rock shall be placed in the outside portion of the embankment and the earth material placed in the central portion of the embankment. During this construction, the elevations of both portions shall be substantially the same, but the elevation of the layers of earth shall be, at all times, above the rock layers to allow for compaction of the layers of earth.

All rock embankment shall be placed so that larger pieces are well distributed and the voids filled to the extent that is practicable.

Rock embankment shall not be placed in localized areas where bearing piles are to be driven or drainage is to be constructed.

203.06 Backfilling. Backfilling shall be completed and the material compacted before any embankment is placed.

Embankment constructed in the vicinity of bridges and similar structures prior to the completion of abutments and wingwalls shall terminate temporarily on slopes 5:1, or flatter, which shall be located to allow ample space for construction of the structure and for placing and compacting the backfill, porous fill and remaining adjacent embankment. Embankment and porous fill around and adjacent to arches, rigid frame bridges, culverts and piers shall be placed simultaneously on both sides to approximately the same elevation.

Where existing pipes and conduits have insufficient earth cover during embankment construction, the pipes and conduits shall be protected against damage by the equipment and operations. Any damage to such facilities that may be caused by the operations shall be repaired.

Porous fill shall be placed in layers and compacted as provided in Subsection 203.10. The maximum layer thickness shall be 12 inches, loose measurement. Material which does not meet the gradation requirements shall be removed and may be blended, off the placement site, to correct gradation and then returned to the site.

Rock backfill shall be placed and constructed, as directed, on slopes where slumping has occurred. The rock shall measure 4 to 12 inches in the longest dimension and shall be in accordance with the geologic classifications in Subsection 901.04.

203.07 Placement and Compaction Methods. Embankment material shall be placed and compacted in accordance with following Subsections:

Zone 3 embankments of sand, sand and gravel or a combination of other granular materials shall be constructed in accordance with Subsection 203.08. When Zone 3 embankments consist of rock or of nongranular material, when they are of a minor nature or are so variable as to make the control fill method impractical, in the opinion of the Engineer, Zone 3 embankments shall be constructed in accordance with Subsection 203.09.

The top 6 inches in cut sections shall be compacted in accordance with Subsection 203.09.

Zone 1 and Zone 2 embankments shall be constructed in accordance with Subsections 203.11, 203.12, 203.13 and 203.14.

203.08 Control Fill Method.

(a) Control Strips. One or more control strips shall be constructed for the purpose of determining compaction requirements for each material. Any change in the character of the material or the compaction equipment used requires the construction of a new control strip. Each control strip is to remain in place and become a portion of the completed embankment.

(1) Material. The material used in each control strip shall be furnished from the same source and shall be the same type as the material to be used in the embankment. Unless otherwise approved, moisture content of the test strip material shall be within plus or minus 2 percent of its optimum moisture content as determined by AASHTO T 99, Method C, including the replacement option. If the control strip compaction is being adversely affected by the moisture content of the soil being either excessive or deficient, the control strip construction shall not continue until the moisture content is reduced or increased, to produce necessary compaction.

(2) Equipment. The type and weight of the compaction equipment used shall be such that uniform density is obtained throughout the depth of the layer of material being compacted.

When the embankment material is sand, sand and gravel, or a combination of other granular materials, a pneumatic-tire roller or a dynamic compactor shall be used.

(3) Placing. The maximum compacted thickness of each layer shall not exceed 8 inches except when it can be shown, in construction of the control strip, that adequate compaction of thicker lifts is possible with the equipment to be utilized in compaction. Compaction shall be established by demonstrating that a maximum reference density in the control strip, having lifts thicker than 8 inches, is equal to or greater than the maximum reference density attained in a control strip having layers of 8 inches or less in thickness.

(4) *Procedure.* The subgrade or course upon which a control strip is constructed shall be approved prior to the construction of the control strip.

Each control strip shall consist of an area of at least 400 square yards, and the thickness shall be the same as for at least three compacted layers of the embankment.

The first two embankment layers of the control strip shall be compacted in accordance with the rolling and vibrating method.

The third layer of the control strip shall be compacted by a minimum of two passes with the compaction equipment. A pass is defined as one passage of one tire, compacting wheel or vibrating unit over the entire surface of the layer. Compaction shall continue until no appreciable increase in density is obtained by additional passes. The surface of the final lift shall be smooth, dense and free from ruts and roller marks. Density of the control strip will be determined in accordance with AASHTO T 191, AASHTO T 205, or AASHTO T 238, Method B and AASHTO T 239 except that only one method will be used throughout the Project.

Upon completion of compaction, a minimum of ten tests will be made at random locations to determine the average in-place dry density of the control strip. If the average dry density of the material in the control strip is equal to or greater than 90 percent of its maximum density as determined by AASHTO T 99, Method C, including the replacement option, then the compaction equipment and its method of use shall be approved for compaction of embankment of the same materials and thicknesses on the Project. The value of this average shall be the reference maximum density. A control strip satisfying the 90 percent of AASHTO T 99, Method C, density requirement shall be established before construction with the test strip type material can proceed on the Project. Failure to achieve this density level in the control strip shall be cause for rejection of the compaction equipment and/or its method of use.

(b) *Embankment Compaction.* Each layer of Zone 3 embankment shall be compacted by the same equipment and the number of passes that obtained maximum density as determined by the control strip procedure.

When a control strip has been constructed for a given material and where the conditions are such that access with compacting equipment specified above is not possible, each layer of embankment shall be compacted to a density of not less than 95 percent of the established reference maximum density.

The density of such inaccessible areas will be determined from the average of five randomly located measurements in accordance with AASHTO T 191, AASHTO T 205, or AASHTO T 238, Method B and AASHTO T 239 except that only one method will be used throughout the Project.

203.09 Rolling and Vibrating Method. Embankment materials, except rock, shall be placed in layers not more than 8 inches thick, loose measurement, except where embankment is compacted with a 50-ton compactor, the layers may be 12 inches thick, loose measurement. Rock shall be placed in accordance with Subsection 203.05, Subpart *(d)*. Compaction equipment shall conform to Subsection 203.04. Each layer shall be compacted in accordance with Table 203-2 below.

Table 203-2 Compaction Requirements

Embankment Material	Equipment	Passes per Layer
Sand, Sand and Gravel	Pneumatic-Tire Roller	5 minimum
	Dynamic Compactor	2 to 5 maximum (As directed)
Silt, Clay	Pneumatic-Tire Roller	5 minimum
	Sheepsfoot Roller	8 minimum
	Three-Wheel 10-Ton Roller	4 minimum
Rock	Dynamic Compactor (Vibratory Roller with 10-ton minimum drum weight)	2 to 5 maximum (As directed)
	50-Ton Compactor	5 minimum

Where the conditions are such that access with compacting equipment specified above is not possible, the embankment shall be placed and compacted in accordance with Subsection 203.10.

203.10 Density Control Method. The density control method shall consist of compaction of embankment materials to a density of not less than 95 percent of maximum density. Except as provided for in Subsection 204.03, maximum density shall be determined in accordance with AASHTO T 99, Method C, including the replacement option. The compacted density of embankments will be determined by taking the average of a minimum of five randomly located measurements for each 1000 cubic yards placed in accordance with AASHTO T 191, AASHTO T 205, or AASHTO T 238, Method B and AASHTO T 239 except that only one method will be used throughout the Project.

203.11 Hydraulic Fill Method. If the hydraulic method of filling is used, the points on the cross section at which the material is discharged and the location of spillways shall be regulated so that material finer than the No. 200 sieve size does not accumulate within the embankment or between it and an existing adjacent embankment. If material finer than the No. 200 sieve size is found in the embankment in such a quantity, location or distribution that is detrimental to the stability of the embankment, such material and overlying material shall be removed and the area shall be backfilled with conforming material without additional compensation.

Material that is bulldozed or otherwise moved or spread after its hydraulic placement shall be compacted in accordance with Subsection 203.09.

The necessary rights and permits shall be obtained from affected property owners for the construction and maintenance of the supply lines from the site of pumping to the Project. Copies shall be furnished to the Resident Engineer.

Adjacent properties and water channels shall be protected against the spread of the hydraulic fill material and the runoff from the filling operations, unless permission is obtained for the discharge and runoff of such material from the property owners and public authorities or agencies affected. Prior to Completion, written releases shall be obtained from such property owners, public authorities and agencies protecting the State against claims on account of any such discharge and runoff on their properties, or by reason of any other conditions adversely affecting their properties which are caused by the operations. Copies of the releases shall be furnished to the Resident Engineer.

Existing vegetation within the highway right-of-way and other property of the State which is not to be removed shall be protected against damage from the runoff and spread of hydraulic fill material. If any such vegetation is killed or dying prior to

Completion, as a result of the runoff or spread of such material, in the opinion of the Engineer, all such dead or dying vegetation shall be removed from the right-of-way or other State property at no cost to the State.

Maintenance of adequate drainage flow shall be provided at all times either in existing or new ditches and channels. Upon completion of the embankments, existing and new streams, ditches and other water channels shall be restored to their former or prescribed cross section where filling material or sediment from runoff has washed, spread or has otherwise been deposited. Restoration of ditches and other water channels shall be performed without additional compensation.

203.12 Wet Excavation and Backfill Method. This method consists of constructing a Zone 2 embankment by end-dumping or hydraulically placing a soil aggregate material into a swamp or wet excavation area which previously had been excavated in accordance with Section 202.

On completion of the wet excavation in a particular area, the excavated area shall be backfilled with Zone 2 embankment. The backfill material may be end-dumped only to such an elevation that permits the use of compacting equipment. The remainder of the Zone 2 embankment shall be placed and compacted as specified for Zone 3 embankment in Subsection 203.07.

The manner of filling and advancing the backfill wedge shall be such as to force all remaining wet excavation material laterally to the sides of the excavation and not entrap it under the fill. All accumulations of wet excavation material at the sides of the excavated area shall be removed as the embankment wedge advances. If wet excavation material is spilled or otherwise deposited on the top or sides of the embankment during this operation, it shall be entirely removed without additional compensation.

The embankment shall not proceed until tests have been performed on the bottom of the excavation to determine that the wet excavation material has been removed down to the firm bottom or the lower limit in partial wet excavation. The formation of the embankment shall proceed continuously except with the necessary interruptions to allow for testing and measuring. When interrupted for a period of more than 24 hours, embankment construction shall not be resumed until the bottom of the excavated area has been tested again and it is determined to be in satisfactory condition.

In widening an existing embankment, the construction of the new embankment shall proceed along and outward from the existing embankment in close coordination with the wet excavation and in such manner that wet excavation material is not entrapped between the existing and new embankments and so as to prevent displacement of unstable materials that may be under the existing embankment.

Precautions shall be taken to prevent settlement or dislocation of, or damage to, any existing adjacent roadways and utility or other facilities therein. If such roadways or facilities are damaged by or as a result of the work, they shall be repaired, replaced or otherwise restored, without additional compensation, to a condition as good as prevailed at the time the Project started.

203.13 Vertical Drain Method. This method consists of the stabilization of foundation soils by placing thereon a drainage layer of Zone 1 material, placing Zone 2 and Zone 1 materials in channels and soft areas, then placing a Zone 2 working table, vertical drains, Zone 3 embankment and an overload. This method may also include the installation of settlement platforms, control stakes, pore pressure measuring devices and drainage windrows.

(a) *General.* The work shall be performed in a manner to prevent failures of the embankment and the foundation. The term foundation as used in this connection shall be construed to mean the existing swamp materials and the vertical drains below the bottom of the Zone 1 blanket. Repair of the embankment and foundation damaged by failures shall be performed without additional compensation.

The work of placing and compacting the embankment will be monitored using the data obtained from readings on the settlement platforms, pore pressure measuring devices, control stakes and by other monitoring means and by inspection of the filling operations as they proceed. The suspension of operations may be ordered for up to 45 calendar days at such times as conditions develop which may be detrimental to the work or may cause damage to adjacent property.

Priority shall be given to the construction of embankments adjacent to bridges and other structures so as to coordinate with proposed bridge construction schedules.

Embankment operations shall proceed simultaneously at as many locations and with sufficient forces and equipment as may be necessary to complete all embankments within the time necessary to complete the highest embankments at the prescribed controlled rates of filling.

Where embankment that is to be constructed by the vertical drain method adjoins the embankment to be constructed in wet excavation areas, the wet excavation and backfill shall be completed before the work is started in the vertical drain area.

The embankment overload shall be compacted in accordance with Subsection 203.07.

(b) *Construction of Zone 1 and Zone 2 Embankments.* Settlement platforms shall first be placed and initial elevations determined. Zone 1 material shall then be deposited to a minimum thickness of 4 feet, or to such other thickness as may be specified and shall be graded to a level surface. After measurements have been taken by the Engineer on the surface of Zone 1 material, Zone 2 material shall be placed on top of Zone 1 material to form a working table. If the working table settles below a specified limiting elevation before vertical drains are installed, additional Zone 2 material shall be placed to bring the working table up to the specified elevation.

Existing ditches, channels, pockets and other low areas shall be filled with Zone 1 or Zone 2 material at the locations specified. If excessive settlement occurs or is expected to occur in these or other critically soft or unstable areas, Zone 2 material shall be placed directly on the existing swamp surface before Zone 1 material is placed.

Zone 1 material may be placed in one layer provided this does not cause excessive displacement of the underlying material. If excessive displacement is anticipated, Zone 1 material shall be placed in two layers. The second layer shall be spread initially at least 20 feet back from the outer edges of the first layer. The second layer may then be completed to the full width 1 day after the first layer has been placed.

When Zone 2 is placed directly on existing swamp surface, it shall be placed as specified for Zone 1 embankment.

End-dump methods may be used in placing the initial layer of Zone 1 or Zone 2 material. The spreading shall be performed with a light bulldozer or other equipment having treads giving equivalent effect, the gross weight of which shall not exceed 17,000 pounds. Heavier bulldozers may be used when

authorized and then only if they are equipped with marsh-type extension treads so that they do not displace the underlying foundation soil or force the sand blanket into the foundation soil. If necessary, to avoid the development of mud waves ahead of the placement of the Zone 1 or Zone 2 material in very soft areas or channel areas, the material shall be cast ahead in a thin layer with a small clamshell crane, or with other suitable equipment before spreading additional material with the bulldozer.

If any mud waves or heaves develop within the proposed limits of Zone 1 and Zone 2 materials in advance of the placing of these materials, they shall be removed down to the elevation of the original ground. If any mud waves or heaves are entrapped under the Zone 1 or Zone 2 materials to a height of more than 1 foot above the original ground, they and the overlying Zone 1 or Zone 2 materials shall be removed and replaced with layers of Zone 1 and Zone 2 material. All work of removing mud waves and heaves and replacement of Zone 1 and Zone 2 materials shall be performed without additional quantity allowance or other additional payment, if such mud waves or heaves were due to negligence.

Zone 2 material shall be placed on top of the Zone 1 material to form the working table and shall be compacted in accordance with Subsection 203.09. However, in forming the working table, not more than 1 foot of Zone 2 material shall be placed in any 1 day.

After the working table is constructed, the vertical drains shall be installed.

(c) *Construction of Zone 3 Embankment.* Zone 3 embankment shall conform to Subsection 203.07 and the following:

- When Zone 1 and Zone 2 materials have been placed to form the working table, or when Zone 2 has been constructed to a level higher than the working table and all the required devices have been installed and measurements taken by the Engineer at the appropriate levels, Zone 3 material shall be placed to complete the embankment and overload. The overload thickness shall be increased if directed.
- If rock is placed in Zone 3 embankment, sufficient earth shall be placed around the settlement platforms and other monitoring devices in advance of placing the rock, to prevent disturbances of or damage to them.
- Zone 3 material shall be placed at the rate as provided for in the Supplementary Specifications.

(d) *Installation of Vertical Wick Drains.* Vertical wick drains shall be as provided for in the Supplementary Specifications.

(e) *Installation of Vertical Sand Drains.* Vertical holes not less than 20 inches in diameter shall be formed from the working table and shall extend through the zone materials and underlying soft material down to the firm stratum, or to such depth as directed. The holes shall be backfilled with the soil aggregate as specified in Subsection 203.03 before the placing of embankment material above the established working table.

The holes shall be formed by jetting a casing down to the required depth by driving a plugged mandrel with a pile driver or by other methods. If the holes are formed by driving a plugged mandrel, the mandrel shall be not less than 20 inches, outside diameter, for its full depth. The driving rig shall be equipped with a compressed air supply for forcing the soil aggregate out of the mandrel. If other methods are used, the equipment shall be of such

203.13

design as to obtain holes of equivalent size and to maintain them at that size until they are filled with soil aggregate. Provisions shall be made for durable markings on equipment for measurement of the depth of holes.

If the holes are excavated by jetting a casing to the required depth, the jetting shall be continued for a sufficient length of time, after the casing has reached required depth, to remove all solid materials within the casing. Holes that contain muddy water shall be pumped out until the water contains not more than a total of 2 percent, by weight, of silt and clay. After the hole has been backfilled with soil aggregate, the casing shall be removed by such method that leaves the hole completely filled with soil aggregate. Jetted material shall not be permitted to come in contact with Zone 1 materials.

Where obstructions are encountered that cannot be penetrated by the mandrel or other methods in use, the holes shall be formed by spudding with a pointed steel spud of such type and operated by equipment with sufficient driving capacity as to punch through the materials encountered. The following variations in procedure will be permitted:

- Where obstructions are encountered with the mandrel or spud, the hole may be abandoned and the sand drain installed at a distance not more than 3 feet from the prescribed location of the sand drain. However, where an obstruction is encountered at a depth of more than one-half the depth of the proposed sand drain, and such obstruction cannot be dislodged or penetrated by spudding, a vertical sand drain may be directed to be constructed above the obstruction.
- Where unusual obstructions do not permit a satisfactory pattern of vertical sand drains, the obstructions shall be removed and discarded. All such excavation shall be refilled.

Any method of excavating or constructing the holes which causes an appreciable disturbance of the adjacent existing ground shall be discontinued. Holes that must be abandoned on account of obstructions shall be backfilled with material conforming to Zone 1 requirements. Holes that are out of place and those that are damaged in excavating, forming the hole, or during the placing of soil aggregate shall be backfilled with Zone 1 material and abandoned. If any previously completed sand drains are damaged or destroyed in excavating for the removal of obstructions, such sand drains shall be replaced with new ones.

Each hole shall be inspected and approved before the soil aggregate is placed. The material jetted or excavated from the holes shall be disposed of in accordance with Subsection 202.12.

(f) Pore Pressure Measuring Devices. Pore pressure measuring devices shall be installed at intervals specified. They shall be grouped approximately equidistant from the vertical drains.

The pore pressure measuring devices shall be maintained and any or all components which may be damaged or worn out shall be replaced or repaired. The devices shall remain in place and become the property of the State except those removed because of interference with roadway construction.

(g) Settlement Platforms. Settlement platforms shall be carefully set and leveled. The pipes shall be kept plumb and shall extend upward in sections as the filling progresses, always keeping the pipes a minimum of 4 feet above the top of the embankment.

If the platforms or pipes are disturbed during construction, by the action of tides or otherwise, they shall be restored before additional embankment material is placed at their locations. The pipes shall remain in place upon Completion and become the property of the State except those which may be removed, as directed, because of interference with roadway construction.

(h) Drainage Windrows. Trenches for drainage windrows shall be excavated in the Zone 1 sand blanket and backfilled with materials as described in Subsection 203.03.

(i) Control Stakes. Control stakes shall be constructed to indicate any foundation or slope movement.

203.14 Sand Blanket Method. This method consists of the stabilization of foundation soils by placing thereon a sand blanket of Zone 1 material, placing Zone 2 and Zone 1 materials in channels and soft areas, then placing a Zone 2 working table, Zone 3 embankment, and an overload. This method may also include the installation of settlement platforms, pore pressure measuring devices, control stakes and drainage windrows.

The materials and methods of construction shall be the same as specified in Subsection 203.13 except that vertical drains shall not be installed and the thickness of Zone 1 sand blanket may be varied, as directed, according to the actual ground conditions encountered during progress of the work.

COMPENSATION

203.15 Method of Measurement. Porous fill and drainage windrows will be measured by the cubic yard.

Breaking of concrete within embankment area will be measured by the square yard.

Rock backfill will be measured by the ton.

Vertical drains of the various kinds will be measured by the linear foot.

Pore pressure measuring devices of the various types will be measured by the number of each.

Control stakes and settlement platforms will be measured by the number of units.

203.16 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Porous Fill	Cubic Yard
Drainage Windrows	Cubic Yard
Breaking Concrete	Square Yard
Rock Backfill	Ton
Vertical Sand Drains	Linear Foot
Vertical Wick Drains	Linear Foot
Pore Pressure Measuring Devices, Type ____	Unit
Control Stakes	Unit
Settlement Platforms	Unit

Payment for the removal of unusual obstruction difficulties which have prevented the formation of a satisfactory pattern of vertical drains will be made in accordance with Subsection 104.02.

Separate payment will not be made for embankment.

SECTION 204 - BORROW EXCAVATION

204.01 Description. This work shall consist of furnishing material required for backfill and embankment in excess of that obtained from roadway excavation and excavation from other items of work, and the construction of embankments with borrow excavation material.

MATERIALS

204.02 Borrow Excavation. Borrow excavation for embankment material shall conform to Subsection 203.03.

CONSTRUCTION

204.03 Construction Requirements. Borrow pits shall not be located within sight of any State highway except as authorized. When located within sight of a State highway, borrow pits shall be graded and shaped to final slopes of 3:1 or flatter, wherever possible, so that they blend into the general topography of the area. Steep slopes and sheer faces shall be avoided.

Placement and compaction with borrow excavation shall be in accordance with Subsection 203.07 except that borrow excavation for bridge foundations on which footings are founded without piles shall not be less than 95 percent of maximum density as determined in accordance with AASHTO T 180, Method D, including the replacement option. The maximum thickness of any layer shall be 12 inches, loose measurement. A minimum of two field density tests will be taken in accordance with AASHTO T 191, AASHTO T 205, or AASHTO T 238, Method B and AASHTO T 239 on each compacted layer at each substructure unit, except that only one of the referenced methods will be used on the Project. The number of field density tests for each compacted layer is to be at least one test for every 1000 square feet of embankment.

Material which does not meet the gradation requirements shall be removed and may be blended to correct gradation off the placement site and then returned to the site.

COMPENSATION

204.04 Method of Measurement. Borrow excavation of the various zones and kinds will be measured by the cubic yard except that borrow excavation of Zone 3 material equals the volume of Zone 3 embankment less the volume of project excavation determined by computation as follows:

- Zone 3 embankment is the volume of embankment plus the volume of stripping in embankment areas less the volume of materials measured under other Pay items.
- Project excavation is the volume of roadway excavation plus the volume of excavation for other items of work less the volume of stripping in excavation areas as adjusted by applying the prescribed volume correction factor.

Borrow excavation of Zone 3 material in vertical drain and sand blanket areas will be measured by elevations taken or interpolated from settlement platform readings.

204.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Borrow Excavation, Zone ____	Cubic Yard
Borrow Excavation, Bridge Foundation	Cubic Yard
Borrow Excavation, Selected Material	Cubic Yard

SECTION 205 - CHANNEL AND DITCH EXCAVATION

205.01 Description. This work shall consist of the excavation for the construction of new ditches and water channels and for deepening, widening and relocating existing ditches and water channels.

Excavation is defined as channel excavation if the bottom width of the excavation is more than 5 feet. If the bottom width of the excavation is 5 feet or less, the excavation is defined as ditch excavation.

205.02 Classification of Excavation. Channel excavation and ditch excavation is classified as earth, rock or unclassified as defined in Subsection 202.02 except rock in ditch excavation shall be as defined in Subsection 207.02.

CONSTRUCTION

205.03 Construction Requirements. Excavated material shall be used for embankments. Excavation shall be in accordance with Section 202 and the excavated material shall be used in accordance with Section 203 except that the material may be permitted to be used adjacent to the channels, graded and sloped to provide drainage flow from the adjacent lands to the channels, and the sites shall be restored to a condition acceptable to the property owners and the Engineer.

Two adequately equipped boats shall be provided, when required, at each location where channel excavation work is in progress, and space and opportunity shall be provided for the work of measuring the bottom of the excavation.

205.04 Excess or Unusable Material. Excess material shall be used in accordance with Section 203 or if not required for embankments, the material shall be disposed of in accordance with Subsection 202.12.

Unusable material shall be disposed of in accordance with Subsection 202.12.

COMPENSATION

205.05 Method of Measurement. Channel excavation and ditch excavation, of the various kinds, will be measured by the cubic yard.

205.06 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Channel Excavation, Earth	Cubic Yard
Channel Excavation, Rock	Cubic Yard
Channel Excavation, Unclassified	Cubic Yard
Ditch Excavation, Earth	Cubic Yard
Ditch Excavation, Rock	Cubic Yard
Ditch Excavation, Unclassified	Cubic Yard

SECTION 206 - FOUNDATION AND BRIDGE EXCAVATION

206.01 Description. This work shall consist of excavation for the construction of piers, walls, abutments, box culverts, and other structures.

206.02 Classification of Excavation. Foundation and bridge excavation are unclassified and shall consist of excavation and disposal of any material of whatever character encountered in the work.

MATERIALS

206.03 Coarse Aggregate Layer. Material shall be broken stone or washed gravel conforming to Subsections 901.04 and 901.05. The aggregate size shall be No. 56, 57, or 67 conforming to Subsection 901.21, Table 901-1.

206.04 Backfill Material. Material for backfill shall be made with excavated material free from stones or rock fragments larger than 2 inches in any dimension. Additional material needed shall be borrow excavation as described in Section 204 or shall be porous fill as described in Section 203, as directed.

CONSTRUCTION

206.05 Roadway Embankments. In excavating for footings which are within new embankments, the excavation shall be so made as to remove the minimum amount of embankment material and the operations conducted so as to cause minimum disturbance to the embankment. The excavated area shall be backfilled and compacted in accordance with Subsection 203.07 and the embankment shall be restored to the final section.

206.06 Preservation of Stream Channel. If any excavation is made at the site of the structure before caissons or cofferdams are sunk or in place and after the foundation base is in place, all such excavation shall be backfilled to the original ground surface or river bed without additional compensation. Material deposited within the stream area from foundation or other excavation or from the filling of cofferdams shall be removed.

206.07 Excavation. Foundation or bridge excavation shall not be started until all excavations which are to be performed under other items of work have been completed within the limits of foundation or bridge excavation.

Excavations adjacent to pavement, sidewalks and curbs shall be sheathed and shored to prevent undermining or displacing them.

Substructures, where practicable, shall be constructed in open excavation and, where necessary, the excavation shall be shored, braced or protected by sheeting, cofferdams or other similar installations.

Boulders or fingers and ledges of rock projecting into the bottom of the excavation shall be removed to a minimum depth of 6 inches below the bottom of footing and the space backfilled with coarse aggregate layer material and compacted in accordance with Subsection 203.09.

If shale is encountered at the bottom of the footing and the footing is not poured the same day and the shale is exposed to air and/or water, the shale shall be undercut 4 inches minimum and sealed with concrete seal, with a rough finish, to the bottom of footing elevation.

In areas where the bottom of footing would rest partly on earth and partly on rock, the rock shall be excavated to 2 feet below the bottom of footing and the space backfilled with coarse aggregate layer material and compacted in accordance with Subsection 203.09.

Except at locations where the concrete footings are to bear against solid rock, the footing shall be constructed by using side forms. Sheeting specified to remain in place may be used as side forms.

Rock or other hard material shall be freed from loose material, cleaned and cut to a firm surface, either leveled, stepped, or roughened, or shall have anchors installed, as required, to produce a suitable surface. All seams shall be cleaned out and filled with concrete, mortar or grout conforming to Section 914.

Care shall be exercised in excavating for stepped footings so as to avoid any disturbance of the bearing material adjacent to the steps. If this material is disturbed so that it does not provide an acceptable bearing surface, the material shall be replaced with footing concrete at no cost to the State.

206.08 Cofferdams. Cofferdams used in the preparation and protection of the foundation shall be carried below the bottom of the footings, shall be braced in all directions and shall be of such construction as to permit them to be pumped and maintained free of water until the construction therein has been completed. The interior dimensions of the cofferdam shall be such as to allow clearance to provide for the construction and inspection of forms and for the handling and pumping of leakage outside of the footing area.

Cofferdams shall be so constructed as to protect the foundation and the construction against damage from a rise in the water elevation.

Timber or bracing of a cofferdam may extend into or through the substructure masonry only with written authorization.

Design calculations and working drawings shall be submitted in accordance with Subsection 105.04.

Cofferdams with all falsework, sheeting, bracing, etc shall be removed after the completion of the substructure therein except where sheeting is designated to remain.

Vertical structural members supported on rock shall be toed-in sufficiently to ensure stability against movement.

Where sheeting interferes with batter piles, the depth of penetration of the interfering sheets may be reduced or the sheeting may be moved out to provide clearance between the sheeting and the batter piles as authorized.

If the foundation or bridge excavation has become disturbed or distorted due to the construction operation, it shall be cleaned out and restored to an acceptable condition without additional compensation.

Except at locations where a sheet pile cofferdam is indicated, the use of dikes, well points or other means may be permitted for dewatering the areas of foundation excavation. Plans shall be submitted showing proposed construction and approval shall be obtained prior to proceeding with the work. The plans shall be accompanied by evidence of approval in accordance with Subsection 107.05.

Note - When environmental considerations eliminate the need for cofferdams, the Pay Item of Cofferdams will be deleted.

206.09 Preparation of Footings. The elevation of the bottoms of footings shall be considered as approximate and the Engineer may order, in writing, such changes in dimensions or elevation of footings as may be necessary to secure an acceptable foundation.

When the excavation has been completed to the elevation of the bottom of footing, construction shall only proceed pending approval.

When the rock is shattered below the foundation elevation, the shattered material shall be removed and the space created shall be refilled with the same class of concrete as the overlying footing.

Dewatering shall be done in such a manner as to preclude the possibility of any portion of concrete material being carried away. Dewatering required during the placing of concrete, or for a period of at least 24 hours thereafter, shall be done from a sump located outside the concrete forms.

When conditions are encountered which render it impracticable to dewater the excavation before placing the footing, the construction of a concrete seal of such dimensions and thickness as necessary to resist any possible uplift may be permitted. Before placing the concrete seal, the excavation shall be cleared of all objectionable

material by the use of sand pumps, spud bars or other means. The seals shall then be constructed in accordance with Section 501. Dewatering a sealed cofferdam shall not commence until the seal has cured sufficiently to withstand the hydrostatic pressure. The excavation shall then be dewatered and the seal cleaned of all laitance and prepared for further construction.

When masonry is to rest on an excavated surface other than rock, care shall be taken not to disturb the bottom of the excavation. The final removal of material to grade shall not be made until just before the masonry is to be placed.

When directed, coarse aggregate layer material shall be placed following the completion of the excavation. The material on which the coarse aggregate layer is to be placed shall be shaped to an even surface. The aggregate shall then be placed in 6-inch lifts and compacted in accordance with Subsection 203.09.

206.10 Backfilling. Backfilling shall be in accordance with Section 203 and with the following:

- Backfill against footings is permitted after stripping of the footing forms.
- Backfill shall not be placed against other structures, or a section or unit thereof, until the masonry has been in place for 14 calendar days, or until the concrete has a strength of 3000 pounds per square inch.

206.11 Excess or Unusable Material. Excess material shall be used in accordance with Section 203 or if not required for embankments, the material shall be disposed of in accordance with Subsection 202.12.

Unusable material shall be disposed of in accordance with Subsection 202.12.

COMPENSATION

206.12 Method of Measurement. Foundation and bridge excavation will be measured by the cubic yard. When, in the opinion of the Engineer, it is necessary to carry any foundation below the prescribed elevation in order to reach suitable material, only the volume of additional depth is eligible for consideration of price adjustment as provided in Subsection 104.05 except that negotiations may be finalized when the additional excavation at any location has been performed.

Coarse aggregate layer will be measured by the cubic yard.

Cofferdams will not be measured and payment will be made on a lump sum basis.

206.13 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Foundation Excavation	Cubic Yard
Bridge Excavation	Cubic Yard
Coarse Aggregate Layer	Cubic Yard
Cofferdams	Lump Sum

Payment for concrete seals will be made in accordance with Section 501.

Payment of the lump sum price bid for cofferdams where sheet piling is to be left-in-place will be divided equally among the total number of cofferdam units required unless a separate lump sum Pay Item is scheduled for each substructure unit. Partial payment for each substructure unit will be made as follows:

- 25 percent of the amount bid when driving of the sheet piling has been completed.
- The balance when the footing construction has been completed and accepted.

Partial payments will not be made for cofferdams where dewatering areas of foundation excavation is accomplished by the use of dikes, well points or other means in accordance with Subsection 206.08, but payment of the total lump sum price bid will be made upon completion and acceptance of the bridge substructure unit or other structure.

SECTION 207 - SUBSURFACE STRUCTURE EXCAVATION

207.01 Description. This work shall consist of the excavation and backfill for the construction of pipes, electrical conduits, culverts, manholes, inlets and similar subsurface structures.

207.02 Classification of Excavation. Rock in the excavation for subsurface structures is defined as boulders more than 1/2 cubic yard in volume or rock in ledge formation which, in the opinion of the Engineer, cannot be excavated except by drilling or drilling and blasting.

MATERIALS

207.03 Bedding Materials. Portland cement concrete for Class A bedding shall conform to Section 914 for miscellaneous concrete.

Material for Class B bedding shall consist of sand or sandy soil, all of which shall pass a 3/8 inch sieve and not more than 10 percent of which shall pass a No. 200 sieve.

CONSTRUCTION

207.04 Construction Requirements. Before excavating, existing subsurface structures shall be located which may be affected by or interfere with the proposed construction. If directed, test pits shall be excavated to obtain the required information. Test pits shall be backfilled in accordance with Subsection 203.06.

The excavation shall be made in open cut and shall be of sufficient size to permit construction of the subsurface structure.

Excavations shall be shored, braced and sheathed as conditions warrant. If close to existing pavement, sidewalks, curbs, pipes, railroads or structures of any kind, the excavation shall be secured by sheet piling or other methods so that such facilities and structures are protected.

Excavations located within the traveled way, and shoulder and sidewalk areas shall be excavated with vertical sides except that the sides may be sloped above the bottom of subbase.

Boulders, logs and any other debris encountered in the excavation shall be removed.

When the material at the bottom of the excavation is unstable, it shall be removed and the space backfilled with granular material.

Subsurface structures or bedding material shall not be placed until the depth of excavation and the material at the bottom of the excavation has been approved.

(a) Pipes and Culverts. The width of trench shall be at least 18 inches greater than the outside diameter of the pipe or culvert. When the material at the bottom of the excavation is rock or other hard material, it shall be removed within 6 inches outside the bottom of the pipe or culvert and the space backfilled with suitable material.

Excavation for trenches in embankments shall not proceed until the embankment has been constructed to an elevation of at least 3 feet above the proposed top of the pipe or culvert.

When conditions permit, trenches or pipes shall not be excavated more than 300 feet in advance of laying the pipe.

Trench crossings shall be provided and maintained where necessary.

(b) Structures Other Than Pipes and Culverts. When the material at the bottom of the excavation is rock or other hard material, it shall be cleaned of all loose material and cut to a level surface.

207.05 Bedding for Pipes and Culverts. Recesses shall be provided to accommodate pipe bells and shall be deep enough so that the bell is not resting on the bottom of the recess. The width of the recess shall not exceed the width of the bell by more than 2 inches.

If the class of bedding is not designated, pipes and culverts shall be placed directly on the material at the bottom of the excavation.

Class A bedding shall consist of a concrete cradle constructed in accordance with Section 501.

Class B bedding shall consist of bedding material shaped with a template to fit the lower part of the pipe exterior for at least 10 percent of the outside vertical pipe diameter. The minimum thickness of the bedding material, after shaping, shall be 6 inches and the material shall be compacted in accordance with Subsection 207.06.

207.06 Backfilling.

(a) Pipes and Culverts. Backfill to a height of 2 feet above the top of pipes and culverts, except underdrains, shall be made with excavated material free from stones or rock fragments larger than 2 inches in any dimension. Below this level, the backfill shall be placed in layers not more than 6 inches thick and each layer shall be compacted with flat-face mechanical tampers.

All backfill more than 2 feet above the top of pipes and culverts, except underdrains, shall be made with excavated material and compacted in 6-inch layers as follows:

- By vibratory soil compactors, if the backfill material is predominately sand, or sand and gravel.
- By flat-faced mechanical tampers, if the backfill material is not predominantly sand, or sand and gravel.
- Flat-faced mechanical tampers may be substituted for the vibratory soil compactors where the shoring and bracing of trenches or other special conditions make the use of vibratory compactors impractical.

The Engineer may direct compaction to be in accordance with Subsection 203.10 except that the frequency of measurements may increase.

The special backfill in trenches for the underdrains shall be compacted by vibratory compactors. Earth backfill above the special backfill material shall be compacted as specified in Subsection 203.07.

Shoring, bracing and sheathing shall be withdrawn as the backfilling proceeds.

(b) Structures Other Than Pipes and Culverts. Backfilling shall be made with excavated material and shall be in accordance with Subsection 206.10 except that backfill shall not be placed against newly constructed masonry or concrete for 72 hours except as authorized.

207.07 Excess or Unusable Material. Excess material shall be used in accordance with Section 203 or, if not required for embankments, the material shall be disposed of in accordance with Subsection 202.12.

Unusable material shall be disposed of in accordance with Subsection 202.12.

COMPENSATION

207.08 Method of Measurement. Earth excavation for test pits will be measured by the cubic yard.

Earth excavation, additional depth made below the bottom of pipes or subsurface structures caused by changes in grades or by removal of unstable material will be measured by the cubic yard. The quantity excavated will be measured within vertical planes located 9 inches outside the surface of pipes and culverts, and 6 inches outside the neat lines of other structures. However, for pipes of less than 18 inches in diameter, measurement is based on a trench width of 36 inches.

Rock excavation will be measured by the cubic yard.

Pipe bedding of the various classes will be measured by the cubic yard.

207.09 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Earth Excavation for Test Pits	Cubic Yard
Earth Excavation, Subsurface Structures, Additional Depth	Cubic Yard
Rock Excavation, Subsurface Structures	Cubic Yard
Pipe Bedding, Class ____	Cubic Yard

Payment for removal of buried cribbing, heavy timbers and similar material encountered in subsurface structure excavation which cannot be performed by means of equipment and methods ordinarily used for trench excavation, without special work, and which is outside the limits of roadway excavation or excavation made under any other Pay Item will be made as provided in Subsection 104.02.

Separate payment will not be made for subsurface excavation and backfill except backfill required in accordance with Section 204.

SECTION 208 - SUBBASE

208.01 Description. This work shall consist of the construction of one or more courses of the subbase and the preparation of the subgrade.

MATERIALS

208.02 Materials. Materials shall conform to the soil aggregate designations in Subsection 901.09.

EQUIPMENT

208.03 Equipment. Equipment shall include spreading equipment that can spread aggregate, without segregation, and one or more motor graders. The compaction equipment shall be pneumatic-tire or dynamic compactors conforming to Subsection 203.04.

CONSTRUCTION

208.04 Preparation of Subgrade. Prior to the placing of any subbase, the subgrade shall be shaped and compacted to grade and contour in accordance with Section 203 and shall be free from water pockets. Subbase material shall not be placed on soft, muddy, or frozen areas, or until all irregularities in the prepared areas, including soft areas in the foundation, have been corrected.

208.05 Spreading and Compacting. The subbase material shall be deposited on the prepared areas as uniformly as possible to avoid segregation.

Subbase shall be constructed in layers not exceeding a compacted thickness of 8 inches. If the required compacted depth of the subbase exceeds 8 inches, the subbase shall be constructed in two or more layers of approximately equal thickness.

Subbase shall be completed at least 500 feet in advance of construction of the next course.

Except for the subbase layer directly under concrete surface or concrete base course, compaction shall be by the control fill method in accordance with Subsection 203.08 except that a single layer control strip shall be used. The subbase layer directly under the concrete surface and concrete base courses shall be compacted in accordance with Subsection 301.05. Compaction shall progress gradually from the sides to the center with each succeeding pass uniformly overlapping the previous pass, and shall continue until the entire area is shaped and compacted.

Unstable subbase conditions, including soft foundation areas which develop prior to or ahead of the base course or paving operations, shall be corrected by scarifying, reshaping and recompacting, or by replacement as required. Work may be suspended to permit such areas to stabilize.

208.06 Protection of Existing Facilities. If damage is caused to any utility, pipe, facility, building, structure or to its contents, the method of operation shall be changed so as to avoid such damage. At such locations the subbase and subgrade shall be compacted by the density control method specified in Subsection 203.10.

208.07 Maintenance Under Traffic. When it is provided in the Supplementary Specifications that traffic is permitted on the completed subbase course, the subbase shall be maintained smooth and uniform until covered by the following stage of construction.

Completed subbase which has been subjected to construction traffic or exposed to the elements for periods in excess of 120 calendar days will be retested for reapproval before construction of the base and surface courses.

Retesting of subbase prior to 120 calendar days may be required if there is reason to believe it no longer meets specified requirements. In all cases, subbase failing to meet requirements shall be corrected or replaced.

COMPENSATION

208.08 Method of Measurement. Subbase will not be measured and payment will be made for the quantity in the Proposal adjusted for Change Orders except as provided for in Subsection 109.01.

208.09 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Subbase	Cubic Yard

SECTION 209 - UNDERLAYER PREPARATION

209.01 Description. This work shall consist of the final preparation of the surface of the unbound material immediately underlying a concrete, a bituminous or a stabilized surface or base course.

EQUIPMENT

209.02 Equipment. Final rolling of such surfaces shall be accomplished by a three-wheel 10-ton steel roller conforming to Subsection 203.04.

CONSTRUCTION

209.03 Construction Requirements. The surface shall be prepared after the underlying drains and other subsurface structures have been placed and the backfill has been compacted, and when the subbase, base course or subgrade has been completed. The specified surface shall not be prepared during freezing weather or when frozen, or when it is unstable because of excessive moisture.

Surfaces shall be shaped and compacted to a firm and even surface. Such surfaces shall be shaped and smoothed to correct ridges and other surface irregularities. Final compaction shall be by smooth steel, three-wheel power rollers. Inaccessible areas shall be compacted in accordance with Subsection 203.10.

The subbase surface to receive concrete surface and concrete base courses shall be initially prepared slightly above its required grade and contour so that the final grading operation shall be one of blading and scraping. The final compaction between forms for concrete surface or concrete base course shall be performed by a three-wheel power roller. Water shall be applied wherever necessary to facilitate compaction. The final preparation of the subbase shall be completed for a distance of not less than 500 feet in advance of construction of the next course.

For concrete surface and concrete base courses, a grading machine shall be mounted on visible rollers riding on the side forms, or on crawler type tracks, or on wheels traveling on a prepared grade. The machine shall be so designed that its cutting edge shall conform to the required cross section and shall be so arranged that when it is riding on the forms or traveling on a prepared grade, the cutting edge shall trim the grade to the required cross section and elevation and dispose of the excess material outside the forms.

If voids develop at the surface of the subbase for concrete surface or concrete base course, fine granular material of stone, sand, or sand and small gravel particles shall be applied and vibrated or broomed and rolled into place so as to fill all such voids and close the surface. Material in excess of that required to fill the voids shall be removed.

If transverse cracking of the concrete slabs occurs within 24 hours of placement, prime coat may be directed to be applied in accordance with Section 404.

The compaction above and on each side of utility and other subsurface pipes and structures that are located at or close to the described surfaces shall be as specified in Subsection 208.06 for compaction of subbase and subgrade under similar conditions, and any damage to such facilities that may be caused by the operations shall be repaired.

Soft, yielding material and areas of nonuniform density shall be reworked, or removed and replaced, and the replacement material graded and compacted in accordance with the provisions for the given material and the underlayer prepared in accordance with this Subsection. Such corrective work shall be done at no cost to the State. Should the soft or yielding condition be due to excessive moisture, work may be suspended in such areas until they sufficiently dry out.

209.04 Drainage and Protection. Grading shall be performed in such a manner as to provide drainage of water to the side ditches. Side ditches and drains shall be maintained to provide drainage during construction.

Precautions shall be taken to protect the underlayer from damage. Hauling over the finished underlayer shall be limited to that which is deemed essential for construction purposes. In no case shall there be hauling or operation of construction equipment between forms on the finally prepared subbase surface for concrete surface and concrete base courses.

Ruts, ridges or rough places that develop shall be smoothed and recompacted.

COMPENSATION

209.05 Method of Measurement. Underlayer preparation for concrete surface and concrete base course will be measured by the square yard.

209.06 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Underlayer Preparation	Square Yard

Payment for prime coat will be made in accordance with Section 404.

Separate payment will not be made for underlayer preparation for bituminous or stabilized surface or base course.

SECTION 210 - SHOULDERS

210.01 Description. This work shall consist of the construction of shoulders of soil aggregate, dense graded aggregate, bituminous surface treatment or bituminous concrete.

MATERIALS

210.02 Materials. Bituminous concrete shall conform to Section 903 except that the composition of mixture for the top layer may also include up to 20 percent of reclaimed asphalt pavement. Prime coat and tack coat shall be as specified in Section 404.

Bituminous surface treatment shall conform to Section 402. Other materials shall conform to the following Subsections:

Dense Graded Aggregate	901.08
Soil Aggregate	901.09

EQUIPMENT

210.03 Equipment. Equipment for the various types of shoulder construction shall be in accordance with the following Sections:

Dense Graded Aggregate	401
Soil Aggregate	401
Bituminous Surface Treatment	402
Bituminous Concrete	404

CONSTRUCTION

210.04 Soil Aggregate Shoulders. Soil aggregate shoulders shall be constructed in accordance with Section 401.

210.05 Dense Graded Aggregate Shoulders. Dense graded aggregateshoulders shall be constructed in accordance with Section 401.

210.06 Bituminous Surface Treated Shoulders. The construction of bituminous surface treated shoulders shall consist of a single surface treatment on a previously constructed surface course in accordance with Section 402 except as follows:

- Where dirt cannot be removed by the use of power brooms and power blowers, the surface shall be flushed with water and allowed to dry.
- A single application of bituminous material shall be applied at a rate between 0.20 and 0.30 gallon per square yard followed by the spreading of size No. 8 aggregate at the rate of 20 to 24 pounds per square yard.

210.07 Bituminous Concrete. Bituminous concrete in shoulder areas shall be constructed in accordance with Section 404.

COMPENSATION

210.08 Method of Measurement. Soil aggregate and dense graded aggregate shoulders, of the various thicknesses, will be measured by the square yard.

210.09 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Soil Aggregate Shoulders, ____" Thick	Square Yard
Dense Graded Aggregate Shoulders, ____" Thick	Square Yard

Payment for bituminous surface treatment will be made in accordance with Section 402.

Payment for bituminous concrete, tack coat and prime coat will be made in accordance with Section 404.

SECTION 211 - PREPARATION OF ROADBED

211.01 Description. This work shall consist of shaping, grading and preparing the surface of a previously constructed roadbed.

MATERIALS

211.02 Materials. The material used to raise the roadbed grade or to fill berm areas shall be material obtained from regrading the roadbed in accordance with Section 202 or from borrow excavation in accordance with Section 203 for Zone 3.

CONSTRUCTION

211.03 Construction Requirements. Vegetation within the roadbed area shall be removed by means of blading or scraping prior to the start of final grading and shaping or filling.

In lieu of raising the roadbed to the prescribed grade in areas with deficiencies, the roadbed may be prepared in accordance with Section 208 and then any deficiency may be corrected by increasing the depth of the bottom course of subbase.

Compaction of the roadbed material shall be in accordance with Subsection 203.09.

COMPENSATION

211.04 Method of Measurement. Preparation of the roadbed will be measured by the square yard.

211.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Preparation of Roadbed	Square Yard

Payment for borrow excavation will be made in accordance with Section 204.

Separate payment will not be made for subbase material used to correct deficiencies in raising the roadbed to prescribed grade.

CONTENTS

SECTION 300 - BASE COURSES

5A

SECTION 301 - SOIL AGGREGATE BASE COURSE AND DENSE GRADED AGGREGATE BASE COURSE

301.01 Description. This work shall consist of the construction of base courses of soil aggregate and dense graded aggregate and the reconstruction of soil aggregate base course.

MATERIALS

301.02 Materials. Materials shall conform to the following Subsections:

Dense Graded Aggregate	901.08
Soil Aggregate	901.09

EQUIPMENT

301.03 Equipment. Spreading equipment shall include an aggregate spreader that can be adjusted to spread to the specified depth, without segregation, and one or more motor graders. The compaction equipment shall be pneumatic-tire rollers or dynamic compactors complying with Subsection 203.04.

CONSTRUCTION

301.04 New Base Course.

(a) Preparation of Subgrade or Subbase. Prior to placing base course material on the subgrade or subbase, the surfaces shall conform to Subsection 208.04.

(b) Placing and Spreading. Material shall not be placed when the subgrade or subbase is frozen or when it is unstable because of excessive moisture. The base course material shall be spread with mechanical spreaders except in limited or restricted areas. If approved, the material may be dumped in windrows or end dumped. Material dumped in windrows or end dumped shall be spread so as to eliminate segregation and all ruts and ridges caused by dumping or hauling over the material.

301.05 Compaction. Compaction of each layer shall continue until the material complies with the compaction acceptance testing requirements of Subpart *(b)* below. The in-place dry density of each compacted layer will be determined in accordance with AASHTO T 191, T 205 or T 238, Method B and T 239 except that only one method will be used throughout the Project.

The base course shall be constructed in layers not exceeding a compacted thickness of 8 inches.

If the required compacted depth of the base course exceeds 8 inches, the base course shall be constructed in two or more layers of approximately equal thickness. Each layer shall be compacted as specified above.

Water shall be applied uniformly over the materials during compaction in the amount necessary to obtain the required density.

(a) Control Strips. One or more control strips shall be constructed for the purpose of determining compaction requirements. One control strip shall be constructed at the beginning of work. Additional control strips shall be constructed whenever a change is made in the type or source of material and whenever a significant change occurs in the composition of the material from the same source. Each control strip shall consist of an area of at least 400 square yards. The thickness shall be the same as for completed courses in the pavement section. Each control strip shall remain in place and become a portion of the completed base course.

The material used in each control strip shall be furnished from the same source and shall be of the same type as the material used in the base course whose compaction requirements are established by that control strip. Moisture content of the test strip material shall be within 2 percent of its optimum moisture content as determined from AASHTO T 99, Method C including replacement option. Compaction of control strips shall be accomplished using the same type and weight of equipment that is to be used for compaction of the remainder of the base course.

The material upon which a control strip is to beconstructed must be approved prior to the construction of the control strip.

The control strip shall be compacted by a minimum of two complete passes with the compaction equipment. A pass is defined as one passage of any one tire, compacting wheel or vibrating unit over the entire surface of the layer. Compaction shall continue until no appreciable increase in density is obtained by additional passes. For this purpose, between successive passes, three density determinations will be made using the same apparatus as is to be used for acceptance testing.

Upon completion of compaction, a minimum of ten tests will be made at random locations to determine the average in-place dry density of the control strip. If the average density of the material in the control strip is equal to or greater than 95 percent of its maximum density, as determined from AASHTO T 99, Method C, including replacement option, then the value of this average shall be the reference maximum density for courses of the same materials and thicknesses. A control strip satisfying the 95 percent of AASHTO T 99, Method C, density requirement shall be established before construction of the additional base courses. If this density level in the control strip is not achieved, the compaction equipment and/or its method of use will be rejected.

(b) Compaction Acceptance Testing. For the purpose of checking conformance to the compaction requirements, the base course will be divided into lots consisting of approximately 5,000 square yards or 1,000 cubic yards. Each lot of completed base course will be tested for compliance.

To be acceptable, as determined by the formula below, a lot must have not more than 20 percent of the lot area with a dry density of less than 95 percent of the reference maximum density. If a lot fails to meet this requirement, it shall be reworked and recompacted and shall be resubmitted for acceptance testing.

The percent of lot area with a dry density less than 95 percent of the reference maximum density shall be determined from the calculated value of the term Q. Q shall be equal to or greater than 0.36.

The term Q is defined as:

$$Q = \frac{\text{Average Lot Density - 0.95 of the Reference Maximum Density}}{\text{Range of Lot Density}}$$

Where average lot density is the average dry density of five randomly selected locations in the lot and the range of lot density is the absolute difference between the lowest and highest dry density values recorded at these same five locations. The five locations for density tests will be determined by the use of a table of random numbers. One density determination will be made at each of the selected locations using AASHTO T 191, T 205 or T 238, Method B and T 239 except that only one method will be used throughout the Project. The specified density of all completed lots shall be maintained.

(c) *Waiving Standard Compaction Requirements.* When the Supplementary Specifications waive the requirements of Subparts *(a)* and *(b)* above and no alternative method is specified, the base course shall be placed and compacted in accordance with Subsection 203.09.

301.06 Thickness. The thickness will be measured at a frequency not exceeding 500 feet or as established by means of test holes or other methods. Test holes shall be refilled with base course material and the material recompacted. Any deficiency in total thickness of the base course, in excess of 1 inch, shall be corrected by reconstructing the base course as specified in Subsection 301.07.

301.07 Reconstructed Soil Aggregate Base Course. The existing soil aggregate base course shall be scarified thoroughly to a depth of 3 to 4 inches. Scarified material containing an excess of clay or other unsatisfactory materials shall be removed and replaced with new soil aggregate. If necessary, new soil aggregate shall be added to obtain the required grade. The new soil aggregate shall be added while the existing surface is in a loose, scarified condition and shall be mixed with the existing soil aggregate.

301.08 Maintenance Under Traffic. When it is provided in the Supplementary Specifications that traffic is permitted to ride on the completed base course, the base course shall be maintained smooth and uniform until covered by the following stage of construction.

COMPENSATION

301.09 Method of Measurement. Soil aggregate base course and dense graded aggregate base course, of the various thicknesses, will not be measured and payment will be made for the quantity in the Proposal adjusted for Change Orders except as provided for in Subsection 109.01.

Reconstructed soil aggregate base course will be measured by the square yard.

New soil aggregate required for reconstruction of soil aggregate base course will be measured by the cubic yard based on the volume in the hauling vehicle in accordance with Subsection 109.01.

301.10 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Soil Aggregate Base Course, ____" Thick	Square Yard
Soil Aggregate Base Course, Variable Thickness	Cubic Yard
Dense Graded Aggregate Base Course, ____" Thick	Square Yard
Dense Graded Aggregate Base Course, Variable Thickness	Cubic Yard
Reconstructed Soil Aggregate Base Course	Square Yard
Soil Aggregate, Designation ____	Cubic Yard

SECTION 302 - ROAD-MIXED STABILIZATION

302.01 Description. This work shall consist of the construction of base course of existing soil aggregate mixed in place with a stabilizing agent.

MATERIALS

302.02 Materials. Materials shall conform to the following Subsections:

Coarse Aggregate	901.03
Soil Aggregate	901.09
Water	919.15

Stabilizing Agents:	
Bituminous Materials:	
Cut-Back Asphalt, Grade MC-250 or MC-800	904.02
Emulsified Asphalt, Grade SS-1, SS-1h, CSS-1 or CSS-1h	904.03
Inverted Emulsified Asphalt, Grade IEMC-250 or IEMC-800	904.04
Calcium Chloride	919.03
Fly Ash	919.07
Hydrated Lime	919.09
Portland Cement	919.11
Curing Materials:	
Emulsified Asphalt, Grade SS-1, SS-1h, CSS-1 or CSS-1h	904.03
Polyethylene Sheeting	905.03
Waterproof Paper	905.03
Water	919.15

302.03 Sampling. The following quantities of samples shall be submitted for testing and for determination of a design mix at least 45 days prior to construction of road-mixed stabilized base course:

Aggregates	200 lb
Bituminous Materials	1 gal
Fly Ash	50 lb
Hydrated Lime	25 lb
Portland Cement	25 lb

EQUIPMENT

302.04 Equipment. Equipment shall include a traveling plant with a rotary mixer capable of mixing the components to a uniform consistency and thickness and proper grade control, motor graders, pneumatic-tire or steel-wheeled vibratory rollers, 10-ton three wheel or tandem rollers and such other equipment and small tools as may be required. The rollers shall conform to Subsection 203.04.

The traveling plant shall be self-propelled or tractor drawn and be capable of maintaining a uniform rate of travel while mixing. It shall be mounted on wheels or tracks of such type that, when loaded to capacity, it does not rut or damage the subgrade or subbase. For bituminous stabilization, the mixer shall be capable of mixing so as to ensure that all particles are completely coated.

Other machines capable of accomplishing the required results in one pass, in regard to both uniformity and depth, are acceptable.

CONSTRUCTION

302.05 Limitations. Stabilization will not be permitted when the materials to be stabilized are frozen or excessively wet. Emulsions shall be used only when the air temperature is above 50 degrees F. Other types of stabilization shall not be started until the surface temperature is at least 40 degrees F.

Lime-fly ash stabilization will not be allowed from September 30 to April 1. Portland cement stabilization will not be allowed from October 30 to April 1. No form of stabilization will be allowed in rainy or snowy weather.

302.06 Addition of Aggregates. When new soil aggregate or coarse aggregate is used for blending or to obtain grade, it shall be added to and placed uniformly on the existing soil aggregate prior to placement of the stabilizing agent.

302.07 Application of Stabilizing Agent.

(a) Rate of Application. Calcium chloride shall be applied at the rate of 1/2 pound per square yard per inch of compacted depth. Lime-fly ash, portland cement and bituminous materials shall be applied at the rate specified in the design mix.

(b) Spreading. Stabilizing agents shall not be spread or distributed more than 2 hours before they are to be mixed with the materials to be stabilized. Calcium chloride, portland cement or lime-fly ash shall not be applied when the moisture content of the windrowed or blanket material exceeds the optimum moisture content of the design mix by more than 2 percent. For bituminous stabilizing agents, the range of moisture content of the soil aggregate shall be as prescribed in the design mix. The optimum moisture content shall be determined in accordance with AASHTO T 99, Method C, including replacement option.

Windrow type operations will be allowed only when a traveling plant specifically designed for this purpose is used.

The soil aggregate shall be spread to a uniform thickness to the width required. The specified quantity of portland cement, lime-fly ash or calcium chloride shall be applied uniformly in a trench on top of the windrow or spread uniformly over the aggregate. Stabilizing agent that is lost shall be replaced, without additional compensation, before mixing is started.

302.08 Mixing. The soil aggregate and stabilizing agent shall be mixed thoroughly to the required depth by means of a traveling plant with a rotary mixer. Water, as required, shall be added from the traveling plant or a metered water truck and shall be mixed with soil aggregate and the stabilizing agent. Mixing shall be continued until the mixture is uniform in appearance. If more than one pass of the mixer is required, at least one pass shall be made before water or bituminous material is added.

The moisture content of the portland cement, lime-fly ash or chloride soil aggregate mixture, at the time of a final mixing, shall not vary from the optimum moisture content by more than 2 percent.

(a) Lime-Fly Ash. Where the application of lime-fly ash creates an unacceptable dust condition, the lime-fly ash may be moistened or the specified quantities of fly ash and lime may be preblended (with or without a portion of the aggregate) with water prior to application to the soil aggregate or addition to the mixer.

(b) Multiple Layers and Lanes. The maximum thickness of a compacted layer shall be 8 inches. When the compacted base course thickness is required to be greater than 8 inches, it shall be constructed in approximately equal depth lifts.

For lime-fly ash stabilization, the time between placement of subsequent lifts should be kept as short as possible to ensure that the lower layer has not set up and to ensure bonding with the upper layer. The lower layer shall be kept free of loose material, dirt or sand. Otherwise, the lower layer shall be lightly scarified to a depth of 1 inch prior to placement of subsequent layers. Placement of the subsequent lift shall be within 4 hours for lime-fly ash stabilization.

Portland cement stabilization shall not be used for multiple lifts.

For bituminous stabilization, subsequent layers containing emulsions shall not be placed for 3 days. When MC grade cut-back asphalts are used, subsequent layers shall not be placed for 5 days.

If the stabilized material is placed in multiple lanes, the maximum time for placement of an adjacent lane shall be the same as the time permitted between multiple lifts. Adjacent lanes of bituminous material may be laid without delay. For adjacent lanes of portland cement stabilization, the second lane shall be mixed within 2 hours after the water is added to the first lane.

302.09 Compaction, Shaping and Finishing.

(a) *Compaction.* Pneumatic tire rollers or vibratory rollers shall be used to provide initial compaction of the mixture.

One or more control strips shall be constructed, in accordance with Subsection 301.05, for the purpose of determining the moisture content and density requirements. Any change in the source of materials or methods of construction requires the construction of a new control strip. Each control strip shall remain in place and become a portion of the completed base course. The in-place dry density of each compacted course will be determined in accordance with AASHTO T 191, T 205 or T 238, Method B and T 239 except that only one method will be used throughout the Project.

When portland cement is used as the stabilization agent, the base course shall be compacted at the specified moisture content and with the same equipment and number of passes used to achieve the reference maximum density in the control strip. In inaccessible areas, portland cement stabilized base course shall be compacted to 95 percent of the reference maximum density obtained in the control strip.

For all other stabilizing agents the base course shall be compacted at the specified moisture content to 95 percent of the reference maximum density determined in the control strip.

(b) *Shaping and Finishing.* After the mixture has been compacted, but prior to the initial set, the surface shall be shaped to the required grade and cross section. When necessary, the surface shall be lightly scarified with a drag harrow or similar equipment to produce a smooth and uniform surface. The final surface shall be rolled with a tandem roller. The moisture content of the surface material shall be maintained within plus or minus 2 percent of the specified optimum during finishing operations. Compacting and finishing operations shall be completed within the specified times and shall produce a smooth, dense surface. During the final finishing of the portland cement stabilization, or lime-fly ash stabilization, accumulated material shall be removed.

The number of compaction and finishing units shall be sufficient to ensure completion of the initial compaction within 2 hours for portland cement and 4 hours for lime-fly ash, from the time the water is added at the mixer. The final finishing and compaction shall be completed within 4 hours for portland cement and within 8 hours for other stabilizers from the time of mixing.

302.10 Construction Joints. At the beginning of each day's construction, a straight transverse construction joint shall be formed by cutting back into the previously completed work to form a true vertical face free of loose or shattered material. For multiple lane and multiple layer sections, the construction joints shall be offset by at least 5 feet.

302.11 Surface and Thickness. The surface will be tested using a 10-foot straightedge at random locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed

3/4 inch. All depressions exceeding 3/4 inch shall be corrected by removing the entire layer and replacing it with new material. High spots may be removed by methods that provide an acceptable surface.

The thickness of the base course will be determined from the test holes dug at random locations at intervals not to exceed 500 feet. If the measured thickness deviates by plus 3/4 inch or minus 1/2 inch from that specified, the base course shall be reconstructed or replaced. Test holes shall be filled with base course material and recompacted.

302.12 Curing and Protection.

(a) *Bituminous Stabilization.* No curing material shall be applied. The length of curing time prior to surface treatment or other surfacing shall be as specified in Subsection 302.08.

(b) *Calcium Chloride Stabilization.* No curing material is required.

(c) *Portland Cement or Lime-Fly Ash Stabilization.* If the next layer is to be placed within 72 hours, curing material is not required. If the next layer is not to be placed within 72 hours, the curing material shall be applied as soon as possible but not later than 24 hours after completion of the finish operation. The finished base course shall be kept moist continuously until the curing material or next layer is placed. Placement of the next layer shall not occur within 12 hours after the application of the curing material. The curing material shall be maintained for a 7 day period so that all of the base course is covered during the period, unless the subsequent layer is constructed within the 7 day period.

The emulsified asphalt curing material shall be diluted with an equal volume of water by the manufacturer. Each shipment of the material shall include a certified statement specifying the rate of dilution. The rate of application of the diluted emulsions shall be 0.10 to 0.25 gallon per square yard.

If it is necessary for construction equipment or other traffic to use the surface before the bituminous material has dried sufficiently to prevent pickup, a cover, consisting of clean sand passing a 3/8-inch sieve or other material, shall be applied. All material placed for this purpose shall be removed prior to placement of the next lift.

Portland cement and lime-fly ash base courses shall be protected from freezing for 7 days after construction.

302.13 Maintenance Under Traffic. Maintenance shall be in accordance with Subsection 105.19.

COMPENSATION

302.14 Method of Measurement. Road-mixed stabilized soil aggregate base course of the various thicknesses will be measured by the square yard.

Bituminous material used as a stabilizing agent or curing material will be measured by the gallon based on the volume as determined by the temperature-volume correction factors in accordance with Subsection 904.06.

Calcium chloride, lime, fly ash and portland cement used as stabilizing agents will be measured by the ton.

New soil aggregate and coarse aggregate will be measured by the cubic yard based on the volume in the hauling vehicle in accordance with Subsection 109.01.

302.15 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Stabilized Soil Aggregate Base Course, Road-Mixed, _____" Thick	Square Yard
Stabilizing Agent, Bituminous Material	Gallon
Stabilizing Agent, Calcium Chloride	Ton
Stabilizing Agent, Fly Ash	Ton
Stabilizing Agent, Lime	Ton
Stabilizing Agent, Portland Cement	Ton
Curing Material, Bituminous	Gallon
Coarse Aggregate, Size No. _____	Cubic Yard

Payment for new soil aggregate will be made in accordance with Section 301.

SECTION 303 - PLANT-MIXED STABILIZATION

303.01 Description. This work shall consist of the construction of base course of soil aggregate and stabilizing agent mixed in a drum or in a batch-type pugmill, and hauled to the Project.

MATERIALS

303.02 Materials and Sampling. The materials shall be as specified in Subsection 302.02. Samples for testing and for determination of a design mix shall be submitted in accordance with Subsection 302.03.

EQUIPMENT

303.03 Equipment. The equipment shall be as specified in Subsection 302.04 and in the following Subsections.

CONSTRUCTION

303.04 Limitations. Limitations on the construction of plant-mixed stabilization shall be in accordance with Subsection 302.05.

303.05 Mixing. The soil aggregate, stabilizing agent and water, when necessary, shall be mixed in a stationary or portable mixer equipped with batching or metering devices to measure the quantities of soil aggregate, stabilizing agent and water, by weight or volume. A bituminous batch-type plant or drum-mixing plant conforming to Subsection 404.05 may be used for mixing these materials.

For a continuous type plant, the pugmill shall be equipped with adjustable paddles or an adjustable baffle which can be locked in position at the discharge end of the pugmill. Either device shall be used to advance or retard the mixture flow through the pugmill in order to achieve adequate mixing. The plant shall have a manufacturer's plate giving the net volumetric content of the mixer, at several heights, inscribed on a permanent gauge.

A surge hopper with rotary vane or belt feeder shall be used to introduce materials into the mixer. The capacity of the plant shall not be less than 50 tons per hour.

Lime, fly ash and cement shall be stored in vertical silos. Fly ash previously stored in open stockpiles shall not be used. Bituminous materials shall be stored in tanks equipped with heating devices.

The soil aggregate shall be loaded into a single compartment bin from a stockpile or it shall be loaded into multiple bins where the material is to be made by blending to meet gradation requirements.

For bituminous stabilization, the soil aggregate shall be fed into the plant and combined with emulsified asphalt. Mixing shall be continued until the aggregate is uniformly coated.

For other stabilizers prepared in a batch type plant, the dry materials shall be blended for a period of not less than 15 seconds per cubic yard or three revolutions of the mixing drum, prior to the introduction of water, when necessary. Water shall be added in sufficient quantity to achieve optimum moisture content in accordance with AASHTO T 99, Method C, including replacement option. The minimum mixing time will be determined from three trial runs.

When non-bituminous stabilizers are prepared in a continuous mixing plant, the mixing time will be determined in accordance with AASHTO M 156 as follows:

$$\text{Mixing Time in Seconds} = \frac{\text{Pugmill Capacity in Pounds}}{\text{Output in Pounds per Second}}$$

The minimum mixing time will be established based on a visual inspection of the output of the dry materials.

Details for anticipated plant operations and layout shall be submitted.

303.06 Preparation of Subgrade or Subbase. The preparation of subbase or subgrade surface shall be in accordance with Subsection 208.04.

303.07 Hauling. The mixture shall be transported from the central plant in vehicles that prevent segregation and loss of moisture and fine materials.

303.08 Spreading. The mixture shall be delivered to the prepared subgrade or subbase and spread as uniformly as possible with a minimum of manipulation to prevent segregation. Spreader boxes, tracked asphalt laydown machines, or similar equipment with automatic grade control shall be used.

The maximum thickness of a compacted layer shall be 8 inches. When the compacted base course is required to be greater than 8 inches, it shall be constructed in approximately equal depth lifts.

For bituminous stabilization, placement of subsequent layers shall be in accordance with Subsection 302.08.

For portland cement and lime-fly ash stabilization, the time between placement of subsequent lifts should be kept as short as possible to ensure that the lower layer has not set up and to ensure bonding with the upper layer. The lower layer shall be kept free of loose material, dirt or sand; otherwise, the lower layer shall be lightly scarified to a depth of 1 inch prior to placement of the next layer. The lower layer shall be moistened as required prior to placement of the subsequent layer.

Placement of the subsequent layer shall be within 2 hours for portland cement stabilization and within 4 hours for lime-fly ash stabilization.

If the stabilized material is placed in multiple lanes, the maximum time for placement of an adjacent lane shall be the same as the time permitted between multiple lifts, however, adjacent lanes of bituminous stabilization may be placed without delay.

303.09 Compaction, Shaping and Finishing. Compaction, shaping and finishing operations shall be in accordance with Subsection 302.09.

303.10 Construction Joints. Construction joints shall be in accordance with Subsection 302.10.

303.11 Surface and Thickness. Surface and thickness requirements shall be in accordance with Subsection 302.11.

303.12 Curing and Protection. Curing and protection of the various stabilizations shall be in accordance with Subsection 302.12.

303.13 Maintenance Under Traffic. Maintenance shall be in accordance with Subsection 105.19.

COMPENSATION

303.14 Method of Measurement. Plant-mixed stabilized soil aggregate base course of the various thicknesses will be measured by the square yard.

303.15 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Stabilized Soil Aggregate Base Course, Plant-Mixed, _____" Thick	Square Yard

Payment for the various types of stabilizing agents will be made in accordance with Section 302.

SECTION 304 - BITUMINOUS-STABILIZED BASE COURSE

304.01 Description. This work shall consist of the construction of base course of bituminous concrete.

MATERIALS

304.02 Materials. Bituminous concrete shall conform to Section 903. Other materials shall conform to the following Subsections:

Prime Coat:	
Cut-back Asphalt, Grades MC-30 or MC-70	904.02
Tack Coat:	
Cut-back Asphalt, Grades RC-70 or RC-T	904.02
Emulsified Asphalt, Grades RS-1, SS-1 or SS-1h	904.03
Cationic Emulsified Asphalt, Grades CSS-1 or CSS-1h	904.03

304.03 Composition of the Mixture. Bituminous-stabilized base course shall be Mix I-2. The mixture shall be stone mix or gravel mix as provided in the Supplementary Specifications.

EQUIPMENT

304.04 Equipment. The equipment shall be as specified in Subsection 404.04.

CONSTRUCTION

304.05 Weather Limitations. The limitations shall be as specified in Subsection 404.12.

304.06 Preparation of Subgrade or Base Course. The preparation of subgrade or base course shall be in accordance with Section 208 or 209 and each shall be checked and approved far enough in advance of spreading the bituminous base mixture to permit one day's paving operations.

304.07 Conditioning of Existing Surface. The conditioning of existing surface shall be as specified in Subsection 404.13 and the following:

- Tack coat shall be applied to previously constructed layers of the bituminous-stabilized base course if the layers become coated with dust, dirt, or other foreign material which would inhibit proper bond to subsequent layers.

304.08 Transportation and Delivery of Mixture. The transportation and delivery of the mixture shall be as specified in Subsection 404.14.

304.09 Spreading and Finishing. The spreading and finishing of the mixture shall be as specified in Subsection 404.15 and the following:

- The base course shall be constructed in layers not more than 3 inch compacted thickness except 4 inch layers may be constructed in those areas where the total combined thickness of surface course and bituminous-stabilized base is 7 inches or greater.

304.10 Compaction and Air Voids. Compaction and air voids requirements of the base course shall be as specified in Subsections 404.16 and 404.17.

304.11 Surface and Thickness. The surface will be tested using a 10-foot straightedge at selected locations. The variation of the surface, from the testing edge of the straightedge, between any two contacts with the surface, shall at no point exceed 3/8 inch. All humps or depressions exceeding 3/8 inch shall be corrected by removing defective work and replacing it with new material.

The thickness requirements shall be as specified in Subsection 404.19.

304.12 Maintenance Under Traffic. Maintenance shall be in accordance with Subsection 105.19.

COMPENSATION

304.13 Method of Measurement. Bituminous-stabilized base course will be measured as specified for bituminous concrete surface course in Subsection 404.21.

304.14 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Bituminous-Stabilized Base Course, Mix I-2	Ton

Payment for tack coat and prime coat will be made in accordance with Section 404.

SECTION 305 - CONCRETE BASE COURSE

305.01 Description. This work shall consist of the construction of portland cement concrete base course, with or without reinforcement.

MATERIALS

305.02 Materials. Portland cement concrete shall conform to Section 914. Other materials shall conform to the following Subsections:

Curing Materials	905.03
Preformed Expansion Joint Filler	908.01
Joint Sealers	908.02
Reinforcement Steel	915.03

Where concrete base course is to be constructed monolithically with curb, the concrete shall conform to the requirements specified for the curb.

EQUIPMENT

305.03 Equipment. The equipment shall conform to Subsection 405.03 except a slip-form paver, conforming to the requirements specified below, will be permitted.

CONSTRUCTION

305.04 Construction Requirements. The surface upon which the concrete base course is to be constructed shall be prepared in accordance with Section 209.

Preformed expansion joint filler, 1/2 inch thick, shall be placed around inlets, manholes and other similar structures projecting through the base course.

The concrete base course shall be constructed in accordance with Section 405 except as follows:

(a) Joints. Transverse contraction joints are required and shall be coincident with the transverse expansion joints in adjacent concrete surface course. In addition, one or more transverse contraction joints, spaced equidistantly not less than 13 feet or more than 20 feet apart, are to be installed between the above joints. Elsewhere, contraction joints are to be installed at 15 foot intervals.

No transverse or longitudinal expansion joints are required.

When the base course is not constructed full width in one operation or when placing of concrete is temporarily discontinued, it shall be finished against a vertical form or bulkhead, and when resumed, the form or bulkhead shall be removed and the concrete shall be placed against the previously finished concrete.

(b) Surface Finish. The concrete base course may be hand finished. The surface shall be rough broomed. Edges need not be rounded.

(c) Curing. If liquid curing compound is used, it shall be removed prior to surfacing with bituminous concrete.

(d) Surface Tolerance. The surface will be tested using a 10-foot straightedge at randomly selected locations. The variation of the surface, from the testing edge of the straightedge, between any two contacts with the surface, shall at no point exceed 3/8 inch. Surface variations which exceed 3/8 inch shall be corrected.

(e) Thickness Requirements. The requirements of Subsection 405.21 do not apply.

(f) Slip-Form Paving. Subject to a demonstrated ability to adapt slip-form paving methods to the Department's pavement design, the concrete base may be constructed, without the use of fixed forms, in accordance with Section 405 and the following:

- After the subbase has been placed and compacted to the required density, the areas which support the paving machine and the areas on which the base is to be constructed shall be graded to the proper elevation. If the density of the subbase is disturbed by the grading operations, it shall be recompacted before concrete is placed. The subbase shall be constructed in advance of placing of the concrete for at least the distance required for an average day's paving. If any traffic is permitted to use the prepared subbase, the subbase shall be checked and corrected immediately prior to the placing of the concrete.
- The concrete shall be placed for the full depth of the slab with a slip-form paver designed to spread, consolidate, screed and float-finish the concrete in one pass of the machine, or may be placed with a mechanical spreader and then struck off, consolidated, screeded, and float-finished with a slip-form paver designed for this

purpose. By either method, the concrete shall be finished in such a manner that a minimum of hand finishing is necessary to provide a dense and homogeneous base. The machine shall vibrate the concrete for the full width and depth of the base.

- Reinforcement, if specified, shall be placed in the plastic concrete after spreading by mechanical or vibratory means.
- Any edge slump of the concrete, exclusive of edge rounding, in excess of 1/4 inch, shall be corrected before the concrete has taken its initial set and operations shall be modified to prevent recurrence.
- Alignment and grade shall be controlled by an automatic sensing device in continuous contact with a sensing guide.
- The concrete shall be placed at a uniform consistency as specified in Section 914, Table 914-1.
- The slip-form paver shall be operated with a continuous forward movement and all operations of mixing, delivering and spreading concrete shall be so coordinated as to provide uniform progress, with stopping and starting of the paver held to a minimum. All vibrations shall automatically cease when the forward movement of the paving machine is stopped. No tractive force shall be applied to the machine except that which is controlled from the machine.
- In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, materials shall be made available at all times for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood plank having a nominal thickness of not less than 2 inches and a nominal width of not less than the thickness of the concrete at its edge, for the protection of the edges, and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the base course. When rain is imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the base course and covering the surface of the unhardened concrete with the protective covering.

305.05 Opening to Traffic. The opening to traffic shall be as specified in Subsection 405.19 except that the schedule is as follows:

May 16 - Oct 15	Concrete Class C	12 days
Oct 16 - May 15	Concrete Class C	15 days

COMPENSATION

305.06 Method of Measurement. Concrete base course, with or without reinforcement, of the various thicknesses will not be measured and payment will be made for the quantity in the Proposal adjusted for Change Orders except as provided for in Subsection 109.01.

305.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Concrete Base Course, _____" Thick	Square Yard
Concrete Base Course, Reinforced, _____" Thick	Square Yard

Payment for the preparation of the underlayer will be made in accordance with Section 209.

CONTENTS

SECTION 400 - SURFACE COURSES

SECTION 401 - SOIL AGGREGATE SURFACE COURSE AND DENSE GRADED AGGREGATE SURFACE COURSE

401.01 Description. This work shall consist of the construction of surface courses of soil aggregate and dense graded aggregate and the reconstruction of soil aggregate surface course.

MATERIALS

401.02 Materials. Materials shall conform to the following Subsections:

Dense Graded Aggregate	901.08
Soil Aggregate	901.09
Calcium Chloride	919.03

EQUIPMENT

401.03 Equipment. The equipment shall be in accordance with Subsection 301.03.

When a stabilizing agent is required and is to be mixed on grade, equipment shall also include a traveling plant conforming to Subsection 302.04.

CONSTRUCTION

401.04 Construction Requirements. Soil aggregate surface course, dense graded aggregate surface course and reconstructed soil aggregate surface course shall be constructed in accordance with Section 301 and the following:

- When required, a stabilizing agent (calcium chloride) shall be applied at the approximate rate of 1/2 pound per inch of compacted depth per square yard and shall be uniformly spread over the previously placed aggregate prior to compaction. The aggregate and admixture shall then be thoroughly mixed. In lieu of spreading and mixing on the grade, the admixture may be added and mixed with the aggregate at a stationary plant conforming to Subsection 303.05.

401.05 Maintenance Under Traffic. Maintenance under traffic shall conform to Subsection 105.19.

COMPENSATION

401.06 Method of Measurement. Soil aggregate surface course and dense graded aggregate surface course, of the various thicknesses, will be measured by the square yard.

Reconstructed soil aggregate surface course will be measured by the square yard.

401.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Soil Aggregate Surface Course, ____" Thick	Square Yard
Dense Graded Aggregate Surface Course, ____" Thick	Square Yard
Reconstructed Soil Aggregate Surface Course	Square Yard

Payment for new soil aggregate required for reconstruction of soil aggregate surface course will be made as specified for reconstructed soil aggregate base course in Section 301.

Payment for calcium chloride will be made in accordance with Section 302.

SECTION 402 - BITUMINOUS SURFACE TREATMENT

402.01 Description. This work shall consist of the furnishing and placing of bituminous and cover materials.

MATERIALS

402.02 Materials. Materials shall conform to the following Subsections:

Aggregates for Bituminous Surface Treatment	901.12
Bituminous Concrete Patch	903.04
Bituminous Materials:	
Cut-back Asphalts,	
Grades RC-250, RC-800 and RC-3000	904.02
Grades MC-250, MC-800 and MC-3000	904.02
Emulsified Asphalts,	
Grades RS-1 and RS-2	904.03
Grades CRS-1 and CRS-2	904.03
Inverted Emulsified Asphalts,	
Grades IEMC-250 and IEMC-800	904.04

The range of application temperatures for the bituminous materials, in degrees F, shall be as follows:

RC-250	170° -200°	RS-1	70° -140°
RC-800	205° -235°	RS-2	125° -185°
RC-3000	235° -265°	CRS-1	70° -140°
MC-250	170° -200°	CRS-2	125° -185°
MC-800	205° -235°	IEMC-250	125° -175°
MC-3000	235° -265°	IEMC-800	150° -185°

The type and grade of bituminous material will be provided in the Supplementary Specifications. Within the specified ranges, the quantities of bituminous material and aggregate and the application temperature of the bituminous material will be designated.

Duplicate delivery slips shall accompany each load of bituminous material and shall contain the name of the producer and the supplier, the type and grade of material, the loading temperature of material, and the lot number and date of approval of the material from which delivery is made.

Safety Precautions. The foregoing chart indicates temperature ranges necessary to provide proper viscosity for spraying and mixing applications for the grades shown. However, the temperature ranges indicated by this chart generally are above the minimum flash point for the RC and MC cut-back asphalts. In fact, some of these cut-back asphalts flash at temperatures below the indicated ranges. Accordingly, safety precautions are mandatory at all times when handling these cut-back asphalts.

Safety precautions include, but are not limited to the following:

- Do not permit open flames or sparks of any kind close to these materials except in heating kettles, mixers, distributors, or other equipment designed for handling and applying them.
- Do not use an open flame to inspect or examine containers in which these materials have been stored.
- Vent and ground vehicles transporting these materials.
- Permit only experienced personnel to supervise the handling of these materials.
- Comply with all applicable local, State and Federal laws and regulations.

EQUIPMENT

402.03 Equipment. Equipment shall include a self-propelled power broom, equipment for heating bituminous material, a pressure distributor, rollers, and aggregate spreading equipment that can be adjusted to spread at the specified rate, and such other equipment and small tools as may be required.

Steel-wheel rollers shall conform to Subsection 404.09. Pneumatic-tire rollers shall conform to Subsection 203.04 except they shall be provided with a device for wetting and cleaning the tires.

The bituminous distributor shall be so designed, equipped, maintained and operated that bituminous material at a consistent temperature may be applied uniformly on variable widths of surface up to 15 feet within the specified range. Distributor equipment shall include a tachometer, pressure gauges, a calibrated tank, and a thermometer for measuring temperature of tank contents. Accurate thermometers shall be so placed and installed in the truck body as to indicate the temperature of the bituminous material contained therein. Distributors shall be equipped with a separate power unit for the pump and full circulation spray bars adjustable laterally and vertically.

The following shall be furnished with each distributor:

- A calibration sheet which shows the number of the truck body, the capacity thereof, and an outage table in increments of not over 1/2 inch. This calibration sheet must be certified by the manufacturer or a testing agency.
- Metal rod with accurate 1/4-inch divisions, having the inch divisions more prominently marked and consecutively numbered starting with the first inch at the bottom. The rod shall be not less than 1 foot longer than the diameter of the tank.
- Slip-proof steps with handrail to reach ground level.
- Slip-proof catwalk with handrail, running along the top of the tank.
- Slip-proof steps with handrail, leading from catwalk to dome.
- Fire extinguisher in working order.
- Sampling system for distributors shall conform to AASHTO T 40.

CONSTRUCTION

402.04 Limitations. Bituminous material shall be applied when the surface is dry, firm, cured, and otherwise acceptable, only from April 1 to November 1 and when the air temperature in the shade and away from artificial heat is above 50 degrees F.

402.05 Preparation of Surface. The existing surface shall be cleaned of all dirt and other foreign or loose matter immediately prior to the first application of bituminous material. Where dirt remains that cannot be removed by the use of power brooms and/or power blowers and at the option of the Engineer, the surface shall be flushed with water and allowed to dry. All holes and surface failures shall be repaired in advance of the surface construction.

(a) New Construction. On new construction, the surface of the subbase, base course, or surface course upon which the bituminous treatment is to be placed shall conform to the requirements of the appropriate Section. Soil aggregate or dense graded aggregate surface shall be treated with a prime coat in accordance with Subsection 404.13.

(b) *Previously Treated Surfaces.* Previously treated surfaces shall be prepared for the bituminous treatment as specified in the Supplementary Specifications. Where there are indications of unstable foundation or base failure, excavation shall be made to the depth required, and the unstable material removed and replaced, and surfaced with patch material. Where directed or approved, the surface shall be patched with plant-mixed bituminous mixture by cutting out the existing surface so as to form square openings with vertical sides. The openings shall be cleaned out and painted with a bituminous material as specified in Subsection 404.13, then filled with patch material which shall be compacted.

402.06 Application of Bituminous Material and Aggregate. Bituminous material and aggregate shall be applied by one of the following methods as provided for in the Supplementary Specifications.

Method 1. The first application of bituminous material shall be applied by pressure distributors at a uniform rate between 0.2 and 0.4 gallon per square yard. The actual rate within that range will be established. Each width of spread shall be not less than one half of the surface to be treated.

Areas which are inaccessible to the distributor shall be treated with hand pressure sprayers.

If less than the full width is being treated, the aggregate shall not be spread on the inside 6 inches of either first or second application until the adjacent lane has been treated. Immediately after each application of bituminous material has been made, it shall be covered uniformly with size No. 6 or 67 aggregate. The aggregate shall be free of surface moisture except when asphalt emulsion is used as the bituminous material.

The aggregate shall be spread from trucks equipped with mechanical spreaders or from self-propelled mechanical spreaders, at a rate established by the Engineer, between 25 and 45 pounds per square yard.

The second application of bituminous material shall be applied in the same manner as the first application, at a uniform rate between 0.3 and 0.5 gallon per square yard. The actual rate within that range will be established. Aggregate size No. 8 shall then be spread in the same manner as the first application at a rate established by the Engineer within the range of 15 to 30 pounds per square yard.

Immediately after each application of cover aggregate, uniform coverage shall be achieved by hand brooming. Additional aggregate shall be placed by hand on thin or bare areas.

Method 2. The first application of bituminous material shall be applied by pressure distributors at a uniform rate of 0.4 and 0.5 gallon per square yard using the procedures described in Method 1.

After the bituminous material has penetrated, fine aggregate cover shall be spread at the rate of not less than 15 pounds per square yard.

After the curing period and only when permitted, the surface shall be cleaned and the second application of bituminous material shall be made at the rate of approximately 0.3 gallon per square yard, and immediately covered with fine aggregate cover material at the approximate rate of 15 pounds per square yard.

Following each application and during the curing process, the surface shall be dragged as directed. Additional cover material shall be spread when bituminous material comes to the surface before Acceptance.

Method 3. The application of bituminous material shall be at the rate of 0.25 to 0.45 gallon per square yard and covered with aggregate size No. 8 at the rate of 15 to 30 pounds per square yard using the procedures described in Method 1.

402.07 Rolling and Curing. Immediately after spreading the cover aggregate and hand brooming where required, the entire surface shall be rolled, beginning at the edges and progressing to the center. Initial rolling shall be done with steel-wheel rollers or by pneumatic tire rollers followed by a minimum of three complete coverages with the pneumatic tire roller.

The first application of bituminous material and aggregate shall be allowed to cure for the length of time required before the second application.

The same rolling and curing procedures required in making the first application of bituminous material and cover aggregate shall be repeated in making the second application.

402.08 Maintenance Under Traffic. Slow-moving traffic may be permitted to use sections after the bituminous material has been covered with aggregate and cured. Traffic shall be controlled.

402.09 Cleanup. Cleanup shall include sweeping up all quantities of loose, dislodged cover aggregate from the completed surface and along the edges of the completed surface and disposing of the material in accordance with Subsection 201.09.

COMPENSATION

402.10 Method of Measurement. Bituminous material for bituminous surface treatment will be measured by the gallon in accordance with Subsection 109.01.

Aggregates for the bituminous surface treatment and the bituminous concrete for patching will be measured by the ton. The tonnage will be determined by certified weigh tickets in accordance with Subsection 404.21.

The number of gallons of bituminous material and the tonnage of aggregates exceeding the quantities as determined by the application rates, established by the Engineer, will not be measured.

402.11 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Bituminous Material for Bituminous Surface Treatment	Gallon
Coarse Aggregate for Bituminous Surface Treatment	Ton
Fine Aggregate for Bituminous Surface Treatment	Ton
Bituminous Concrete Patch	Ton

SECTION 403-BITUMINOUS CONCRETE FRICTION COURSE

403.01 Description. This work shall consist of the construction of open-graded and crushed gravel friction courses.

MATERIALS

403.02 Materials. The materials and their use shall conform to Subsection 404.02 except as follows:

- Coarse aggregate for crushed gravel friction course shall be crushed gravel conforming to Subsection 901.05 except that it need not be washed and shall not contain more than 10 percent total carbonates as determined in accordance with Section 990, NJDOT A-5.

- Stone sand used for fine aggregate in crushed gravel friction course shall not be made from argillite or carbonate rock.
- Coarse aggregate for open-graded friction course shall be broken stone of gneiss, granite, quartzite or trap rock conforming to Subsection 901.04 or shall be crushed gravel conforming to Subsection 901.05 except that it need not be washed and shall not contain more than 50 percent of total carbonates (30 percent on Federally-funded Projects) as determined in accordance with Section 990, NJDOT A-5.

403.03 Composition and Preparation of Mixtures.

(a) Crushed Gravel Friction Course. The mixture for crushed gravel friction course shall conform to Section 903 and shall be Mix I-4 or Mix I-5. Whichever mix is selected shall be used for the entire Project except that Mix I-5 shall be used in transition (run out) areas, as directed.

(b) Open-Graded Friction Course. The mixture for open-graded friction course shall conform to Section 903 and to the following:

Sieve Sizes	**Total Percent Passing by Weight**
1/2"	100
3/8"	80-100
No. 4	30-50
No. 8	5-15
No. 200	2-5
Asphalt Cement, percent by weight of dry aggregate	5.7-7.0 (See Note 1)

Note 1 - The specific asphalt content for the job mix formula shall be determined. A minimum of three 1,000 gram trial batches having different asphalt cement contents within the specified range shall be mixed in the producer's laboratory at 250 plus or minus 10 degrees F and placed on an 8 to 9 inch diameter heat resistant transparent pyrex dish. The mixture shall be spread on the dish with a minimum of manipulation. The dish shall be placed immediately in an oven at 255 plus or minus 5 degrees F for a period of 1 hour. After 1 hour the bottom of the dish shall be examined. The mixture with a slight puddle at points of contact between the aggregate and the glass dish shall be selected. Photographs of a desirable drainage condition are on file in the Department Laboratory and can be obtained upon request.

The formula selected and samples of all materials used in the final mixture design shall be submitted by the producer to the Engineer at least 3 weeks prior to the initial production date.

Sampling requirements are as follows:

Coarse Aggregate	35 lbs
Fine Aggregate	35 lbs
Mineral Filler	5 lbs
Asphalt Cement	2 qts

The submitted materials will be tested for verification of the producer's mix design and for resistance to effects of water in accordance with AASHTO T 165 and T 167.

Samples are to be molded at 255 degrees F using a pressure of 2000 pounds per square inch. After 4 days of immersion at 120 degrees F, the index of retained strength must not be less than 50 percent. Should laboratory tests establish the need for a heat-stable, antistripping additive, the amount added shall be as directed.

The mixture shall have a minimum void content of 15 percent. Verification of the minimum void content will be made in accordance with Section 990, NJDOT B-7.

During production operations five random samples will be taken from each lot of approximately 1000 tons to verify mixture compliance with composition requirements. When a lot is necessarily less than 1000 tons, samples will be taken at random at the rate of one sample for each 200 tons or fraction thereof.

Sampling and testing for mixture composition will be performed in accordance with Section 990, NJDOT B-3 and B-4.

EQUIPMENT

403.04 Equipment. The equipment shall be as provided in Section 404 except the open-graded mix shall be transported in clean vehicles with smooth dump beds that have been sprayed with a non-petroleum release agent. Mineral fillers, fine aggregates, slag dust, etc. shall not be used to dust truck beds. The mix shall be covered during transportation to prevent cooling and the formation of lumps. Long hauls, particularly those in excess of 30 miles, may result in separation of the mix and its rejection.

CONSTRUCTION

403.05 Construction Requirements. The construction requirements shall be as specified in Section 404 except as follows for open-graded mix:

- Hand placing shall be avoided except where necessary.
- Laying temperature of the mix shall not be less than 225 degrees F.
- Ambient temperature shall be 60 degrees F minimum.
- Thickness shall be 3/4 plus or minus 1/4 inch.
- Temperature at discharge from the plant shall be maintained from 240 to 270 degrees F.

Immediately after spreading and strikeoff, the open-graded friction course shall be compacted by a minimum of one pass of a two-axle or three-axle tandem roller conforming to Subsection 404.09. Additional rolling shall be done if and as directed to firmly set the aggregate in the surface.

COMPENSATION

403.06 Method of Measurement. Friction courses of the various kinds will be measured as specified for bituminous concrete surface course in Section 404 except reductions due to nonconformance to job mix formula, air voids and thickness requirements do not apply for open-graded friction course.

403.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Crushed Gravel Friction Course	Ton
Open-Graded Friction Course	Ton

Payment for tack coat will be made in accordance with Section 404.

SECTION 404-BITUMINOUS CONCRETE SURFACE COURSE

404.01 Description. This work shall consist of the construction of a surface course of a top layer or top and bottom layers of bituminous concrete.

MATERIALS

404.02 Materials. Bituminous concrete shall conform to Section 903. Other materials shall conform to the following Subsections:

Prime Coat:	
Cut-back Asphalt, Grade MC-30 or MC-70	904.02
Tack Coat:	
Cut-back Asphalt, Grade RC-70 or RC-T	904.02
Emulsified Asphalt, Grade RS-1, SS-1 or SS-1h	904.03
Cationic Emulsified Asphalt, Grade CSS-1 or CSS-1h	904.03

404.03 Determination of Theoretical Weight. Before construction of bituminous concrete surface course the theoretical weight per square yard per inch of thickness shall be determined for each mix.

EQUIPMENT

404.04 Equipment. The plant and equipment shall consist of one or more bituminous concrete plants, bituminous concrete pavers and rollers, sufficient vehicles for transporting bituminous mixtures, small tools and all other equipment necessary for the construction of the bituminous concrete surface course and for conditioning the existing or previously constructed base course.

404.05 Bituminous Concrete Plants.

(a) General Requirements for all Mixing Plants. Plants used for the preparation of bituminous concrete mixtures may be of the manual batch type, fully automated batch type or drum mixing type except that effective January 1, 1989, batch plants must be of the fully automated type.

All plants shall be designed, equipped, calibrated and operated to deliver well-coated, homogeneous bituminous mixtures complying with the job mix formula. Any defects which adversely affect the functioning of a plant or plant unit or the quality of the mixture shall be corrected immediately.

(1) Aggregate Storage. Storage space shall be provided for each size and source of aggregate. The different aggregates shall be kept separated until they have been delivered to the cold feed belt or elevator. The aggregate storage area shall be maintained and the separate materials stockpiled in accordance with Subsection 901.02 except that the use of steel-tracked equipment will be permitted.

(2) Aggregate Bins. The plant shall have cold feed aggregate storage bins of sufficient number and capacity to store the amount of aggregate required to keep the plant in continuous operation. The bins shall be designed to prevent overflow of material from one bin compartment to another. There shall be at least one cold feed aggregate bin for each stockpile of material to be used. An indicator shall be provided on each bin to show the gate opening.

(3) Equipment for Preparation of Bituminous Material. Tanks for storage of bitumen shall be equipped for heating the material to a uniform temperature, under effective and positive control at all times, to the temperature requirements for the mixture. Heating shall be accomplished so that no flame comes in contact with the heating tank.

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A circulating system for the bitumen shall be provided of adequate capacity to ensure continuous circulation between storage tank and proportioning units during the entire operating period. The discharge end of the bituminous circulating pipe shall be maintained below the surface of the bitumen in the storage tank to prevent discharging the hot bitumen into the open air.

All pipe lines and fittings shall be steam or oil jacketed electrically or otherwise heated and insulated to prevent heat loss.

Provisions shall be made for sampling bituminous material by means of valves complying with AASHTO T 40 except that a sampling valve shall be located in the lowest third of the storage tank.

(4) *Feeder for Dryer.* Separate feeders shall be provided for each size and source of aggregate. Each size shall be fed onto the belt going to the dryer by mechanical feeders with separate adjustable gates. The feeders shall be capable of delivering the separate aggregates onto the belt in proper proportions. The feeders shall provide for adjustment of total feed and proportional feed.

Means shall be provided to assure a constant and uniform flow of material from each bin.

The aggregate shall be fed into the dryer so that uniform production and uniform temperature may be obtained.

(5) *Thermometric Equipment.* An armored thermometer or dial thermometer of adequate range shall be fixed in the bituminous feed line at a suitable location near the charging valve at the mixer unit, and shall indicate the temperature of the bituminous material.

The plant shall also be equipped with a recording thermometer, pyrometer or other thermometric instrument so placed at the discharge chute of the dryer as to indicate and record automatically the temperature of the heated aggregates.

(6) *Dust Collector.* The plant shall be equipped with a dust collector capable of wasting or uniformly returning to the plant all or any part of the material collected as directed. Dust collecting systems shall be installed and operated in compliance with NJAC 7:27-6.1 *et seq.*

(7) *Safety.* Adequate and safe stairways to the mixer platform and sampling points shall be provided and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Overhead protection shall be provided at locations deemed necessary. A hoist or pulley system shall be provided to raise scale calibration equipment, sampling equipment and other similar equipment from the ground to the mixer platform and return. All gears, pulleys, chains, sprockets, and other hazardous moving parts shall be guarded and protected. Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free from drippings from the mixing platform.

Accessibility to the top of truck bodies shall be provided by two platforms located away from the mixing plant to enable samples and temperature data to be obtained from each side of loaded trucks. One platform is acceptable if the truck has room to turn around and return to the platform.

In addition to the above, the plant shall conform to all State and local safety requirements. When plant production occurs during nighttime hours, lighting shall be provided throughout the plant operations, plant laboratory and truck scale areas to ensure a clear view of the operations.

(8) Truck Scales. Platform truck scales shall be a direct-reading, cabinet dial type or an electronic load cell type with a visual indicating device capable of automatically printing both gross and tare weights and time and date on the delivery ticket. The time and date may be printed automatically by a time clock each time the truck passes over the scale. The scales shall be equipped with a motion detection device or a time delay relay which prevents printing the weight on the delivery ticket until the scale is fully at rest. Tare beams must be removed or permanently locked in place.

The scale shall have a manufacturer's rating equal to or greater than the maximum gross load being weighed, and the accuracy and certification requirements shall be as specified for plant scales in Subpart *(b),(4)* below.

The approaches to the scale at both ends shall have a level grade at the same elevation as the platform. The scale cabinet and dial and the mechanical weight recorder shall be housed in a suitable shelter, furnished with adequate heat and light.

(9) Surge and Storage Bins. A plant may be permitted to store hot mixture in a surge or storage bin provided the bin has received prior evaluation and approval by the Department. Use of the bin shall be in conformance with the limitations on retention time, type of mixture, heater operation, bin atmosphere, bin level or other characteristics set forth in the Engineer's letter of approval.

Each bin shall be equipped with a device that visually or audibly signals automatically when the material in the bin reaches the 25 plus or minus 5 ton level. The signal device shall be visible or audible from within the plant laboratory and shall remain in operation until the bin level exceeds the specified minimum.

An evaluation of a surge or storage unit will be made by the Department upon written request by the supplier. The supplier shall submit with his request two copies of plans for his surge or storage system showing bin capacity, heating and splitter arrangements. The evaluation determines the degree of composition uniformity, the temperature characteristics and the degree of asphalt cement hardening of the mixture processed through the surge or storage unit. Bin usage that consistently results in mixtures having gradation, temperature and asphalt hardening properties of no less quality than acceptable mixtures discharged directly from the plant will be approved.

For bin evaluation, the method of sampling, rate of sampling and testing, and analysis procedures will be performed in accordance with the requirements of Storage of Hot Bituminous Concrete Mixes, New Jersey Department of Transportation Research Report No. 74-007-7733 (October 1973).

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The analysis of asphalt hardening performed as a part of the prequalification of the surge bin system shall consist of a comparison of the penetration of the asphalt cement from mixture recovery samples obtained at the plant discharge and the surge bin discharge. The penetration of the asphalt cement recovered from the stored mixture samples is acceptable if the average penetration is at least 85 percent of the average penetration of the asphalt cement recovered from mixture samples from the plant discharge. Recovery of asphalt from mixture samples will be performed in accordance with ASTM D 1856.

In the event that the surge or storage system is changed or altered, the Department shall be notified of the modification. Any radical departure necessitates re-evaluation. The Department may re-evaluate any surge or storage system whose performance becomes suspect due to deficiencies in mixture quality.

(10) *Incidental Equipment.* The plant shall be furnished to include all other equipment necessary for proper and continuous operation.

(b) *Special Requirements for Manual and Fully Automated Batch Type Plants.* Daily checks shall be made to ensure that hoppers are discharging completely and that the balance returns to zero tare whenever the hoppers are emptied. When directed, checks shall be made to verify the accuracy of the batch scales within the normal weighing range and to assure that the interlocking devices and automatic recordation equipment are functioning properly. At least ten 50-pound standard weights shall be provided for testing all scales. For each scale, a suitable cradle or platform shall be provided for applying the test load so that the load may be uniformly distributed. The test weights shall be kept clean and stored at the asphalt plant site.

For mixes containing reclaimed asphalt pavement, the batch plants shall have a means for adding the reclaimed asphalt pavement to the heated new aggregate at a point in the system beyond the hot bins and shall provide control for proportioning the reclaimed asphalt pavement into the mixture.

The recycled bituminous mixtures shall be prepared by the heat transfer method of recycling. When preparing recycled mixtures by this method, the batch plant shall be operated as a conventional plant except for a higher temperature of new aggregate leaving the dryer, provisions for adding reclaimed asphalt pavement to the heated aggregate after it has exited the hot bins and the time interval of the dry and wet mixing cycles.

Prior to being combined with the heated new aggregate, the reclaimed asphalt pavement shall pass through a 2 1/2 inch vibrating scalping screen.

(1) *Dryer.* Plants shall include a dryer or dryers which continuously agitate the aggregate during the heating and drying process. The dryer shall be capable of drying and heating the aggregate to the specified moisture and temperature requirements without leaving any visible unburned oil or carbon residue on the aggregate when discharged from the dryer.

(2) *Screens.* Plant screens shall be capable of screening aggregates to the specified sizes and proportions and shall have capacities in excess of the capacity of the mixer.

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(3) *Aggregate Hot Bins.* The plant shall include at least four aggregate storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. Separate dry storage shall be provided for mineral filler or hydrated lime when used and the plant shall be equipped to feed such material into the mixer accurately and uniformly. Each bin shall be provided with overflow pipes, of such size and at such locations as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with an individual outlet gate, constructed so that when closed there shall be no leakage. The gates shall cut off quickly and completely. Bins on fully automated plants shall be provided with means to obtain representative samples. Bins shall be equipped with a device that visually or audibly signals automatically when the level of aggregate reaches the lowest quarter point. The signal device shall be visible or audible from within the plant laboratory and shall remain in operation until the bin level exceeds the minimum.

(4) *Plant Scales.* All plant scales shall be of the springless dial type or electronic load cell type, with a readout, and shall be accurate within the tolerances permitted by the New Jersey Department of Law and Public Safety, Office of Weights and Measures, and shall conform to the requirements of the National Bureau of Standards Handbook 44. Scales shall be tested annually and certified by the Office of Weights and Measures, New Jersey Department of Law and Public Safety, or a municipal weights and measures agency.

Scales or slave systems shall be so located that they are plainly visible to the plant operator at all times.

The graduation of scales used in weighing amounts of aggregates less than 5,000 pounds shall not be greater than 5 pounds; for amounts of aggregates from 5,000 to 10,000 pounds, not greater than 10 pounds; and for amounts of aggregates in excess of 10,000 pounds, not greater than 0.1 percent of the capacity of the scales.

Scales for weighing bituminous material shall conform to the requirements for aggregate scales except that they shall read to the nearest pound and shall have a capacity of not more than 250 percent of the normal amount of asphalt required.

All plants shall be capable of continuously weighing, within the tolerances specified, the various components of the mixture for the full range of batch sizes. All tolerances are based on the total batch weight of the bituminous mix.

Weighing Tolerances	**Percent**
Each Aggregate Component	± 1.5
Mineral Filler	± 0.5
Bituminous Material	± 0.1
Zero Return (Aggregates)	+ 0.5
Zero Return (Bituminous Material)	+ 0.1

If mineral filler is used in a batch cycle, the allowable tolerance for the aggregate component weighed just prior to the filler in a cumulative weighing system shall be plus or minus 0.5 percent.

(5) *Weigh Box or Hopper.* The equipment shall include a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and of ample size to prevent overflow to the pugmill.

The discharge gate shall close so that no material is allowed to leak into the mixer while a batch is being weighed. The weigh box or hopper shall be supported on fulcrums and knife edges so constructed that they are not easily thrown out of alignment or adjustment.

(6) *Bituminous Control.* When a bituminous material bucket is used, it shall be a type recommended by the plant manufacturer. The length of the discharge opening or spray bar shall be not less than three fourths the length of the mixer and it shall discharge directly into the mixer. The bituminous material bucket discharge valve and spray bar shall be adequately heated. The plant shall have an adequately heated, quick-acting, nondrip charging valve located directly over the bituminous material bucket.

When a volumetric meter is used, it shall automatically meter the asphalt into each batch. The dial to indicate the amount of bituminous material shall have a capacity of at least 10 percent in excess of the bituminous materials required in one batch. The meter shall be constructed so that it may be locked at any dial setting and automatically resets to this reading after the addition of bituminous material to each batch. The dial shall be in full view of the mixer operator.

For all bituminous control units the flow of bituminous material shall be automatically controlled to begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged within 15 seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material for the full length of the mixer.

(7) *Mixer.* The batch mixer shall be capable of producing a uniform mixture within the job mix tolerances. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of dust.

The clearance of paddles shall not exceed 1 1/2 inches from all fixed and moving parts.

(8) *Control of Mixing Time.* The mixer shall be equipped with an accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh box gate after charging of the mixer until the closing of the mixer gate at the completion of the cycle. It shall lock the bituminous material discharge throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the start of introduction of bituminous material. The wet mixing period is the interval of time between the start of introduction of bituminous material and the opening of the mixer gate.

The control of the timing shall be adjustable and capable of being set at intervals of 5 seconds or less. A mechanical batch counter shall be installed as a part of the timing device and shall be so designed as to register only completely mixed batches.

The setting of time intervals shall be performed in the presence of the Engineer and shall be such as to provide aggregate coating as specified in Subsection 903.02.

(9) *Automated Batching and Mixing Control.* Fully automated plants shall include an automatic batching and mixing control system including an automatic printer system conforming to the following:

- The recording equipment and batch scales shall be interlocked and the panels providing access to interlocking devices shall be maintained under sealed conditions.
- The system shall contain auxiliary interlocking cutoff circuits to interrupt and stop the automatic cycling of the batching operations any time the weighing tolerances are exceeded or when any aggregate bin becomes empty or when there is a malfunctioning of any portion of the control system. A platform truck scale is not required. If, however, the automatic proportioning or recording devices become inoperative or inaccurate, the plant shall be operated manually in conformance with all the requirements for manual batch plants, including a platform truck scale.
- The Department may make independent checks on batch weights by weighing trucks before and after loading and may request an inspection of the plant scales by the Office of Weights and Measures, New Jersey Department of Law and Public Safety for verification of the automatic printout tickets.

(c) *Special Requirements for Drum Mixing Plants.* Drum mixing plants may be used in the preparation of bituminous paving mixtures. The heating, coating, and mixing of the bituminous mixture shall be accomplished in a parallel flow dryer-mixer.

(1) *Aggregate Bins.* The fine aggregate bin compartments shall be equipped with a vibrator or other anti-bridging device which is automatically actuated when bridging of the material occurs and which automatically shuts off when continuous material flow is restored.

(2) *Mineral Filler Bin.* When mineral filler is to be added, it shall be from a bin and feeder separate from the aggregate cold bins. Equipment shall be provided to feed the mineral filler at adjustable rates. The mineral filler feed rate in tons per hour shall be accurate within 3 percent of the indicated rate throughout the range of the plant's production capacity. The feeder shall be interlocked in such a manner that production is stopped if the flow of mineral filler is interrupted.

(3) *Aggregate Feeder.* The plant shall have a mechanical system for uniformly and continuously feeding each aggregate in its proper proportion onto a collecting belt and then into the drum mixer.

The feeder system shall be designed so that prior to entering the mixer, the aggregates on the collector belt pass through a 2-inch scalping screen or other device that removes oversize material or debris. One feeder shall be provided for each bin compartment. Each aggregate feeder shall be interlocked in such a manner that production is stopped if flow of aggregate from any of the cold bins is interrupted.

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The control of the quantity of aggregate fed to the drum mixer shall be by a variable speed system which provides for total and proportional control.

The individual bin feeder belts or the intermediate collecting belt that delivers the aggregate to the main feed for the drum mixer shall be equipped with belt type scales (load cells) capable of continuously displaying, at the operator's station, the weight of aggregate flow in tons per hour or the corresponding percentage of total mix from each individual bin and the accumulated total from each bin in tons. The aggregate feed rate in tons per hour from each bin shall be accurate within 1 percent of the indicated rate throughout the range of the plant's production capacity.

Means shall be provided for conveniently diverting the aggregate cold feed delivery into trucks or other containers for checking the accuracy of the aggregate feed system. Means shall be provided for obtaining representative samples of the composite aggregate from the main feed to the drum mixer at any time during production.

For mixes containing reclaimed asphalt pavement, the drum mix plant shall have a means for adding the reclaimed asphalt pavement to the dryer-mixer in a manner that does not damage the asphalt in the reclaimed material. Control shall be provided for proportioning the reclaimed asphalt pavement into the mixture.

Means shall be provided for compensating for the moisture in the reclaimed asphalt pavement.

Prior to being combined with the heated new aggregate, the reclaimed asphalt pavement shall pass through a 2 1/2 inch vibrating scalping screen.

(4) *Bituminous Metering System.* The plant shall have a metering system which introduces the proper amount of bituminous material into the mix.

The system shall be capable of measuring the quantity and temperature of the bituminous material being introduced into the mix and transmitting that data to the operator's station. The metering system shall be interlocked in such a manner that production is stopped if the flow is interrupted.

The metering system shall include a temperature compensation device to correct the quantity of bituminous material introduced into the mix to 60 degrees F. The flow of bituminous material to the drum mixer shall be continuously displayed in the operator's station in units of tons per hour, corrected to 60 degrees F, or as the corresponding percentage of total mix. The feed rate in tons per hour shall be accurate within 1 percent of the indicated rate throughout the range of the plant's production capacity. The accumulated weight of bituminous material fed to the mixer shall be totaled.

Convenient means shall be provided for diverting the bituminous material into trucks or other containers for checking the accuracy of the metering system.

404.05

(5) *Proportioning Controls.* The combined aggregates shall pass over a weigh belt or belt scale that is electronically interlocked with the bituminous material metering system in such a manner as to automatically vary the bituminous material feed rate, as required, to maintain the required bituminous material content in the mixture.

Provisions shall be made for introducing the moisture content of the cold feed aggregates into the composite aggregate weigh belt signal and correcting wet aggregate weight to dry aggregate weight. The dry weight of the composite aggregate flow shall be continuously displayed by electronic readout at the operator's station in units of tons per hour and shall be totaled. The composite aggregate feed rate shall be accurate within 1 percent of the indicated rate. Belt conveyors shall be equipped with scrapers or other suitable devices to prevent adherence or other loss of the weighed cold feed aggregate.

Prior to the start of production of Department mixes, plant controls shall be calibrated. Any changes in or modifications to the equipment or operation occurring subsequent to the initial calibration shall be reported to the Engineer. Depending on the nature and extent of the modifications made, calibration checks and/or a new plant calibration may be directed. Recalibrating the plant also may be directed if the finished mixture displays composition deficiencies. For each drum mix plant placed in operation, two complete sets of plant drawings, a plant operator's manual and a plan detailing the method of plant calibration shall be submitted. The Engineer will witness the calibration of the individual cold feeders at several production rates throughout the range of plant's capacity. A copy of the computations for the combined rate of flow and a plot of calibration charts shall be submitted. Such charts shall indicate the rate of aggregate delivery in tons per hour from each cold feeder for particular dial settings and gate openings. Calibration points shall be determined by independently diverting each cold feed into trucks (or running each feed through the plant) and determining the proper console dial setting corresponding to the measured rate of delivery. Such calibration points shall be determined in increments of approximately 100 tons per hour of total aggregate flow.

The Engineer will witness a check on the mineral filler and bituminous material feeds at several production rate increments throughout the range of the plant's capacity. Calibration of the bituminous material metering system and subsequent checks shall be accomplished by diverting the bituminous material into trucks or other containers for weight or volumetric measurements. The method used to calibrate the mineral filler feeder system is subject to approval. The procedures shall be sufficient to assure that the controls are marked to correspond with the calibration of the bituminous material and mineral filler feeds.

(6) *Drum Mixer.* The drum mixer shall be the type that continually agitates the mixture of aggregate and bituminous material during heating and in which the aggregate or bituminous material is not adversely affected in the drying and heating operations. The mixer

discharge shall be equipped with a pyrometer or thermometer probe to record the temperature of the mixture, and the data transmitted to the operator's station.

Methods and facilities shall be provided for safely and conveniently obtaining representative mixture samples prior to the mixture's introduction into the surge bin.

The Engineer may perform test comparisons between the consistency of the bituminous material in its original form from plant tank samples and in processed form from mixture recovery samples obtained prior to the mixture's introduction into the surge bin. The results of such consistency tests will be used to determine whether a processing improvement is necessary to eliminate excessive volatilization, oxidation or other causes of premature hardening.

(7) *Surge Bin.* The plant shall be provided with a surge bin system of adequate capacity to minimize production interruptions during the normal day's operation. The surge bin shall conform to Subpart *(a),(9)* in this Subsection.

(8) *Emission Control System.* The plant shall be equipped with an emission control system so as to meet all applicable limitations concerning emissions.

(9) *Control Console.* The following items shall be part of a control furnished in the operator's station:

- Cold aggregate feed controls capable of both total and proportional control of the aggregates.
- Dryer burner controls that automatically control the temperature of the mix and record the mix temperature at the dryer discharge.
- Aggregate weigh belt readouts displaying the weight of material being proportioned from each aggregate bin in tons per hour or the corresponding percentage of total mix weight and the total flow over the main feeder to the drum mixer in tons per hour. The accumulated weights in tons from each bin and the total feed to the mixer shall be separately totaled. These separate totals shall be either continuously displayed or available on demand from a printout device.
- Mineral filler readouts displaying the weight of material being proportioned from the mineral filler bin in tons per hour or the corresponding percentage of total mix weight together with an accumulative total in tons.
- Bituminous metering system readouts indicating the quantity of asphalt, corrected to 60 degrees F, being proportioned into the mix together with an accumulative total in tons and a recording pyrometer or thermometer that records the temperature of the bituminous material at the pump.
- Proportioning controls that set the bituminous material content as well as the aggregate moisture adjustment.

404.06 Plant Laboratory. A plant laboratory shall be provided and maintained at each plant site for use of the Engineer for sampling and acceptance testing and for use of the producer for quality control testing during periods of production. The plant laboratory shall also include an office area for use by the Engineer.

The producer's laboratory technician shall be present during periods of mix production.

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Effective January 1, 1989, the producer's quality control technician must be certified by the Society of Asphalt Technologists of NJ Inc as an Asphalt Technologist.

The plant laboratory shall be located to provide an unobstructed view of the trucks as they are loaded.

The plant laboratory, including office area, shall have a floor area of not less than 225 square feet, a ceiling height of not less than 7 1/2 feet, adequate ventilation and artificial lighting, and sanitary facilities in accordance with Subsection 107.10.

The plant laboratory shall be weathertight, heated and air-conditioned to maintain temperatures for testing purposes between 68 and 80 degrees F.

The plant laboratory shall have the following:

- Work benches, totaling not less than 2 by 15 feet, and two stools.
- Desk, table and at least two chairs.
- Four-drawer, legal-size file cabinet with lock and two keys.
- Shelves and supply cabinets.
- Electronic calculator with printout tape.
- Water cooler supplied with bottled water.
- Telephone.
- Class ABC fire extinguisher, or a Class A and a Class B fire extinguisher, meeting fire underwriters' approval.
- Electrical outlets sufficient in number and capacity for operating the required equipment.
- Display area, approximately 4 by 4 feet, for mounting control charts.
- Mechanical shakers, screens and sieves conforming to AASHTO M 92. The mechanical shaker shall be installed and bolted down in a sounddampening and dustproof enclosure. When acceptance procedures for fully automated batch plants using hot bin samples in accordance with Section 990, NJDOT B-6 are used, an 8-inch shaker and a larger shaker are required.
- A minimum 12-inch diameter exhaust fan shall be provided in proximity to the mechanical shaker.
- Sink with hot and cold running water having adequate pressure, drainboard and drain capable of handling elutriable material.
- Stand to hold sieves used in washing elutriable material.
- Two-element hot plate or electric range having dial-type thermostatic controls to adjust the heat for drying aggregates.
- Hood, enclosed on three sides, top and bottom and of such size as to enclose the operations of extractions, evaporation, and ashing as well as other operations in which a vapor or gas is emitted, and designed, constructed and maintained in such a manner that any operation involving 1,1,1 trichloroethane within the hood does not require the insertion of any portion of an employee's body, other than hands and arms, and which contains an exhaust system for exhausting air to the outside at the required linear velocity, all complying with OSHA Safety and Health Standards.
- Apparatus in accordance with Section 990, NJDOT B-4 and NJDOT B-9.
- Apparatus in accordance with AASHTO T 245 for stability testing by the Marshall Method including an automatic compaction hammer and extrusion jack.
- Apparatus in accordance with AASHTO T 209.
- Other necessary small hand tools required for sampling and testing.

Accuracy and certification requirements for all weighing devices utilized for the testing of bituminous mixture samples shall be as specified for plant scales in Subsection 404.05, Subpart *(b),(4)*.

Bituminous concrete plants producing more than 2500 tons of bituminous concrete mixture per day shall require increased laboratory facilities and equipment.

404.07 Vehicles for Transporting Bituminous Mixtures. The mixture shall be transported from the mixing plant to the Project in trucks equipped with tight, clean bodies which shall be lightly coated with a soap or lime solution or other such nonpetroleum-based release agent. Each truckload of mixture delivered shall be covered with a waterproof canvas tarpaulin or other such material of such size, and so fastened, as to protect the mixture from the weather. Any truck causing excessive segregation of the mixture by its suspension or other contributing factors or that leaks or causes delays shall be removed from the work until such conditions are corrected.

404.08 Bituminous Concrete Paver. Bituminous concrete pavers for 8-foot widths or more shall be self-contained, power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing bituminous concrete in the lane widths and thicknesses required.

The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture. Screed or strike-off assemblies shall extend the full width of the course being laid and shall impart initial compaction thereon. The paver shall be capable of being operated at forward speeds consistent with satisfactory laying of the mixture.

Bituminous concrete pavers shall be equipped and operated with automatic grade and slope control. The automatic control system must maintain the screed or strike-off in a constant position relative to profile and cross-slope references. The references shall be such that control of the screed or strike-off position is independent of irregularities in the underlying surface and of spreader operation. When paving in widths exceeding the manufacturer's recommendations for use of the automatic slope control, a grade reference system shall be used on both sides of the paver.

While operating automatically, it shall be possible to manually override the automatic controls.

In the event of mechanical failure of the automatic controls, the use of manual controls may be permitted to finish the day's work but resumption of work will not be allowed on the following working day until both the grade and slope controls are in working order. Such permission shall not constitute a waiver of any of the applicable quality requirements contained in the Specifications.

Automatic controls will not be required where they cannot be used effectively, such as at intersections.

A stringline grade reference system shall be used for longitudinal grade control on the first lift of paving except that a ski type may be used if a previously placed strip of bituminous or concrete surface or base course or other suitable grade reference such as concrete gutter or a similar item has been placed to a specified line, grade and cross section and is to adjoin the strip to be placed. Grade reference system for subsequent lifts of paving shall be ski type. The use of a joint matching shoe may be permitted instead of the ski.

The stringline reference system shall consist of suitable line supported by devices compatible with the type of automatic paver control system used. The stringline and supports shall be capable of maintaining line and grade at the point of support while withstanding the tensioning necessary to prevent sag in excess of 1/4 inch between supports spaced 50 feet apart. Additional supports shall be installed to provide a spacing of 25 feet or less to remove any apparent deviation of the stringline from specified grade. Spacings of 25 feet may be required at the crest and bottom of vertical curves.

All materials, equipment, labor and incidentals required to construct the stringline reference system shall be furnished and maintained until no longer required. The stringline reference system shall be complete in place sufficiently in advance of the construction to avoid any delay or interruption of the paving operations.

Bituminous concrete pavers for less than 8-foot widths used for shoulders and similar construction shall be capable of spreading and finishing bituminous concrete material in the widths and thicknesses required.

404.09 Rollers. Rollers shall consist of steel wheel rollers, or vibratory rollers as described hereinafter.

There shall be technical literature available giving the weight and dimensions of the rollers to be used.

Rollers shall be equipped with adjustable scrapers to keep the wheels clean and with means of keeping the wheels moist to prevent bituminous concrete from sticking to the wheels. Wheels shall also be free of flat areas, openings, or projections which may mar the surface.

Rollers shall be capable of reversing without backlash and shall conform to the following:

(a) *Steel Wheel Rollers.* Three-wheel power-driven rollers shall have a load of not less than 330 pounds per inch of width of tread of rear wheels and a total metal weight of not less than 10 tons.

Two-axle tandem rollers shall be power driven and shall have a load of not less than 250 pounds per inch of width of tread of drive roll and shall have a total metal weight of not less than 8 tons.

Three-axle tandem rollers shall be power driven and shall conform to the requirements specified in No. 1 or 2 below:

1. Rollers having two guide rolls of equal diameter and a larger diameter drive roll, all rolls having equal width. The drive roll shall have a load of not less than 250 pounds per inch of width of tread. The rollers shall have a total metal weight of not less than 12 tons, and a wheel base of not less than 17 feet measured from the center of the front guide roll to the center of the drive roll. The rolls, when locked in position so that all rolls are in the same plane, shall conform to the rigidity requirements prescribed under the following tests with full load:
   - With the weight of the roller supported on the central roll and drive roll, the bottom of the central roll shall be not more than 1/8 inch above the plane tangent to the bottom of the end rolls, and
   - With the weight of the roller supported on the end rolls, the bottom of the central roll shall be not more than 1/4 inch below the plane tangent to the bottom of the end rolls.

2. Rollers as described in No. 1 above which, when the rolls are in a semilocked position, shall meet the rigidity test described and are designed so that, with the rolls in a semilocked position and with the weight of the roller supported on the end rolls, the central roll shall ride freely on the surface being rolled and there shall be no transfer of the weight from any one roll to another.

(b) *Vibratory Rollers.* Vibratory rollers shall be of the self-propelled type and shall have one or two smooth steel drums. Vibratory rollers used on the top layer shall have at least two steel drums. Vibratory rollers having rubber tires on any axle shall not be used on the top layer. Vibratory rollers shall have a static weight of not less than 6 1/2 tons and shall be capable of maintaining the frequency of vibration and the amplitude specified by the manufacturer.

Each vibratory roller shall be equipped with the following:

- Two lights shall be mounted on the fenders or one light shall be mounted above the roller so as to be visible from a distance of 200 feet and shall blink when the vibratory system is in operation.
- A speed indicator in feet per minute or tenths of a mile per hour shall be provided to permit the operator to closely control the rolling speed.
- A vibrating reed tachometer shall be provided with each roller for use by the Engineer to provide a mechanical check on the rollers' vibration control system.
- Rollers shall be equipped with an automatic vibration disconnect system which automatically shuts off the vibration when the roller is in a stationary position. A mechanical override system shall be provided in the event of temporary failure of the automatic system which shuts off the vibration when the roller is in a stationary position.
- Instruction plates indicating operational instructions, recommended amplitude, vibrations per minute and speed settings shall be provided.

404.10 Pressure Distributor. The pressure distributor for tack and prime coats shall conform to Subsection 402.03.

404.11 Small Tools. All necessary small tools, including hand compactors, and suitable means for keeping them clean and free from accumulation of bituminous material shall be supplied.

CONSTRUCTION

404.12 Weather Limitations. Bituminous concrete mixtures shall be placed when the combinations of laydown and base surface temperatures are within the limits shown in Table 404-1 below, when it is not raining and when the base is in a satisfactory condition. For other than surface courses, in case of sudden rain, the placing of mixture then in transit from the plant may be permitted, if laid at proper temperature and if the base is free of pools of water. Such permission shall in no way waive any of the requirements of the specification.

Laydown temperature will be measured in the receiving hopper of the paver.

Table 404-1 Minimum Laydown Temperature (Degrees F)

Base Temperature	Thickness (Inches) 1/2	3/4	1	1 1/2	2	3 and Greater (2)
Less than 20	(1)	(1)	(1)	(1)	(1)	(1)
20-30	(1)	(1)	(1)	310	300	285
31-40	(1)	(1)	(1)	305	295	280
41-50	(1)	(1)	310	300	285	275
51-60	(1)	310	300	295	280	270
61-70	310	300	290	285	275	265
71-80	300	290	285	280	270	265
81-90	290	280	275	270	265	260
91 and over	280	275	270	265	260	255

Note (1) - No paving permitted.
Note (2) - Increase by 15 degrees F when placement is on base or subbase containing frozen moisture.

404.13 Conditioning of Existing Surface. The surface upon which the bituminous concrete is to be placed shall be clean of all foreign and loose material, dry and free from ice when the paving operations are about to start and shall be maintained in that condition.

In areas where the distributor spray bar cannot reach, the use of hand spraying equipment will be permitted for tack and prime coat.

All bituminous materials shall be cleaned from exposed surfaces of curbs, gutters, manholes and other similar structures.

(a) Tack Coat. When bituminous concrete is placed on existing portland cement concrete, existing bituminous concrete, or newly constructed bituminous concrete on which traffic has been maintained, the paved surface shall be given an application of tack coat material, uniformly sprayed and conforming to Subsection 404.02. The application is not acceptable if the material is streaked or ribboned.

Contact surfaces of curbing, gutters, manholes and other similar structures shall be painted with a thin uniform coating of tack coat material just prior to the placing of the bituminous concrete mixture against them.

Tack coat application shall be in accordance with the following:

Material	Spraying Temperature	Gallon per Square Yard	Season
Cut-back Asphalt			
RC-70	120° -190° F	0.02-0.08	Oct 15-Apr 15
RC-T	85° -150° F	0.02-0.08	Oct 15-Apr 15
Emulsified Asphalt			
RS-1	70° -140° F	0.02-0.08	All year
SS-1*, SS-1H*	70° -140° F	0.04-0.15	All year
CSS-1*, CSS-1H*	70° -140° F	0.04-0.15	All year

* Diluted with an equal volume of water by manufacturer. Each shipment shall include a certified statement specifying the rate of dilution.

Safety precautions, in accordance with Subsection 402.02, shall be observed when using cut-back asphalts.

Prior to paving, sufficient time shall be allowed to permit the tack coat to cure to a condition which is tacky to the touch.

All uncoated or lightly coated areas shall be corrected. All areas showing an excess of bituminous material shall be blotted with sand or other similar material. Blotting material shall be removed prior to paving.

No more tack coat should be applied than can be covered in the same day.

Traffic control shall be provided to prevent vehicles from riding on surfaces upon which tack coat has been applied.

(b) *Prime Coat.* When bituminous concrete is to be placed on newly constructed or existing soil aggregate or dense graded aggregate base courses, the surface shall be given a prime coat of cut-back asphalt conforming to Subsection 404.02.

Prime coat application shall be in accordance with the following:

Material	Spraying Temperature	Gallon per Square Yard	Season
Cut-back Asphalt			
MC-30	85°-150° F	0.15-0.35	All year
MC-70	120°-190° F	0.15-0.35	All year

Safety precautions, in accordance with Subsection 402.02, shall be observed when using cut-back asphalts.

Application of the prime coat shall be made not less than 12 hours prior to the placing of the bituminous concrete and shall not be made when the base courses are wet or frozen.

404.14 Transportation and Delivery of Mixture. The mixture shall be transported from the mixing plant to the point of use in vehicles conforming to Subsection 404.07. Loads shall not be sent out so late in the day as to prevent completion of the spreading and compaction of the mixture during daylight, unless sufficient artificial light is provided.

Plant production and the number of trucks used for transportation shall be such as to ensure delivery of the mixture in sufficient quantities and at such intervals to permit continuous placement of the material with minimal stopping and starting of the paving operation. Failure to maintain such delivery shall be cause to suspend the work.

404.15 Spreading and Finishing. The mixture shall be laid upon an approved surface, spread and struck off to the grade and elevation required. Bituminous pavers conforming to Subsection 404.08 shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.

Bituminous concrete Mix I-5 shall be used in transition (run out) areas, where directed.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked, and luted by hand tools. For such areas, the mixture shall be dumped, spread and screeded to give the required compacted thickness.

If it is determined that the underlying material has not been compacted and finished to the specified thickness or grade, construction of any subsequent course shall not proceed until corrective measures have been completed.

(a) *Longitudinal Joints.* The longitudinal joint in one layer shall offset that in the layer immediately below by approximately 6 inches, however, the joint in the top layer shall be at the lane lines.

If a single paver does not spread the mixture the entire width, when practical and when production of the mixture can be maintained, two pavers shall be used. The second unit shall follow the first unit in echelon, and so closely behind the first unit so as not to permit cooling of the longitudinal joint between the two lanes.

Where the paving must be confined to one lane at a time, the spreading and compacting shall advance in any one lane for not more than 1500 feet or for such distance that maintains the temperature of the material at the longitudinal joint at not less than 150 degrees F. The paver shall then be moved back and spreading and finishing started in the adjacent lane.

If, due to the required maintenance of traffic or to unforeseeable conditions, the longitudinal edge of the mixture previously placed has cooled to less than 150 degrees F, the edge shall be painted with a thin, uniform coating of tack coat material. If such joint edge is not vertical, it shall be cut back to a vertical face and the adjoining lane and joint constructed as follows:

- The material being placed in the abutting lane shall be tightly crowded against the vertical face of the previously placed lane. The paver shall be positioned so that in spreading, the material overlaps the edge of the lane previously placed by 1 to 2 inches and should be left sufficiently high to allow for compaction. To assure a true line, the paver shall closely follow the lines or markings placed along the joint for alignment purposes. The width and depth of the overlapped material shall be kept uniform at all times.

(b) *Transverse Joints.* Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints shall be straightedged to check their smoothness. If the line of joint is formed with a bulkhead, it shall form a straight line and vertical face. If a bulkhead is not used to form the joint, the joint shall be made by sawing the compacted mixture for a sufficient distance behind the end of the placement to assure full thickness and a smooth surface at the joint. The material ahead of the sawed joint shall be removed. In either case, the joint face shall be painted with a thin coat of hot asphalt cement before the fresh material is placed against it. Cross rolling, unless prohibited by field conditions, is required to obtain thorough compaction of these joints.

404.16 Compaction. After the bituminous mixture has been spread, struck off and surface irregularities adjusted, it shall be compacted thoroughly and uniformly with rollers conforming to Subsection 404.09.

The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving.

Rolling shall begin at the sides and progress gradually to the center, except that on superelevated curves, rolling shall progress from the lower to the upper edge parallel to the centerline and uniformly lapping each preceding track until the entire surface has been rolled at least once by the rear wheels.

Alternate trips of the roller shall be terminated in stops approximately 2 feet from the preceding stop. When paving in echelon, rollers shall not compact within 6 inches of an edge where an adjacent lane is to be placed.

The drive wheels of the rollers shall be toward the paver during compaction operation.

Rollers shall move at a slow but uniform speed. Maximum roller speed shall be 3 miles per hour except for vibratory rollers used on top layer where the maximum speed shall be 2 1/2 miles per hour. Rolling shall be continued until all roller marks are eliminated and the air voids conform to the specified requirements.

Any displacement occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of lutes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture.

If necessary to prevent adhesion of the mixture to the rollers, the wheels shall be kept moistened with water mixed with very small quantities of detergent or other similar material. Excess liquid will not be permitted.

Along forms, curbs, header, walls, and other places not accessible to the rollers, the mixture shall be compacted with mechanical tampers. On depressed areas, a trench roller may be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous material shall be removed and replaced.

When the average laydown rate does not exceed 2,000 square yards per hour, initial or breakdown rolling shall be accomplished by at least one three-wheel roller and final rolling shall be accomplished by at least one tandem roller except, if permitted, one vibratory roller, meeting the requirements specified elsewhere herein, may be substituted for both the three-wheel roller and the tandem roller. However, if the vibratory roller does not produce a surface free of roller marks and ridges, a tandem roller shall be used for final rolling.

When the average laydown rate exceeds 2,000 square yards per hour but is less than 4,000 square yards per hour, initial or breakdown rolling shall be accomplished by at least two three-wheel rollers and final rolling shall be accomplished by at least one tandem roller except, if permitted, one vibratory roller, meeting the requirements specified elsewhere herein, may be substituted for one three-wheel roller and the tandem roller. However, if the vibratory roller does not produce a surface free of roller marks and ridges, a tandem roller shall be used for final rolling.

When the average laydown rate exceeds 4,000 square yards per hour, initial or breakdown rolling shall be accomplished by at least three, three-wheel rollers and final rolling shall be accomplished by at least two tandem rollers except, if permitted, one vibratory roller, meeting the requirements specified elsewhere herein, may be substituted for one three-wheel roller and one tandem roller, or two such vibratory rollers may be substituted for two three-wheel rollers and the two tandem rollers. However, if the vibratory roller does not produce a surface free of roller marks and ridges, a tandem roller shall be used for final rolling.

When directed, demonstration of compaction capability for a particular vibratory roller will be required. Verification of such capability shall be accomplished by one of the following methods:

Test Strip Method. A test strip shall be constructed consisting of at least 400 square yards of the mixture type and minimum lift thickness proposed for use. The test strip shall be compacted by the vibratory roller using frequency and amplitude levels selected from those recommended by the equipment manufacturer. The number of roller coverages shall be such that the test strip is in conformance with the control air voids requirements. Five cores will be taken from randomly selected locations in the test strip and will be measured for air voids in accordance with Subsection 903.05, Table 903-5. Should the average voids level be in conformance with the control air voids requirements, the vibratory roller will be approved.

Comparison Method. Two test strips, at least 400 square yards each shall be constructed. Each strip shall be of the mixture type and minimum lift thickness proposed for use. The first test strip shall be compacted using a three-wheel roller and tandem roller. Ten random density measurements will be made on this test strip. Each density measurement will be made with a nuclear density gauge utilizing the surface preparation, back scatter technique and the average

of two one-minute counts. The average density of the test strip will be determined by averaging the ten measurements. The second test strip shall be compacted using a vibratory roller as specified in the Test Strip Method above. Ten random density measurements will be taken on this strip in a similar manner as for the first test strip. Should the average of these ten measurements be equal to or greater than the average density of the first test strip, the use of the vibratory roller may be permitted.

If, during compaction with the vibratory roller, there is excessive aggregate fracture or crushing, lateral displacement or compaction waves, the vibratory roller will not be approved.

Test strips may remain in place and become a portion of the completed pavement structure subject to the requirements specified elsewhere herein.

The test strip or comparison method for determining the use of a vibratory roller is also to establish the vibratory rolling zone in relation to the paver. If the average forward paver travel speed is such that the vibratory roller falls behind its established roller zone and can only keep up with the paver by increasing speed or by reducing passes or both, then other changes may be required in paving operations. These may include reduction in paver speed or additional rollers to be used in accordance with the results of a new demonstration of compaction capability based on the revised number of rollers.

If it can be demonstrated by the test strip or comparison method that the required density can be achieved by using fewer rollers than hereinbefore specified, the use of fewer rollers may be permitted. However, paving shall cease immediately upon breakdown of any of the remaining rollers. Only one such demonstration will be permitted.

404.17 Air Voids Acceptance Plan. The in-place air voids of each mixture in a completed lot shall be a minimum of 2 percent and a maximum of 8 percent. Conformance will be determined on the basis of the average of five air voids measurements for each lot of approximately 5000 square yards of bituminous concrete surface area of uniform thickness and of approximately 10,000 square yards of variable thickness. Air voids will be determined from drilled cores tested in accordance with Subsection 903.05, Table 903-5.

Table 404-2 Reduction Per Lot Per Mixture Due to Nonconformance to Air Voids Requirements

5 Sample Average Air Voids (Percent)	Reduction per Lot (Percent)
0 to 1.4	20
1.5 to 1.9	10
2.0 to 8.0	0
8.1 to 9.0	5
9.1 to 10.0	10
Over 10.0	20

404.18 Surface Requirements.

(a) Permissible Surface Variations. The top layer of bituminous concrete surface course will be tested with a 10-foot rolling straightedge that automatically marks, in colored dye, the length of surface variations which exceed a tolerance of 1/8 inch in 10 feet. The bituminous concrete top layer will be tested for compliance in accordance with Subpart *(c)* below.

(b) *Control Testing.* Control testing during placement shall be conducted as may be necessary to assure compliance with the specified surface requirement.

(c) *Substantial Conformity.* The paving operation is acceptable if the surface of the top layer is in substantial conformity with a 1/8 inch in 10 feet surface tolerance. Should the surface be found not in conformity, the Resident Engineer may direct that paving operations be discontinued until mutually acceptable paving methods or equipment are utilized.

Additional compensation, extension of Contract Time, or other concession will not be permitted because of revised methods or equipment necessary to produce a bituminous concrete surface in substantial conformity with a 1/8 inch in 10 feet surface tolerance.

404.19 Thickness Requirements. The thickness requirements contained herein shall apply only when each component bituminous mixture in the pavement structure is specified to be of a uniform thickness. When such uniform thickness bituminous mixtures are specified, the combined total thickness of the mixture or mixtures will be measured to determine compliance with the governing acceptance testing limit shown in Table 404-3. In addition, the top layer will be measured to determine compliance with a minimum thickness requirement using an acceptance testing limit of 1.25 inches. Results of this check on top layer minimum thickness will be used solely to determine whether a remove and replace or an overlay condition exists, not for payment reduction.

Table 404-3 Thickness Acceptance Testing Limits

Specified or Total Plan Thickness (Inches)	Acceptance Testing Limit (Inches)
1.5	1.25
2.0	1.70
2.25	1.90
3.0	2.60
4.0	3.50
4.5	3.95
5.0	4.40
5.5	4.85
6.0	5.30
Over 6.0	Specified thickness less 0.7

Conformance to thickness requirements will be determined in lots consisting of approximately 15,000 square yards or less. Areas consisting of different combinations of bituminous mixtures or thicknesses will not be included in the same lot.

A thickness lot shall have not more than 20 percent of the lot area, as determined from Table 404-4 below, less than the governing acceptance testing limit for total thickness shown in Table 404-3 above.

The acceptance of a thickness lot will be determined from thickness measurements of fifteen cores obtained by the Engineer for each lot. Each lot will be divided into three sections of approximately equal area, and five cores will be removed from random locations within each section. The total core thickness and the thickness of each component bituminous mixture contained therein will be determined in accordance with Section 990, NJDOT B-5.

When variations in total thickness cause more than 20 percent of the areas of a lot to be less than the governing acceptance testing limit shown in Table 404-3 above, the lot is unacceptable and shall be removed and replaced or overlaid. However, should the percent of lot deviating from the thickness acceptance testing limit not exceed 40 percent, upon written request, the lot may be left in place without being overlaid provided that the lot payment is reduced in accordance with Table 404-4 below.

The percent of lot area less than the applicable acceptance testing limit shall be determined from the calculated value for the term QL.

The term QL is here defined as:

$$QL = \frac{\text{Average Lot Thickness - Thickness Acceptance Testing Limit}}{\text{Average Range}}$$

Where average lot thickness is the average of the total thickness measurements obtained from the 15 lot cores, average range is the average of the three R values in one lot and R is the absolute difference between the smallest and largest total thickness values in each group of five consecutive cores measured.

Table 404-4 Reduction Per Lot Due to Nonconformance to Thickness Requirements

QL Equal To or Greater Than	QL Less Than	Percent of Lot Area Outside Thickness Acceptance Testing Limit	Reduction per Lot, Percent (See Note 1)
0.36	----	0-20	None
0.29	0.36	21-25	5
0.23	0.29	26-30	10
0.17	0.23	31-35	20
0.11	0.17	36-40	50
----	0.11	Greater Than 40	(See Note 2)

Note 1 - Percent reductions are not applicable when the term QL is calculated to determine if the top layer complies with the minimum thickness requirement.

Note 2 - Remove and replace or overlay.

The term QL shall also be calculated for the top layer of each lot independently using the core thickness values for that course and a minimum thickness acceptance testing limit of 1.25 inches. When the QL value, so calculated, is less than 0.29 indicating that more than 25 percent of the top layer is outside the minimum thickness acceptance testing limit of 1.25 inches, the top layer in that lot shall be removed and replaced or overlaid, and any reduction for that lot based on total thickness requirements is not applied.

When an unacceptable lot is overlaid, the overlay shall be of the top layer mixture specified for that lot and shall be a minimum of 1 inch thick if that mixture is bituminous concrete Mix I-5 and 1 1/2 inches thick if that mixture is bituminous concrete Mix I-4.

The overlaid or replaced lot is only that material placed up to the specified total thickness of the combined bituminous mixtures. For an overlaid or replaced lot, the quantity of material will be determined using the computed average weight of the top course mixture, the area of the lot and the difference between the specified total thickness and the average thickness of the original fifteen lot cores.

404.20 Opening to Traffic. The Resident Engineer will determine when the bituminous surface is to be opened to traffic or construction equipment. Traffic or construction equipment will not be permitted on the bituminous surface until 12 hours after its placement except when approved for maintaining traffic in accordance with Subsection 110.01.

Opening to traffic as provided above shall not relieve responsibility for the work in accordance with Section 107.

COMPENSATION

404.21 Method of Measurement. Bituminous concrete surface course will be measured by the ton excluding wasted material. The tonnage will be determined by one of the following methods:

A weigh ticket printed by an automatic printer system used in conjunction with an automated batching and mixing system. The printed ticket shall show the individual weights of the various components of the bituminous mixture in a batch, the total weight of each batch, and the sum of all batch weights in the truckload. The signature and official seal of a certified weighmaster shall be affixed to each weigh ticket.

A weigh ticket printed by an automatic scale showing the tare and gross weights of the truck as determined for each trip and the time and date indicating when the truck was tared and when it departed from the plant. Time and date may be printed automatically by a time clock. However, the net weight must be documented on each delivery ticket by a certified weighmaster. Fully automatic scales that print gross, tare and net weights are acceptable if the system is of an approved type in accordance with the requirements of the Department and the Office of Weights and Measures, Division of Consumer Affairs, Department of Law and Public Safety. The signature and official seal of a certified weighmaster shall be affixed to each weigh ticket.

Automatic truck scale weighing devices must be approved and certified by the Office of Weights and Measures, Division of Consumer Affairs, Department of Law and Public Safety.

In the event of breakdown of an automatic printer system, weigh tickets showing the gross, tare and net weight of each truck, as entered and certified by a weighmaster, will be accepted for a period not exceeding the necessary repair time as certified by a licensed repairman.

A weigh ticket shall be furnished for each truckload. Material will not be accepted unless accompanied by a weigh ticket, which shall be legible and clearly indicate the printed heading of the supplier and location of the batch plant, the title of the Project for which delivery is intended, the time and date, truck number, lot number and mix number of material being furnished, and the total net weight in each truckload.

The Engineer will compute, from cores of the bituminous concrete mixtures placed on the Project, the average weight per square yard per inch of thickness of each of the various types of bituminous concrete mixtures. The computed average weight will be calculated from the average bulk specific gravity on at least 10 percent of the drilled cores, but not less than three cores, as determined in accordance with Section 990, NJDOT B-9.

When the material does not conform with the specified thickness or air voids requirements, the quantity of material in the affected lot, termed the Computed Lot Tonnage, will be determined using the average weight as established above, the lot area and the average thickness from lot cores except that where the definite distribution of tonnage to lots is known, the tonnage indicated on the weigh tickets will be used in lieu of the computed lot tonnage. The determination of computed lot tonnage may require conversion between tonnage and square yards.

When bituminous concrete Mix I-5 is directed for use in transition (run-out) areas, the tonnage will be included with the tonnage for Mix I-4.

Tack coat and prime coat will be measured by the gallon in accordance with Subsection 109.01 except that the volume of diluted emulsions will be reduced by 50 percent.

404.22 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Bituminous Concrete Surface Course Mix _____	Ton
Tack Coat	Gallon
Prime Coat	Gallon

Payment reductions due to nonconformance to job mix formula requirements will be made in accordance with Subsection 903.05, Table 903-6 and will be applied to the in-place lot tonnage determined from weigh tickets.

Payment reductions due to nonconformance to stability requirements will be made in accordance with Subsection 903.05, Table 903-7 and will be applied to the in-place lot tonnage determined from weigh tickets.

Payment reductions due to nonconformance to air voids requirements will be made in accordance with Subsection 404.17, Table 404-2 and will be applied to the lot tonnage determined in accordance with Subsection 404.21.

Payment reductions due to nonconformance to thickness requirements will be made in accordance with Subsection 404.19, Table 404-4 and will be applied to the lot tonnage determined in accordance with Subsection 404.21.

Note - All payment reductions made in accordance with the above are cumulative.

SECTION 405 - CONCRETE SURFACE COURSE

405.01 Description. This work shall consist of the construction of a surface course of portland cement concrete, with or without reinforcement.

MATERIALS

405.02 Materials. Portland cement concrete shall conform to Section 914. Other materials shall conform to the following Subsections:

Curing Materials	905.03
Preformed Expansion Joint Filler	908.01
Joint Sealer	908.02
Reinforcement Steel for Concrete Base and Concrete Surface Courses	915.03

EQUIPMENT

405.03 Equipment. Portland cement concrete shall be supplied by a plant which meets all requirements of the Specifications and has the facilities necessary to ascertain and control the quality of the concrete.

(a) Batching Plant. The batching plant shall include bins, weighing hoppers and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, hopper and separate scale for cement shall be included. The weighing hoppers shall be sealed and vented to preclude dusting during operation. The batch plant shall be equipped with a nonresettable batch counter which indicates the number of batches proportioned.

(1) *Bins and Hoppers.* Bins with separate compartments for fine aggregate and for each size of coarse aggregate shall be provided at the batching plant.

(2) *Scales.* The scales for weighing aggregates and cement shall be either the beam type, the springless dial type or the electronic load cell type with a readout. They shall be accurate within 0.5 percent for cement and 1 percent for aggregate throughout the range of use. When beam type scales are used, a telltale dial shall be provided for indicating to the operator the required load in the weighing beams and for indicating critical position clearly. Poises shall be designed to be locked in any position and to prevent unauthorized change. The weigh beam and telltale device shall be in full view of the operator who shall have convenient access to all controls while charging the hopper.

Accuracy and certification requirements for plant scales shall be as specified in Subsection 404.05, Subpart *(b),(4)*.

There shall be not less than ten 50-pound weights at hand for frequent testing of all scales. A convenient means of temporarily attaching the weights to the weigh hopper shall be provided.

(3) *Water Measuring Equipment.* Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not over 1 percent. Unless the water is to be weighed, the water measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with outside taps and valves or other means to permit accurate calibration and to provide for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

(4) *Admixture Dispenser.* An automatic displacement dispenser with plant operation shall be used for adding each admixture.

(5) *Automatic Batching System.* Batching plants equipped to proportion aggregates and bulk cement by means of automatic weighing and recordation devices shall consist of a combination of automatic batching controls meeting the following requirements:

- All batching equipment in the system for batching by weight must be actuated by a single starting mechanism. A separate starting mechanism is permitted for volumetric batching of water and/or admixtures not batched at the time of initial weighing.
- Each automatic batcher must return to zero tolerance and each volumetric device must reset to start or signal empty before it may be charged.
- The discharge of any ingredient in the system shall not start unless all batching controls have been cleared of the previous batch with scale returning to zero tolerance and volumetric devices resetting to start or signalling empty. The discharge of any weighed ingredient shall not start until all weighed ingredients have been batched.
- For cumulative batchers, interlocked sequential controls shall be provided.

- Automatic batching controls shall start the weighing operation of each material and stop automatically when the designated weight of each material has been reached, interlocked in such a way that:
  - The charging device cannot be actuated until the scale has returned to zero balance within plus or minus 0.3 percent of the scale capacity.
  - The discharge device cannot be actuated until the required material is within the applicable tolerances.
  - The discharge device cannot be actuated if the charging device or the discharge device is open.

(6) *Recordation.* Each automatic batching plant shall be equipped with an accurate recorder or recorders which provide a permanent and continuous record of batching operations. A maximum of two recording units in lockable enclosures shall be provided with each plant. A batching record shall be removed as directed and it shall become the property of the Department. Each recorder shall produce a digital record on tickets and shall provide the following information:

- The quantity or batched weights of each aggregate, and of portland cement, water and admixture.
- The zero balance condition of each scale after batchers have been discharged, or prior to the start of the batching operation.
- A means of identifying each admixture batched.
- The time, date and batch number of each batch delivered.
- Mix formula or concrete classification identification.

(7) *Plant Laboratory.* A plant laboratory shall be provided and maintained at each plant site for use of the Engineer for sampling and testing and for use of the producer for quality control functions. The plant laboratory shall also include an office area for use by the Engineer.

A quality control technician shall be available during production. Control testing shall include moisture content and gradation of the aggregate, and slump and air tests of the plastic concrete.

Effective January 1, 1989, the quality control technician must be certified by ACI as a Concrete Field Technician, Grade I.

The plant laboratory shall be located to provide an unobstructed view of the trucks as they are loaded.

The plant laboratory, including office area, shall have a floor area of not less than 225 square feet, a ceiling height of not less than 7 1/2 feet, adequate ventilation and artificial lighting, and sanitary facilities in accordance with Subsection 107.10.

The plant laboratory shall be weathertight, heated and air-conditioned to maintain temperatures for testing purposes between 68 and 80 degrees F.

The plant laboratory shall have the following:

- Work benches, totaling not less than 2 by 15 feet, and two stools.
- Desk, table and at least two chairs.
- Four-drawer, legal-size file cabinet with lock and two keys.
- Shelves and supply cabinets.

- Electronic calculator with printout tape.
- Water cooler supplied with bottled water.
- Telephone.
- Class ABC fire extinguisher, or a Class A and a Class B fire extinguisher, meeting fire underwriters' approval.
- Electrical outlets sufficient in number and capacity for operating the required equipment and for drying samples.
- Display area, approximately 4 by 4 feet, for mounting control charts.
- Mechanical shakers, screens and sieves conforming to AASHTO M 92. The mechanical shaker shall be installed and bolted down in a sounddampening and dustproof enclosure.
- A minimum 12-inch diameter exhaust fan shall be provided in proximity to the mechanical shaker.
- Sink with hot and cold running water having adequate pressure, drainboard and drain capable of handling elutriable material.
- Stand to hold sieves used in washing elutriable material.
- Two-element hot plate or electric range having dial-type thermostatic controls to adjust the heat for drying aggregates.
- Platform scale of 200 pounds minimum capacity with a beam or dial with significant graduations of 1/10 pound or less.
- Balance or balances conforming to AASHTO T 27.
- Sample splitter or splitters capable of splitting aggregates from 2 1/2 inches gradation size through concrete sand size.
- Calibrated container for unit weight of aggregates, conforming to AASHTO T 19.
- Unit weight container, 1/2 cubic feet, for concrete, in accordance with AASHTO T 121.
- Slump cone and rod.
- Pressure air meter (and volumetric air meter when required for lightweight concrete.)
- Equipment for determining specific gravity of both fine and coarse aggregates.
- Miscellaneous items including rubber hammer, mason's trowels, pointed shovel, small and large sugar scoops, heavy galvanized pail approximately 14-quart capacity, aggregate sample pans, brushes, flashlight, glassware, steel straightedge approximately 18 by 2 inches, and such expendable supplies as are necessary for the tests to be made.

Accuracy and certification requirements for all weighing devices for the testing of samples shall be as specified for plant scales in Subsection 404.05, Subpart *(b),(4)*.

(8) Safety. Adequate and safe stairways shall be provided at points where accessibility to plant operations is required. Overhead protection shall be provided at locations where deemed necessary. All gears, pulleys, chains, sprockets and other hazardous moving parts shall be guarded and protected.

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The plant shall conform to all State and local safety requirements. When plant production occurs during nighttime hours, additional lighting shall be provided throughout the stockpile, plant, and laboratory areas to ensure a clear view of the operations.

(b) Project Site Equipment.

(1) Scratch Template. An accurately constructed template to check the elevation of the subbase.

(2) Forms. Straight side forms shall be made of metal having a thickness of not less than 3/16 inch and shall be furnished in sections not less than 10 feet in length. Forms shall have a depth at least equal to the thickness of the concrete without horizontal joint, and a base width equal to not less than the depth of the forms. Flexible or curved forms of wood or metal and of proper radius shall be used for curves of 100 foot radius or less. Forms shall be provided with adequate devices for secure setting so that when in place they shall withstand, without visible deflection or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than two thirds the height of the form. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet, and the face of the form shall not vary more than 1/4 inch. The forms shall contain provisions for locking ends of abutting form sections together tightly, and for secure setting. Metal pins shall be of the size and length required to hold the forms rigidly and securely in place, but, unless otherwise authorized, the pins shall be at least 24 inches in length.

Forms with battered top surfaces and bent, twisted, or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. The supply of forms shall not be less than that required for 2 days of placing concrete.

(3) Steel Placing Equipment. Power equipment for placing reinforcement shall accurately position the steel to line and grade.

(4) Spreading and Finishing Equipment. Equipment shall include a mechanical power-driven concrete spreader capable of striking off the concrete to the required cross section and elevation.

The mechanical finishing machine shall be power driven; shall be designed and operated to strike off, screed, consolidate and float; shall be of ample weight and strength to furnish the necessary pressure; shall be capable of being adjusted to produce the cross section and finish required; shall have sufficient power and be geared to operate consistently and smoothly; and shall be equipped with at least two oscillating-type transverse screeds and a scraping device to keep the tops of the forms clean.

Vibrators shall be the spud type, and may be hand operated and/or attached to the spreader or mounted on a separate carriage. The vibrators shall have a minimum frequency of 5000 impulses per minute.

Except for hand-held vibrators, all vibration shall be controlled by the forward movement of the spreading and finishing equipment so that vibration automatically ceases when the forward movement of the spreader is stopped.

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Tube finishers shall be equipped with a smoothing float or floats suspended from and guided by a rigid frame. The frame shall be carried by four or more visible wheels riding on and constantly in contact with side forms.

Individual traveling bridges shall be furnished as directed.

At least two straightedges, each not less than 10 feet long, with handles at least 3 feet longer than one half the width of the slab, shall be constructed of light metal or wood, and shall be maintained clean and straight.

At least two straightedge templates shall be provided for testing the completed surface. They may be made of wood or metal, shall be not less than 12 feet long, and shall be maintained clean, straight, and free from warp.

(5) *Concrete Saw.* When sawing joints is specified, sawing equipment shall be provided, adequate in number of units and power to complete the sawing to the required dimensions and at the rate necessary to prevent uncontrolled cracking, in accordance with Subsection 405.12. The saws shall be equipped with water-cooled diamond-edge blades or abrasive wheels and alignment guides.

When sawcutting of grooves is specified, the saws shall be of a multi-bladed type, adequate in number of units and power, and equipped with water-cooled, circular, diamond-edge blades and alignment wheels. A system of slurry collection shall be provided.

At least one standby saw in working order and an ample supply of saw blades shall be provided at the work site at all times during sawing operations.

(6) *Tines.* The metal tines shall be tempered spring steel, arranged in a single line and securely mounted in a suitable head and shall be of a size and stiffness sufficient to produce a groove of the specified dimensions in the plastic concrete without either slumping of the edge or severe tearing of the surface. The metal comb shall be attached to a mechanical device capable of traversing the entire paving width in a single pass at a uniform speed.

(7) *Spraying Equipment.* When liquid membrane compound is used for curing concrete, the mechanical spraying equipment shall be mounted on a movable bridge. The equipment shall be the fully atomizing type equipped with a tank agitator. The spraying equipment shall be capable of continuously agitating the liquid membrane during application. Small hand-held spray equipment capable of maintaining the liquid membrane in a mixed condition will be permitted if used in accordance with Subsection 405.14.

(8) *Small Tools and Other Equipment.* Small tools such as edgers, trowels, hand floats and brushes necessary to produce the results required.

Water supply equipment shall include pumps or tanks mounted on trucks, of adequate capacity to furnish sufficient water to accommodate this construction and at the required pressure. A pipeline appropriate to the requirements of the construction may be used.

Equipment and tools as necessary for the construction of special features.

CONSTRUCTION

405.04 Preparation of Grade. The subbase shall be prepared as specified in Section 209 for at least 1 foot beyond the edge of the concrete surface course.

405.05 Setting Forms. The material under the forms shall be compacted and shall be at grade so as to be in firm contact with the form for its entire length. Subbase at the form line which is below grade shall be brought to grade with clean granular material in lifts of 1/2 inch or less for a distance of 18 inches on each side of the base of the form and shall be thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary. Pedestals of subbase or other materials upon which to reset the forms to bring them to grade will not be permitted.

Forms shall be set in advance of the point where concrete is being placed for at least the distance required for the next day's paving. This distance may be reduced, as approved, when a shorter distance is justified by prevailing conditions. Forms shall be staked into place with not less than three pins for each 10-foot section. All form sections shall be locked tightly and free from play or movement in any direction.

The alignment and grade elevations of the forms shall be checked and corrections made before placing the concrete. The form shall not deviate from the required alignment by more than 1/4 inch at any point. Forms that settle or deflect under the spreading and finishing equipment shall be reset or removed. The top and face of forms shall be cleaned and the face oiled prior to the placing of concrete. When any form has been disturbed or any grade has become unstable, the unstable condition shall be corrected and the form shall be reset and rechecked.

405.06 Condition of Subbase. The subbase shall be cut to proper cross section by means of the subgrade machine as specified in Section 209. Subbase on widened curves, intersections, and other similar areas may be shaped by hand and checked with special templates.

Prior to placing the concrete, a scratch template shall be used to check the elevation of the finished subbase. The template shall rest on the forms or adjacent surface. After the subbase is checked with the template, low spots shall be filled and high spots shall be scraped to the proper grade and the surface recompacted. Immediately prior to placing the transverse joint on the subbase, the subbase at the joint shall have been finished to its required surface and shall have received its final compaction.

In advance of concreting operations, the subbase shall have been prepared as specified in Subsection 209.03; shall not be muddy, unstable or frozen; shall be free of dust and dry earth and, if dry, shall be sprinkled by means of a spray nozzle sufficiently in advance of placing the concrete so that the subbase is uniformly dampened to a depth of not less than 1/2 inch without forming wet spots, except that before May 15 and after October 1, the subbase shall not be sprinkled unless it is dry for more than 1/2 inch below the surface and its character is such that it should be dampened, in which case only sufficient water shall be applied to dampen the surface.

405.07 Handling, Measuring and Batching Materials. The batch plant site, layout, equipment and provisions for transporting material shall be such as to assure a continuous supply of concrete to the work.

Stockpiles of aggregates shall be in accordance with Subsection 901.02.

The fine aggregate and each size of coarse aggregate shall be weighed separately into hoppers in the amounts in the job mix design.

Cement shall be measured by weight. Each bag of cement shall weigh 94 pounds and 94 pounds of bulk cement shall be considered one bag. Batches involving fractional bags are not allowed except when bulk cement is used. When bulk cement

is used, separate scales and hoppers shall be used for the cement with a device to indicate the complete discharge of the batch of cement into the batch box or container. The weighing hopper and scale shall be of adequate size, completely encased, with provisions for locking. The hopper discharge mechanism shall be interlocked against opening until the full batch is in the hopper and the scale balanced, against opening while the hopper is being filled, against closing until the hopper is entirely discharged and the scale back in balance, and against opening if the batch in the hopper is either overweight or underweight by more than 1 percent of the amount specified. The weighing hopper discharge gate shall operate in such a manner so as not to affect the scale balance. The discharge chute, boot or other such device shall be suspended from the encasement and not from the weighing hopper and shall be so constructed that cement does not lodge therein and there is no loss of cement by air currents or otherwise. There shall be means to assure the presence in each batch of the entire cement content required.

Where bulk cement is to be used, there shall be provided separate storage for tested and approved cement, which shall be held in such storage for the particular Project or Projects for which it was consigned. Different brands of cement, or the same brand of cement from different mills, shall not be mixed nor shall they be used alternately unless approved.

For individual batches, the following tolerances shall apply based on the required scale reading:

- Cement: plus or minus 1 percent of the required weight of material being weighed or plus or minus 0.3 percent of scale capacity, whichever is greater.
- Aggregates 1 1/2 inches or smaller: plus or minus 2 percent of the required weight of material being weighed or plus or minus 0.3 percent of the scale capacity, whichever is greater.
- Aggregates larger than 1 1/2 inches: plus or minus 3 percent of the required weight of material being weighed or plus or minus 0.3 percent of scale capacity, whichever is greater.

The water measuring system shall be capable of incorporating in the batch, the predetermined quantity of water, to an accuracy of plus or minus 1 percent. The measuring device shall automatically register and stop the flow of the water when the designated quantity has been delivered into the mixing drum.

Plants shall be equipped with a separate dispensing system with a visual sight gauge for each admixture incorporated into the concrete. Admixtures shall be added to the mixing water or sand. Each system shall be capable of dispensing the total amount required to within plus or minus 3.0 percent or 1 ounce, whichever is greater. Convenient means shall be provided to calibrate each system.

Fly ash shall be stored at the batching plant in a separate storage facility. The scales and batching tolerances shall be equivalent to those specified for portland cement. When fly ash is weighed cumulatively with the cement, the fly ash shall be last in the batching sequence. A split silo containing fly ash and cement will not be permitted.

A representative of the fly ash producer shall be available for technical assistance.

405.08 Mixing Concrete. Concrete may be mixed at the job site or in a central-mix plant or may be mixed in transit-mix trucks.

Mixing time shall be measured from the time all materials are in the drum.

Mixers of a type capable of mixing not less than a one-bag batch, of the class of concrete or mortar required, may be used where only small quantities of concrete or mortar can be placed at a time.

The following mixing methods are permissible: *(a)* mixing on the Project in truck mixers, *(b)* mixing at a central-mixing plant, *(c)* transit mixing, and *(d)* mixing on the Project in continuous-mixing-type truck mixers.

The following shall apply to mixing methods *(a)*, *(b)* and *(c)* :

A delivery ticket, completely filled out, shall be furnished for each load. The tickets shall be serially numbered, and shall bear the printed heading of the supplier and the location of the batch plant. Each ticket shall show the name of the Project, the name of the Contractor and Subcontractor, if pertinent; the number of cubic yards of concrete and the class and type; the name of each admixture and the quantity shown in liquid measure or weight; the time when loading into the drum was completed as imprinted on the ticket by an automatic clock; the time when the concrete was completely discharged; the amount of mixing water and the amount of tempering water, if used, both in gallons; the total number of revolutions on the counter at the time of complete discharge for truck-mix concrete plus the total number of mixing revolutions for transit mix; the date; and the truck number. In addition, for the first ticket of each day, for the first ticket of each pour, and when changes occur in the information, the number of pounds of portland cement with the brand name and type, the number of pounds and the source of the fine aggregate, and the number of pounds and the sizes and sources of the coarse aggregates shall be indicated. The ticket shall be authenticated by an authorized representative of the supplier.

The concrete will be rejected if:

- the mixer fails to maintain the manufacturer's stated speed of rotation for both mixing and agitation, or is not able to promptly discharge the concrete;
- there is any indication of improper batching, lack of uniform distribution of constituents throughout the load, or balling of the cement and aggregates;
- the concrete is not discharged within the specified time limit, or if the revolution counter shows a total of more than the permitted number of revolutions. However, if the load has been partially discharged and if the concrete yet to be discharged complies with the specified ranges for slump and entrained air without further addition of water, the discharge and use of the concrete may be permitted.

(a) Mixing on the Project in Truck Mixers. Mixing on the Project in truck mixers shall not be used for concrete surface course or structural concrete items.

Truck-mixed concrete shall be materials proportioned at a batching plant and mixed in a revolving-drum truck mixer at the point of delivery following the addition of the proper amount of mixing water.

Each truck mixer shall have attached a metal plate or plates on which is plainly marked the manufacturer's capacity rating in terms of the gross drum volume, the capacity of the drum in terms of the volume of mixed concrete, and the manufacturer's designated drum speed of rotation for both mixing and agitation. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum may be readily verified.

The counter unit shall be positioned on the truck so as to be plainly visible if the driver's door is open.

The mixer shall be capable of producing a thoroughly mixed and uniform mass and discharging the concrete with satisfactory uniformity within the ranges of slump and air entrainment specified for the class and type of concrete being furnished.

Each truck mixer shall be equipped to carry sufficient water to mix a full capacity load of concrete within the required range of slump, and shall also carry wash water as necessary.

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The mixing water tank, pump and the piping shall be kept clean and free of leaks. A measuring device shall be provided which indicates the amount of mixing water added to the batch. The device shall have an accuracy of plus or minus 3 percent, by volume, of the indicated amount dispensed, regardless of the attitude or position of the truck. The distribution system shall be equipped with three-way valves and bypasses or other suitable means for calibration of the water-measuring device. The water-measuring device shall be calibrated prior to use and recalibrated whenever any repairs or modifications are made that may affect the calibration. Documentation showing the date and results of calibration of the water-measuring device shall be carried on each truck mixer and copies shall be furnished upon request. Near the measuring device, on the mixing water tank, there shall be stenciled the word calibrated and the date of the last calibration.

The mixing water-measuring device shall be located so as to be plainly visible to the truck operator when he is operating the mixing water and the drum controls, and to the Engineer while he is standing on the ground. All measuring indicators shall be kept clean and in good condition.

Truck mixers are subject to inspection by the Engineer, including the mechanical condition of the truck mixer, verifying the mixing and agitation rates, the accuracy of the water-measuring device, the size of discharge opening and chutes, and the general condition and wear of the blades. The truck mixer will not be approved for use if any part or section of the pickup and throw-over blades is broken, missing, or excessively worn. Truck mixers shall be examined daily for cleanliness of the drum and blades, leaks in the mixing water system, and the condition of the water-measuring device and the revolution counter.

The concrete supplier shall maintain, at a convenient location, a copy of the manufacturer's design for each size and type of truck showing the dimensions and arrangements of the blades, the dimensions of the drum, the gross volume of the drum, the recommended rates of rotation for all types of operations, and any other pertinent information.

Prior to the time mixing water is added at the job site, no water or other fluids will be permitted in the drum of the truck mixer except concrete admixtures which are measured and dispersed with the dry ingredients. Truck mixers may be required to pull under the batch plant with the drums revolving in discharge rotation as an indication that the drum is empty.

The truck mixer, when loaded for mixing concrete, shall not contain more then 63 percent of the gross drum volume.

The maximum elapsed time from the loading of the portland cement into the drum to the discharge of all the concrete from the mixer shall be 90 minutes except that, under conditions contributing to quick stiffening of the concrete or when the temperature of the concrete is 85 degrees F or above, such time limit shall be changed to 60 minutes. However, if retarders are used, the time limit may be increased to a maximum of 90 minutes, if approved. Under very severe conditions, further reductions of the time limits or the size of the loads may be required.

Immediately following the addition of all the mixing water, the mixing revolution counter shall be reset to zero with the drum revolving at the rate of speed designated by the manufacturer for mixing.

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Each batch shall be mixed not less than 50 and not more than 100 revolutions at the rate of rotation designated as mixing speed. The concrete shall be mixed into a plastic, uniform mass complying with the specified range of slump and air entrainment. The number of revolutions within the limits specified above and the control of the consistency shall be as directed.

If the concrete cannot be entirely discharged within 10 minutes after the mixing has been completed, the concrete remaining in the drum shall be kept plastic and workable by revolving the truck drum, at the manufacturer's designated speed for agitation, for a period of 2 minutes in each 10 minutes. In no case shall the total revolutions exceed 200.

Prior to the completion of 100 mixing revolutions, the operator may add water in increments, if necessary, in order to produce concrete within the required slump range.

During discharge, drum gates and cover shall be fully opened and the rate of discharge shall be governed by drum speed.

Discharge chutes shall be ample in size, without struts, and capable of handling the concrete within the specified slump range. Use of extension chutes shall be restricted as much as practicable.

Wash water shall be provided in addition to the water required for mixing. If the wash water runs through the measuring device for the mixing water, it shall not be used during any of the periods when mixing water is being measured into the drum. Under no circumstances shall the washdown hose be used to temper the concrete or to aid the flow of concrete in the chute except for prewetting the chute. Any concrete that has been wetted with wash water shall be discarded.

Immediately after the discharge of each load, the drum shall be washed out and the wash water and any residue from the previous batch shall be completely discharged before reloading the drum at the batch plant.

(b) *Mixing at a Central-Mixing Plant.* Central-mix concrete shall be materials proportioned and mixed at a central plant and transported to the point of use in an agitator or nonagitator truck of approved design.

Central-mixing plant mixers shall be of the type and capacity capable of combining the cement, aggregates and water into a thoroughly mixed and uniform mass within the specified mixing time and of discharging the mixture with a satisfactory degree of uniformity and shall be operated in compliance with the NJAC 7:27-6.1 *et seq.*

Stationary mixers shall be equipped with a timing device that does not permit the batch to be discharged until the specified mixing time has elapsed. Mixing time at the central-mix plant shall be not less than 1 minute. Mixing time shall be measured from the time all cement and aggregates are in the drum. The batch shall be so charged into the mixer that sufficient water enters in advance of cement and aggregates to prevent caking, and all water shall be in the drum by the end of the first quarter of the specified mixing time.

When the temperature of the mixing water exceeds 100 degrees F, the loading sequence shall be modified by mixing all the water and the aggregates and then the cement. Mixing shall begin immediately following the complete charging of the drum and continue for not less than 1 minute.

Truck mixers for the delivery of central-mix concrete shall have a revolving, watertight drum capable of transporting and discharging the mixed concrete with a satisfactory degree of uniformity. The speed of the drum shall be that stated by the manufacturer to be the agitating speed. Each truck shall have attached thereto, in a prominent place, a metal plate on which is stated

the gross volume of the drum, the manufacturer's rating in terms of mixed concrete for agitation, and the speed of rotation for agitation. The volume of mixed concrete in the drum shall not exceed the manufacturer's rating nor shall it exceed 80 percent of the gross drum volume.

The use of open body trucks with agitating mechanism may be permitted provided that the maximum distance of hauling, from plant to location on the Project, is not more than 10 miles.

Nonagitating trucks may be used if the haul is not to exceed 5 miles and if the surfaces over which the concrete is to be hauled are maintained in a smooth riding condition. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the work shall not exceed 30 minutes. Bodies of nonagitating hauling equipment shall be smooth, mortartight metal containers and shall be capable of discharging the concrete at a controlled rate without segregation.

Covers over trucks shall be provided when needed for protection.

Except for nonagitating trucks, the maximum length of time from loading at the plant to discharge at the Project shall not exceed 90 minutes, except under conditions contributing to quick stiffening of the concrete or when the temperature of the concrete is 85 degrees F or above, such time limit shall be changed to 60 minutes. However, if the use of retarders is permitted, the time limit may be increased to a maximum of 75 minutes. Under very severe conditions, further reduction of the time limits or the size of the batches may be required. During these intervals, the concrete shall be agitated continuously.

If a truck mixer is used, the provisions for adding water at the Project site are as specified below under the transit mixing method.

Two-way telephone or radiotelephone communication between the site of the placement of concrete and the mixing plant shall be provided.

(c) *Transit Mixing.* Transit mix concrete shall be materials, including water, proportioned and introduced into a truck mixer from a one-stop or two-stop batching plant and mixed while the truck is at the plant or a combination of mixing at the plant and on the job site.

A one-stop batching plant shall be a plant where all dry ingredients for each batch of concrete are loaded into the mixer truck simultaneously while water is being introduced.

A two-stop batching plant shall be a plant where the ingredients for each batch of concrete are loaded into the mixer truck at two separate locations.

Each transit mixer shall comply with the requirements for truck mixers except that the mixing water tank and measuring device shall be used only for providing tempering water if necessary.

In addition, all truck mixers used for transit mix concrete shall be equipped with an electrically operated counter unit which shall be nonresettable except by use of a 110-volt device utilizing a nonstandard plug located at the batching plant. The counter unit shall contain two counters. One counter shall record only those revolutions at speeds recommended by the manufacturer of the truck mixer as mixing speed and shall record the total of all such mixing revolutions from the time the truck is loaded. The other counter shall record revolutions of the drum at all speeds and shall record the total revolutions from the time the truck is loaded. The unit shall include an indicator on the front panel which shows if the instrument has been turned off

or tampered with in any manner after being reset at the time of loading. The counter unit and the resetting device shall conform with the National Electric Code.

The counter unit shall be positioned on the truck so as to be plainly visible if the driver's door is open.

In lieu of the time clock, the counter unit may contain a third counter, an electrically-operated timer, which shall be nonresettable except by use of the 110-volt device.

Mixing and delivery for transit mix concrete shall comply with the requirements for truck mix concrete except as follows:

- All ingredients including water shall be introduced into the transit mixer at the batch plant.
- At a one-stop batching plant, at least one third of the mixing water shall be introduced into the mixer prior to the dry ingredients and sufficient mix water to wash down the chute shall be introduced after all the dry ingredients have been added.
- At a two-stop batching plant, the loading sequence shall be one half to three quarters of the mixing water, aggregates, cement, and remaining water.
- As an alternative, at either a one-stop or two-stop batching plant, when the mixing water is less than 100 degrees F, slurry mixing can be used. When this method is used, all mixing water is added first, followed by the cement, and mixed at mixing speed for 1 minute. The remaining ingredients shall then be added.
- At either a one-stop or two-stop batching plant, when the temperature of the mixing water exceeds 100 degrees F, the loading sequence shall be the mixing water, then the aggregates and then the cement.
- Sufficient mix water to wash down the chute shall be introduced after all the dry ingredients have been added. However, not less than 80 percent of the mixing water, as estabiished by the mix design, shall be added at the plant.

Mixing shall begin immediately following the complete charging of the drum and continue for not less than 50 nor more than 100 revolutions of the drum at the mixing speed recommended by the manufacturer of the truck mixer. Upon completion of at least the minimum number of mixing revolutions at the plant, the speed of the drum shall be reduced to the agitation speed recommended by the manufacturer. Concrete delivered to the job with less than 100 mixing revolutions may be mixed to not more than 100 revolutions at mixing speed.

Prior to acceptance testing, mixing water may be added incrementlly, at the Project site, in order to achieve the proper slump. After the addition of water, the drum shall be rotated at the recommended mixing speed for a minimum of 20 revolutions.

If the concrete cannot be entirely discharged within 10 minutes after the mixing has been completed, the concrete remaining in the drum shall be kept plastic and workable by revolving the truck drum at the manufacturer's designated speed for agitation for a period of 2 minutes in each 10 minutes.

The maximum elapsed time from loading at the plant to the discharge of all the concrete from the mixer shall be 90 minutes except that under conditions contributing to quick stiffening of the concrete or when the temperature of the concrete is 85 degrees F or above, such time limit shall be

changed to 60 minutes. However, if the use of retarders is approved, the time limit may be increased to a maximum of 75 minutes. Under very severe conditions, further reduction of the time limits or in the size of the loads may be required.

Transit mix concrete will be rejected for any of the following reasons:

- If the concrete is not discharged within the specified time limit after loading all ingredients into the drum;
- If the indicator on the counter shows that the instrument has been turned off or tampered with;
- If the nonresettable total revolution counter shows more than 300 revolutions;
- If water has been added while the truck mixer is en route to the Project.

Two-way telephone or radio communication between the site of the placement of concrete and the batching plant shall be provided.

(d) Mixing on the Project in Continuous-Mixing-Type Truck Mixers. Mixing on the Project in continuous-mixing-type truck mixers shall be used for headwalls, utility encasement, manhole and inlet foundations and top slabs, gutter, curb, headers, barrier curb and base, sidewalk, islands, driveways, fence post footings and sign foundations, foundations for electrical items, guide rail end treatment footings, junction boxes and other miscellaneous items as approved.

Continuous-mix concrete shall be materials proportioned by volumetric measurement from bins and tanks on the truck mixer and mixed on the truck mixer at the site of the work.

The concrete shall be mixed in a mixing unit which is part of the truck carrying the dry ingredients. The mixing unit shall be an auger type incorporated in the truck's discharge chute or other approved mixing mechanism. The mixer shall produce concrete of uniform consistency and shall discharge the mix without segregation.

The truck mixer shall have permanently attached thereto, in a prominent place, a metal plate or plates on which are plainly marked the gross volume of the unit in terms of mixed concrete, operating speed, and the cement constant of the machine in terms of an indicator revolution count required to deliver 94 pounds of cement, all as rated by the manufacturer.

The truck mixer shall be equipped with a cement bin of sufficient capacity to store and supply the quantity of dry cement required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer. The cement bin shall be free of moisture and contamination at all times.

The truck mixer shall be equipped with aggregate bins of sufficient capacity to store separately the quantities of fine and coarse aggregates required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer. Means shall be provided to prevent contamination or intermixing of the fine and coarse aggregates during loading and transporting. Aggregate bins shall be covered when there exists a possibility of moisture entering the bins.

The truck mixer shall be equipped with a mirror or other means of readily determining the level of aggregates in the aggregate bins without the need for climbing up on the truck.

The aggregate bins shall be equipped with vibrators or other means of maintaining a smooth, even, and continuous flow of aggregate from the bins.

The truck mixer shall be equipped with water tanks of sufficient capacity to store the quantity of water required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer and at the slump specified for each concrete item.

If concrete additives are to be used in the mix, means shall be provided for storing the additives on the truck and incorporating them in the mix including a way to check the rate of flow of the additive into the mix.

The truck mixer shall include a feeder unit mounted under the compartment bins to deliver the ingredients to the mixing unit.

Each bin on the truck shall have an accurately controlled individual gate or feeding mechanism to form an orifice for volumetrically measuring the material drawn from each bin compartment. The cement bin feeding mechanism shall be set to discharge continuously and at a uniform rate, a given volumetric weight equivalent of cement during the concrete mixing operation. The gates of the aggregate bins shall be calibrated at the various openings to discharge the volumetric weight equivalent of aggregates required for various concrete mixes.

The truck mixer shall be so constructed as to permit checking the calibration of the gate openings and meters by means of weight test samples.

The calibration of the gate openings and meters shall be checked and certified for each concrete mix design at least once a year by a testing agency. When approved, a representative of the Contractor may perform the calibration if it can be shown that the representative is knowledgeable in the proper techniques of calibration. The Department shall be notified, at least 1 week prior to the date of the annual calibration, in order that the Department may approve the calibration.

A calibration check or a yield test may be required at any time. The accuracy of the mixer to proportion the specified mix is acceptable if the calibration check shows that the equivalent weights of each component are within the following tolerances:

Cement	0 to +4 percent
Fine Aggregate	±2 percent
Coarse Aggregate	±3 percent
Admixtures	±3 percent
Water	±1 percent

Each truck mixer shall be equipped with a revolution counter indicator permitting the reading of the volumetric weight equivalent of cement discharged during the concrete mixing operation.

Each truck mixer shall be equipped with fine and coarse aggregate dials to permit adjustment of the gates of the aggregate bins for volumetric proportioning of aggregates.

Each truck mixer shall be equipped with a water meter or gauge to register the discharge rate of water by volume entering the mix.

Each truck mixer shall be equipped with automatic means of maintaining the operating speed of the proportioning and mixing operation independent of the drive engine of the truck. The truck mixer shall be operated within plus or minus 8 percent of the revolutions per minute established by the manufacturer, noted on the aforementioned plate and the value used during calibration. A tachometer shall be mounted on the unit to indicate the operating speed.

All indicators, dials, meters, tachometer and controls shall be in full view and near enough to be read or adjusted by the operator while mixing concrete.

Handling, measuring and batching of materials shall conform to Subsection 405.07 except as follows:

- Cement and aggregates shall be proportioned, measured and batched by a volumetric weight equivalent method. Separate batching equipment and storage bins are not required and the materials shall be batched in the continuous-mixing-type truck mixer.
- Each truckload of ingredients shall be accompanied by a sufficient number of delivery tickets such that the operator may supply one copy of the delivery ticket for each Project and for each class of concrete delivered. The delivery tickets shall show the brand name and type of cement, the calibrated cement constant of the machine in terms of the indicator revolution count, the source of aggregates and the size of the coarse aggregate. The delivery tickets shall be signed by a responsible officer or employee of the concrete supplier. At each Project, for each class of concrete and for each separate mixing operation, the mixer operator shall enter on the tickets the name of the Project, the name of the Contractor, the revolution counter readings indicating the volumetric weight equivalent of cement discharged during that mixing operation, the aggregate dial settings, and the class of concrete delivered. The operator shall sign each completed ticket and furnish one copy.

405.09 Limitations of Placing. The limitations shall be as prescribed in Subsection 501.11 and the following:

- Placing of concrete shall be discontinued in time to allow finishing to be completed in daylight hours. If approved, to complete finishing after daylight hours, an artificial lighting system shall be in place and operable.

405.10 Placing Concrete. The concrete shall be unloaded into a concrete spreader except that concrete mixed at a central-mix plant may be deposited on the subbase, and mechanically spread in such a manner as to prevent segregation of the materials. As deposited, the mixture shall be placed where it requires as little rehandling as possible.

Where small quantities of concrete are to be placed, hand placing and finishing of concrete surface may be permitted. Such work shall be in accordance with Subsection 405.13, Subpart *(d)*. The concrete shall be well distributed by the discharge chute across the formed area. In no case shall the concrete be discharged in windrows or piles.

Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels or other appropriate tools. Workmen shall not be allowed to walk on the freshly mixed concrete with boots or shoes coated with earth or other foreign substances.

Where concrete is to be placed adjoining a previously constructed lane and mechanical equipment is to be operated upon the existing lane, that lane shall meet the requirements for opening to traffic in Subsection 405.19.

If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after 4 days. Precautions shall be employed to prevent damage to the previously constructed concrete. In the event of such damage, all damaged areas shall be repaired at no cost to the State.

To prevent bowing or misalignment of the transverse expansion joints during paving operations, concrete shall be deposited simultaneously on both sides of transverse joints in a uniform fashion without disturbing the joints.

Should any material fall on or be worked into the surface of a completed slab, the material shall be removed immediately and the surface repaired immediately. The finished condition of the surface is subject to approval.

Where two or more lanes of concrete are to be constructed, two adjacent lanes may be constructed as a single operation.

Where two adjacent lanes of concrete are constructed as a single operation, the longitudinal joint between the lanes shall be the sawed type. The saw cut shall conform to Subsection 405.12, Subpart *(b)*.

Three or more lanes may be constructed as a single operation, provided that it can be demonstrated that the equipment being used can properly place, strike off, consolidate, finish and cure the concrete.

405.11 Initial Strike-Off of Concrete and Placement of Reinforcement. The placing of the concrete between transverse joints shall be carried out as a continuous operation. If, due to a breakdown in the plant or a delay of more than 30 minutes or other emergency, it is not possible to carry out a continuous paving operation, an intermediate Type A transverse expansion joint shall be constructed and so located that the short slab has a minimum length of 15 feet or of one normal reinforcement mat, whichever is the lesser.

The mixing and placing of the concrete shall progress only at such a rate as to permit proper finishing, protecting and curing.

A layer of concrete mixture shall be placed first and then spread and struck off with a mechanical spreader equipped with a screed board so that the entire area between side forms and for a distance sufficient for placing a reinforcement mat is covered to such a depth that the surface of the layer is at the proper elevation to receive the reinforcement steel. Hand tampers shall be used to secure the steel in place at its proper elevation. Then the next layer of the concrete mixture shall be placed and spread immediately in a manner to prevent segregation and so that the surface is at the proper grade when the consolidation and finishing are completed. Concrete of the lower layer which has developed initial set or has been in place more than 30 minutes before being covered with the next layer shall be removed and replaced.

The use of power equipment for placing reinforcement steel may be permitted. If such equipment is used, the concrete mixture may be placed in a single layer to the full depth of the side forms prior to placing reinforcement steel.

When concrete is constructed without reinforcement, the foregoing requirements for placing the concrete shall apply except that the concrete shall be placed in one layer.

After the concrete is placed, the portions thereof within 1 foot of transverse, longitudinal, and other joints and within 1 foot of all side forms shall be compacted with suitable tools and by vibrating. The method of vibrating and number of vibrating units shall be such as to assure the proper density of the concrete adjacent to the ends and sides of the slab and within the areas of the transverse joint structures.

Vibrators shall not be permitted to come in contact with a joint assembly, the subbase, or a side form. In no case shall the vibrator be operated longer than 5 seconds in any one location.

405.12

405.12 Joints.

(a) Joint Sealer. All joints requiring sealer shall be sealed with hot-poured rubber asphalt before any traffic is permitted. The joint opening shall be cleaned of all extraneous matter. The contact faces of the joint shall be dry at the time of sealing. Compressed-air jets, power-driven wire brushes and any such additional equipment necessary to clean the joint and dry the contact faces shall be provided. The compound shall not be placed when the air temperature in the shade is less than 50 degrees F. The heating kettle in which the compound is prepared for pouring shall be a double-boiler type used with indirect heating, with built-in agitator and equipped with a thermometer to measure the temperature of the sealer. Direct heat will not be permitted.

Where the longitudinal joint between two adjacent lanes was constructed by saw cut, the sawed groove may be filled with a cold-applied type of sealer.

Pouring of this compound for sealing the joints shall be done by the use of hand pots, mechanical methods or any other method which gives satisfactory results. Pouring shall be done in such a manner that the compound is not spilled on the exposed surface of the concrete. Any excess compound on the surface of the concrete shall be removed immediately.

Joints shall be filled so that upon completion, the compound shall be 1/8 to 1/4 inch below the adjacent surface. When more than one pouring is required to fill the joints, the succeeding pouring shall be made immediately after shrinkage of the compound in the previous pouring has taken place. Traffic will not be permitted over the poured joints until the compound has hardened sufficiently to resist pickup.

(b) Longitudinal Joints. Longitudinal joints between adjoining strips or lanes of new concrete shall be of the keyway type. The keyway type longitudinal joint shall also be constructed between strips of existing and new concrete widening where the side of the existing is recessed; but where there is no such recess, the longitudinal joint shall be constructed with vertical plane faces and filled with 1/4-inch preformed expansion joint filler. The side of the concrete abutting shoulders and curbs shall be constructed with a recessed face as in the keyway type joint. The joint between the concrete and the curb shall be filled with 1/2-inch preformed expansion joint filler.

Where adjacent lanes of concrete are constructed one lane at a time, tie-bolts shall be installed in the longitudinal joint between the adjacent lanes.

Where two adjacent lanes of concrete are constructed in a single operation, tie bars shall be installed between the lanes.

Longitudinal sawed joints shall be cut with concrete saws not later than 72 hours after placing concrete and before any equipment or vehicles are allowed on the concrete. The saw cut shall have a depth of 2 1/4 inches in 8 inch concrete, and a depth of 2 3/4 inches in 9 inch concrete. The width of the saw cut shall be not less than 1/8 inch or more than 1/4 inch. If longitudinal cracking of the concrete occurs, sawing of the concrete shall be started just as soon as the concrete has hardened sufficiently to permit sawing without excessive tearing or ravelling of the concrete. The method of repair of concrete in which longitudinal cracking has occurred is subject to approval. If the cracking cannot be satisfactorily repaired, the concrete shall be removed and replaced at no cost to the State.

(c) Transverse Expansion Joints. Transverse expansion joint assemblies shall be rigid metal devices capable of holding dowels and filler firmly in position during the entire construction operation and shall remain in place. The top of the filler shall be set below the surface of the proposed slab to accommodate

the sealant specified. When in position, the filler shall be perpendicular to the surface of the slab. The top edge of the filler shall be protected, while the concrete is being placed, by a metal channel cap. Dowels shall be placed across transverse expansion joints, parallel to and level with the surface course.

Each day's paving shall be terminated at an expansion joint. Any concrete back to that preceding transverse joint shall be removed.

(d) *Expansion Joints at Roadway Structures.* Preformed expansion joint filler shall be installed at all structures and other features projecting through, into or against the slab. Such joints shall be 1/2 inch in width.

405.13 Final Strike Off, Consolidation and Finishing.

(a) *Sequence.* The sequence of operations shall be strike off and consolidation, floating and removal of laitance, straightedging, and surface texturing.

The addition of water to the surface of the concrete to assist in finishing operations will not be permitted.

(b) *Machine Finishing.* As soon as the concrete has been placed, it shall be struck off and screeded with a finishing machine.

The machine shall go over each area as many times and at such intervals as necessary to give the proper compaction and leave a surface of uniform texture. Excessive operation over a given area shall be avoided. The machine and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation which could affect the finish.

During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length. The moving of rolls of concrete in excess of 6 inches with the finishing machine will not be permitted.

If thorough consolidation of the concrete is not obtained by the vibratory method at joints, along forms, at structures and throughout the concrete, then other equipment and methods shall be furnished and employed which produce thorough consolidation.

(c) *Finishing at Joints.* The concrete adjacent to joints shall be placed and consolidated against the joint material, under and around all load transfer devices, joint assembly units and other features which extend into the concrete.

After the concrete has been placed and vibrated, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints. If continuous operation of the finishing machine up to, over, and beyond the joints causes segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the front screed is approximately 8 inches from the joint. Segregated concrete shall be removed in front of and off the joint; the front screed shall be lifted and set directly on top of the joint and the forward motion of the finishing machine resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screeds, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

(d) *Hand Finishing.* Hand finishing methods will not be permitted except under the following conditions:

- In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade or in transit to the job when the breakdown occurs.
- Variable-width areas or other special conditions which make the use of finishing machines impractical may be finished by hand methods.

When hand finishing is permitted, the concrete shall be struck off and screeded as soon as placed. The major part of the concrete above the required grade shall be removed by a hand-operated vibratory screed, moved forward with a combined longitudinal and transverse motion and so manipulated that it remains in contact with the side forms. The vibrating screed shall be at least 2 feet longer than the maximum width of the slab. It shall be sufficiently rigid to retain its shape, and constructed of metal or other suitable material shod with steel.

Screeding shall be repeated until the surface is of uniform texture, true to grade and cross section, and free from porous areas.

Immediately following the longitudinal screeding operation, further finishing with straightedges or lutes, final surface finishing with metal tines, rounding of joint edges, checking of the concrete surface with a straightedge, and the correction of excessive surface irregularities shall be performed as specified for machine finishing except that a mechanical tining machine need not be used. A spud type vibrator shall be used to consolidate the concrete around joints and along forms.

(e) *Floating.* After the concrete has been struck off and consolidated, it shall be further smoothed and trued using hand methods and equipment or a tube finisher described under Subsection 405.03, Subpart *(b)*.

Should the tube finisher be equipped with a fog spray, the fog spray shall be used only when and as directed.

After finishing, any excess water and laitance shall be removed from the surface by a straightedge 10 feet or more in length. Successive drags shall be lapped over one half the length of the blade.

(f) *Straightedge Control Testing and Surface Correction.* Systematic checking of the work during placement shall be performed in order to correct surface irregularities while the concrete is in a workable condition. This checking operation shall be performed after the concrete has been consolidated and the excess water has been removed but while the concrete is still plastic. Such systematic checking shall be performed as follows:

- After the intended final pass with the finishing machine, the concrete surface shall be checked with a 10-foot straightedge parallel to the centerline of the traveled way. Surface variations from the testing face of the straightedge shall be corrected before the concrete sets. Major deviations shall be corrected by the finishing machine, while minor deviations may be corrected by the straightedge or float. The addition of water to the surface of the concrete to assist in finishing operations will not be permitted.
- It is suggested that the checking operation progress in successive 5-foot longitudinal increments, with special attention being given to the concrete surface in the vicinity of joints.

(g) *Surface Texture.* The surface texture shall be a steel tine finish having a uniform pattern of grooves perpendicular to the centerline, spaced at approximately 1/2 to 3/4 inch center, 1/8 to 3/16 inch deep and 0.10 to 0.125 inch wide. A mechanical comb with tines conforming to Subsection 405.03,

Subpart *(b)* shall be used to produce the tine finish. The tine finish for the 12 inches of concrete surface adjacent to the curb or raised berms shall be omitted. The tine finish shall be applied when the water sheen has practically disappeared. Tine finishing shall be completed before the concrete is in such condition that the surface is torn or roughened by the operation. The surface thus finished shall be free from rough and porous areas, irregularities, and depressions. In the event of breakdown of the mechanical comb, hand combs with steel tines shall be available at all times for the purpose of providing a surface texture. The hand combs shall be drawn from the center to the edge of the concrete with lightly overlapping strokes so as to produce the required uniform texture.

(h) Edging and Marking. After the final finish, but before the concrete has taken its initial set, the outside edges of the concrete shall be rounded with an edging tool.

All joints shall be tested with a straightedge before the concrete has set and corrections made to comply with surface requirements.

The slabs, including bridge approach and bridge approach transition slabs, shall be numbered consecutively as the work progresses and the last slab placed each day shall be marked with the date laid. The marking shall be made on a corner of the slab at the end completed last. The figures shall be of uniform type, 1 1/2 inches high, and plainly and neatly stamped after the final finish.

405.14 Curing. The concrete shall be cured by one of the following:

- White-pigmented liquid compound maintained and protected from damage for a period of not less than 72 hours. When the ambient temperature is expected to fall below 40 degrees F, the concrete shall be cured and protected in accordance with Subsection 501.17, Subpart *(b)*.
- Waterproof paper maintained in place for not less than 72 hours.
- White polyethylene sheeting or white burlap-polyethylene sheeting maintained in place for not less than 72 hours.
- Burlap maintained wet and in place for not less than 72 hours.
- Hay or straw maintained wet and in place for not less than 72 hours.

Any of the coverings specified above must be maintained in place until at least the day following concrete placement. If these coverings are removed before 72 hours, the concrete shall be sprayed with white-pigmented liquid compound, or clear or translucent liquid compound immediately after removal of the coverings. The coating shall be maintained and protected from damage for the balance of the 72 hour period.

When clear or translucent liquid compound is used as permitted above, the equipment, method and rate of application and other provisions specified for curing with white-pigmented liquid compound shall apply.

Equipment and methods of application to be used for the various curing methods shall be as follows:

(a) White-Pigmented Liquid Compound. Application of the curing material shall be made immediately following final finishing, before any dehydration of the concrete or surface checking occurs. The compound shall be applied in one or two applications as directed. When the compound is applied in two applications, the second shall follow the first within 30 minutes.

The compound shall be applied in a continuous uniform film by means of power-operated pressure spraying or distributing equipment at the rate directed but not less than one gallon per 200 square feet of surface. The equipment applying the compound shall provide for agitation of the com-

pound. During cold weather the material may be warmed in a water bath at a temperature not over 100 degrees F. Thinning with solvents will not be permitted. Should the method of applying the compound produce a nonuniform film, its use shall be discontinued and the curing shall be done by one of the other methods.

Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted.

If rain falls on the newly coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, a new coat of material shall be applied to the affected areas at the rate specified for the original coat. The treated surface shall be protected from damage for a period of at least 3 days. All vehicular and pedestrian traffic is prohibited except that a minimum of walking will be permitted on the dried film as necessary to carry on the work provided any damage to the film is immediately repaired by the application of another coat of the compound. If hair-checking develops during finishing operations before the curing membrane can be applied, or if there is a breakdown of the spraying equipment, protection of the concrete with wet burlap shall be provided.

(b) *Waterproof Paper.* Waterproof paper blankets shall be not less than 20 nor more then 75 feet in length and shall be of a width so that, when in place, they completely cover the surface of the concrete. Unless the paper has been pretreated to resist such action, an 8-inch pleat to allow for shrinkage of the paper joints in the blankets shall be cemented together to provide seams with a minimum lap of 4 inches, producing and maintaining a waterproof joint.

The blankets shall be placed as soon as possible after the final finishing operation without marring or otherwise damaging the surface of the concrete. The blankets shall be securely weighted down by placing a ridge of earth, or light planks, on the edges of the blankets just inside the forms or by other approved means such that depressions are not formed in the concrete surface. Adjoining blankets shall overlap not less than 12 inches. This lap shall also be securely weighted down to form a closed joint. If hair-checking develops before the paper can be placed, the concrete shall be covered initially with wet burlap.

Before moving the blankets ahead to new locations, the blankets shall be inspected and all holes and tears shall be repaired with cemented patches. When the blankets are no longer serviceable as a single unit, selections may be made from the rejected blankets which, if approved, may serve for further applications, provided that two blankets are used as a single unit. However, the double blanket may be rejected if it no longer provides an airtight cover.

(c) *White Polyethylene or White Burlap-Polyethylene Sheeting.* The top surface and sides of the concrete shall be covered with polyethylene or burlap-polyethylene sheeting. The units used shall be lapped at least 18 inches. The sheeting shall be placed and weighted down so as to remain in contact with the surface covered. The sheeting shall extend beyond the edges of the slab for a distance at least twice that of the thickness of the concrete. The covering shall be maintained in place for 72 hours after the concrete has been placed.

(d) *Burlap.* The concrete shall be covered with strips of wet burlap which, after shrinkage, shall be not less than 2 1/2 feet longer than the width of the slab. Approximately 2 feet shall be allowed for shrinkage of new burlap. The strips shall be laid across the slab and shall overlap not less than one-half

the width of the strip to provide a double thickness of burlap. The burlap shall be laid immediately after surface texturing of the concrete and shall be maintained in a wet condition throughout the specified curing period.

If a pipeline is to be used to furnish water for sprinkling, it shall have tees and stopcocks not more than 200 feet apart. If this pipeline is used for supplying water for the concrete mixer and other operations, it shall be of sufficient size and operated under sufficient pressure to serve all such operations and to permit sprinkling of the curing material and shall not be removed from the site of sprinkling until the curing period is over.

(e) Hay or Straw. The entire surface of the concrete shall be covered with a layer of hay or straw, not less than 6 inches uniform thickness, which shall be placed directly upon the concrete and wet by sprinkling, as soon as possible after surface texturing, without marring or otherwise damaging the surface of the concrete.

If a pipeline is used to furnish water for sprinkling, it shall comply with Subpart *(d)* above.

405.15 Surface Requirements.

(a) Permissible Surface Variations. The surface of the concrete will be tested with a 10-foot rolling straightedge that automatically marks, in colored dye, the length of surface variations which exceeds a tolerance of 1/8 inch in 10 feet.

Concrete placed on a new mainline shall be so constructed that, when tested in accordance with Subpart *(b)* below, the measured length of lot exceeding the specified 1/8 inch tolerance shall not exceed 5 percent.

Concrete placed in non-mainline areas of the Project or constructed adjacent to an existing roadway, for the purpose of widening, will be tested in accordance with Subpart *(c)* below.

(b) Surface Compliance Plan. Prior to acceptance testing and notching of the expansion joint filler paper necessary to permit passage of the straightedge, any required sweeping of the surface shall be performed as part of the work.

Conformance to the surface tolerance will be determined in lots, each lot being equal to the number of square yards of concrete surface placed in each production day.

The compliance of a lot will be determined from the percentage of the total length of the lot having surface variation exceeding 1/8 inch in 10 feet, this percent noncompliance being defined as the Lot Percent Defective Length. Lot percent defective length is computed by adding the lengths of individual surface defects exceeding the specified tolerance, dividing this sum by the total length tested, and multiplying by 100 to convert to percent.

The full extent of the lot will be tested in the longitudinal direction along the wheelpaths, defined as the two imaginary lines located approximately 3 feet on each side of the center of the lane and extending for the full length of the lane. The wheelpath of the test will be determined randomly and varied every 300 to 400 feet.

The minimum number of full-length tests required to determine the lot percent defective length is given in Table 405-1 below. The 25 percent sample plan, wherein the number of tests is at least equal to one fourth of the number of wheelpaths in a day's production, will be used initially. Final compliance may be based on the results of the 25 percent sampling except that if the lot percent defective length exceeds 13.9, each wheelpath will be tested.

When more than one test is specified in Table 405-1 below, the initial and intermediate transverse locations of each test will be determined ran-

domly. Exact duplicate tests will not be performed. When testing of all wheelpaths is specified, no intermediate transverse variation of the individual tests will be made. The results of preceding tests are not to be included in the computation of lot percent defective length when application of the 100 percent sample plan is indicated.

In addition to the minimum number of tests specified in Table 405-1 below and run on randomly selected sites, any area which appears defective may be tested including a previous day's production which is damaged by construction operations.

If the lot percent defective length is 5.1 to 13.9 inclusive, the lot shall be removed and replaced or the lot may be accepted upon written request provided that the lot is reduced in accordance with Table 405-2 below.

Table 405-1 Surface Acceptance Testing Schedule

Sampling Plan	Corresponding Number of Tests				Lot Percent Defective Length Measured	Reduction or Retest Requirement
	One Lane	Two Lanes	Three Lanes	Four Lanes		
25%	1	1	2	2	0 to 13.9	As per Table 405-2
					14.0 or more	Test each wheelpath
100%	2	4	6	8	All Values	As per Table 405-2

Table 405-2 Reduction Per Lot Due to Nonconformance to Surface Requirements

Lot Percent Defective Length	Reduction per Lot, Percent
0-5.0	None
5.1-11.0	2
11.1-13.9	5

If the lot percent defective length exceeds 13.9, any or all of the concrete in the lot may be directed to be removed, replaced and retested for acceptance. If the concrete is allowed to remain in place, the lot quantity will be reduced by 16 percent.

(c) *Other Testing*. The riding surface of non-mainline surface, bridge approach and transition slabs, and lanes constructed for the purpose of widening are not subject to the foregoing surface acceptance requirements.

However, the riding surface of any or all portions of the traveled way of the Project (including, but not limited to, such areas as ramps, acceleration or deceleration lanes and lanes added to widen an existing roadway) may be tested to determine the adequacy of the paving methods and equipment. The paving operation is acceptable if the riding surface is in substantial conformity with a 1/8 inch in 10 foot surface tolerance. If the paving operation is unacceptable, the particular placement operation involved shall be discontinued until mutually acceptable methods or equipment are utilized.

Additional compensation, extension of Contract Time or other concession will not be allowed because of revised methods or equipment necessary to produce substantial conformity with a 1/8 inch in 10 foot surface tolerance.

(d) *Surface Remedial Measures.* Correction of surface by grinding and resubmission for testing may be permitted provided that correction does not require removal of more than 1/4 inch of concrete from the surface. Grinding shall be performed with equipment specifically designed for the purpose and shall employ either a diamond-studded drum or stacked-blade-type cutting head. The texture depth in the ground areas shall be similar to that of the adjacent surface. All ground areas shall be neat areas of uniform appearance. When use of such remedial grinding procedures is requested, a plan shall be submitted in writing setting forth the intended limits of the surface restoration and a complete description of the methods and equipment proposed for use.

405.16 Removing Forms. The side forms shall not be removed until the concrete within them has been in place for at least 12 hours. The forms shall be removed carefully so as to avoid damage to the concrete. After the forms have been removed, the sides of the slab shall be cured using one of the methods indicated in Subsection 405.14. Honeycombed areas shall be repaired as directed and operations shall be modified to minimize further honeycombing.

Precautions shall be exercised with respect to form removal and load applications for portland cement concrete containing fly ash since the rate of strength development may be slower.

405.17 Protection from Traffic. The concrete surface course and its appurtenances shall be protected from traffic in accordance with Subsections 105.17 and 105.19. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, bridges, or crossovers, etc. Such protection devices and personnel shall be provided without additional compensation.

Warning signs shall be erected and maintained during the entire curing period. The warning signs shall be erected at each end of the section being cured and at intervals of approximately 500 feet along such section. In residential and business areas, the signs shall be erected at intervals of 100 feet. Wood bridging for pedestrian crossovers shall be placed at street intersections and at other established pedestrian crosswalks. The words **KEEP OFF** shall appear conspicuously on each warning sign and shall be stenciled on each waterproof paper blanket and each sheet of polyethylene sheeting.

In order that the concrete be protected against the effects of rain before the concrete is sufficiently hardened, materials for the protection of the edges and surface of the unhardened concrete shall be available at all times. Such protective materials shall consist of covering material such as burlap, curing paper or plastic sheeting material. When rain is imminent, all paving operations shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

Any damage occurring prior to Acceptance shall be repaired or replaced at no cost to the State.

405.18 Defective Work. From time to time, an examination of the concrete may be made by the Engineer and, as a part of such examination, cores may be taken or sections removed. If such examination discloses that the concrete contains cracks or other defects caused by negligence, poor workmanship or failure to meet the requirements of the Plans and Specifications, such defective work shall be removed and replaced, if directed, at no cost to the State.

405.19 Opening to Traffic. The Resident Engineer will determine when the concrete surface is to be opened to traffic or construction equipment. Traffic or construction equipment will not be permitted on the concrete surface until test specimens, as

provided for under Section 914, have attained a compressive strength of 3000 pounds per square inch. If such tests are not conducted, the concrete surface will not be opened to traffic or construction equipment until the number of days after placement shown below have elapsed, provided, however, that no concrete surface will be opened for traffic before joints have been filled and sealed, all concrete spilled on the surface has been removed, and all curing and other extraneous materials have been removed.

May 16-Oct 15	Concrete Class B	9 days
Oct 16-May 15	Concrete Class B	12 days

For portland cement concrete containing fly ash, opening to traffic is governed solely by the 3000 pounds per square inch compressive strength requirement and not by time elapsed.

Opening to traffic as provided above shall not relieve responsibility for the work in accordance with Section 107.

405.20 Bridge Approach and Transition Slabs. Bridge approach slabs and bridge approach transition slabs shall be constructed in accordance with the requirements specified for concrete surface course except that paving two or more lanes as a single operation will not be permitted.

Working drawings shall be submitted, in accordance with Subsection 105.04, at least 1 month prior to paving and shall show slab and joint layout, including type of joint, location of reinforcement steel and all dimensions.

405.21 Thickness Requirements. The concrete surface course shall be so constructed that its average thickness, based on fifteen random cores per lot taken by the Engineer, is equal to or in excess of the thickness specified. In addition, not more than two of fifteen cores of a lot shall be deficient by greater than 1/4 inch from the specified thickness.

(a) Procedure. A lot consists of approximately 15,000 square yards of surface area excluding bridge approach slabs and transition slab areas. Each lot will be divided into fifteen sections of approximately equal area and one core will be removed from a randomly selected location within each section and tested in accordance with ASTM C 174.

(b) Reduction. If either of the above core thickness requirements is not met, the lot of concrete surface course to which these cores apply is subject to payment reductions as specified below.

1. When the average thickness is less than the specified thickness, the payment reduction will be determined by the formula below except that, if the average thickness deficiency exceeds 1/2 inch, the lot may be required to be removed and replaced at no cost to the State.

$$\text{Percent Reduction} = 300 \times \frac{\text{Specified Thickness} - \text{Average Thickness}}{\text{Specified Thickness}}$$

2. When more than two individual cores are deficient by more than 1/4 inch, payment for the lot will be reduced by 2.0 percent.

COMPENSATION

405.22 Method of Measurement. Concrete surface course, bridge approach slabs and bridge approach transition slabs, with or without reinforcement, of the various thicknesses, will not be measured and payment will be made for the quantity in the Proposal adjusted for Change Orders except as provided for in Subsection 109.01.

Transverse expansion joints of the various types will be measured by the linear foot.

405.23 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Concrete Surface Course, _____" Thick	Square Yard
Concrete Surface Course, Reinforced, _____" Thick	Square Yard
Bridge Approach Slabs, _____" Thick	Square Yard
Bridge Approach Transition Slabs, _____" Average Thickness	Square Yard
Transverse Expansion Joint, Type _____	Linear Foot

Payment reductions due to nonconformance to surface requirements will be made in accordance with Subsection 405.15, Table 405-2 and will be applied to the lot yardage as determined in accordance with Subsection 405.15, Subpart *(b)*.

Payment reductions due to the average thickness being less than the specified thickness will be made in accordance with Subsection 405.21, Subpart *(b)*, No. 1 and will be applied to the lot yardage as determined in accordance with Subsection 405.21, Subpart *(a)*.

Payment reductions due to more than two individual cores being deficient by more than 1/4 inch will be made in accordance with Subsection 405.21, Subpart *(b)*, No. (2) and will be applied to the lot yardage as determined in accordance with Subsection 405.21, Subpart *(a)*.

Note - All payment reductions made in accordance with the above are cumulative.

Payment for the preparation of the underlayer will be made in accordance with Section 209.

CONTENTS

SECTION 500 - BRIDGES AND STRUCTURES

SECTION 501 - CONCRETE STRUCTURES

501.01 Description. This work shall consist of the construction of portland cement concrete bridges, viaducts, trestles, culverts, headwalls, retaining walls, abutments, piers and deck slabs of steel and concrete except those included in other Sections.

Materials and methods of construction not specifically covered in the Plans and Specifications shall conform to the AASHTO Standard Specifications for Highway Bridges.

MATERIALS

501.02 Materials. Portland cement concrete, mortar and grout shall conform to Section 914. Paints and coatings shall conform to Section 912. Other materials shall conform to the following Subsections:

Grit	901.16
Air-Entraining Admixtures	905.01
Chemical Admixtures	905.02
Curing Materials	905.03
Preformed Expansion Joint Filler	908.01
Joint Sealer	908.02
Preformed Elastomeric Joint Sealer	908.03
Reinforced Elastomeric Expansion Dam	908.04
Epoxy Bonding Coat	912.24
Epoxy Waterproofing Seal Coat	912.25
Reinforcement Steel for Structures	915.01
Bolts and Bolting Materials	917.01
Permanent Steel Bridge Deck Forms	917.04
Structural Steel	917.10
Bearing Pads	919.02
Waterproofing	919.05
Waterstops	919.16

501.03 Chemical Admixtures. A water-reducing and retarding admixture (Type D) or a water-reducing admixture (Type A) and a retarding admixture (Type B) shall be used at ambient temperatures of 50 degrees F or greater as an integral part of the design mix for concrete in the bridge deck slabs and in bridge sidewalk slabs wider than 3 feet. Admixtures may be used for parapets and sidewalk slabs 3 feet wide and less. The amounts used shall be in accordance with manufacturer's recommendation. Admixtures are not required at ambient temperatures below 50 degrees F.

EQUIPMENT

501.04 Equipment. Equipment shall be in accordance with Subsection 405.03.

CONSTRUCTION

501.05 Shop Drawings. Shop drawings shall be furnished in accordance with Subsection 105.04.

501.06 Falsework. Falsework used to support the forms and concrete shall be supported on sills resting on foundation of sufficient strength to carry the loads without appreciable settlement. Falsework that cannot be founded on solid footings must be supported by falsework piling.

Where the superstructure of the bridge is designed on the assumption of composite action (shear connector design) of the concrete deck slab and stringers under live load and impact, shoring shall not be used to support the stringers at any point in the span length.

Sufficient camber shall be provided in the falsework and forms of each span to allow for the tightening of joints in the forms and supporting falsework.

501.07 Forms. Forms shall be mortartight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other stresses incident to the construction operations, including vibration. Forms shall be so constructed and maintained to prevent the opening of joints due to shrinkage of the lumber.

The forms shall be built true to line and grade and shall be held in place by means of studs or uprights and waling, which shall be braced.

All edges shall be chamfered with 1/2 inch material. All chamfer strips shall be straight, of uniform width, and dressed. Forms shall be given a bevel or draft in the case of all projections to assure easy removal.

Wood devices of any kind used to separate forms shall be removed before placing the concrete.

Detailed plans for falsework or centering shall be furnished on request. Jacks, wedges or other devices shall be used to maintain the forms at correct elevation and to permit lowering the centers gradually and uniformly without injury to the structure.

A telltale or other type of indicator shall be attached to the forms and arranged in such a manner that any settlement or movement in the forms or falsework is indicated.

(a) Form Lumber. Form lumber for all exposed concrete surfaces shall be dressed at least on one side and two edges, and shall be so constructed as to produce mortartight joints and smooth, even concrete surfaces.

Plywood forms, or forms face lined with plywood, masonite, plastic coating or other similar material may be used, provided the plywood forms and form linings are of uniform thickness and are mortartight when in position.

(b) Metal Ties. Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 1 inch from the face without injury to the concrete. In case wire ties are used, cones shall be provided. The cavities shall be filled entirely with mortar and the surface left sound, smooth, even and uniform in color.

(c) Form Coating. Prior to placing reinforcement, all forms shall be treated to prevent the adherence of concrete. Material that adheres to or discolors the concrete shall not be used. For concrete exposed to sea water, the forms shall be heavily coated with shellac or oil.

(d) Metal Forms. The requirements for forms regarding design, mortartightness, filleted corners, beveled projection, bracing, alignment, removal, reuse and oiling shall apply to metal forms. The metal used for forms shall be of such thickness that the forms remain true to shape. All bolt and rivet heads shall be countersunk on the face forming the concrete surface. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and allow removal without injury to the concrete. Metal forms which do not present a smooth surface or do not line up shall not be used. Forms shall be free from rust, grease or other foreign matter.

(e) Fiber Tubes. Column forms of manufactured fiber tubes will be permitted for use as forms for round columns of concrete. Column forms shall be rigid and truly circular in section. They shall have a hard, smooth surface on the side in contact with the concrete to produce a satisfactory surface without rubbing.

Fiber tube column forms shall be erected promptly after delivery. If storage is necessary, the tubes shall be supported not less than 3 feet above the ground for their entire length. Minimum protection shall consist of a tarpaulin which covers the ends of the tubes at all times.

Column forms shall be erected and held in a vertical position in a manner which prevents distortion of the circular section during placement of concrete.

501.07

(f) *Reuse of Forms.* The shape, strength, rigidity, mortartightness and surface smoothness of reused forms shall be maintained at all times. Any warped or bulged lumber shall be resized before being used.

(g) *Permanent Steel Bridge Deck Forms.* The use of permanent steel bridge deck forms shall be governed by the Supplementary Specifications and shall conform to the following:

When these are subcontracted, the subcontract shall be in accordance with Subsection 108.02 except that the value of the subcontract is to be based on the value of the work for furnishing and installing the forms.

(1) *Design.* The steel forms shall be designed on the basis of dead load of form, reinforcement and plastic concrete, plus 50 pounds per square foot for construction loads. The unit working stress in the steel sheet shall be not more than 0.725 of the specified minimum yield strength of the material furnished, but shall not exceed 36,000 pounds per square inch.

Deflection under the weight of the forms, the plastic concrete and reinforcement shall not exceed 1/180 of the form span or 1/2 inch, whichever is less, but in no case shall this loading be less than 120 pounds per square foot total.

The permissible form camber shall be based on the actual dead load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits.

The design span of the form sheets shall be the clear span of form plus 2 inches measured parallel to the form flutes.

Physical design properties shall be computed in accordance with the AISI Specification for the Design of Cold Formed Steel Structural Members.

The dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained.

Spacing (pitch) of ribs (flutes) shall match spacing of bottom main reinforcement steel. Width of ribs shall be symmetrical and depth of ribs shall be equal.

The forms shall not be considered as lateral bracing for compression flanges of supporting structural members.

The forms shall not be used in panels where longitudinal deck construction joints are located between stringers nor shall they be used for the slab outside the fascia stringers.

Welding will not be permitted to flanges in tension or structural steel bridge elements fabricated from nonweldable grades of steel.

Fabricator's shop and erection drawings for the forms, together with Deck Reinforcement Placement Drawings, shall be submitted in accordance with Subsection 105.04. These plans shall indicate the grade of steel, galvanizing specification, the physical and section properties for all permanent steel bridge deck form sheets and a clear indication of locations where the forms are supported by steel flanges subject to tensile stresses.

Vertical legs of form supports shall be cut at or below the theoretical bottom of deck slab in order to maintain required concrete cover of reinforcement steel at all locations.

(2) *Construction.* All forms shall be installed in accordance with fabrication and erection plans.

Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 1 inch at each end. Form supports shall be placed in direct contact with the flange of stringer or floor beam. All attachments shall be made by permissible welds, bolts or clips. However, welding of form supports to flanges of steels not considered weldable and to portions of flange subject to tensile stresses will not be permitted. Welding and welds shall be in accordance with AWS D1.1 pertaining to fillet welds except that 1/8 inch fillet welds will be permitted.

Any permanently exposed form metal whose galvanized coating has been damaged shall be repaired as specified in Subsection 503.14.

Transverse construction joints shall be located at the bottom of a flute and 1/4 inch weep holes shall be field drilled at not less than 12 inches on center along the line of the joints.

Bottom main reinforcement steel shall be placed at the center of each rib to provide maximum concrete cover.

(3) *Placing of Concrete.* Emphasis should be placed on vibration of the concrete to avoid honeycombing and voids, especially at construction joints, expansion joints and valleys, and ends of form sheets. Calcium chloride or any other admixture containing chloride salts shall not be used in the concrete.

(4) *Inspection.* The method of construction will be observed during all phases of the construction of the bridge deck slab. These phases include installation of the metal forms, location and fastening of the reinforcement, composition of concrete items, mixing procedures, concrete placement and vibration, and finishing of the bridge deck.

Should the Resident Engineer determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, at least one form panel shall be removed for each span at a location and time selected. This should be done as soon as practicable after placing the concrete in order to provide visual evidence that the concrete mix and the procedures are obtaining the desired results. An additional section shall be removed if it is determined that there has been any change in the concrete mix or in the procedures which warrants additional inspection.

After the deck concrete has been in place for a period of 2 days minimum, the concrete shall be tested for soundness and bonding of the forms by sounding with a hammer. If areas of doubtful soundness are disclosed by this procedure, the forms shall be removed, in accordance with Subsection 501.13 and at no cost to the State, from such areas for visual inspection after the concrete has attained specified strength.

At locations where sections of the forms are removed, it is not necessary to replace the forms, but the adjacent metal forms and supports shall be repaired to present a neat appearance and assure their retention. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing and other defects. If irregularities are found, and it is determined that these irregularities do not justify rejection of the work, the concrete shall be repaired as directed and shall be given a Class 1 finish conform-

ing to Subsection 501.14. If the concrete where the form is removed is unsatisfactory, additional forms shall be removed in order to inspect and repair the slab, and the methods of construction shall be modified to obtain satisfactory concrete in the slab. All unsatisfactory concrete shall be removed or repaired.

The amount of sounding and form removal may be moderated, at the Resident Engineer's discretion, after a substantial amount of slab has been constructed and inspected, if the methods of construction and the results of the inspection indicate that sound concrete is being obtained throughout the slabs.

All facilities as are required for the safe and convenient conduct of the Resident Engineer's inspection procedures shall be provided.

(5) *Quantities.* Additional reinforcement steel required by the use of the permanent steel forms shall be provided without additional compensation.

501.08 Reinforcement Steel.

(a) *Order Lists.* Before ordering material, working drawings, order lists, and bending diagrams shall be submitted in accordance with Subsection 105.04.

(b) *Protection of Materials.* Reinforcing steel shall be protected at all times from damage and shall be stored above ground level. When placed in the work, reinforcing steel shall be free of dirt, detrimental scale, paint, oil, or other foreign substances.

All exposed reinforcing steel at construction joints except galvanized or epoxy-coated reinforcement shall be protected with a brush coat of neat cement, mixed with water to a consistency of thick paint, within 1 week after the placing of the initial concrete, unless it is known that the steel is to be embedded within 30 days. Loose coating shall be removed by lightly tapping with a hammer or other tool, not more than 1 week previous to the placing of the concrete.

When epoxy-coated reinforcing steel bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage. Repair of epoxy coating due to damage from fabrication, shipping, handling, minor adjustments, and installation shall be in accordance with AASHTO M 284.

(c) *Bending.* Field bending of bars will be permitted in accordance with Subsection 915.01, Subpart *(a)*. Tolerances for field bent bars shall conform to Subsection 915.01, Subpart *(g)*. Minor adjustments of Grade 60 bars, including those partially embedded in concrete, shall be by the heat method. Such bending shall be accomplished by preheating the bar to between 1000 to 1200 degrees F, and then bending as gently and in as gradual an arc as possible. For bars partially embedded in concrete, heating must be performed in such a manner that there is no damage to the concrete. If the bend area is within 9 inches of the concrete, protective insulation shall be used.

Arrangements shall be made for the portable motive-power bending machine manufacturer's technical representative to be on the site for the first 2 days of production bending, to ensure that the machine is used properly and is of adequate capacity for the Project.

(d) *Placing and Fastening.* All reinforcing steel shall be accurately placed and, during the placing of concrete, firmly held by supports. Bars shall be tied at all intersections except where spacing is less than 12 inches in each direction, in which case alternate intersections shall be tied. Distance from the forms shall be maintained by means of stays, blocks, ties, hangers or chairs. Blocks

for holding reinforcement from contact with forms shall be precast mortar blocks. Blocks shall not be used where they are exposed to view in a finished surface. Metal bar chairs, used to support uncoated reinforcing steel, shall be galvanized or provided with plastic coated feet where the reinforcing steel is directly above stay-in-place forms. Where the reinforcing steel is not directly above stay-in-place forms, metal bar chairs shall be provided with plastic coated feet. Bar supports and wire ties for epoxy coated reinforcement shall be plastic coated or epoxy coated. Reinforcement in any member shall be inspected and approved before any concrete is placed.

Reinforcement steel shall be placed within the following tolerances:

	Tolerance
1. Clear concrete protection and for depth "d" (see Note) in flexural members, walls and compression members:	
• where "d" is greater than 8 inches and less than 24 inches.	± 3/8 inch but cover shall not be reduced by more than 10 percent of the specified cover.
• where "d" is greater than or equal to 24 inches.	± 1/2 inch but cover shall not be reduced by more than 10 percent of the specified cover.
Note - "d" equals specified effective design depth.	
2. Longitudinal location of bends and ends of bars.	± 2 inches except at discontinuous ends of members, the tolerance shall be ± 1/2 inch.
3. Bar spacing, except where inserts etc might require some shifting of bars, where spacing is:	
• equal to or less than 12 inches.	± 3/8 inch
• greater than 12 inches	± 1/2 inch
4. Deck slabs, cover for reinforcement.	+ 1/4 inch, - 1/8 inch

(e) *Splices.* All reinforcement shall be furnished in the full lengths. Splicing of bars, except where prescribed, will not be permitted without written approval. All splices shall be of the lap type wired together to prevent displacement during placement of the concrete.

(f) *Galvanized Fabric Reinforcement.* Mesh sheets shall be overlapped not less than one mesh in width. Overlaps shall be fastened securely at the ends and edges.

501.09 Handling, Measuring and Batching Materials. Handling, measuring and batching materials shall conform to Subsection 405.07.

Different brands of cement or the same brand of cement from different mills shall not be used in any structure unless authorized in writing. Only those cements which can produce similar color in the concrete of any structure will be authorized.

501.10 Mixing Concrete. Mixing of the concrete shall conform to Subsection 405.08.

501.11 Limitations of Placing. At least 30 days prior to the placement of concrete, a plan of action shall be submitted for approval for the placement of concrete during hot and cold weather conditions as defined herein. In no case, during mixing and placement, shall the temperature of the concrete be less than 50 or more than 90 degrees F. When the ambient temperature reaches 75 degrees F, the provisions of hot weather concreting, as specified in Subpart *(b)* below, shall apply. When the temperature of the plastic concrete reaches 85 degrees F, immediate steps shall be taken to cool either the mixing water or the aggregates, or both, in accordance with the plan of action. In no case shall concrete be placed when its temperature in the plastic state at the completion of mixing exceeds 90 degrees F.

(a) Cold Weather Concreting. When the ambient temperature is above 40 degrees F, the plastic concrete shall have a temperature of at least 50 degrees F at the time of placing. When the ambient temperature is 40 degrees F or below, the plastic concrete shall have a temperature of at least 60 degrees F. Concrete shall not be placed when the ambient temperature is less than 10 degrees F.

Maintenance of at least the minimum temperature shall be accomplished by heating the water or the aggregates, or both, as necessary. Heating methods which alter or prevent the entrainment of the required amount of air in the concrete shall not be used. Heating shall be in accordance with the ACI 306, Part 2.2 through 2.6.

(b) Hot Weather Concreting. When the ambient temperature reaches 75 degrees F, one or more of the following precautions shall be followed:

- Schedule work so that concrete can be placed with the least possible delay and, if necessary, start placing during late afternoon, at night or early morning.
- Use a water-reducing admixture or a water-reducing and retarding admixture as per manufacturer's recommendation. When more than one admixture is used, they shall be from the same manufacturer.
- Sprinkle the coarse aggregate stockpile to cool it by evaporation.
- Use chilled mixing water or shaved ice to replace part of the mixing water as recommended in ACI 305R, Subpart 2.3.6.
- In the case of truck mixing, do not rotate the drum during and after the addition of cement to the mix until mixing water is added at the construction site. This may require reduced loads or the utilization of horizontal type mixers.
- Prevent absorption by sprinkling the underlying material and the wood forms just before placing so that they do not absorb water from the mix.
- Erect windbreaks to prevent winds from drying exposed concrete surfaces while they are being finished.
- Screed and float concrete as it is placed and start curing immediately.

501.12 Placing Concrete. Concrete shall not be placed until forms and all reinforcing steel have been placed, inspected and approved. The forms shall be clean of all debris immediately prior to placing concrete, and surfaces not oil treated shall be wetted. Concrete shall be placed so that segregation does not occur and there is no displacement of reinforcement. Concrete shall be placed in the forms as nearly as practical in its final position in order to avoid rehandling, and a horizontal surface of

the plastic concrete shall be maintained. After initial set of the concrete, forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement. Concrete shall not be placed until all laitance which may have formed on concrete previously placed or any loose, deleterious material on reinforcing bars has been removed.

The external surface of all concrete shall be worked during the placing so as to force all coarse aggregate from the surface and to bring mortar against the forms to produce a smooth finish substantially free from water and air pockets or honeycombs.

(a) Chutes and Troughs. Concrete shall not be dumped or dropped for a distance greater than 5 feet, unless confined by closed chutes or pipes.

All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by flushing with water after each run. The water used for flushing shall be discharged outside of the forms and clear of the concrete already in place.

(b) Vibrating. The concrete shall be compacted with mechanical vibrators operating within the concrete. When required, vibrating shall be supplemented by hand spading to assure proper and adequate compaction.

Vibrators shall be so manipulated as to work the concrete around the reinforcement and embedded fixtures and into corners and angles of the forms.

Vibrators shall not be used as a means to cause concrete to flow or run into position. The vibration at any point shall be of sufficient duration to accomplish compaction, but shall not be prolonged to the point where segregation occurs.

At least one additional standby vibrating unit shall be available for individual concrete placements in excess of 10 cubic yards.

(c) Depositing Concrete Under Water. Only concrete classified as seal concrete in Subsection 914.05, Table 914-2, shall be deposited under water. The concrete shall be placed in one continuous operation.

To prevent segregation, the concrete shall be placed in a compact mass in its final position by means of a tremie or a closed bottom dump bucket, and shall not be disturbed after being deposited. Care must be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water.

When a tremie is used, it shall consist of a tube not less than 10 inches in diameter, constructed in sections having flanged couplings fitted with gaskets. The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the concrete and to permit its being lowered rapidly when necessary to choke off or retard the flow. The tremie shall be filled by a method that prevents washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall contain sufficient concrete to prevent any water entry.

When concrete is placed with a bottom-dump bucket, the bucket shall have a capacity of not less than 1/2 cubic yard and shall be equipped with loose fitting top covers. The bucket shall be lowered gradually and carefully until it rests upon the prepared foundation or upon concrete already placed. It shall then be raised very slowly during the discharge travel, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture. Seal concrete shall be placed as closely as possible to the top of the seal elevation. Isolated depressions in the top of seal placed shall not be lower than 6 inches below the theoretical elevation,

nor shall any individual peaks project more than 9 inches above the theoretical elevation. Soundings will be taken during the placement of the final lift of each seal, before initial set, to ensure the concrete is placed to these limits. Areas found to exceed the 9-inch tolerance shall be cut down to within the permissible height above the theoretical top of seal.

After dewatering, all laitance or other unsatisfactory material shall be removed from the surface of the seal by scraping, chipping or other means until sound concrete is exposed.

(d) *Pier Columns.* Concrete in columns shall be placed in one continuous operation between construction joints. The concrete shall be allowed to set at least 4 calendar days before caps are placed provided that the concrete has been conditionally accepted as meeting the requirements of these Specifications, pending results of final compressive strength tests.

(e) *Deck Slabs.* At least 20 calendar days prior to the start of placing bridge deck concrete, a plan of operation shall be submitted for review. This plan shall include a screed and rail erection plan, deck grades, the sequence and rate of placing concrete, the number and type of personnel who shall be engaged in the work, and a complete description of the equipment to be used in handling, placing and finishing the concrete including the weight of the finishing machine.

Computations for setting forms and screed supports shall be based on elevations obtained at points not farther than 10 feet apart on each beam.

Placing of concrete will not be permitted until it is evident that the placement and finishing operation shall be completed within the scheduled time, that experienced concrete finishers are available to finish the deck, that any required weather protective materials are in place and that all necessary finishing tools and equipment are on hand at the site of the work.

Methods, procedures and equipment shall be used which shall produce a riding surface in accordance with the texture and surface tolerance requirements specified in Subsections 501.15 and 501.16.

Any request for a change in the number, location or configuration of construction joints shall be included in the plan of operation.

Placement of concrete shall be maintained at a minimum rate of approximately 30 cubic yards per hour for deck slabs of 180 cubic yards or less. When the deck slab is in excess of 180 cubic yards of concrete, the minimum rate of placement shall be approximately 40 cubic yards per hour. The placement of concrete shall be scheduled so that finishing operations can be completed during daylight hours unless adequate lighting facilities are provided on the site and approval is given.

The concrete shall be delivered, placed and consolidated at a uniform rate to insure a continuous operation. The working face of fresh concrete shall at all times be maintained parallel to the finishing machine or other strikeoff.

Unless otherwise designated, a self-propelled finishing machine shall be used for striking off and finishing the surface. The finishing machine shall be the rotating cylinder type or the oscillating type. Longitudinal or transverse type finishing machines may be used. The finishing machine shall be capable of being propelled both forward and backward to enable repeat passes to be made in order to correct surface irregularities and to produce a surface which conforms to the required profile grade, cross section and surface tolerances. Longitudinal finishing machines shall be of a type capable of concrete placement for the full length of the span, or between designated or approved

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construction joints. Transverse finishing machines shall preferably be of sufficient size to finish the full width of deck between curbs or the distance between longitudinal construction joints. In areas outside the width of traffic lanes or in areas inaccessible by machine, vibratory screeds or other manually operated strikeoffs may be used.

The machine shall travel on steel rails, pipe or other grade control, which shall be adequately supported by vertical supports securely fastened in place at close spacing to prevent any appreciable deflection between rail supports. The supports for the rails, when located in the deck concrete, shall be of the type which can be removed without disturbing the concrete, or shall be partially removable so that no part remains above 2 1/2 inches below the finished concrete surface. If such supports are removed before initial set has taken place, the resulting holes shall be filled with deck concrete; if the concrete has hardened, holes shall be filled with nonshrink, nonmetallic grout.

Prior to placing the concrete, rails or other guides for the finishing machine shall be in place, set to achieve the deck elevations required, and secured for the full length of the concrete placing plus such additional distance that the machine clears all finishing operations.

The finishing machine shall be operated over the full length of the bridge segment to be finished prior to beginning concreting operations. This test run shall be made with the screed adjusted to its finishing position. During the test run, checks shall be made of the height and deflection of guide rails and of the cover over slab reinforcement and forms. All necessary correcting shall be made before concreting is begun. If the finishing machine is of the longitudinal type, the test run may be omitted when reinforcement clearances preclude movement of the machine across the deck.

Concrete placement and initial strikeoff by a transverse finishing machine shall be coordinated so that initial strikeoff is never more than 10 feet behind the concrete placement.

Strikeoff by a longitudinal finishing machine shall not be initiated until concrete has been placed a minimum of two bays wide for the entire slab length. In this context, a bay is defined as the horizontal distance between adjacent girders. The final pass made by the longitudinal finishing machine shall uniformly lag behind the placement by the minimum two-bay width. Sufficient depth checks shall be made behind the machine and along the full length of the span to insure achievement of the required section and reinforcement cover.

The concrete shall be given as few passes of the machine as are necessary to obtain a smooth, dense surface of the required contour. A small uniform quantity of mortar shall be maintained ahead of the screed on each pass. At no time shall the quantity of concrete carried ahead of the screed be so great as to cause slipping or lifting of the finishing machine on the rails.

Improper adjustment or operation of the finishing machine which results in unsatisfactory consolidation, reinforcement cover or surface requirement shall be corrected immediately. Unsatisfactory performance, particularly with respect to surface tolerances attained, may be cause for rejection of the equipment.

Work bridges or other positive means of permitting access to the surface of the deck shall be provided for the purpose of finishing, straightedging, making corrections and for other operations requiring access to the surface of the deck after the passing of the screed. Before concrete placing operations

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begin, substantial bulkheads or headers shall be set and shaped to the required deck surface cross section. The concrete shall be placed as a monolithic unit in a continuous operation between joints.

When the concrete placing within any complete unit (i.e., for trusses, arches, continuous or cantilevered unit) is to be divided, the placing shall be made and finished in the numbered sequence shown, beginning with the lowest number. All sections having the same number shall be placed before sections of higher number. The sequence of placing for sections having the same number shall be optional. No deck section shall be placed until all previously placed concrete within the complete unit has cured for 72 hours. This requirement may be waived if the succeeding section can be completed within 4 hours of the initial placement of the day. Written request for approval is required to waive this requirement.

Sidewalks, parapets and curbs within any one complete unit shall not be placed until all the deck slabs within that complete unit have been placed. The numbered sequence shown shall also apply to pedestrian sidewalk sections over 2 feet 6 inches wide, but it need not apply to safety curbs, 2 feet 6 inches wide or less, curbs and parapets.

For simple spans the placing of concrete shall preferably progress upgrade. However, deck slabs may be placed with a finishing machine in a continuous operation from either end of a bridge regardless of grade.

(f) *Arches.* Arch centering work shall be lowered gradually and symmetrically so as to avoid overstresses in the arch.

Centering shall be placed upon jacks to provide means of correcting any slight settlement which may occur after concrete placement has begun. Any adjustments, made necessary by settlement, shall be made before the concrete has taken its initial set. Railings and copings shall not be constructed until centering has been struck and the arch made self-supporting.

For closed-spandrel arches, such portions of the spandrel walls as may be necessary to avoid jamming of the expansion joints shall be left for construction subsequent to the striking of centers.

For filled-spandrel arches, backfilling of embankment material shall be in accordance with Subsections 206.04 and 206.10, with care being taken to load the ring uniformly and symmetrically.

Concrete in arch rings and ribs shall be placed in the order prescribed. Generally, keys shall be placed at laps in reinforcing steel.

When permitted, arch rings may be cast in a single continuous operation.

(g) *Parapets.* Care shall be exercised to obtain smooth and tight-fitting forms which can be held rigidly to line and grade and can be removed without injury to the concrete. All moldings, panel work, and bevel strips shall be constructed with neatly mitered joints. All corners in the finished work shall be true, sharp, and clean cut and shall be free from cracks, spalls or other defects.

(h) *Construction and Contraction Joints.* Construction or contraction joints shall be located only where shown or authorized. The construction joint between the walls and top slab of a box culvert may be deleted if the joint is designated as optional. If the optional joint is deleted, concrete shall not be placed in the top slab until at least 2 hours after the final concrete had been placed in the walls.

Newly placed concrete in contact with previously placed concrete (at horizontal construction joints and at contact with existing concrete structures where the joints are exposed to view in the finished structure) shall contain an

excess of mortar to insure bond and provide a neat joint. In order to provide sufficient mortar for such joints, a layer of portland cement mortar, 1 to 2 inches thick, shall be deposited against the existing concrete into which the regular mix concrete shall be deposited immediately. The cement-sand mortar shall be of the same proportions as in the regular concrete mix except that the coarse aggregate is omitted.

(i) *Expansion Joints.* Expansion joints shall be of the following kinds:

(1) *Open Joints.* Open joints shall be constructed by insertion and subsequent removal of a wooden strip or metal plate. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint.

(2) *Filled Joints.* Expansion joints shall be constructed similarly to open joints.

When preformed bituminous, cork, sponge rubber or other material is specified, it shall be cut to the same shape and size as that of the surfaces being jointed. It shall be fixed firmly against the surface of the concrete already in place in such manner that it is not displaced when concrete is deposited against it. When more than one piece of filler is used, the abutting pieces shall be covered with a layer of asphalt-saturated roofing felt of not less than 40 pound grade, one side of which shall be covered with hot asphalt to insure proper retention.

When preformed elastomeric joint seals are specified, the sealer shall be installed as soon as practicable after the concrete curing period using a lubricant-adhesive. Temperature limitations of the adhesive as recommended by the manufacturer shall be observed. Joints shall be cleaned and shall be free of oil, curing compound and all other foreign materials immediately prior to the application of the lubricant-adhesive.

The sealer shall be furnished and installed in a continuous length across the full width of slab unless otherwise authorized in writing.

The sealer shall be installed by the use of hand or machine tools and secured in place with the lubricant-adhesive which shall cover both sides of the sealer over the full area in contact with the concrete. The adhesive may be applied to the concrete or the sealer or both.

(3) *Steel Joints.* The plates, angles or other structural shapes shall be shaped at the shop to conform to the section of the concrete slab. Fabrication and painting shall conform to Section 503. When specified, the material shall be galvanized in lieu of painting. Care shall be taken to insure that the surface in the finished plane is true and free of warping. Methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion joints shall be adjusted to ambient temperatures.

(4) *Waterstops.* Metallic waterstops shall be spliced, welded or soldered, as necessary, to form continuous, watertight joints.

Nonmetallic waterstops shall be installed in continuous strips, without splices, except that splices will be permitted at changes in direction when necessary. All splices of nonmetallic waterstops shall

be made in accordance with the manufacturer's recommendations. In the case of polyvinyl chloride waterstops, the heat used shall be sufficient to melt but not char the plastic.

Provisions shall be made to support the waterstops during the progress of work and to insure their proper embedment in the concrete. The concrete shall be worked in the vicinity of the joints to ensure maximum density and imperviousness. Forms shall be so designed that they can be removed without damaging the waterstops. Guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from mechanical damage.

(5) *Reinforced Elastomeric Expansion Dam.* The expansion dam shall be bolted to the bridge deck, forming a mechanical connection between the metal components molded in the expansion dam and the bridge deck. All exposed steel shall be galvanized. Cavities for anchor bolts shall be provided with tight-fitting, removable neoprene plugs.

Detailed shop drawings of the expansion dam, including all information pertinent to the installation procedure, shall be submitted in accordance with Subsection 105.04.

The expansion dam shall provide a watertight joint. It shall be able to withstand vehicular traffic and shall be capable of preventing debris from clogging the joint and interfering with the natural movement of the bridge.

Minor differences in the configuration of the expansion dam will be permitted subject to written approval, however, any major departure from design and details will not be permitted.

The expansion dam shall be installed as soon as practical after the concrete has cured unless otherwise authorized. Vehicles will not be permitted to pass over the joint until the expansion dam has been installed.

The expansion dam shall be set in a depression formed in the concrete. The shelves of the depression must be in a plane parallel with the surface of the bridge deck or approach slab. The entire depression shall be uniform in width and depth. Any cavities or high area shall be corrected by filling with epoxy grout or grinding.

Expansion type anchor bolts are not permitted but threaded anchor bolts may be used by coring and grouting to vertical surfaces and to the bridge deck on rehabilitation projects. Stainless steel, automatic, end-welded, threaded studs or stainless steel anchor bolts that have been placed before the concrete is placed may be used to secure the expansion dam to new bridge deck. Anchor bolt lines shall be symmetrical around the theoretical centerline of joint.

The depression in the concrete shall be cleaned of all dirt, loose mortar or other debris and shall be dry prior to placing sealant.

Before installation, the expansion dam shall be cleaned by wire brushing both ends and the underside along each anchor bolt line. Sealant shall then be applied to the horizontal surface of the unit and the unit inserted into the depression so as to engage all anchor

bolts. All anchor bolts shall be tightened to the torque called for except the two bolts at the end that receives an adjacent unit. All excess sealant shall be immediately removed.

Upon completion of installation, all anchor bolts shall be checked and retightened to the proper torque.

The bolt hole recess shall be cleaned and filled with the sealant to a maximum of one half its depth and immediately closed with a plug.

The top of the expansion dam shall not be closer than 1/8 or more than 1/4 inch from the top of the finished bridge deck.

The epoxy grout or sealant shall be placed immediately following installation of the expansion dam. The opening that is to receive the grout or sealant shall be cleaned of all dirt, loose mortar and other debris before the grout or sealant is placed.

A stud-welding machine shall be used to weld threaded studs onto the top leg of the anchored steel angles. Care shall be exercised while welding the threaded studs and tightening nuts to insure proper alignment and no thread damage.

(j) *Anchor Bolts.* Anchor bolts in piers, abutments or pedestals shall be set either in the concrete as it is being placed, or in holes formed while the concrete is being placed, or in holes drilled after the concrete has set except that drilling will not be allowed in rigid frame and T-type piers. Sleeves for anchor bolts shall be circumferentially corrugated and shall be of galvanized metal or plastic. The wall thickness of the sleeves shall be that which is necessary to withstand the construction loads applied to them. If drilled, holes shall be at least 1 inch larger in diameter than the bolts used. During freezing conditions, anchor bolt holes shall be protected from water accumulations at all times. Bolts shall be set accurately and fixed with grout completely filling the holes.

(k) *Shoes and Bearing Plates.* Bridge seat bearing areas shall preferably be finished high and bush-hammered to grade. Shoes and bearing plates shall be set as provided in Section 503.

(l) *Drainage and Weep Holes.* Drainage and weep holes shall be constructed in the manner and at the locations required. Ports or vents for equalizing hydrostatic pressure shall be placed below low water, if shown.

Forms for weep holes through concrete shall be 4-inch clay pipe, polyvinyl chloride, transite or nonreinforced concrete drain pipe.

(m) *Pipes, Conduits and Ducts.* Pipes, conduits and ducts encased in concrete shall be installed before the concrete is placed. Pipes shall be held or braced rigidly during concrete placement in order to prevent their displacement. Public utilities shall be installed as specified in Section 510.

(n) *Concrete Exposed to Sea Water.* Construction joints shall not be formed between levels of extreme low water and extreme high water. Between these levels, sea water shall not come in direct contact with the concrete for a period of 28 calendar days after being placed. This shall be accomplished by pumping, retention of forms or use of a waterproof concrete coating.

(o) *Pumped Concrete.* At least 20 calendar days prior to beginning operations, a plan of operation conforming to ACI 304.2R shall be submitted for approval, showing method and procedures along with a list of adequate description of equipment and manpower proposed for use, including contingency equipment and manpower. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete. Aluminum alloy pipe will not be permitted as a conveyance for the concrete nor for any pieces of equipment

in contact with the concrete. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there is no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be cleaned.

501.13 Removal of Forms and Falsework. Unless concrete strength test specimens are required as controls for form stripping and structure loading, the requirements herein shall apply.

Superstructure load shall not be placed upon finished bents, piers or abutments until authorized, but the minimum time allowed for the hardening of concrete in the substructure before any load of the superstructure is placed thereon shall be 14 calendar days.

Forms and falsework shall not be loosened, disturbed or removed without authorization. Blocks and bracing shall be removed at the time the forms are removed and in no case shall any portion of the wood forms be left in the concrete.

Falsework removal for continuous or cantilevered structures shall be such that the structure is gradually subjected to its working stress. To facilitate finishing, forms used on ornamental work, railings and parapets shall be removed in not less than 12 nor more than 48 hours, depending upon weather conditions. In order to determine the condition of concrete in columns, forms shall always be removed from them before the removal of shoring from beneath beams and girders.

Forms and their supports may be removed from under arches, bents, pier caps, beams and deck slabs after the expiration of 14 calendar days, column forms after 5 calendar days, and wall forms and side forms for beams carrying no loads after one calendar day provided that, for structures exposed to sea water, the time for removal shall be as specified in Subsection 501.12, Subpart *(n)*.

Falsework and centering for spandrel-filled arches shall not be struck until back of abutments have been placed up to spring line. Falsework supporting the deck of rigid frame structures shall not be removed until fills have been placed back of the vertical legs.

Precautions shall be exercised with respect to form removal and load applications for portland cement concrete containing fly ash since the rate of strength development may be slower.

501.14 Finishing Concrete Surface. The surface of the concrete shall be finished immediately after form removal.

Vertical outside face of sidewalk and deck slab fascia overhang, vertical surfaces of parapets and all other surfaces to be rubbed shall be given a Class 2 finish. All other concrete surfaces shall be given a Class 1 finish.

In addition to the Class 1 finish, all surfaces of concrete exposed to view in the finished structure shall be finished by rubbing with burlap and grout composed of equal parts of cement and clean, sharp sand to produce a smooth surface of uniform color.

(a) Class 1, Ordinary Surface Finish. As soon as the forms are removed, all projecting wire or metal devices that have been used for holding the forms in place and which pass through the body of the concrete, shall be removed or cut back at least one inch beneath the surface of the concrete. Lips of mortar and all irregularities caused by form joints shall be removed.

All small holes, depressions and voids that show upon the removal of forms shall be filled with cement mortar mixed in the same proportions as that used in the body of the work. In patching larger holes and honeycombs, all coarse or broken material shall be chipped away until a dense uniform surface of concrete exposing solid coarse aggregate is obtained. Feathered edges

shall be cut away to form faces perpendicular to the surface. All surfaces of the cavity shall be saturated with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with stiff mortar composed of one part of portland cement to two parts of sand, which shall be tamped into place. The mortar shall be preshrunk by mixing approximately 30 minutes before using (the length of time may be varied in accordance with the brand of cement used, temperature, humidity and other local conditions.) The surface of this mortar shall be floated with a wooden float before initial set takes place. The patch shall be kept wet for a period of 5 calendar days.

For patching large or deep areas, coarse aggregate shall be added to the patching material and precautions shall be taken to ensure a dense, well-bonded and cured patch.

Areas having excessive honeycombs may be considered cause for rejection of a structure. Where written notice is given that a structure has been rejected, said structure shall be removed and rebuilt, in part or wholly, as specified, without additional compensation.

All construction and expansion joints shall be tooled and free of all mortar and concrete.

(b) *Class 2, Rubbed Finish.* After removal of forms, the rubbing of concrete shall be started as soon as its condition permits. Immediately before starting this work, the concrete shall be kept saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing to set. Surfaces shall be rubbed with a wetted wooden block or a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in proportions used in the concrete being finished. The carborundum stone shall not be used until the concrete has hardened to the state where the sand grinds rather than ravels or rolls. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place. A brush finish or painting with grout will not be permitted.

After all concrete above the surface being finished has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color.

(c) *Class 3, Tooled Finish.* This finish, for panels and other like work, may be obtained by using a bushhammer, pick, crandall, or other approved tool. Air tools, preferably, shall be used. Tooling shall not be done until the concrete has set for at least 14 days or longer, as may be necessary, to prevent aggregate particles from being picked out of the surface. The finished surface shall show a grouping of broken aggregate particles in a matrix of mortar, each aggregate particle being in slight relief.

(d) *Class 4, Sandblasted Finish.* The cured concrete surface shall be sandblasted with hard, sharp sand to produce an even, fine-grained surface in which the mortar has been cut away, leaving the aggregate exposed.

(e) *Class 5, Wire Brushed or Scrubbed Finish.* As soon as the forms are removed and while the concrete is comparatively green, the surface shall be scrubbed thoroughly and evenly, with stiff wire or fiber brushes, using a solution of one part muriatic acid to four parts water. When the cement film or surface is completely removed and the aggregate particles are exposed,

leaving an even pebbled texture having an appearance grading from that of fine granite to coarse conglomerate, the surface shall be washed thoroughly with water containing a small amount of ammonia to remove all traces of acid.

(f) Class 6, Special Surface Finish. As an alternative to the Class 2 finish, an acrylic, latex or other waterproofing type concrete coating may be used after completion of a Class 1 finish on the concrete surface. The finished color of the coating shall be gray, to match the color of the concrete in the structure.

501.15 Deck Slab Surface Texture Finish. The surface of the deck slab shall be finished in accordance with Subsection 405.13 except that Subpart *(g)* shall not apply. All concrete bridge deck slabs shall be textured with an artificial turf drag and shall be sawcut groove finished.

(a) Turf Drag. Immediately after finishing has been completed, the surface shall be given a texture with an approved turf drag. The drag shall be made of molded polyethelene with synthetic turf blades approximately 0.50 inches long. There shall be approximately 6000 blades per square foot.

The drag shall be operated in a longitudinal or transverse direction. Once begun, the direction of texturing shall not be changed. Transverse texturing shall be done from a work bridge.

When texturing is done in the longitudinal direction, the turf drag shall be attached to the finishing machine and shall be a single full-width strip. Small areas inaccessible to the full-width drag shall be textured by hand methods.

The turf drag finish shall be applied so as to prevent ridges or gouges from forming in the concrete surface. The drag shall be weighted and the contact area changed as required to produce a uniform texture. The drag shall be cleaned periodically to remove all hardened concrete particles. Texture resulting from the drag shall stop within 1 foot of curbs.

(b) Sawcutting. Sawcutting shall not be permitted until the concrete on the deck has attained a strength of at least 3000 pounds per square inch as determined from cylinders cast during the placing of the concrete deck and which are at least 14 calendar days old. Unless otherwise approved, sawcutting shall be completed prior to opening to traffic.

(c) Sawcut Grooved Surface. The hardened surface of concrete bridge deck slabs shall be grooved except at the locations shown in Table 501-1 below.

At least 7 days prior to sawcutting, a plan of action shall be submitted for approval detailing the layout of the grooving procedure to be followed. Spacing dimensions at the starting and ending point of each pass shall be noted. A description of the sawcutting equipment shall be included.

Grooves shall be cut perpendicular or radial to the centerline of the traveled way. Radial grooving shall be conducted in partial-width passes. Each pass shall be limited to one lane width. Adjustment along the longitudinal axis of the bridge deck shall be made at no less than 12-foot intervals, yielding a uniformly grooved surface finish. Grooves shall be rectangular in shape and shall conform to the following dimensions:

Width	0.10 to 0.15 inch
Depth	0.25 to 0.375 inch

Grooves shall be spaced at 1.5 plus or minus 0.0625 inches center-to-center of groove. This spacing dimension may be increased up to 3 inches at the end of each consecutive, multiple-bladed, saw cut pass as necessary to accommodate the distance limits required at the joint system in accordance with Table 501-1 below. The required dimension shall be determined prior to actual deck grooving and shall be stated in the plan of action. Grooves shall

not be cut over an area which has been already grooved. No cutting blade shall be introduced into a groove that has been already established. When it is necessary to rotate the sawing equipment to complete grooving to within the limits specified in Table 501-1 below, the longitudinal gap created shall not exceed 3 inches in width.

Grooves shall terminate within the limits prescribed in Table 501-1 below.

Table 501-1 Sawcut Grooved Area Limits

Location	Closest Allowable Distance	Farthest Allowable Distance
Drainage structure	1 ft - 0 in	1 ft - 3 in
Vertical face (curb or parapet), or face of railing (no curb)	1 ft - 0 in	1 ft - 3 in
Joint system	6 in	(see Note 1)

Note 1 - This distance is a variable which is dependent upon equipment size. This dimension shall be measured perpendicular to the direction of the grooves. The distance shall be measured from the edge of the joint system and, in no case, shall be greater than the width of the saw head plus 9 inches tolerance up to a maximum distance of 2 feet 9 inches.

Grooves shall be constructed using multiple-bladed sawcutting equipment, fitted with diamond-tipped circular saw blades except when the use of single blade circular saw equipment is permitted where such equipment is necessary to complete the work, as required.

Prior to grooving operations, two approved gauges to verify groove depth shall be supplied. The gauges shall be accompanied by the manufacturer's instructions for their use.

During grooving operations, the groove dimensions will be checked at random. If the minimum groove depth has not been achieved, grooving operations shall stop and the necessary adjustments shall be made.

Slurry or debris from the grooving operations shall not accumulate in the grooves. Slurry or debris shall not be disposed of in the structure or highway drainage system or on roadway slopes. Slurry shall be collected promptly and removed for off-site disposal.

Sidewalks and top of curbs shall receive a final finish with a fine-bristle broom.

501.16 Concrete Deck Surface Requirements.

(a) Permissible Surface Variations. The surface of concrete bridge deck slabs will be tested with a 10 foot rolling straightedge that automatically marks, in colored dye, the length of deck surface variations which exceed a tolerance of 1/8 inch in 10 feet.

Deck slabs which are required to be struck and finished with a self-propelled finishing machine shall be so constructed that, when tested in accordance with Subpart *(c)* below, the measured length of lot exceeding the specified 1/8 inch in 10 foot tolerance shall not exceed 8.9 percent specified in Table 501-2, Schedule A below.

501.16

When manual strikeoff and finishing is permitted and the option for manual methods is used, the deck slab shall be so constructed that the measured length of lot exceeding the specified 1/8 inch tolerance shall not exceed 19.9 percent specified in Table 501-2, Subschedule B1 below.

If the option to use a self-propelled finishing machine is selected when manual strikeoff and finishing is permitted, the deck slab shall be so constructed that the measured length of lot exceeding the specified 1/8 tolerance shall not exceed 13.9 percent specified in Table 501-2, Subschedule B2 below.

(b) *Control Testing.* Deck slab surfaces shall be systematically checked during placement to correct surface irregularities while the concrete is in a workable condition.

Such systematic control testing shall be performed as follows:

- After the intended final pass with the finishing machine or other strikeoff, the deck surface shall be checked with a 10 foot metal straightedge operated parallel to the centerline of the bridge. Surface variations from the testing face of the straightedge shall be corrected before the concrete sets. Major deviations shall be corrected by the finishing machine or other strikeoff, while minor deviations may be corrected by the use of a straightedge or float. The addition of water to the surface of the concrete to assist in finishing operations will not be permitted.

The specific conduct of the control testing, including the number and location of straightedge checks, shall be entirely the province of the Contractor. However, it is suggested that the checking operation progress in successive 5-foot longitudinal increments, with at least one full-slab length straightedge check being made within the transverse limits of each of the designated lanes of traffic.

(c) *Acceptance Testing.* Conformance to the surface tolerance for concrete deck slabs will be determined in lots, each lot being equal to the number of cubic yards of deck concrete placed in the designated lanes of traffic in each production day. Such lot quantity will be calculated using the specified nominal deck thickness and excludes the quantity of concrete placed in haunches, end dams and diaphragms.

The acceptance of a lot is based on the percentage of the total length of the lot having surface variation exceeding 1/8 inch in 10 feet, this percent noncompliance being defined as the Lot Percent Defective Length. Lot percent defective length is computed by adding the lengths of individual surface defects exceeding the specified tolerance, dividing this sum by the total length tested, and multiplying by 100 to convert to percent.

The full extent of the lot will be tested in the longitudinal direction. The transverse location of the test generally is in the wheelpaths of vehicle travel, defined as the two imaginary lines located approximately 3 feet on each side of the centerline of the lane and extending for the full length of the lane.

The minimum number of full-length tests required to determine the lot percent defective length is equal to the total number of wheelpaths in the lot. The number of tests performed beyond this minimum, if any, and their location, are at the option of the Engineer.

When the lot percent defective length of a deck slab exceeds the value specified in the applicable paragraph of Subpart *(a)* above but is less than 25 in the case of a machine-finished deck or 35 in the case of a manually finished deck, and if the slab is not removed and replaced, the lot may be accepted upon written request provided that payment for the lot is adjusted in accordance with Subpart *(e)*, Table 501-2 below.

If the lot percent defective length equals or exceeds 25 on any machine-finished deck (irrespective of whether such machine finishing was required or optional) or 35 on a manually struck and finished deck, the Engineer may order any or all of the concrete in the lot to be removed, replaced, and retested for acceptance. If the Engineer allows the concrete to remain in place, payment for the lot will be reduced by 15.0 percent.

(d) Cessation of Deck Concreting. The Resident Engineer reserves the right to reject bridge deck construction methods or equipment which do not result in surfaces which are in substantial conformity with a 1/8 inch in 10 feet surface tolerance. The deck will be considered in substantial conformity with the required surface tolerance only if the lot percent defective length does not exceed the value specified in the applicable paragraph of Subpart *(a)* above.

The continued use of methods and equipment which result in a lot percent defective length of 20 or more on any machine finished deck slab or 35 or more on any manually struck and finished deck will not be permitted. If these limitations are exceeded, deck placement and finishing shall be discontinued until other methods or equipment are proposed for trial and submitted in writing for approval. Approval of this revised plan of operations does not relieve responsibility for the satisfactory performance of the revised method or equipment.

Additional compensation, extension of Contract Time or other concession will not be granted because of revised methods or equipment necessary to produce deck slabs in substantial conformity with a 1/8 inch in 10 foot surface tolerance.

(e) Surface Remedial Measures. Regardless of the overall surface conformity of a lot of bridge deck concrete, if surface deviations have a detrimental effect on deck drainage or reinforcement steel cover, the Engineer may require appropriate remedial measures to restore any or all of the deck slab surface to the required grades and surface tolerance. When such remedial procedures are ordered by the Engineer, a plan shall be submitted, setting forth the intended limits of the surface restoration and a complete description of the methods, equipment and materials proposed for use.

Following satisfactory completion of the surface restoration measures to the bridge slab, the lot containing the affected area shall be retested.

Additional compensation, extension of Contract Time or other concessions will not be granted for any surface restorations ordered by the Engineer.

Table 501-2 Reduction Per Lot of Deck Slab Concrete Due to Nonconformance with Surface Requirements

Schedule A Machine Finishing Required		Schedule B Machine Finishing Optional			
		Subschedule B1 Manual Finishing		Subschedule B2 Machine Finishing	
Lot Percent Defective Length	Reduction Per Lot, Percent	Lot Percent Defective Length	Reduction Per lot, Percent	Lot Percent Defective Length	Reduction Per Lot, Percent
0-8.9	none	0-19.9	none	0-13.9	none
9.0-13.9	1.0	20.0-27.0	2.5		
14.0-24.9	7.0	27.1-34.9	7.0	14.0-24.0	7.0

501.17 Curing and Protecting Concrete.

(a) Curing Concrete Under Normal Conditions. Concrete decks, curbs and tops of sidewalks shall be cured in accordance with Subsection 405.14, Subpart *(a)*. Other concrete structures and concrete surfaces to receive an epoxy coating, rubbed finish or to be covered with another material shall be cured in accordance with Subsection 405.14, Subpart *(b)*, *(c)*, *(d)* or *(e)*.

(b) Protection and Curing Under Cold Weather Conditions. When the ambient temperature is expected to fall below 40 degrees F, measures shall be provided to maintain the concrete surface temperature between the minimum specified and 85 degrees F.

If concrete is placed or is scheduled to be placed at a time when the provisions for cold weather concreting apply in accordance with Subsection 501.11, Subpart *(a)*, the Resident Engineer shall be advised of the plans for curing and protecting the concrete. Concrete shall be protected in such a manner as to prevent damage from cold weather. Frozen concrete or concrete damaged by cold weather shall be removed and replaced without additional compensation.

Calendar days on which the surface temperature of the concrete falls below the minimum specified shall not be considered curing days.

Protection under cold weather conditions may be accomplished by heating and housing and by the use of insulated forms.

(1) General. Forms shall be free of ice, snow and frost at time of placing concrete. No substructure concrete shall be placed when the ambient temperature is below 40 degrees F, unless the interior of forms, metal surfaces, and the surface of the concrete adjacent to the new concrete placement are preheated to that temperature or higher.

Certain procedures and requirements must be adhered to when protecting superstructure concrete. The top of the freshly placed concrete shall be protected as soon as possible with insulating blankets. Tarpaulins or other similar material shall be hung so that the entire section being protected is enclosed. Heated air shall be circulated under this enclosed portion for the full protection period as specified for concrete protected by heating and housing. No superstructure concrete shall be placed when the ambient tempera-

ture is below 40 degrees F, unless the interior of the forms, metal surfaces, and the surface of the concrete adjacent to the new concrete placement are preheated to that temperature or higher.

The concrete shall be kept at a temperature not lower than 60 degrees F for a period of 7 calendar days after placing and then, at a temperature not lower than 40 degrees F for a period of 4 calendar days.

After the specified curing is complete, the temperature of the concrete shall not be permitted to fall at a rate greater than 10 degrees F per 12 hour period.

(2) *Heating and Housing.* Before placing concrete in the forms, housing shall be provided for the section of concrete to be placed so that the temperatures specified can be maintained within such enclosure. Enclosures shall be so arranged as to permit removal of forms and finishing of concrete surfaces without interruption of heating.

The heating system shall be so arranged as to provide uniform heating by forced air or radiation within the enclosure. The heating system shall be operated for a sufficient period of time in advance of placing concrete so that the temperature of form surfaces to be in contact with the concrete, reinforcing steel and abutting construction shall be 70 plus 10 or minus 20 degrees F.

During and after the period of placing concrete, the heating plant shall be operated so as to maintain the temperature of the air within the enclosure at 70 plus 10 or minus 20 degrees F. Such temperatures shall be maintained in the enclosure until the completion of the curing period.

Salamanders shall be provided at the site or be available within an hour in such quantity as to ensure maintaining the concrete at the minimum temperature specified in the event of a breakdown, and shall be used for such reasonable time as to permit repair of the heating plant, subject to such location, arrangement, operation and provision for moisture.

(3) *Insulated Forms.* Insulated forms may be used to protect concrete in abutments, piers, walls and other structure units. The insulation shall be of a type which meets the requirements of cold-weather concreting.

The temperature of the concrete and the temperature of the surface of the forms under the insulation will be checked at intervals, and the temperature of the concrete being mixed shall be adjusted to insure that the rate of increase in concrete temperature after placement is not greater than 10 degrees F per hour. Maximum concrete temperatures shall not be greater than 100 degrees F.

The insulated forms shall remain in place for the protection period. The blankets or straw may be removed from tops of footings only as necessary to permit forming for subsequent concrete placements. Approval shall be obtained before loosening forms or removing the top covering.

501.18 Painting Metals. The exposed surfaces of all metals such as deck joint plates and shapes which are not galvanized or bituminous coated shall be painted. Painting shall conform to Section 503.

501.19

501.19 Waterproofing. Waterproofing shall consist of a primer, applied cold, followed by four applications of either tar or asphalt seal coat, applied hot, and three layers of bituminized cotton fabric.

(a) Preparation of Surface. Before surfaces are waterproofed, they shall be given a Class 1 finish in accordance with Subsection 501.14. Immediately prior to applying the primer, the surface of the concrete shall be cleaned of all dust or other objectionable material. The surface of the concrete shall be dry and free from frost at the time the primer is applied.

Joints which are open, but which are not designed to provide for expansion, shall be first caulked with oakum or lead wool, and then filled, flush with the surface, with hot joint filler.

(b) Application. Waterproofing shall be applied only in dry weather and when the ambient temperature is above 40 degrees F.

Waterproofing shall begin at the lower part of the surface and continue upward, if on an inclined or vertical surface. On horizontal surfaces it shall begin at one end and continue through to the other end.

All bitumen, except primer coats, shall be mopped or brushed on the surface to be waterproofed. Spraying will be permitted for primer coats.

Mopping shall be thorough so that the surface is completely covered and, on fabric, each layer shall be covered so that the weave is concealed and the layers of the fabric entirely separated.

Primer shall be spread over the surface at the rate of not less than 0.2 gallon per square yard and shall be allowed to cure thoroughly before the subsequent coats of hot bitumen are applied.

Not less than 0.25 gallon per square yard shall be used for each coating or between layers of fabric on horizontal surfaces, and not less than 0.30 gallon per square yard on vertical surfaces.

All waterproofing material shall be carried continuously across expansion joints.

Bitumen to be applied hot shall be stirred or otherwise agitated to secure uniform heating and to avoid local overheating.

Application temperatures for asphalt shall be not less than 250 or more than 325 degrees F and, for tar, shall be not less than 200 or more than 250 degrees F.

At the point where waterproofing begins and upon the prime coat, a section, 2 inches wider than the strip of fabric to be applied, shall be covered with hot bitumen for the full length of the section and, while the bitumen is still hot, a strip of fabric shall be rolled or pressed thereon. Upon 2 inches of this strip of fabric and the adjoining surface area equal to 2 inches wider than a strip of fabric, a coating of hot bitumen shall be applied and a strip of fabric, full width, shall be rolled or pressed thereon, as required for the first strip. Thereafter, full widths of fabric shall be laid as specified for the first strip, and in such manner that each strip laps the preceding strip by 2 inches. Side laps shall be not less than 2 inches and end laps not less than 12 inches.

The second and third layers of fabric shall be applied in the same manner as the first layer of fabric, but the laps of the layers shall not come directly over the laps of either of the other layers. The third layer of fabric shall be covered with a coat of hot bitumen.

When being placed upon vertical or inclined surfaces, the bitumen between 2 layers of fabric shall be allowed to cool before placing the next layer of fabric.

When placing upon horizontal surfaces, one layer may be applied immediately following the preceding layer, but care shall be taken not to disturb the preceding layer.

Each strip of fabric shall be laid without folds or creases, and all air bubbles and pockets shall be eliminated.

All surfaces that have been waterproofed with bituminous materials shall be cured before backfilling or other material is placed against them.

501.20 Rock Anchors. Holes shall be cleaned out by air under pressure. A metal tube, sufficient in length to reach the bottom of the drilled hole, shall be inserted until it touches the bottom of the hole. Grout shall then be placed inside the metal tube which, while being filled, shall be withdrawn gradually allowing the grout to flow into the hole and fill the space behind it. Immediately after the grout has been placed, the steel anchor rod shall be forced into the grout-filled hole by steady pressure or light tapping until it comes to rest on the bottom of the hole.

When the grout has set and hardened sufficiently to be ready for testing, anchor assemblies, amounting to not less than 5 percent of the total number provided, but in no case less than 2, shall be subjected to a pull-out test by the application of a force specified. The test procedure and apparatus are subject to approval.

501.21 Epoxy Waterproofing Seal Coat. Epoxy waterproofing seal coat shall be applied to concrete surfaces as follows:

(a) Abutment and Pier Seats. The epoxy waterproofing seal coat shall be applied not earlier than 7 calendar days after stripping the forms. Before application, the surfaces shall be cleaned of dirt, grease, form oil or other foreign material which may have accumulated.

The two components of the sealer shall be blended in equal parts by volume, and to each four parts of the mixture thus obtained, there shall be added one part toluene as a thinner. Only enough sealer which can be applied in one hour shall be mixed. The ambient temperature shall be from 40 to 85 degrees F at the time of application which shall be by brush only. Two coats shall be applied with the second coat being applied after the first coat is dry. The thickness of the finished coating shall be 10 mils. Before the second coat is dry, and while still tacky, a layer of grit shall be spread over the top surfaces, except on masonry plate bearing areas, and tamped into the sealer. After the sealer has set, all excess grit shall be brushed off.

Bearing surfaces of masonry shall receive the application of sealing compound after they are bush-hammered to the proper elevation.

These waterproofing materials may be toxic and all necessary precautions shall be taken to prevent injury due to their use.

(b) Culvert Top Slabs. Epoxy seal coat shall be applied only to top slabs of culverts having less than 2 feet of fill and where bituminous concrete overlay is placed directly over the culvert slab. However, epoxy waterproofing seal coat shall not be applied to top slabs which are used as a riding surface.

Epoxy waterproofing seal coat shall be placed only after a dry weather period of at least 3 days. The concrete surface shall be dry at the time the coating is placed. Air jets or a large vacuum cleaner shall be used to ensure removal of all dust and small particles immediately prior to coating.

Oil and grease spots shall be removed by scrubbing with hydrochloric acid solution followed by flushing with clear water for about 3 to 5 minutes

The epoxy seal coat shall be applied at the rate of one gallon per 100 square feet. The sealer shall be mixed and applied in strict accordance with the manufacturer's recommendations. Solvents shall not be added. Hand

spraying methods will be permitted provided care is taken to insure uniform and adequate coverage. The coating shall also be placed on the vertical faces of headwalls for a height of at least 2 inches above the top of fill.

Before the coating has set and while it is still tacky, grit shall be broadcast over the coating by truck spreader or by hand at a uniform rate of at least 5 pounds per square yard on the top surface of the culvert top slab. The grit shall be clean and dry when applied. The grit shall be lightly rolled into the seal coat. When the coating has hardened, the excess grit shall be swept away. The grit removed may be reused on remaining areas to be resurfaced, provided that it is clean and dry.

Backfill or bituminous concrete overlay shall not be placed until the sealer has cured sufficiently so as to be tack free. Any areas of the sealer damaged by the operations shall be replaced without additional compensation.

The pot life of the resin, mixing period, maximum time lapse between mixing and grit application and curing period are all dependent on the temperature, humidity, wind conditions and on the proprietary product being used. The manufacturer's recommendations shall be followed.

501.22 Cast Stone. Cast stone lettering panels shall be erected in place. The finished product shall conform to Federal Specification SS S721. Coloring used in the mixture shall be a nonfading mineral especially prepared for use in cast stone.

Cast stone units shall be furnished in one piece, including anchors, and shall be made true and straight. Arrises shall be accurate and clean. A sample of cast stone showing design, coloration and surface finish shall be submitted for approval before casting, if requested.

501.23 Sealing of Joints. Prior to sealing joints with hot-poured rubber asphalt or cold applied joint sealer, the surfaces of the seams and joints must be clean and dry, and must be free of all loose aggregate, paint, corrosion, form oil and concrete curing compound.

All loose concrete, dirt and foreign matter shall be removed by sandblasting or by the use of a wire brush. Projections of concrete into the seams shall also be removed. The joints and surfaces adjacent to the seams shall be blown free from all loose dust by means of oil-free compressed air immediately prior to priming.

Alkaline seepage and form oil shall be cleaned by etching of the concrete surface with hydrochloric acid, thorough rinsing, neutralizing and drying.

The sealing compound shall be made flush with or not more than 1/16 of an inch above the adjacent surfaces.

501.24 Opening to Traffic. Traffic, heavy equipment, storage of materials, or other loading will not be permitted on a structure or any part thereof until after all forms and falsework have been removed as permitted under Subsection 501.13.

When the concrete on the deck has attained a strength of not less than 3600 pounds per square inch as determined from cylinders cast during the placing of the concrete deck and is not less than 7 curing days old, mixed concrete and materials may be transported on the slab in trucks.

When concrete is used for deck slabs, traffic and construction equipment not exceeding the legal load limit may be permitted on deck slabs when the minimum strength for individual tests, as defined in Section 914, exceeds 3600 pounds per square inch from four additional cylinders cast during placement and the deck slab concrete is not less than 7 curing days old in accordance with Subsection 501.17, Subpart *(b)*.

Hand operated buggies, if used, shall be equipped with pneumatic rubber tires and shall not be operated over concrete which has cured less than 72 hours.

Heavy equipment shall not exceed legal loads unless special lanes are included in the design and the maximum loads are prescribed.

Cranes will be permitted on deck slabs only with specific approval. Stress analysis calculations shall be submitted for loading of the crane, together with location of the crane on the deck slab. Stresses shall not exceed the design allowables by more than 20 percent.

If placement of a crane is permitted, matting shall be provided to protect the deck slab from damage. However, cranes will not be permitted until the concrete has cured 28 calendar days and the compressive strength is not less than the class design strength specified as determined from test cylinders cast during placing of the concrete.

COMPENSATION

501.25 Method of Measurement. Concrete in the various structures, substructures and superstructures will not be measured and payment will be made for the quantity in the Proposal adjusted for Change Orders except as provided for in Subsection 109.01.

Concrete seal in cofferdams will be measured by the cubic yard.

Reinforcement steel will not be measured and payment will be made for the quantity in the Proposal adjusted for Change Orders except as provided for in Subsection 109.01, in which case, the weight of steel bar reinforcement will be computed from cutting lists in accordance with Subsection 915.01, Subpart *(h)*.

Epoxy waterproofing seal coat and waterproofing will be measured by the square yard.

Preformed elastomeric joint sealer and reinforced elastomeric expansion dam, of the various sizes, will be measured by the linear foot along the centerline including the vertical face of curbs and tops of sidewalks and brush curbs.

Rock anchors will be measured by the linear foot.

Sawcut grooved deck surface will be measured by the square foot of deck less the ungrooved border area.

501.26 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Concrete in Structures, Culverts	Cubic Yard
Concrete in Structures, Footings	Cubic Yard
Concrete in Structures, Retaining Walls	Cubic Yard
Concrete in Substructures, Abutment Walls	Cubic Yard
Concrete in Substructures, Pier Columns and Caps	Cubic Yard
Concrete in Substructures, Pier Shafts	Cubic Yard
Concrete in Superstructure, Deck Slabs	Cubic Yard
Concrete in Superstructure, Sidewalks	Cubic Yard
Concrete in Superstructure, Parapets	Linear Foot
Concrete Seal in Cofferdams	Cubic Yard
Reinforcement Steel in Structures	Pound
Reinforcement Steel in Structures, Epoxy Coated	Pound
Epoxy Waterproofing Seal Coat	Square Yard
Waterproofing	Square Yard
_____" x _____" Preformed Elastomeric Joint Sealer	Linear Foot
_____" x _____" Reinforced Elastomeric Expansion Dam	Linear Foot
Rock Anchors	Linear Foot
Sawcut Grooved Deck Surface	Square Foot

Payment reductions due to nonconformance with surface requirements will be made in accordance with Subsection 501.16, Subpart *(e)* , Table 501-2 and will be applied to the lot yardage for concrete in deck slabs.

Payment adjustments for strength will be made in accordance with Subsection 914.02, Subpart *(e)* and will be applied to the lot yardage for concrete in deck slabs.

Note - All payment reductions or adjustments made in accordance with the above are cumulative.

Payment adjustments for strength will be made in accordance with Subsection 914.02, Subpart *(e)* and will be applied to the lot footage for concrete in parapets.

SECTION 502 - PRESTRESSED CONCRETE STRUCTURES

502.01 Description. This work shall consist of the furnishing and erection of prestressed members.

All operations pertaining to the fabrication and erection of prestressed concrete structures shall conform to Division II, Section 4 of the AASHTO Standard Specifications for Highway Bridges except as herein amended.

Materials, test method, method of manufacture or any other item not specifically covered in the Plans and Specifications shall be in accordance with the PCI Manual for Control for Plants and Production of Precast Prestressed Concrete Products.

MATERIALS

502.02 Materials. Portland cement concrete and grout shall conform to Section 914. Other materials shall conform to the following Subsections:

Curing Materials	905.03
Preformed Expansion Joint Filler	908.01
Reinforcement Steel for Structures	915.01
Prestressing Reinforcement	915.02
Bolts and Bolting Materials	917.01
Structural Steel	917.10
Transverse Tie Rods	917.11
Bearing Pads	919.02

EQUIPMENT

502.03 Equipment.

(a) Jacks. Prestressing shall be done with jacking equipment. If hydraulic jacks are used, they shall be equipped with pressure gauges. The combination of jack and gauge shall be calibrated and a graph or table showing the calibration shall be furnished. Should other types of jacks be used, calibrated proving rings or other devices shall be furnished so that the jacking forces may be known.

Prior to use in manufacture of prestressed members, all jacks to be used, together with their gauges, shall be calibrated and certified by a testing agency.

Calibration of jacks and gauges shall be repeated at intervals of not more than one year. During progress of the work, if any jack or gauge appears to be giving erratic results or if gauge pressure and elongations indicate differing stresses of more than 5 percent, recalibration will be required immediately. Means shall be provided for measuring the elongations of reinforcement to at least the nearest 1/16 inch.

(b) *Forms and Casting Beds.* Only metal forms on concrete-founded casting beds shall be used. The forms and casting beds shall be carefully aligned, substantial and firm, braced and fastened together, sufficiently tight to prevent leakage of mortar and strong enough to withstand the action of mechanical vibrators. The forms should be constructed to permit movement of the members without damage during release of the prestressing force. The casting beds and all form work will be approved before any concrete is placed therein, but such approval does not signify relief of responsibility for the results obtained.

(c) *Grouting Equipment.* Grouting equipment shall conform to Division II, Section 4 of the AASHTO Standard Specifications for Highway Bridges.

(d) *Plant Approval.* All plants manufacturing prestressed concrete members shall be certified as having met the minimum standards of the Prestressed Concrete Institute and will be approved before manufacture of the members may be started. Requests for such approvals shall be submitted at least 3 weeks prior to the date of fabrication.

CONSTRUCTION

502.04 Shop Drawings. Shop drawings shall be furnished in accordance with Subsection 105.04.

When a prestressed pretensioned beam is designated and a design based on a system other than pretensioning is submitted, the design shall include end blocks.

When a post-tensioned or combination post-tensioned and pretensioned beam is designated and a pretensioned design is submitted, the design may delete the end blocks.

A pretensioned design without end blocks may be submitted.

In the case of multiple span structures, if the design of beams of any one span requires end blocks, the fascia beams for all spans shall have end blocks.

502.05 Inspection and Testing. The Department shall be notified, in writing, at least 45 days prior to the start of fabrication so that all component materials may be sampled and tested and the concrete mix design verified. Quality control of the concrete and acceptance testing will be performed in accordance with Section 914.

Prestressed concrete members shall be fabricated to plan dimensions within the tolerances specified in applicable sections of PCI Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products. Members having dimensions outside the tolerance limits may be subject to rejection unless corrective measures are taken. The Engineer is the sole judge in determining where the function and use of a particular member is impaired by some dimensional excesses above specified tolerances.

502.06 Placing Steel. All reinforcement and prestressing steel shall be accurately placed in position and firmly held during the placing of the concrete.

Distances from the forms shall be maintained by stays, blocks, ties, hangers or other such supports. Blocks for holding units from contact with the forms shall be precast mortar blocks. Layers of units shall be separated by mortar blocks or other such devices. Wooden blocks shall not be left in the concrete.

Wires, wire groups, parallel-lay cables and any other prestressing elements shall be straightened to ensure proper positioning in the enclosures.

Horizontal and vertical spacers shall be provided, if required, to hold the wires in place in the enclosures.

All reinforcement including prestressing reinforcement, reinforcing bars and welded wire fabric shall be free of frost, loose rust, grease, dirt, oil, paint mill scale, corrosion or other deleterious substances. If an anti-bonding agent is used on the forms to facilitate their removal, every precaution shall be taken to protect the prestressing strands against any degree of coating by the anti-bonding agent. Any steel which cannot be cleaned shall not be used.

Enclosures for prestressed reinforcement shall be accurately placed and shall be metallic and mortartight, with the exception that the enclosures may be formed by means of cores or ducts composed of rubber or other such material which can be removed prior to installing the prestressing reinforcement. Enclosures shall be strong enough to maintain their shapes under such forces that come upon them. They shall be 1/4 inch larger in internal diameter than the bar, cable, strand or group of wires which they enclose. Where pressure grouting is specified, cores or ducts shall be provided with pipes or other such connections for the injection of grout after the prestressing operations have been completed.

Reinforcement steel shall be placed within the following tolerances:

- Cover for Reinforcement Steel: Plus 1/2 inch, minus 1/4 inch.
- Spacing of Reinforcement: Plus or minus 1/2 inch except where inserts etc might require some shifting of the bars.

502.07 Pretensioning. The amount of stress to be given each cable shall be as shown on the shop drawings. Pretensioning shall be by either the single strand or multi-strand jacking method.

When prestressing is performed by the multi-strand jacking method, the cables shall be brought to a uniform initial tension of 3000 pounds prior to being given their full pretensioning. The initial tension of each cable shall be measured by a dynamometer, a gauge or other such means.

After the initial tensioning, the cables shall be stressed until the specified elongation and jacking pressure are attained.

Draped pretensioned strands shall be pretensioned by either partially jacking at the end of the bed, followed by raising or lowering the strands to their final position, or entirely by jacking operation.

Low-friction devices shall be used at all points of change in slope of strand trajectory at the time of tensioning of draped pretensioned strands, regardless of the tensioning method used.

If the strands are tensioned in their draped position, they shall be supported by lubricated rollers with bronze bushings or roller bearings at all hold-up points and low-friction free-turning rollers at all hold-down points, or other such devices.

When strands are deflected after partial tensioning, the strands shall be raised or depressed simultaneously at all points or in an approved specified sequence.

When single strand jacking is used, only one splice per strand will be permitted. When multi-strand jacking is used, either all strands shall be spliced or no more than 10 percent of the strands shall be spliced. Spliced strands shall be similar in physical properties, from the same source, and shall have the same twist or lay. All splices shall be located outside of the prestressed units.

Any wire breaks which may occur should be located and the ends tied to the strand with wire to preclude the possibility of raveling during the vibration of the concrete.

The occurrence of more than the permissible number of wire breaks in any particular strand pattern, as shown below, or the occurrence of more than one broken wire in any individual strand requires that the strand or strands be removed and replaced.

For 7-wire strands, the following wire breaks will be permitted to remain on the casting bed under the following conditions:

Less than 20 strands	0 wire breaks
20 to 39 strands	1 wire break
40 to 59 strands	2 wire breaks
60 and more strands	3 wire breaks

Failure of wires in parallel wire post-tensioned tendon is acceptable provided the total area of wire failure is not more than 1 percent of the total area of tendons in any member or more than one wire in tendon (this is comparable to one wire in fifteen 7-wire strands).

After final stressing, all strands shall be positioned and the stress in the strands shall be uniformly distributed throughout the bed length.

With the cables stressed in accordance with requirements and with all other reinforcing in place, the concrete shall be cast to the lengths specified. Cable stress shall be maintained between anchorages until the concrete has reached a compressive strength as specified in Subsection 502.09.

502.08 Concrete. The handling, measuring, proportioning, mixing and placing of concrete shall conform to Section 501. Concrete shall be deposited only in the presence of the Engineer.

All reinforcement shall be free from dirt, loose rust, grease and other deleterious substances. All items to be encased in concrete shall be accurately placed in position and firmly held during the placing and setting of the concrete.

Concrete shall be vibrated internally or externally, or both. Internal vibration shall be applied to the concrete for time intervals of approximately 10 seconds and at points not more than 30 inches apart. Vibrators shall not be used to move the concrete horizontally in the form. The vibrating shall be done in such a manner as to avoid displacement of the reinforcement, prestressing strands, sheaths, shoes and inserts.

502.09 Transfer of Stress. The stress transfer shall not be made to the bridge members until the test specimens indicate that the concrete has reached a compressive strength of at least 4000 pounds per square inch for Class P, 4500 pounds per square inch for Class P-1 and 5000 pounds per square inch for Class P-2 concrete.

Before any stress is transferred to the bridge members, the pattern and schedule for releasing the strands shall be approved. Forms which tend to restrict the horizontal or vertical movement of the member shall be stripped or loosened prior to stress transfer.

Transfer of stress shall be either by the multiple strand release method or by the single strand release method.

When the multiple strand method of release is used, either a symmetrical group of strands or all of the strands shall be released gradually and simultaneously. The load on the strands shall be removed from the anchorage and placed on the jacking system. The jack or jacks shall be gradually released until the strands are relaxed.

When the single strand release method is used, the strands shall be detensioned by slow-heat cutting, using a low-oxygen flame. The strands shall not be quickly cut, but each strand shall be heated and allowed to pull itself apart in the sequence of the pattern and schedule of release.

502.10 Removal of Forms and Finishing. Side forms may be removed as soon as their removal does not cause distortion of the hardened concrete. The members shall not be removed from the bottom forms until they have been stressed to sustain all forces and bending moments which may be applied during handling.

All formed surfaces of the concrete members shall receive a Class 1 finish in accordance with Subsection 501.14. The top surface of members shall be scored transversely with a stiff wire brush. After hold-down devices are removed from the bottom of the beams, the resulting holes shall be coated with an epoxy bonding compound and plugged with mortar.

502.11 Curing. Curing of the concrete members shall be by any one of the methods specified in applicable sections of the PCI Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products.

If steam curing is used, the PCI Manual is amended as follows:

- The applications of steam within the enclosure shall be delayed for a period of 5 to 6 hours when the air temperature is 50 degrees F or lower and shall be delayed for a period of 3 hours when the air temperature is 50 degrees F or higher. If retarders are used, the waiting period shall be from 4 to 6 hours regardless of the air temperature. The curing period shall be maintained at 145 plus or minus 10 degrees F for a period of 12 hours.

Representative concrete test cylinders, similarly cured, shall be tested after the curing procedure specified. Should tests indicate the concrete members have not achieved a compressive strength of at least 4000 pounds per square inch for Class P, 4500 pounds per square inch for Class P-1 and 5000 pounds per square inch for Class P-2 concrete, the members shall be cured further until the required strength is achieved.

502.12 Post-tensioning. Tensioning of the prestressing reinforcement shall not be commenced until tests on concrete cylinders made of the same concrete and cured under the same conditions indicate that the concrete of the particular member to be prestressed has attained compressive strength of at least 4000 pounds per square inch for Class P, 4500 pounds per square inch for Class P-1 and 5000 pounds per square inch for Class P-2 concrete.

After the concrete has attained the required strength, the prestressing reinforcement shall be stressed by means of jacks to the desired tension and the stress transferred to the end anchorage.

The tensioning process shall be so conducted that the tension being applied and the elongation of the prestressing elements may be measured at all times. The friction loss in the element, i.e., the difference between the tension at the jack and the minimum tension, shall be determined in accordance with Division I, Section 9 of the AASHTO Standard Specifications for Highway Bridges.

A record shall be kept of gauge pressures and elongation at all times and submitted for approval.

502.13 Grouting of Bonded Steel. Grouting shall conform to Division II, Section 4 of the AASHTO Standard Specifications for Highway Bridges.

502.14 Transverse Tie Rods. Transverse tie rods shall be placed in position through preformed holes and stressed to a total of 30,000 pounds. Tension in 1-inch diameter tie rods shall be applied by torquing to approximately 600 foot-pounds. Precautions shall be taken to prevent damage to the concrete under the outside bearing plates. The tensioning process shall be conducted so that the tension being applied may be measured at all times.

After stressing, the exposed end of the rod at the fascia member shall be removed so that no part of the rod or of the end fittings extends beyond a point of 1 inch inside the exterior face of the fascia member. The cutting shall be done in such a manner as to cause no damage to the rod or fitting.

The exposed parts of the end fittings shall be coated with two coats of a bituminous paint and the opening filled with nonshrink grout to match the concrete surface.

When the transverse bars have been stressed to the specified tension, the longitudinal shear keys shall be filled with nonshrink grout.

502.15 Storage, Transportation and Erection. All members may be handled immediately after completion of stressing. If stressing is not done in a continuous operation, members shall not be handled before they are sufficiently stressed to sustain all forces and bending moments due to handling.

Units shall be surface dry prior to removal from beds when air temperatures are below 40 degrees F.

Beams shall not be placed outside the bed unless the differential between beam and air temperature is less than 50 degrees F.

The prestressed beams shall not be shipped until the minimum 28 day compressive strength has been attained, but in no case before 72 hours total storage time has elapsed following transfer of stress. If shipments are permitted prior to 28 days following casting, the additional test cylinders must attain a strength of at least 200 pounds per square inch higher than the specified 28 day strength.

Care shall be exercised in handling and moving precast, prestressed concrete members. Precast girders and slabs shall be transported in an upright position and the points of support and directions of the reactions with respect to the member shall be approximately the same during transportation and storage as when the member is in its final position. If it is deemed expedient to transport or store precast units in other than this position, it shall be done after notifying the Engineer of the intention to do so. Units damaged by improper storage or handling shall be replaced.

Before box and slab beams are moved to storage, all nonmetallic draining devices shall be inspected and opened to provide satisfactory passage of water.

A pre-erection meeting will be scheduled, at least 20 calendar days prior to the start of erection, prior to which a written plan of operations shall be submitted. This plan shall include, but not be limited to, the method of erection and the amount and character of equipment and manpower.

Erection of prestressed concrete beams shall not proceed until substructure concrete has cured for the minimum length of time specified under Subsection 501.13. The embankment backfill shall be in place behind the abutment walls to at least 50 percent of their height prior to erection unless otherwise approved.

Anchor bolts for masonry plates of structural steel bearings shall be set in accordance with Subsection 501.12.

COMPENSATION

502.16 Method of Measurement. Prestressed concrete members of the various sizes will be measured by the linear foot.

502.17 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Prestressed Concrete Beams, ____"	Linear Foot
Prestressed Concrete Beams, ____" x ____"	Linear Foot

Payment for cast-in-place concrete and reinforcement steel for diaphragms will be made in accordance with Section 501.

Payment adjustments for strength will be made in accordance with Subsection 914.02, Subpart *(e)* and will be applied to the lot footage for prestressed concrete beams.

SECTION 503 - STEEL STRUCTURES

503.01 Description. This work shall consist of the furnishing, fabrication, erection and painting of bridges and such other parts of bridges which are composed of structural steel and miscellaneous metals.

Materials and construction operations not specifically covered in the Plans and Specifications shall be in accordance with Division II of the AASHTO Standard Specifications for Highway Bridges.

MATERIALS

503.02 Materials. Materials shall conform to the following Subsections:

Bearing and Expansion Plates	911.02
Paint	912.01
Basic Lead Silico Chromate, Primer	912.03
Basic Lead Silico Chromate, Intermediate	912.04
Basic Lead Silico Chromate, Finish Coat (Foliage Green)	912.05
Finish Coat (Lake Blue)	912.06
Basic Lead Silico Chromate, Finish Coat (Brown)	912.07
First Finish Coat (Off-Gray)	912.08
Final Finish Coat (Gray)	912.09
Vinyl Wash Primer	912.12
Vinyl Shop Primer	912.13
Vinyl Intermediate Coat or Alternate Shop Primer	912.15
Vinyl Finish Coat (Green or Blue)	912.16
Zinc-Rich Primer, Organic Vehicle	912.17
Grout	914.03
Bolts and Bolting Materials	917.01
Flooring	917.02
Steel Bearings	917.06
Steel Castings	917.07
Steel Forgings	917.08
Structural Steel	917.10
Zinc-Coating on Steel	917.12
Bearing Pads	919.02

Steel bridge member components, designated (T) shall conform to the toughness requirements specified in Subsection 917.10.

503.03 Inspection and Testing. Inspection and testing shall conform to Section 6 of the 1981 AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges as modified by the following:

- Quality control inspections shall be performed at least to the minimal extent specified, and, additionally, any other testing and inspections necessary to control production quality shall be made. Quality assurance inspections will be performed by the Department.
- Initial testing for quality control is to be followed by quality assurance testing performed during normal Department working hours. All repairs shall be tested in the same manner. Further assembly is prohibited until quality assurance acceptance by the Department.

(a) Mill and Shop Inspection. The Department shall be notified, in writing, 15 calendar days in advance of the date of beginning of work at the mill and shop, so that arrangements for inspection may be made. Any materials rolled

or work done prior to inspection may be rejected. The term mill means any rolling mill or foundry where the material for the work is to be manufactured and fabricated.

Certified mill reports shall be submitted, in accordance with Subsection 106.04, showing chemical and physical properties of the materials to be used. Samples and test pieces shall conform to Subsections 105.06 and 106.03.

(b) *Nondestructive Testing.* Field welded splices, if any, will be inspected by nondestructive tests at the site of erection.

The Department shall be notified, in writing, not less than 15 calendar days in advance, when any shop or field welding is to be undertaken so that arrangements for inspection may be made.

(c) *Fracture Control Plan.* Steel bridge members or member components designated as Fracture Critical Members (FCM's) shall conform to the provisions of the AASHTO Guide Specifications for Fracture Critical Non-Redundant Steel Bridge Members and in accordance with the Supplementary Specifications.

CONSTRUCTION

503.04 Shop Drawings. Shop drawings shall be furnished in accordance with Subsection 105.04.

503.05 Fabrication and Welding. Fabrication of steel structures including, but not limited to, bolt holes, finishing and shaping, bolts and bolted connections, pins and rollers, shop assembling, tests, marking and shipping shall conform to Division II, Articles 10.1 through 10.37 of the AASHTO Standard Specifications for Highway Bridges.

Welding shall conform to the Structural Welding Code AWS D1.1 as modified by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges except that joint designations shall conform to AWS D1.1 and electro-slag weldments on main structural members will not be permitted.

AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges are amended as follows:

The following is added to the provisions of 3.13.2:

- All steel backing of weld on the outside faces of fascia girders shall also be removed and the joints ground or finished smooth.

The provisions of 4.24.1 are changed to:

- Stud shear connectors shall be installed in the field, only after the structural steel is erected and prior to placing of reinforcement steel, with automatically timed stud welding equipment connected to a suitable power source.

The following is added to the provisions of 6.7:

- Butt weld splices in longitudinal stiffeners shall also be tested by nondestructive testing.
- All joints subject to tension or reversal of stress and all butt welds shall be tested for the full length of the weld and will be tested for quality assurance.
- All welds scheduled for nondestructive testing under quality control and quality assurance inspection procedures shall be ground flush for the full length of the weld. Grinding shall be in the direction of applied stress.
- For purposes of quality assurance inspection, groove welds will be tested using ultrasonic testing procedures which may be supplemented by radiographic testing.

Paragraph 9.2.5 is modified in accordance with 1984 AASHTO Interim Specifications.

503.06 Camber. All structural steel members shall be cambered at the mill or fabricated in the shop to provide a true curve without abrupt changes.

503.07 Erection. Erection of structures including, but not limited to, handling and storing materials, falsework, methods and equipment, straightening bent materials, assembling steel and connections shall conform to Division II, Section 10 of the AASHTO Standard Specifications for Highway Bridges, and to the following:

- Falsework and all tools, machinery and appliances, including drift pins and fitting-up bolts necessary for the expeditious handling of the work, erection of the metalwork, removal of the temporary construction, maintenance of traffic and all work necessary to complete the structure shall be provided.
- At least 20 calendar days prior to the proposed start of erection, a written plan of operations for review shall be submitted at a pre-erection meeting.
- Erection of structural steel shall not proceed until substructure concrete has cured and hardened for the minimum length of time specified under Subsection 501.13. Unless otherwise approved, the embankment shall be in place in back of abutment walls for at least 50 percent of their height, before bearings are set, in order to avoid displacement or bearings due to movement of the abutments.

503.08 Setting Shoes and Bearings.

(a) Bridge Seat Bearing Areas. Shoes and bearing plates shall not be placed on bridge seat bearing areas that are improperly finished, deformed or irregular. They shall be set level in position and shall have full and even bearing. Bearing plates shall be bedded on the masonry with either elastomeric bearing pad or preformed fabric pad.

(b) Setting Anchor Bolts for Bearings. Anchor bolts for the masonry bearing plates shall be set in accordance with Subsection 501.12, Subpart *(j)*.

During the time between the setting of the bolts and placing of the bearings, measures shall be taken against collection of water in holes and its freezing in cold weather by filling the holes with a permanent type antifreeze and sealing the top with a watertight cap of rubber or other suitable material and sealing with rubber-asphalt joint sealer. Before the shoe is set, the material and any other foreign material shall be removed from the holes. The bolts shall be set and fixed by filling the holes with grout.

(c) Setting Bearings. Allowance shall be made for the effect of stress deformation and temperature changes when setting bearings. The axis of rockers and segmental roller bearings shall be set in an inclined position so that the rocker or roller is vertical under full dead load at a temperature of 60 degrees F. A sketch shall be shown on the erection drawing prepared by the fabricator indicating the proper inclination for setting the bearings at various temperatures.

Rocker bearings shall be adjusted after all loads from the bridge superstructure and approaches are in place, so as to provide the inclination from the vertical necessary to compensate for expansion or contraction in the bridge deck in conformity with the temperature.

The rocker bearings shall have the correct inclination at the time the bridge is accepted.

503.09 High-Strength Bolts. The installation of high-strength bolts shall be in accordance with the AASHTO Standard Specifications for Highway Bridges.

503.10 Automatic End-Welded Studs. Automatic end-welded studs shall be used as shear connectors or for other purposes where called for or directed. They shall conform to Section 4, Part F of the 1981 AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

Stud shear connectors shall be installed in the field only after the structural steel is erected and prior to placing of reinforcement steel.

503.11 Field Splice. Stringers involving field splices shall be completely preassembled in the shop, taking into account their relative position in the finished structure as to grade, camber and curvature. The built-up stringer or girder may be erected as a unit providing traffic conditions permit. Lateral support shall be provided in hoisting members into position so as to prevent lateral buckling or other damage. Bolt heads of high-strength bolts shall be on the outside of fascia stringers.

503.12 Pedestrian Bridge. The girders, stiffeners, diaphragms and steel bridge flooring for each span shall be assembled in the shop and delivered to the site and erected as a unit. As specified hereinafter, the two field coats of paint may be applied in the shop or on the site prior to erection. If painted areas are damaged during transportation or erection, these areas shall be repainted.

503.13 Formed Steel Flooring for Pedestrian Bridges. Formed steel flooring plates shall be welded at the supports with two 1/8 x 1 inch fillet welds through the holes in each valley. The lapped edges of adjacent plates shall be welded together with a bead, 3 inches long, midway in the span between supports.

Painting is not required for galvanized surfaces.

503.14 Repair Galvanizing. Where limited areas of galvanized surfaces are damaged during shipping or erection, they shall be repaired by any of the three methods specified in ASTM A 780. In all cases, the repair shall achieve the minimum coating thickness specified for the item.

503.15 Cleaning and Painting of Structural Steel. Cleaning and painting of structural steel shall conform to the requirements for the zone system specified.

The color of finish coat shall be as prescribed.

Surfaces of steel which are to be in contact with or embedded in concrete shall be given one prime coat of paint.

Surfaces within 2 inches of field welds shall not be painted, but shall receive a light coat of rust-inhibitive coating.

Contact surfaces at joints made with high-strength bolts shall be free of oil, paint or lacquer.

Rollers and machined surfaces shall be coated with a corrosive-preventative compound conforming to Military Specification MIL-C-11796B, Class 3 or MIL-C-11673D, Grade 2. The coating shall be applied as soon as practicable before removal from the shop.

(a) Zones 1 and 3A System.

Type: Basic lead silico chromate primer and intermediate coats, and finish coat.

Surface Preparation: Surface shall be cleaned in accordance with SSPC-SP 6 followed immediately (4 hours maximum) by shop primer.

Paint Application: Paint shall be applied in accordance with SSPC-PA 1.

Number of Coats: A minimum number of three coats shall be applied: prime coat in the shop, intermediate coat in the field, except when Zone 3A is specified, then the intermediate coat may be applied in the shop prior to delivery, and finish coat in the field.

503.15

Paint Film Thickness: The dry film thickness of the paint at any point shall not be less than the following:

• For the prime coat	1.7 mils
• For the intermediate coat	1.3 mils
• For the finish coat	1.0 mils
• For the 3 coat system	4.0 mils

When off-gray color is specified, a second finish coat (gray, 1.0 mil dry film thickness) shall be applied. The dry film thickness for the four coat system shall be 5.0 mils.

If the required paint film thickness is not achieved, additional coats shall be applied.

Touch-up painting: Before application of the finish coats, the steel shall be touched up in accordance with SSPC-PA 1.

(b) Zone 2 System.

Type: Vinyl wash primer, vinyl shop primer or intermediate coat, vinyl intermediate coat, and vinyl finish coat.

Surface Preparation: Surface shall be cleaned in accordance with SSPC-SP 5 or matching ASTM D 2200 Grades A Sa3, B Sa3, C Sa3 and D Sa3 followed immediately (4 hours maximum) by wash prime coat.

Paint Application: Paint shall be applied in accordance with SSPC-PA 1. The prime coat must be applied within 4 hours after the wash prime coat.

Number of Coats: A minimum number of four coats shall be applied; wash prime coat in the shop, prime coat in the shop, intermediate coat in the field or in the shop just prior to delivery, and finish coat in the field.

Paint Film Thickness: The dry film thickness of the paint at any point shall not be less than the following:

• For the wash prime coat	0.3 to 0.5 mils
• For the shop prime coat	2.0 mils
• For the intermediate coat	2.0 mils
• For the finish coat	2.0 mils
• For the 4 coat system	6.3 mils

If the required paint film thickness is not achieved, additional coats shall be applied.

Touch-up Painting: Before application of the finish coats the steel shall be touched up in accordance with SSPC-PA 1.

(c) Zone 3B System.

Type: Organic zinc-rich primer Type I and II, vinyl wash primer, and vinyl finish coat.

Surface Preparation: Surface shall be cleaned in accordance with SSPC-SP 10 followed immediately (3 hours maximum) by prime coat.

Paint Application: Paint shall be applied in accordance with SSPC-PA 1 and the following:

- The paint shall be thinned, using a power-agitated stirrer, not exceeding one volume of a mixture of 82 percent by volume of ethylene glycol monoethyl ether acetate and 18 percent by volume toluene to 4 volumes of paint prior to use to produce a smooth uniform coating. After thinning and thorough mixing, the primer shall be strained through a 30 to 60 mesh screen or double layer of cheesecloth. There shall be no undispersed agglomerates of zinc pigment remaining in the paint after mixing.

- After blast cleaning, the anchor pattern shall be a minimum of 1 1/2 mils deep in a dense and uniform pattern of depressions and ridges.
- The first coat of zinc-rich primer must be applied within 3 hours of blast cleaning the surface.
- Blast cleaning and painting will not be permitted when the relative humidity exceeds 85 percent as measured at the site of operations.
- All paint shall be applied by spray methods except that areas inaccessible to spray application shall be brushed. Coated surfaces which are damaged, faulty or abraded, and all exposed uncoated surfaces shall be cleaned by sandblasting and spot painted with primer after erection and before application of specified top coats.
- First coat on the cleaned steel surface shall be Type I, Red Tint. Second coat shall be Type II, Gray. If additional coats are required, they shall be alternating Type I and Type II. An agitating pot containing the paint brush shall be mandatory in all spray painting or application work. The agitator or stirring rod shall reach to within 2 inches of the bottom of the spray pot and shall be in motion at all times during paint application. Such motion shall be sufficient to keep the paint well mixed. The paint shall be stored in a cool place.
- Complete instructions for use shall be included with each container of paint.
- Whenever painting operations are interrupted, the zinc-rich primer remaining in the fluid hose shall be expelled from the hose. Spray equipment which is used for application of zinc-rich primer shall be thoroughly cleaned at the end of each workday with the thinner described hereinabove.
- Prior to application of the finish coats, except for the fayed areas, all surfaces painted with zinc-rich primer shall be treated with vinyl wash primer conforming to Subsection 912.12. The zinc-rich primer shall be cured for at least 24 hours before application of the vinyl wash primer. The vinyl wash primer shall be applied in such a manner as to produce a wet film as the spray contacts the surface. The vinyl wash primer shall be applied at the rate of 260 to 430 square feet per gallon and dried film thickness of 0.3 to 0.5 mils. It shall completely and uniformly cover the underlying surface.
- The first finish coat shall be applied over the pretreatment vinyl wash primer within 72 hours.

Number of Coats: A minimum number of four coats shall be applied; prime coats Type I and II in the shop, and wash prime coat and finish coat in the field.

Paint Film Thickness: The dry film thickness of the paint at any point shall not be less than the following:

• For the prime coats, Type I and II	3.0 mils total
• For the wash primer coat	0.3 to 0.5 mils
• For the finish coat	2.0 mils
• For the 4 coat system	5.3 mils

If the required paint film thickness is not achieved, additional coats shall be applied.

Touch-up Painting: Before application of the finish coats, the steel shall be touched up in accordance with SSPC-PA 1.

(d) *Painting of Galvanized Surfaces.* Paint will not be required for galvanized surfaces, but damaged galvanized surfaces shall be repaired as specified under Subsection 503.14.

(e) *Protection of Structure, Persons and Property.* Pedestrians, vehicular and other traffic upon or underneath the bridge and all portions of the bridge superstructure and substructure shall be protected against damage or disfigurement by spatters, splashes and smirches of paint or paint materials. Canvas or other such material shall be furnished for such protection.

(f) *Clean Up.* Paint dropped on concrete surfaces and all debris from the cleaning operations shall be removed from the superstructure and the substructure. Paint containers and refuse shall be removed from the site.

503.16 Steel Grid Flooring. Steel grid flooring shall conform to Division II, Section 12 of the AASHTO Standard Specifications for Highway Bridges. Concrete placement for filled type grid flooring shall conform to Section 501.

COMPENSATION

503.17 Method of Measurement. Structural steel of the varous kinds will be measured by the pound or will not be measured and payment will be made on a lump sum basis.

Components fabricated from metals will be considered as structural steel and computed on the following basis:

	Unit Weight Pounds Per Cubic Foot
Aluminum, cast or rolled	173
Bronze or copper alloy	536
Copper sheet	558
Iron, cast	445
Iron, malleable	470
Steel, cast or rolled, including alloy, copper bearing, and stainless	490
Zinc	450

The weight of rolled shapes and of plates, up to and including 36 inches in width, will be computed on the basis of their nominal weights and dimensions, deducting for cuts and open holes, exclusive of high-strength bolt holes.

The weight of plates wider than 36 inches will be computed on the basis of their actual dimensions deducting for cuts and holes, exclusive of high-strength bolt holes. To this will be added one half of the Permissible Variation in Thickness and Weight as shown in AASHTO M 160.

The weight of castings will be computed from the dimensions shown on the shop drawings, deducting for open holes. To this weight will be added 5 percent allowance for fillets and overrun. Scale weights may be substituted for computed weights in the case of castings or of small complex parts for which computations of weight would be difficult.

The weight of heads, nuts, single washers and threaded stick-through of all high-strength bolts is based on the following:

Diameter of Bolts, Inches	Weight in Pounds per 100 Bolts	Diameter of Bolts, Inches	Weight in Pounds per 100 Bolts
1/2	19.7	1	116.7
5/8	31.7	1 1/8	165.1
3/4	52.4	1 1/4	212.0
7/8	80.4	1 3/8	280.0
		1 1/2	340.0

The weight of shop and field fillet welds is based on the following:

Size of Weld, Inches	Weight in Pounds per Linear Ft	Size of Weld, Inches	Weight in Pounds per Linear Ft
1/4	0.20	5/8	0.80
5/16	0.25	3/4	1.10
3/8	0.35	7/8	1.50
7/16	0.45	1	2.00
		1/2	0.55

In the case of the lump sum basis, the approximate estimated weight is shown for informational purposes only and no guarantee is expressed or implied that it is the correct weight to be furnished.

Steel grid flooring and formed steel flooring will be measured by the square foot.

Shear connectors will be measured by the number of units.

503.18 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Structural Steel	Lump Sum
Structural Steel	Pound
Structural Steel Bearings for Prestressed Concrete Beams	Lump Sum
Structural Steel Deck Joints	Lump Sum
Steel Grid Flooring	Square Foot
Formed Steel Flooring for Pedestrian Bridges	Square Foot
Shear Connectors	Unit

SECTION 504 - TIMBER STRUCTURES

504.01 Description. This work shall consist of the construction of structures or parts of structures, other than piles, composed of treated or untreated timber or a combination of both, on prepared foundations.

MATERIALS

504.02 Materials. Materials shall conform to the following Subsections:

Timber Connectors and Hardware	918.04
Timber for Structures	918.05
Timber Preservatives	918.06

CONSTRUCTION

504.03 Construction Requirements. Construction methods shall conform to Division II, Section 20 of the AASHTO Standard Specifications for Highway Bridges.

Cant hooks, peaveys, pikes or hooks shall not be used.

The design of ring or shear plate timber connectors shall be submitted for approval in accordance with Subsection 105.04. Connectors shall be of corrosion-resistant metal.

Painting requirements will be provided in the Supplementary Specifications.

COMPENSATION

504.04 Method of Measurement. Timber structures of the various kinds will be measured in 1000 feet board measure (MBM) of untreated and treated timber, computed on the basis of nominal sizes and shortest commercial lengths which could be used.

504.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Treated Timber Structures	MBM
Treated Timber Structures, Bridge Decking	MBM
Treated Timber Structures, Sheeting	MBM
Treated Timber Structures, Wales	MBM
Untreated Timber Structures	MBM

SECTION 505 - LOAD BEARING PILES

505.01 Description. This work shall consist of furnishing and driving concrete, steel and timber piles.

Materials and methods of construction not specifically covered in the Plans and Specifications shall conform to AASHTO Standard Specifications for Highway Bridges.

505.02 Materials. Portland cement concrete shall conform to Section 914. Other materials shall conform to the following Subsections:

Reinforcement Steel for Structures	915.01
Steel Castings for H-Pile Tips (Medium Strength)	917.07
Steel Piling	917.09
Timber Bearing Piles	918.02
Timber Preservatives	918.06

EQUIPMENT

505.03 Equipment.

(a) Types of Hammers. Piles shall be driven with steam, air, diesel, vibratory or drop hammer. The type and size of hammer used shall be capable of driving the pile to its design capacity without damage to the pile.

Steam, air and diesel hammers shall develop a minimum of 6,000 foot-pounds energy per blow. Drop hammers shall have a minimum weight of 2,000 pounds and a maximum drop of 8 feet.

(b) Impact Pile Drivers. The impact pile driving equipment shall be selected according to the following criteria:

- The pile design capacity shall be achieved between 2 to 4 blows per inch for timber piles and between 8 and 12 blows per inch for other type piles by any accepted driving criteria.

- The weight of the pile to be driven for steam or air hammers should be no more than two times the weight of the ram used to drive it; for diesel hammers, no more than four times the weight of the ram driving it.
- Diesel hammers shall be equipped with gauges and charts for the determination of the actual driving energy produced under any driving conditions.

(c) Vibratory Pile Drivers. The vibratory pile driver shall be selected to satisfy the equation in which Driving Amplitude equals two times the Eccentric Moment divided by the Vibratory Load. The solution of this equation shall be between 1/4 and 1/2 inch. The vibratory load shall be the sum of the weight of the pile and the weight of the vibrating mass of the vibrator including the weight of the clamp, housing and jaws. The Eccentric Moment shall be provided by the Contractor or the manufacturer.

Vibratory pile drivers may be used to advance bearing piles. However, the use of an impact pile driver shall be required for at least the final 3 feet of penetration.

(d) Plant and Equipment. The plant and equipment furnished for steam and air driven hammers shall have sufficient capacity to maintain, under working conditions, the pressure at the hammer specified by the manufacturer. The boiler or tank shall be equipped with a pressure gauge. A gauge shall also be installed which measures the pressure for the hammer intake unless another method is provided to furnish the data necessary for the determination of energy delivered by the hammer.

(e) Leads and Followers. Pile driving equipment shall include leads that are straight and constructed in such a manner as to afford freedom of movement to the hammer. The leads shall be held in position by guys or braces to ensure support to the pile during driving. Except where piles are driven through water, followers shall not be used unless approved.

(f) Water Jets. When water jets are approved for use, the number of jets and the volume and pressure of water at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. The plant shall have sufficient capacity to deliver at all times at least 100 pounds per square inch pressure at the jet nozzles. Before the desired penetration is reached, the jets shall be withdrawn and the piles shall be driven with the hammer to secure the final penetration.

CONSTRUCTION

505.04 Preparation for Driving. Excavation, pile caps, collars, points, splicing piles and painting of steel piles shall be as specified in Division II, Section 3 of the AASHTO Standard Specifications for Highway Bridges.

(a) Embankments. Piles located in embankment shall not be driven until the embankment has been placed, compacted, surcharge removed and excavation completed.

(b) Prebored Holes. The diameter of auger may vary as follows:

- For round piles, not less than 2 inches nor more than the average nominal diameter of piles.
- For steel H-piles, 4 to 6 inches less than nominal diagonal dimension of piles unless otherwise authorized. Voids between the pile and the prebored material shall be backfilled with granular material.

(c) *Furnishing Equipment for Driving Piles.* Prior to delivery of the equipment to the work site, information regarding the type, striking energy per blow, rated speed, source of energy and serial number of the hammer proposed for use is to be submitted for approval.

505.05 Order List of Piles. Piles shall be furnished in accordance with an order list. When test piles and/or load tests are specified, the data obtained will be used in conjunction with other available geotechnical information to determine the lengths of production piles to be furnished. The Engineer will not prepare the order list for any portion of the foundation until the required test data representative of the portion has been completed. The order list will be furnished as promptly as conditions permit.

The lengths given in the order list are based on the lengths which are assumed to remain in the completed structure. Without added compensation, the lengths shall be increased to provide for fresh heading and for additional lengths as may be necessary to suit the method of operation.

505.06 Methods of Driving. Piles shall be driven by hammers and equipment conforming to Subsection 505.03. In addition, when followers are permitted for use in driving, one pile from each group of 10 shall be a long pile driven without a follower, and shall be used as a test pile to determine the average bearing power of the group.

(a) *Accuracy of Driving.* Piles shall be driven with a variation of not more than 1/2 inch per foot from the vertical or from the batter, except that piles for trestle bents shall be so driven that the cap may be placed in its proper location without inducing excessive stresses in the piles, and foundation piles shall not be out of the required position by more than 6 inches after driving.

(b) *Penetration.* For all types of piles, including those whose tip elevation is noted, there shall be a procedure for jetting, blasting, or the use of spuds, and other work necessary to obtain the penetration required.

(c) *Rock Bearing Piles.* Steel H-piles or other steel piles that are intended to bear on rock shall be driven to the refusal necessary to penetrate the rock sufficiently to provide uniform and adequate bearing. Generally, the pile is considered as reaching refusal when a penetration of not less than five blows per 1/4 inch has been achieved.

505.07 Determination of Bearing Values.

(a) *Test Piles.* Test piles of the materials, dimensions and at the designated locations shall be furnished and driven. Order lengths for test piles will be directed. They shall be driven to such tip elevation or minimum bearing value as may be directed. Test piles shall be driven with the same type of equipment that is used for driving permanent (production) piles.

(b) *Pile Load Test.* Load tests shall be made where prescribed or directed. When diesel or other types of hammers requiring calibration are to be used, load tests shall be made even though no load tests are scheduled. Load tests will not be required when the hammer is to be used only for driving piles to refusal, rock or a fixed tip elevation or when the hammer is of a type and model that has been previously calibrated for similar type, size and length of pile and foundation material. Calibration data must be obtained from acceptable sources.

The pile load test shall be performed in accordance with ASTM D 1143 except as may be modified in the Supplementary Specifications. Detailed plans of the loading apparatus and methods to be used shall be submitted. The apparatus shall be so constructed as to allow the various increments of the load to be placed gradually without causing vibration to the test piles. If the approved method requires the use of anchor piles, such piles shall be of

the same type and diameter as the permanent piles and shall be driven in the location of permanent piles when practical. Pipe and shell pipes whose walls are not of adequate strength to sustain the testing loading when empty, shall have the required reinforcement and concrete placed before loading.

Loads for load tests for cast-in-place concrete piles shall not be applied until the concrete in the test pile has set at least 7 days. The total test load to be applied to piles shall be as specified in the Supplementary Specifications.

The total test load shall be applied in four equal increments. Each increment of load shall remain in place until the settlement over a period of 2 hours is less than 0.01 of an inch. The full test load shall be maintained until the settlement over a 48 hour period does not exceed 0.01 of an inch. The full test load shall be removed in four decrements with a 6-hour period between decrements. Following the removal of all loading, rebound readings shall be taken for a period of not less than 12 hours. Upon completion of each load test, all records shall be submitted for approval.

After the completion of loading tests, the load used shall be removed and the piles, including anchor piles, may be used in the structure if found by the Engineer to be satisfactory for such use. Test piles not loaded may be used similarly. If any pile, after serving its purpose as a test or anchor pile, is found unsatisfactory for use in the structure, it shall be removed if so ordered, or shall be cut off below the ground line or footings as directed.

505.08 Defective Piles. The procedure for driving shall not subject the piles to excessive and undue abuse producing crushing and spalling of the concrete, injurious splitting, splintering and brooming of the wood or deformation of the steel. Manipulation of piles to force them into proper position, considered to be excessive, will not be permitted. Any pile damaged by reason of internal defects, improper driving, use of an improper hammer, or driven out of its proper location shall be corrected without additional compensation by one of the following methods approved for the pile in question:

- The pile shall be withdrawn and replaced by a new and, if necessary, longer pile.
- A second pile shall be driven adjacent to the defective pile; the defective pile shall be removed to at least 2 feet below cut-off elevation and the hole filled with sand if a cast-in-place pile.
- The pile shall be spliced or built up as otherwise provided herein or a sufficient portion of the footing extended to properly embed the pile.

All piles pushed up by the driving of adjacent piles or by any other cause shall be re-driven. Any pile which cannot be driven as specified due to an obstruction shall be considered complete if adequate penetration has been achieved in the sole judgement of the Engineer. In such case, the length of the pile driven is to be added to the total aggregate footage.

505.09 Timber Piles. Timber piles shall be stored, handled and cut off as prescribed in Division II, Section 3 of the AASHTO Standard Specifications for Highway Bridges. Timber piles shall be driven to production pile order lengths unless otherwise directed. If timber piles are delivered substantially longer than the ordered length, the pile should be cut off at the tip end in advance so that the maximum diameter butt end remains in the structure.

505.10 Cast-in-Place Concrete Piles. The inspection of steel shells, reinforcement and placing of concrete shall be in accordance with Division II, Section 3 of the AASHTO Standard Specifications for Highway Bridges.

505.11 Manufacture of Precast Concrete Piles. The manufacture of precast concrete shall conform to Section 502. The water method of curing shall be used except that steam curing as specified in Subsection 502.11 may be authorized.

Piles shall not be driven until cured for not less than 21 days and, when ambient temperatures are below 40 degrees F, for a longer period as determined by the Engineer.

Concrete piles for use in seawater shall be cured for not less than 30 days before being used.

505.12 Extensions and Splices.

(a) Steel Piles, Pipes, and Shells. Full length steel piles, pipes and shells shall always be used where practicable, but if splices cannot be avoided, the method of splicing and splice location for each pile shall be submitted for approval.

(b) Precast Concrete Piles. Before cutting off a pile, the pile shall be braced securely to prevent any vibration during the cutting or building up an extension.

After the driving is completed, the concrete at the end of the pile shall be cut away leaving the reinforcing steel exposed for a length of 30 diameters. The final cut of the concrete shall be at right angles to the axis of the pile.

505.13 Cutoffs and Cappings. Tops of foundation piles shall be embedded in the concrete footing at least 1 foot except that at locations of tremie concrete, the piles shall project at least 6 inches above the top of the seal concrete. Piles shall be cut off level at the designated elevation. The length of pile cutoff shall be sufficient to permit the removal of all injured material. The distance from the side of any pile to the nearest edge of the footing shall be a minimum of 9 inches. When the cutoff elevation for a precast concrete pile is below the elevation of the bottom of the cap, the pile shall be built up from the butt of the pile to the elevation of the bottom of the cap by means of a reinforced concrete extension. Steel shells or concrete casings for cast-in-place concrete piles shall be cut off at the designated elevation before being filled with concrete.

Cutoffs of steel bearing piles shall be made at right angles to the axis of the pile. The cuts shall be made in clean, straight lines.

505.14 Painting Steel Piles and Pipe Shells. When steel piles or pipe shells in the completed structure extend above the original ground line or finished ground surface, they shall be protected by four coats of paint as specified for Zone 3B in Subsection 503.15. This coating shall extend from an elevation 3 feet below the bed of waterway or finished ground surface respectively to the top of the exposed steel. Finish coat color shall be gray to match the concrete color.

COMPENSATION

505.15 Method of Measurement. Prebored holes will be measured by the linear foot from the bottom of foundation excavation elevation to the bottom of hole elevation.

Test piles will be measured by the linear foot. The length of test piles, when driven, will be measured as the total length of test piles as designated or as ordered by the Engineer; or if the penetration for any one test pile is greater than the length of the pile indicated or directed, then the linear feet of actual penetration of such test pile will be measured. Where a buildup or extension is placed on a test pile to be left in place, the linear feet of buildup or extension will be included.

Piles of the various kinds and sizes, including buildups or extensions, will be measured by the linear foot. The part cut off after driving will not be measured.

Splices for steel H-piles will be measured per each individual splice except splices within the pile lengths ordered by the Engineer will not be measured unless the ordered length is in excess of 80 feet.

Cutoffs will be measured by the linear foot as determined by subtracting the total length of pile remaining in each of the furnished structures from the lesser of either the total length of pile ordered by the Engineer for each structure or the total length of pile delivered to the Project for each structure excluding the length of test piles.

Pile load tests will be measured by the number of units for each load test made including those during which the pile fails.

Furnishing equipment for driving piles will not be measured and payment will be made on a lump sum basis.

505.16 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Prebored Holes	Linear Foot
Test Piles	Linear Foot
Cast-In-Place Concrete Piles, _____" Diameter	Linear Foot
Precast Concrete Piles, _____" x _____"	Linear Foot
Prestressed Concrete Piles	Linear Foot
Steel H-Piles, HP _____" x _____"	Linear Foot
Untreated Timber Piles, _____" Diameter	Linear Foot
Treated Timber Piles, _____" Diameter	Linear Foot
Splices for Steel H-Piles	Unit
Load Tests	Unit
Furnishing Equipment for Driving Piles	Lump Sum

Payment of 75 percent of the lump sum price bid will be made when the equipment necessary for driving piles is furnished and driving of test piles has commenced. Payment for the remaining 25 percent will be made when the work of driving piles is entirely completed on an individual bridge basis. If piles are deleted from the design, or if the number of pile units is decreased, payment for the remaining 25 percent will be made without any reduction. If the number of pile units is increased, no increase in payment will be made in the total remaining 25 percent.

Payment for pile cutoffs not used in the Project will be made in an amount equal to the actual per linear foot material cost of piles furnished, provided that such cost does not exceed 85 percent of the bid price for the Pay Item. An invoice or bill of sale shall be furnished to show the linear foot price paid for the materials delivered to the site.

Payment for pile cutoffs will not be made for pile lengths which were included for material payments under the provisions of Subsection 109.06.

Payment adjustments for strength will be made in accordance with Subsection 914.02, Subpart *(e)* and will be applied to the lot footage for cast-in-place, precast or prestressed concrete piles.

SECTION 506 - BULKHEADS, FENDER SYSTEMS AND DOLPHINS

506.01 Description. This work shall consist of the construction of concrete, steel and timber bulkheads, fender systems and dolphins.

MATERIALS

506.02 Materials. Portland cement concrete for concrete sheet piles shall conform to Section 914 and Table 914-2 for prestressed concrete piles. Other materials shall conform to the following Subsections:

Tie rods, plate washers, turnbuckles, nuts, bolts, washers, and all other hardware in bulkheads shall be of steel with dual coating system consisting of zinc coating (galvanizing) and coal tar epoxy-polyamide paint. Coal tar epoxy-polyamide paint shall be applied immediately after the installation of all connections except that tie rods, excluding threaded ends, shall be painted at least 72 hours prior to the installation. All galvanized surfaces to receive coal tar epoxy-polyamide paint shall be cleaned in accordance with the procedure given under Painting Galvanized Steel in Steel Structures Painting Manual. Galvanizing shall not be damaged during the cleaning process.

Concrete materials, proportioning, and construction requirements shall conform to Section 501.

Materials not covered by the above provisions shall conform to Division II, Section 2 of the AASHTO Standard Specifications for Highway Bridges.

EQUIPMENT

506.03 Equipment. The equipment shall conform to Sections 501 and 505.

CONSTRUCTION

506.04 Timber Structures. The methods of construction for timber structures shall conform to Division II, Section 20 of the AASHTO Standard Specifications for Highway Bridges and to the following amendments and additions:

- Handling and driving of timber piles shall conform to Section 505.
- Nails shall be driven with sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces may be cause for rejection. All cutting, framing and boring of treated timbers shall be done before treatment.
- Timbers, sheeting and piles shall be handled without dropping, breaking of outer fibers, bruising or penetrating the surface with tools. They shall be handled with rope slings. Cant hooks, peaveys, spikes or hooks shall not be used.
- All cuts and abrasions in treated timbers, sheeting and piles, after having been trimmed, shall be covered with two applications of a mixture of 60 percent creosote and 40 percent roofing pitch or brush coated with at least two applications of hot creosote and covered with hot roofing pitch.
- Before driving bolts, hot creosote shall be poured into all bolt holes in such a manner that the entire surface of the hole is coated. Any unfilled holes, after being treated with creosote, shall be plugged with creosoted plugs.

506.05 Sheet Piling. The method of manufacture and the construction of all prescribed types of sheet piling shall conform to Section 505 except that lighter driving equipment or vibratory pile drivers may be used.

The lower ends of timber sheet piling shall be drift sharpened to wedge against the adjacent timbers. If the tops are battered in driving, they shall be left slightly high and then cut off at the required elevation. After cutting, the ends of sheeting members and wales shall be treated with two applications of coal tar creosote.

(a) Coating Steel. All surfaces of sheeting, plates, and wales shall be blast cleaned conforming to SSPC-SP 6 of the Steel Structures Painting Council and then shall be coated with coal tar epoxy-polyamide paint at least 72 hours prior to driving in the manner prescribed below:

Promptly after blast cleaning, the surfaces shall be given two coats of coal tar epoxy, each at a coverage rate of not more than 125 square feet per gallon, but in no case shall the dry film thickness of the two coats total less than 16 mils at any point. Application may be by brush, roller, or spray. The first coat may be thinned not more than 10 percent with a solvent recommended by the coating manufacturer; the second coat shall not be thinned. The first coat shall be thoroughly dry before applying the second coat. The second coat shall be dry and hard before handling the steel.

Damaged or rejected areas of coating shall be cleaned of all foreign or loose material and promptly recoated. The loose or damaged coating in the surrounding area shall be removed and the surface of the remaining sound film, immediately adjacent thereto, shall be brushed with methyl isobutyl ketone to provide a good bonding surface for the new coats. The top coat shall be dry before driving, however, coated areas shall not be driven until the top coat has cured for at least 72 hours.

(b) Alignment. The completed piling shall be vertical, in line, driven to the prescribed depth, cut off to a straight line at the prescribed elevation, and practically watertight at the joints.

COMPENSATION

506.06 Method of Measurement. Sheet piling of the various kinds will be measured by the square foot of projected area exclusive of indentation of pile section.

Tie rods will be measured by the pound based on the weight table in Suosection 503.17.

506.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Concrete Sheet Piling	Square Foot
Steel Sheet Piling	Square Foot
Treated Timber Sheet Piling	Square Foot
Tie Rods	Pound

Payment for timber wales, caps and other structural members used in bulkhead and fender system construction will be made in accordance with Section 504.

Payment for piles used in bulkhead and fender system construction will be made in accordance with Section 505.

SECTION 507 - PNEUMATICALLY APPLIED MORTAR

507.01 Description. This work shall consist of the removal and the restoration of deteriorated concrete with pneumatically applied mortar.

For structural steel members, encased or non-encased, this work shall consist of cleaning, priming, and encasing of these members with pneumatically applied mortar.

MATERIALS

507.02 Materials. Materials shall conform to the following Subsections:

Fine Aggregate	901.13
Curing Materials	905.03
Epoxy Bonding Coat	912.24
Reinforcement Steel for Structures	915.01
Portland Cement	919.11
Water	919.15

CONSTRUCTION

507.03 Preparation and Cleaning. Cleaning of structural steel shall conform to Subsection 514.05.

Cleaning and replacement of reinforcement shall conform to Subsection 518.04, Subpart *(b)*.

Cleaning of concrete shall consist of removal of deteriorated concrete to a sound concrete surface and to a minimum of 3/4 inch behind the first mat of reinforcement. In the case of abutment, pier seat or column repairs, removal shall not extend under the bearing seats or more than 15 percent of the column cross sectional area without approval.

Removal shall be by chipping with pneumatic hammers and chisels weighing not more than 30 pounds with the bit removed. Repair procedures for beams shall be in conformance with the Supplementary Specifications.

Cavities shall be chipped so that their sides form an approximate 90 degree angle to the exposed surface for at least 1/2 inch in depth. Areas which are to receive the mortar course shall be cleaned by flushing or scouring with compressed air jets to assure removal of all loose particles.

The newly chipped and sandblasted concrete surfaces or primed steel surfaces shall be coated thoroughly with epoxy bonding coat prior to application of the mortar.

507.04 Applying Mortar. Prior to construction, test specimens shall be made by each application crew using the equipment, materials and mix proportions proposed for each type of repair on the Project.

Test panels shall be at least 30 by 30 inches for each mix, each type of repair and for each shooting position to be encountered on the job including the overhead position. The same reinforcement as is in the structure shall be provided in at least half the panels to test for proper embedment of the reinforcing steel. Test panels shall be fabricated in the same thickness as the structure, but thickness shall not be less than 3 inches or the least dimension of the proposed repair, whichever is less. Test panels shall be field cured in the same manner as the work. Test panels shall be gunned preferably against similar support conditions, such as a 6-inch thick precast concrete slab section or equivalent, to simulate actual field conditions for concrete repairs to pier surfaces.

At least five 3-inch diameter cores or 3-inch cubes shall be cut from each test panel not earlier than 5 days after applying the mortar. The specimens shall be delivered to the Engineer for testing. Test specimens are to be cured and tested in accordance with AASHTO T 24.

For acceptance purposes, the average 28-day core strengths, as a minimum, shall be equal to f'c = 3450 pounds per square inch for cores with L/D = 2.0. For cores with L/D between 1.0 and 2.0, the correction factors specified in AASHTO T 24 shall apply. For cube specimens, the average strength, as a minimum, shall be equal to f'c/0.85.

The cut surfaces of the specimens will be examined carefully and additional surfaces shall be exposed by sawing or breaking portions of the test panels, as directed. The mortar shall be bonded to the existing substrate and reinforcing bars and shall be sound and uniform. Cut and broken surfaces shall be free of honeycomb, laminations, and sand pockets.

Unreinforced test panels, from which four cubes or cores shall be obtained, shall be at least 1 foot square and 3 inches thick and shall be made daily. The cores shall be tested in pairs for 28-day strength, the average compressive strength for these pairs shall be minimum 3300 pounds per square inch. If 250 square feet or less per day are applied, sampling requirements may be reduced or waived.

The mortar shall be applied in one or more layers to the total thickness required to restore the area as detailed over the original lines of the adjoining surface. Where the cavity exceeds 4 inches in depth, a layer of mesh shall be used for each 3-inch depth of mortar. However, in no case shall wire mesh be placed behind existing reinforcement.

The time interval between applying successive layers in sloping, vertical, or overhanging work must be sufficient to allow initial set to develop. During the time initial set is developing, the surface shall be cleaned to remove the thin film laitance in order to provide bonding with succeeding applications.

Texture of finished surface shall be a natural gun finish troweled to meet the originally constructed contours.

Clear liquid curing compound shall be applied immediately after applying the mortar course.

Unless otherwise designated, the areas of concrete and encasement to be repaired will be determined before work begins and access to the areas shall be provided.

The requirements for scaffolding and temporary shielding will be provided in the Supplementary Specifications.

COMPENSATION

507.05 Method of Measurement. Pneumatically applied mortar will be measured by the square foot.

507.06 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Pneumatically Applied Mortar	Square Foot

SECTION 508 - METAL BRIDGE RAILING AND FENCE

508.01 Description. This work shall consist of the construction of metal railing and fence on bridges.

MATERIALS

508.02 Materials. Materials shall conform to the following Subsections:

Chain-Link Fence	907.02
Metal Railing:	
Aluminum Alloy	911.01
Structural Steel, Carbon	917.10
Aluminum-Pigmented Alkaline-Resistant Paint	912.02
Zinc Chromate Primer	912.20
Mortar and Grout	914.03
Bolts and Bolting Material	917.01
Zinc Coating on Steel	917.12
Bearing Pads, Elastomeric	919.02
Caulking Compound	919.04

CONSTRUCTION

508.03 Shop Drawings. Shop drawings shall be furnished in accordance with Subsection 105.04. Minor variations in details of metal railings and chain-link fence may be permitted. However, any major departure from the design will not be accepted.

508.04 Construction Requirements. All railing posts shall be vertical. Railing shall not be placed on a span until the centering or falsework is removed and the span is self-supporting.

The base plates of the posts shall be attached to top of parapet by anchor bolts set in the concrete. Bolts set prior to concreting shall be held securely in place by a nut above the form template and a threaded aluminum alloy washer (6061-T6) below the form template. The lower fastening shall prevent passage of mortar onto the exposed bolt threads.

Where posts are set in aluminum sleeves which have been previously installed in the concrete, the annular space between the posts and sleeves shall be filled with aluminum-impregnated caulking compound. Surfaces receiving the caulking compound shall be dry and free from dirt, oil, paint and other deleterious materials. Care shall be taken to secure a dense and complete seal. The top of the compound shall be beveled sufficiently to drain freely.

Where necessary for vertical alignment of the railing, lead strips for steel and aluminum shims, for aluminum railings, shall be placed under the perimeter of base plates. The strips shall be 1 1/4 inches wide and of the required thickness. The strips, when placed, shall project 1/8 inch from the base plates. When the railing has been aligned, the nuts shall be tightened on the anchor bolts and the lead or aluminum shims caulked to form a watertight seal between the base plates and the concrete of the parapet or other foundation. The anchor bolts shall be tightened again, where necessary, and all bolts shall not project more than 1/4 inch above the nut and shall be staked to prevent the loosening of the nut due to vibration or vandalism. Care shall be taken to prevent injury to the concrete and impairment of the bond between the bolt and the concrete.

508.05 Steel Railing.

(a) Fabrication and Erection. Fabrication and erection of ferrous metal railing shall be done in accordance with Section 503. In the case of welded railing, all exposed joints shall be finished by grinding or filing, after welding.

Railings shall be adjusted prior to fixing in place to ensure matching at abutting joints and correct alignment and camber throughout their length. The railing shall be so fabricated as to allow for minor adjustments in both horizontal and vertical directions. In the bottom of the sealed end, a 1/2-inch hole for drainage shall be provided.

(b) Painting. Ferrous metal railing shall be given three coats of paint as specified in Subsection 503.15, Subpart *(a)*. All coats may be applied in the shop but all damaged coating shall be touched up before or after erection. No painting is required on railing or posts where galvanizing is specified.

508.06 Aluminum Railing.

(a) Fabrication and Erection. The fabrication and erection of aluminum railing shall conform to Subsection 508.04 and to the following:

- Material 1/2 inch thick or less may be sheared, sawed, or milled. Material over 1/2 inch thick shall be sawed or milled. Cut edges shall be true, smooth, and free from excessive burrs or ragged breaks. Re-entrant cuts shall be filleted by drilling prior to cutting.
- Rivet or bolt holes shall be drilled or subpunched 3/16 inch smaller than the nominal diameter of the fastener and reamed to size. The finished diameter of holes shall not be more than 7 percent greater than nominal diameter of the fasteners. Anchor bolt holes and slotted bolt holes to take care of expansion shall be provided.

(b) Protection Against Other Materials. Where aluminum surfaces are to be in contact with metals other than stainless steel or other compatible metals, the contact surfaces shall be coated by painting the dissimilar metals with a prime coat of zinc chromate primer followed by one coat of aluminum metal paint, aluminum-impregnated caulking compound of a heavy brushing consistency, or by the use of an elastomeric bearing pad separator.

Aluminum surfaces to be placed in contact with concrete shall be given a heavy coat of an aluminum-pigmented, alkaline-resistant paint.

The paint shall be applied without the addition of thinner.

After erection, all spaces between base plates and concrete shall be caulked with an aluminum-impregnated caulking compound.

A 1/8 inch minimum thickness elastomeric bearing pad may be placed under each post as an alternative. The pad shall cover the entire contact area between post and concrete and shall be trimmed to the shape of the post base.

(c) Finishing. After the concreting has been completed, the aluminum bridge railing shall be cleaned, removing any accumulation of oil, grease, dirt or other foreign materials. A solvent cleaner may be used. Where mechanical means are used to remove stains, grease and minor scratches, the resulting finish shall be uniform in appearance over the entire tube.

Finished tubing shall be free from grease and stains, gouges, dents, burrs and shall have a minimum of rubs, scratches and minor extrusion marks from the dies. Painting of aluminum alloy railing is not required.

508.07 Aluminum Chain-Link Fence, Bridge. The fence shall be fabricated and erected in accordance with this Section and Section 614. In addition, the fence fabric shall be cleaned to remove oil film and other deleterious substances prior to leaving the shop.

COMPENSATION

508.08 Method of Measurement. Chain-link fence of the various sizes will be measured by the linear foot.

Metal railing of the various kinds and sizes will be measured by the linear foot.

508.09 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Chain-Link Fence, Aluminum, Bridge, ____' ____" High	Linear Foot
Chain-Link Fence, Aluminum, Bridge, ____' ____" High, Curved Top	Linear Foot
Metal Railing (____ Rail, Aluminum)	Linear Foot
Metal Railing (____ Rail, Steel)	Linear Foot

SECTION 509 - SIGN SUPPORT STRUCTURES

509.01 Description. This work shall consist of the furnishing, fabrication and erection of sign support structures.

MATERIALS

509.02 Materials. Materials shall conform to the following Subsections:

Electrical Conduits and Fittings	906.07
Aluminum Alloys	911.01
Aluminum-Pigmented Alkaline-Resistant Paint	912.02
Grout	914.03
Bolts and Bolting Material	917.01
Zinc Coating on Steel	917.12
Bearing Pads, Elastomeric	919.02

Galvanized steel structures shall consist of seamless steel pipe conforming to ASTM A 53, Type S or Type E, Grade B, and of plate, shapes, flat washers and shims conforming to ASTM A 36.

Nuts, washers and the upper 12 inches of the anchor bolts shall be galvanized. The upper 10 inches of the bolts shall be threaded before coating and shall be furnished with double nuts.

Portland cement concrete, reinforcement steel and curing material shall be as specified in Subsection 501.02.

CONSTRUCTION

509.03 Shop Drawings. Shop drawings shall be furnished in accordance with Subsection 105.04. Minor variations in details may be permitted. However, any major departure from the design will not be accepted.

A copy of the welding procedure shall be submitted by the fabricator.

509.04 Steel Structures. Welding and fabrication for steel structures shall be in accordance with Sections 1 through 6 and Section 10 of the Structural Welding Code, ANSI/AWS D1.1-84 (Steel). All weldments will be inspected visually by magnetic particle and by dye penetrant.

Radiographic inspection will be at the discretion of the Engineer.

After fabrication, the steel assemblies shall be hot-dip galvanized in accordance with ASTM A 123. The average thickness of coating (each side) shall be at least 5 mils, but in no case less than 4 mils thickness at any location. Inspection of the coating will be made by magnetic thickness gauge measurements as specified in ASTM A 123.

Galvanized areas damaged during shipping or erection shall be repaired as specified in Subsection 503.14.

509.05 Aluminum Alloy Structures. Welding and fabrication for aluminum alloy structures shall be in accordance with Sections 1 through 6 and Section 10 of the Structural Welding Code, ANSI/AWS D1.2-83 (Aluminum) except that all overhead, cantilever, butterfly and bridge mounted sign support structures shall be classified as Class II structures as defined in Article 10.1.2 of ANSI/AWS D1.2-83 (Aluminum).

All weldments will be inspected visually, by dye penetrant and by radiographic testing.

509.06 Inspection. Written notice shall be given not less than 15 calendar days in advance of when welding is to be undertaken so that arrangements for inspection may be made.

The fabricator shall schedule his work in such a way that the radiographic inspection may be performed between his first and second work shifts, and shall provide sufficient indoor space during winter months and inclement weather to perform these inspections.

Radiographic inspection and acceptance of aluminum alloy sign supports will be performed in accordance with Part III, Subpart F of the Department's Operation Bulletin No 14-A. Copies may be obtained from the Department Laboratory upon written request. Radiographic inspection of weldments at the site of fabrication will be performed by the Department or by a testing agency designated by the Department. The initial radiographic inspection for each weldment will be performed without charge. The cost of radiographic inspection of all repaired weldments shall be paid to the State at the rate provided in the Supplementary Specifications. Such costs may be recovered by the State, in accordance with Subsection 109.05, from any monies due or that may become due the Contractor.

Prior to shipping, the completed and accepted truss units shall be assembled in the shop and the truss span checked for dimensions, straightness, alignment, and camber.

Defects in weldments identified by visual, penetrant or X-ray inspection shall be corrected by removing the defect and rewelding.

509.07 Release for Shipping. Sign support structures will be accepted and released for shipping on the basis of a total structural unit being completed and inspected. This approval and release for shipment will be provided by the Department Laboratory or the testing agency, in writing, directly to the fabricator with a copy to the Contractor. This notice will be provided within 10 working days after completion of the inspection for the total structure.

The structures shall be loaded on trucks or rail cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed or otherwise damaged. Reinspection may be required on the site of erection for such cause

509.08 Erection. Structural components shall be handled with care to prevent damage and shall be stored in accordance with Subsection 509.09. Detailed written instructions and drawings for the erection of all structures shall be supplied prior to erection.

All walkways, luminaires, signs and miscellaneous attachments shall be installed within the same 8-hour period that the trusses are erected. In addition, dampers shall be provided for all aluminum alloy overhead sign support structures (exclusive of cantilever, butterfly and bridge mounted sign support structures), and shall be installed prior to erection.

The dampers for aluminum alloy overhead sign support structures shall consist of two galvanized cast-iron weights connected by a short length of flexible 7-wire steel messenger cable and shall be attached to the structure by means of an aluminum clamp cast integrally with the messenger cable. The damper shall weigh about 31 pounds and shall be furnished and installed complete with U-bolts, lock nuts, additional support pipe and all other necessary appurtenances. The damper shall be located at midspan on the upper front chord. Damper location and details shall be shown on the shop drawings.

509.09 General.

(a) *Fabrication.* The loading, transporting, unloading, and erection of structural materials shall be done so that the metal is kept clean and free from injury in handling.

Structural materials shall be stored above the ground upon platforms, skids or other supports. They shall be kept free from accumulation of dirt, oil, acids, or other foreign matter.

Any structural material which has been deformed shall be straightened before being laid out, punched, drilled, or otherwise worked on in the shop. Sharp kinks or bends are cause for rejection.

(b) *Concrete Footings.* Excavation and backfill shall be performed in accordance with Section 206. Concrete construction requirements shall conform to Section 501.

Anchor bolts shall be set to template for alignment and elevation and shall be secured in position to prevent displacement while concrete is being placed. The steel reinforcement and conduit elbows shall have been placed and secured before the placing of concrete.

The top surface of the concrete footing shall be leveled off 3 inches below the grade of the base of the vertical members of the structure, to provide for grout fill under the base after the structure has been adjusted to the lines and grades.

(c) *Installation of Conduits.* Galvanized steel conduit ells in footing pedestal shall be furnished and installed. Where this conduit is not to be extended to a junction box, the lower end of each ell shall terminate 3 feet from the face of the pedestal and 18 inches below grade and shall be capped with a standard galvanized steel pipe cap. The upper end of each ell shall project above the foundation for a sufficient distance to terminate at the level of the bottom of the handhole in the sign support post, or at a maximum of 2 inches below such level, at which point it shall be terminated by means of a ground bonding bushing (with closure disk in conduits not to be extended).

(d) *Handholes and Wire Outlets.* Where a cable passes through a hole or runs along a surface at any point on the complete assembly, such holes and surfaces shall be deburred and free of sharp edges or protruberances that may, in any manner, damage the cable.

(e) *Protection Against Other Materials.* The underside of aluminum alloy shoe base plates shall be coated with an aluminum-pigmented alkaline-resistant paint.

Where aluminum surfaces are to be in contact with other metals, Subsection 508.06, Subpart *(b)* shall apply.

(f) *Posts.* Posts shall be erected in position to engage the anchor bolts on top of the concrete footing. After the entire structure, including truss arms and sign panels, has been erected and adjusted for plumbness, grades and alignment by the manipulation of the leveling nuts on the anchor bolts, the 3 inch grout course shall be placed so as to fill the spaces between the top of the concrete footing and the post bases. The exposed portions of the top surface shall be sloped down away from the post base plate.

End posts shall not be erected upon the completed footings until authorized, but the minimum time allowed for the curing of the concrete before any load is placed thereon shall be 7 calendar days. Footings shall be backfilled prior to erection.

COMPENSATION

509.10 Method of Measurement. Sign support structures of the various kinds will be measured by the number of each.

509.11 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Cantilever Sign Support, Structure No. ____	Unit
Bridge Mounted Sign Support, Structure No. ____	Unit
Butterfly Sign Support, Structure No. ____	Unit
Overhead Sign Support, Structure No. ____	Unit

Payment for foundation excavation will be made in accordance with Section 206.

Payment for concrete and reinforcement steel will be made in accordance with Section 501.

SECTION 510 - PUBLIC UTILITIES IN STRUCTURES

510.01 Description. This work shall consist of the construction of electric and telephone conduits, and gas and water mains on bridges.

MATERIALS

510.02 Materials. Materials shall conform to the following Subsections:

Fiberglass Pipe	913.11
Bolts and Bolting Material	917.01
Structural Steel	917.10
Timber for Structures	918.05
Gaskets	919.08

Steel pipe sleeves shall conform to ASTM A 252 and shall be galvanized in accordance with ASTM A 123.

Channel supports, rods, bolts, nuts, washers, inserts and other hardware required for the permanent installation shall be hot-dip galvanized in accordance with ASTM A 123 or A 153.

Gas Mains. Pipe, pipe sleeves, pipe hanger assemblies, expansion joints, and seals between the pipe and sleeves shall be furnished by the gas company. Pipe, in 20 foot or longer lengths, shall be delivered to the job site, by the gas company, close to the point where it is to be used.

Water Mains. Materials shall be as provided in the Supplementary Specifications.

CONSTRUCTION

510.03 Construction Requirements.

(a) Electric and Telephone Conduits. Couplings shall be used to connect all conduits and shall be placed on terminal ends. Expansion couplings shall be used at expansion joints. Galvanized steel pipe lengths shall be joined with standard screw couplings conforming to requirements for galvanized wrought iron pipe couplings.

Steel pipe sleeves shall be installed in the abutment backwalls. The annular space between conduit and sleeves shall be caulked with asphalt-impregnated hemp.

All conduits shall be rodded and No. 9 galvanized fish wires placed therein.

Structural steel shapes and plates for utility supports shall be furnished and erected in accordance with Section 503.

The conduit installation is subject to inspection and approval of the utility company.

(b) Gas Mains. The gas company shall be notified at least 3 working days in advance of when pipe delivery is required. The pipe shall be unloaded at the delivery point and shall be moved into place on the structure and joined together by welding. The gas main shall terminate approximately 5 feet beyond the abutments at each end of the bridge structure. Expansion joints shall be installed in the main as instructed by the gas company representative. Structural shapes and plates for utility supports shall conform to Section 503.

Prior to welding, the pipe shall be aligned on the common axis, properly gapped and firmly held by a welding clamp. All welding areas shall be cleaned to a bright metal surface by wire brushing or grinding. The first or stringer bead shall be deposited at least 50 percent around the circumference in equally spaced segments before the weld clamp is removed. Before applying the next pass, all tack welds and each bead shall be cleaned free of scale and oxide.

Welding shall conform to the manual arc welding procedure in accordance with API 1104 - Standard for Field Welding of Pipe Lines. Welders shall be qualified under API 1104 standards.

All welds shall be examined by radiographic (X-ray) inspection by a qualified inspection company acceptable to the gas company. The welds shall be accepted only if they meet API 1104 standards of acceptability. The X-ray films and one copy of the radiographic inspection report are to be delivered to the gas company. Defective welds shall be removed from the line and the pipe rebeveled by grinding and rewelded. Repair welds also shall also be inspected radiographically in accordance with the provisions of this paragraph.

Before sections of pipe are welded together, each length shall be cleaned by passing a fiber and wire pipe brush of proper size through it.

Hangers shall be adjusted to provide uniform support of the pipe across the bridge and to align it in the abutment sleeves.

Upon completion of the installation, the carrier pipe shall be given a bottle test with air, for 24 hours, at a pressure specified by the gas company with test caps and gauges supplied by the gas company. Caps or expansion joints, if used, shall be anchored to prevent movement during the test. The method employed to anchor caps and expansion joints is subject to approval of the company inspector.

After completion of the test and relieving the test pressure, anchoring devices shall be removed as directed by the company inspector.

The pipe and hanger supports shall be cleaned and painted in accordance with company specifications. Copies of these specifications are available upon written request to the gas company.

The installation of gas mains is subject to inspection and approval of the utility company.

(c) ***Water Mains.*** The construction of water mains shall be in accordance with the provisions in the Supplementary Specifications.

COMPENSATION

510.04 Method of Measurement. Utility conduits and mains will be measured by the linear foot including the length projecting beyond the rear face of the abutment.

510.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Electric Conduits	Linear Foot
Telephone Conduits	Linear Foot
_____" Gas Mains	Linear Foot
_____" Water Mains	Linear Foot

SECTION 511 - STRUCTURAL PLATE PIPE

511.01 Description. This work shall consist of the construction of structural plate pipe and pipe arches, and structural plate arch.

MATERIALS

511.02 Materials. Materials shall conform to the following Subsections:

Aluminum Alloy Structural Plate for Pipe, Pipe Arches and Arches	913.01
Structural Steel Plate for Pipe, Pipe Arches and Arches	913.15

CONSTRUCTION

511.03 Shop Drawings. Shop drawings shall be furnished in accordance with Subsection 105.04.

511.04 Excavation, Bedding and Backfill. Excavation, bedding and backfilling shall be in accordance with Section 206 and the following:

- When filling around and over arches before headwalls are in place, the first fill material shall be placed midway between the ends of the arch, forming as narrow a ramp as possible, until the top of the arch is reached. The ramp shall be built evenly from both sides and the fill material shall be compacted as it is placed. After the two ramps have been built to the top of the arch, the remainder of the fill material shall be deposited from the top of the arch both ways from the center to the ends, and as evenly as possible on both sides of the arch.

- If the headwalls are built before any fill material is placed around and over the arch, the fill material shall first be placed adjacent to one headwall until the top of the arch is reached, after which it shall be placed from the top of the arch toward the other headwall, with care being taken to deposit the material evenly on both sides of the arch. In multiple installations, the procedure specified above shall be followed, but care shall be used to bring the material up evenly on each side of each arch so that unequal pressure is avoided.

511.05 Fabrication.

(a) Description of Plates. Plates shall consist of structural units of galvanized corrugated steel or of corrugated alumimnum alloy, whichever is specified. Single plates shall be furnished in standard sizes to permit structure length increments of 2 feet.

The plates at longitudinal and circumferential seams of structural plates shall be connected by bolts.

(b) Forming and Punching Plates. Plates shall be formed to provide lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature and the same number of bolts per foot of seam shall be interchangeable.

Bolt holes along those edges of the plates that form longitudinal seams in the finished structure shall be staggered in rows 2 inches apart, with one row in the valley and one on the crest of the corrugation. Bolt holes along those edges of the plates that form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 inches. The minimum distance from center of the hole to edge of plate shall be not less than one and three quarters times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams except those at the plate corners shall not exceed the diameter of the bolt by more than 1/8 inch.

Plates for forming skewed or sloped ends shall be cut to give the angle of skew or slope specified. Burned edges shall be free from oxide and burrs. Identification numerals shall be placed on each plate to designate its proper position in the finished structure.

511.05 Erection. Structural plate pipe, pipe arches and arches shall be erected in their final position by connecting the plates with bolts at longitudinal and circumferential seams. Drift pins may be used to facilitate matching of holes. All plates shall be placed in the order recommended by the manufacturer with joints staggered so that not more than three plates come together at any one point. All bolts shall be drawn tight, without overstress, before beginning the backfill.

After the pipe or arches have been erected, all erection bolts and all spots where damage has occurred to galvanized coating shall be field galvanized in accordance with Subsection 503.14. Damage to bituminous coating shall be repaired whith two coats of hot asphalt coating.

511.07 Elongation. Elongated structural plate shall be formed so that the finished pipe is elliptical in shape, with the vertical diameter approximately 5 percent greater than the nominal diameter of the pipe. Elongated pipe shall be installed with the longer axis vertical.

Pipe arches shall not be elongated.

COMPENSATION

511.08 Method of Measurement. Structural plate pipe and pipe arches, and structural plate arch will be measured by the linear foot along the bottom centerline for pipe and pipe arches, and by the average of the spring line lengths for structural plate arch.

511.09 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
_____" Structural Plate Pipe, _____Gauge	Linear Foot
_____" x _____" Structural Plate Pipe Arch, _____Gauge	Linear Foot
_____" x _____" Structural Plate Arch, _____Gauge	Linear Foot

Payment for excavation will be made in accordance with Section 206.

SECTION 512 - TEMPORARY STRUCTURES

512.01 Description. This work shall consist of the structural design, construction, maintenance and removal of temporary structures including substructures and approaches.

MATERIALS

512.02 Materials. Any material or combination of materials which are appropriate for the type of structure may be used.

CONSTRUCTION

512.03 Working Drawings. Detailed drawings shall be furnished in accordance with Subsection 105.04. Design calculations shall be included and shall be signed by a Professional Engineer licensed in the State of New Jersey.

512.04 Capacity. Design loadings shall conform to the New Jersey Department of Transportation Design Manual for Bridges and Structures.

512.05 Structures. For waterway structures, the elevation of the bottom of the floor system shall not be lower than the ordinary high-water elevation. Waterway opening shall be provided which is at least equal to the waterway opening provided by the existing structure at ordinary high-water level. If there is no existing structure, the temporary bridge shall be constructed to provide a waterway opening at least equal to that indicated for the new structure at ordinary high-water level.

Curbs shall be painted white.

512.06 Maintenance. Each temporary structure and the approaches shall be maintained to safely accommodate traffic. Barricades, signs, lights, and flagmen shall be provided where specified. Temporary structures shall be removed after the new work is open to traffic.

COMPENSATION

512.07 Method of Measurement. Temporary structures of the various kinds will not be measured and payment will be made on a lump sum basis.

512.08 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Temporary Structure, One-Way	Lump Sum
Temporary Structure, Two-Way	Lump Sum
Temporary Structure, Pedestrian Bridge	Lump Sum

Payment of 75 percent of the lump sum price bid will be made when the temporary structure is opened to traffic. Payment for the remaining 25 percent will be made when the temporary structure has been removed.

SECTION 513 - TEMPORARY SHEETING

513.01 Description. This work shall consist of the structural design, construction, maintenance, and removal of temporary sheeting.

MATERIALS

513.02 Materials. Any type of sheeting and system of bracing may be used that is adequate and effective in safely withstanding the external forces to be sustained during construction.

CONSTRUCTION

513.03 Working Drawings. Detailed drawings shall be furnished in accordance with Subsection 105.04. Design calculations shall be included and shall be signed by a Professional Engineer licensed in the State of New Jersey.

513.04 Construction Requirements. Structural members for the temporary sheeting and bracing system shall be of adequate size and cross section with physical properties for proper functioning, and shall be braced to protect workers, adjoining properties and the public.

The temporary sheeting shall be tight and continuous for its entire length.

Except for untreated timber, the Resident Engineer may authorize leaving the sheeting in place. When sheeting is left in place, the upper portion shall be removed to 3 feet minimum below finish ground.

COMPENSATION

513.05 Method of Measurement. Temporary sheeting will be measured by the square foot.

513.06 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Temporary Sheeting	Square Foot

SECTION 514 - PAINTING EXISTING BRIDGES

514.01 Description. This work shall consist of the cleaning and painting of structural steel and metal surfaces on existing bridges.

MATERIALS

514.02 Materials. Materials shall conform to the following Subsections:

Paint	912.01
Touch Up (Spot Coat)	912.03
First Field Coat	912.03
Second Field Coat	912.04
Finish Coat (Foliage Green)	912.05
Finish Coat (Lake Blue)	912.06
Finish Coat (Brown)	912.07
First Finish Coat (Off-Gray)	912.08
Final Finish Coat (Gray)	912.09
Finish Coat (Aluminum)	912.10
Finish Coat (Black)	912.11

The finish coat shall be the same color as that on the existing bridge but all paint shall match the Federal Color Chip Number specified.

EQUIPMENT

514.03 Equipment. The equipment shall include cleaning and painting equipment, tools, tackle, scaffolding, facilities for protection of pedestrian, vehicular or other traffic upon or underneath the bridge, and facilities for protection of all portions of the structure against disfigurement by spatters, splashes and smirches of paint.

CONSTRUCTION

514.04 Limits of Cleaning and Painting. Surfaces to be cleaned and painted shall include all surfaces of structural steel which have previously been painted and surfaces of other metal. They shall include structural steel girders, beam and metal plate flooring, towers and bents, metal protection for piers and abutments, metal railing on bridge spans, wing walls and along the bridge approaches, and metalwork exposed on bridge deck and sidewalks. On drawbridges, the work includes cleaning and painting of bridge houses, warning and crash gates, and counterweights. Woodwork, if any, shall be painted with two coats of appropriate paint.

Aluminum alloy metal work and galvanized metal used as permanent metal deck forms for concrete decks and bridge deck grid flooring shall not be painted.

The bridges to be painted will be provided in the Supplementary Specifications. For the bidders information, the approximate weight (in tons) of structural steel, on an individual bridge basis, will be provided in the Supplementary Specifications.

When more than one bridge is to be painted, the Resident Engineer may specify, at any time, the sequence in which the structures shall be painted.

514.05 Cleaning Methods. Method A, SSPC SP 2 or Method B, SSPC SP 3, or combination of both shall be used in all cases except where Method C, SSPC SP 7, or Method D, SSPC SP 6 is specified in the Supplementary Specifications.

Oil, grease or salts, or other surface contaminations must first be removed by the methods outlined in SSPC SP 1.

Dust conditions at each bridge site shall be anticipated and such dust as may collect shall be removed before paint is applied.

514.06 Painting Galvanized Surfaces. Galvanized surfaces and galvanized surfaces made bare by the cleaning operations shall be treated before painting in accordance with ASTM D 2092, Method A or Method D.

514.07 Conditions for Painting. Paint shall be applied on clean and dry surfaces. Paint shall not be applied when the temperature of the air, paint, or metal is below 40 degrees F or when the temperature is expected to fall below 40 degrees F before the paint is cured, during rain, or when the air is misty or when, in the opinion of the Resident Engineer, conditions are unsatisfactory for the work. Paint shall not be applied upon damp or frosted surfaces or when the metal is hot enough to cause the paint to blister, produce a porous paint film, or cause the vehicle to separate from the pigment. Paint shall not be applied when the steel surface temperature is lower than 5 degrees F above the dew point. The dew point may be determined by the use of a sling psychrometer and appropriate tables. In practice, the dew point requirement can be presumed to be satisfied if a thin, clearly defined film of water, applied to the cleaned vertical surface with a damp cloth, evaporates within 15 minutes.

Each coat of paint shall be allowed to dry and harden before the succeeding coat is applied. The Engineer will make the decision as to when the paint is dry and hard enough for application of the succeeding coat, but in no case shall the drying time be less than 24 hours for any coat of paint including spot coats.

The prime coat or spot coat of paint shall be applied as soon as the cleaning operations permit, but not until the cleaning operation is far enough ahead to eliminate danger of dirt or other material from the cleaning operations falling or blowing on the fresh paint.

514.08 Number and Thickness of Coats. The number of coats and kind of paint will be provided in the Supplementary Specifications.

The spot coat or prime coat shall have a minimum dry film thickness of 2.0 mils. The succeeding coat shall have a minimum dry film thickness of 1.50 mils and any additional coats shall have a dry film thickness of 1.25 mils minimum. If the dry film thickness is less than that specified, additional coats shall be applied until the thickness is not less than that specified. The dry film thickness will be measured by a method determined by the Resident Engineer.

514.09 Mixing of Paint. All paints shall be mixed in original containers before use and the pigments shall be kept in suspension by frequent stirring during application. Paint shall be mixed by hand or mechanical (power) mixers. To ensure complete mixing, the paint shall be poured several times from one container to another (boxing) until the composition is uniform. Paint shall be strained to remove all skins and dried particles. Excessive skinning or partial hardening of the paint due to improper or prolonged storage is cause for rejection even though it may have been previously inspected and accepted.

Containers and all tools and equipment used for storing, mixing, handling and applying paint shall be kept free from accumulation of hardened paint.

514.10 Thinning Paint. Paint as delivered, when mixed, shall be ready for application and no thinning will be permitted. In cool weather the paint may be warmed to reduce the viscosity for use. Such warming shall be accomplished by heating the paint containers in water or by placing them on steam radiators.

514.11 Application. Each coat of paint must be approved before a succeeding coat may be applied. Prior to the application of the first field coat, a paint coating shall be applied to all edges of plates and rolled shapes, corners, crevices, welds, rivet heads and exposed parts of bolts, by the use of hand brushes or spray equipment. This striping is to be accomplished not less than 14 hours nor more than 72 hours prior to the general painting of the whole surface, including edges and corners, already painted as specified. Touch-up painting shall be by the use of hand brushes only.

Brush painting is the only method to be used for painting above the deck elevation on all truss type bridges.

Except as specified above, paint may be applied with hand brushes, rollers or any combination of these methods. If any method of painting shows evidence of producing unsatisfactory results, another method shall be used.

The coating of paint shall be smoothly and uniformly spread so that every part of the surface is covered with at least the minimum specified thickness and so that no excess paint collects at any point.

If the paint coating is too thin or if portions of the surface are not completely coated, such portions of the work shall be repainted.

All small cracks, joints and cavities which were not sealed in a watertight manner by the first coat of paint shall be filled with red lead and linseed oil paste conforming to Federal Specification TT-R-191, Type II, or plastic caulking compound conforming to Federal Specification TT-C-598 or other similar caulking compound, which shall be permitted to dry before the second coat of paint is applied.

The requirements of SSPC PA 1 shall apply for any provisions not fully covered in these Specifications.

(a) *Brush Painting.* Brushes preferably shall be round or oval in shape, but if flat brushes are used, they shall not exceed 4 1/2 inches in width. All brushes shall have sufficient body and length of bristle to spread the paint in a uniform coat.

The paint shall be manipulated under the brush to produce a uniform, even coat in contact with the metal or with previously applied paint, and shall be worked into all corners and crevices. In general, the primary movement of the brush shall describe a series of small circles to fill all irregularities in the surface, after which the coating shall be brushed out and smoothed by a series of parallel strokes until the paint film has an even thickness.

(b) *Roller Painting.* Rollers, when used, shall be of a type which does not leave a stippled texture in the paint film. Rollers may be used only on flat, even surfaces. The rollers shall be manipulated in a manner to produce a paint film of even thickness with no skips, runs, sags or thin areas.

(c) *Inaccessible Surfaces.* On surfaces which are inaccessible for painting by regular means, the paint shall be applied by sheepskin daubers or sprayed, or by other means if necessary, to ensure coverage of the proper thickness of paint.

514.12 Removal of Unsatisfactory Paint. If the paint coat lifts, blisters, wrinkles or shows evidence of having been applied under unfavorable conditions, or if impure or unauthorized paint has been used, or if, for any other reason, the painting is unsatisfactory, the paint shall be removed and the metal cleaned and repainted without additional compensation.

514.13 Protection of Structure, Persons and Property. Pedestrians, vehicular and other traffic upon or underneath the bridge, and all portions of the bridge superstructure and substructure shall be protected against damage or disfigurement by spatters, splashes and smirches of paint or paint materials. Canvas or other material shall be furnished for such protection.

514.14 Clean-Up. Paint dropped on concrete surfaces and debris from the cleaning operations shall be removed from the superstructure and the substructure. Paint containers and refuse shall be removed from the site.

514.15 Inspection. Facilities for the safe and convenient conduct of the Engineer's inspection shall be provided.

COMPENSATION

514.16 Method of Measurement. Painting will not be measured and payment will be made on a lump sum basis for the total number of bridges.

Blast cleaning will be measured by the square foot.

514.17 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Painting Bridges	Lump Sum
Brush-Off Blast Cleaning	Square Foot
Commercial Blast Cleaning	Square Foot

SECTION 515 - GRANITE MASONRY

515.01 Description. This work shall consist of the construction of granite masonry facing for pier shafts.

MATERIALS

515.02 Materials. Materials shall conform to the following Subsections:

Granite Facing for Pier Shafts	910.07
Mortar	914.03
Bolts and Bolting Material	917.01

CONSTRUCTION

515.03 Shop Drawings. Shop drawings shall be furnished in accordance with Subsection 105.04 and shall show all stone masonry, individual stones in position, their face dimensions, anchor cramps designating marks, and such other sections and drawings as are necessary to cut and set the work.

515.04 Cutting and Delivery. The facing pattern shall be coursed ashlar masonry. The stones shall have lengths between 4 and 8 feet and shall be of such heights as comply with the heights of courses, including bed joints. Thicknesses not less than 8 nor more than 12 inches, including projections measured from the theoretical front arris line, shall be provided. Curved stones at ends of piers shall conform to these thickness requirements.

The front face shall be smooth, split surfaces with a 3-inch maximum projection on straight stones and a 4-inch maximum projection on curved stones, and no part of the face shall recede back of the arris lines. Arrises shall be cut sharp and true to pattern with a maximum tolerance of 1/4 inch from the theoretical true arris. Snipped corners over 3/8 inch will not be permitted. Drill holes shall not appear in the face.

The back may be quarry-split surface but in no case shall rear projections exceed the prescribed 12-inch maximum measurement from the arris line. The face of the granite shall be as smooth as possible to the arris line.

The joint surface of stones shall be cut full and square for not less than 2 inches back of the arris line, and the balance of the joint surfaces roughed off on a batter away from the joint of not more than 1 in 12. Depression in a joint surface shall not be greater than 3 inches and a distance of more than 6 inches from the arris line.

Lewis holes will be permitted in all stones weighing over 100 pounds except that Lewis holes or other holes will not be permitted in exposed surfaces without approval.

Holes for anchor cramps shall be at least 4 inches from any face of the stone and shall be of such size as to allow at least 3/16 inch for mortar between metal and stone.

The granite shall be handled, loaded and fastened for delivery so that there is no danger of spalling or breaking of the stones during transit. All holes shall be protected from the weather, during shipment and storage, in such a way as to prevent the collection of water which may freeze. At all times during handling and storage, the granite shall be kept clear of the ground. Should the surrounding ground at storage sites be of such a nature that the granite may become stained by spattering during rainstorms, steps shall be taken to protect it and, should any of it become stained, the stain shall be removed or else the stones so stained shall be replaced.

515.05 Mortar and Anchors. Setting mortar shall be mixed in such quantities as needed for immediate use. For very small batches, mortar shall be mixed in a batch-type machine mixer. Materials which have been mixed for a period exceeding 30 minutes shall not be used on any portion of the work. Retempering of mortar will not be permitted.

Anchor cramps required to tie the granite firmly to the concrete pier shaft shall be furnished. They shall be of the general character as indicated and shall be of stainless steel. At least two anchors shall be used for each stone.

515.06 Setting. Granite facing shall be set before the concrete directly behind it is placed. The work shall not be constructed in freezing weather or when the stone contains frost except by written permission and conforming to such conditions as may be expressed. Under no circumstances shall salt be used for thawing out holes.

Bed joints and vertical joints shall average 3/4 inch in thickness with a tolerance of plus or minus 1/4 inch.

All joints, sinkages, holes, and any other spaces between stones, or between stones and metal parts, shall be filled with mortar, packed tightly. Lead buttons or hardwood wedges, soaked in water before use and removed before the mortar has set hard, may be used to facilitate proper setting. Each stone shall be cleaned by brushing or other means and drenched with water immediately before it is set, and the bed which is to receive it shall be cleaned and settled in place with a wooden maul. Stones shall not be dropped or slipped but shall be placed without jarring any stone already laid. Heavy hammering will not be allowed after a course is laid. All mortar droppings or smears on the exposed faces of the granite shall be brushed off immediately after the stone is set. Stones becoming loose after the mortar is set shall be removed, cleaned and relaid with fresh mortar.

515.07 Pointing. All joints shall be raked out to a depth of 1 inch, cleaned out, mortar set, and pointed.

Pointing shall be done with lead wool of commercial quality. It shall be driven into the joints with caulking tools so as to fill all openings, and then finished with a pointing tool so as to give flush joints.

515.08 Protecting and Cleaning Stonework. As soon as stonework is set, it shall be protected from damage from weather or other causes until final completion and acceptance of the work.

Immediately after laying and while mortar is still fresh, all face stones shall be cleaned of all mortar stains and shall be kept clean until the work is completed. Before final acceptance, the surface shall be cleaned using wire brushes and muriatic acid if necessary.

In hot or dry weather, the masonry shall be protected from the sun and shall be kept wet for a period of 5 days after completion.

COMPENSATION

515.09 Method of Measurement. Granite masonry will be measured in square feet, computed on the basis of the total front surface area of granite facing, including joints, measured as theoretical smooth planes along the neat and arris lines.

515.10 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Granite Masonry	Square Foot

SECTION 516 - CONCRETE CRIB WALLS

516.01 Description. This work shall consist of the furnishing and installation of precast reinforced concrete units to form a crib wall.

MATERIALS

516.02 Materials. Materials shall conform to the following Subsections:

Porous Fill	203.03
Coarse Aggregate Layer	206.03
Broken Stone	901.04
Concrete Crib Members	910.05

CONSTRUCTION

516.03 Shop Drawings. Shop drawings shall be furnished in accordance with Subsection 105.04. Cribbing with dimensions varying from the prescribed sizes may be permitted.

516.04 Placing Crib Members. Excavation and backfill shall be constructed in accordance with Section 206. The foundation for the crib wall shall be normal to the face of the cribbing and shall be approved before any of the cribbing is placed. Any devices cast in the cribbing units for handling purposes shall be removed flush with the face after erection. If a slight adjustment is needed to correct the alignment, a shim made of neoprene shall be used.

516.05 Filling Crib. The fill for crib walls shall be broken stone, size No. 2, and shall be placed behind the front face of the cribbing and the remainder of the enclosure shall be filled with porous fill. As the filling progresses, bulkheads shall be placed, or other methods shall be used, to keep the broken stone and porous fill material within their prescribed limits. The filling of the interior and backfilling behind the crib shall progress simultaneously with the erection of the cribbing. The space behind the cribbing shall be filled with embankment material free from large lumps, clods, rocks or other debris. All material shall be placed in loose layers not exceeding 6 inches in depth and compacted by means of flat-faced mechanical tamper. This method of filling and compacting the interior and backfill shall be continued until the embankment is level with the top of the structure except where the backfill is accessible to a roller the backfill may be compacted in accordance with Subsection 203.06. Care shall be exercised in the placing and compacting of material between and back of the crib cells so that the cribbing is not damaged.

COMPENSATION

516.06 Method of Measurement. Concrete cribbing will be measured by the cubic foot as determined by the number and volume of each size of stretchers and headers. However, if another design is used that involves a greater volume, measurement will be made only for the lesser.

Broken stone fill will be measured by the cubic yard.

516.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Concrete Cribbing	Cubic Foot
Broken Stone Fill for Crib Wall	Cubic Yard

Payment for foundation excavation and coarse aggregate layer will be made in accordance with Section 206.

Payment for porous fill will be made in accordance with Section 203.

SECTION 517 - STORM DRAINS, BRIDGE

517.01 Description. This work shall consist of the construction of scuppers, inlets and downspouts for surface drainage of bridge decks.

MATERIALS

517.02 Materials. Materials shall conform to the following Subsections:

Fiberglass Pipe	913.11
Steel Alloy Pipe	913.14
Bolts and Bolting Material	917.01
Zinc Coating on Steel	917.12

Frames shall be gray iron castings and grates shall be ductile iron castings conforming to Subsection 917.03.

Ladder rungs shall conform to Subsection 915.01, Subpart *(b)* except that plain bars shall be furnished.

CONSTRUCTION

517.03 Shop Drawings. Shop drawings shall be furnished in accordance with Subsection 105.04.

517.04 Construction Requirements.

(a) Inlet Frames and Grates. The bearing surfaces of inlet frames and grates shall be machined so that the grates have uniform bearing on the frames. They shall be match marked before being delivered.

Inlet frames and grates, and scuppers shall be zinc-coated.

(b) Steel Alloy Pipe. Areas where galvanizing has been damaged shall be repaired as specified under Subsection 503.14. The type of threaded concrete inserts for support brackets and clamp shall be approved.

(c) Fiberglass Pipe and Fittings. Fiberglass pipe and fittings may be substituted where steel alloy pipe is specified.

All connections of pipes and fittings shall be made with threaded, gasketed coupler system or bolted, gasketed flange system. Adhesive bonded joints shall not be used.

Runs of pipe shall be supported at spacings not exceeding those recommended by the manufacturer of the pipe. Supports that have point contact or narrow supporting areas shall be avoided. Standard sling, clamp and clevis hangers and shoe supports designed for use with steel pipe may be used. A minimum strap width for hangers shall be 1 1/2 inches for 6-inch diameter pipe and 2 inches for 12-inch diameter pipe. Straps shall have 120 degrees contact with the pipe. Pipe supported on surface with less than 120 degrees of contact shall have a split fiberglass pipe protective sleeve bonded in place with adhesive.

If pipe of a concrete gray color is not readily available, another color may be furnished. However, the pipe and fittings shall be painted concrete gray with a paint suitable for coating fiberglass. Fiberglass pipe and fittings shall be handled and installed in accordance with manufacturer's recommendations.

COMPENSATION

517.05 Method of Measurement. Inlet frames and grates, and scuppers will be measured by the number of units.

Pipe of various sizes will be measured by the linear foot.

517.06 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Inlet Frames and Grates	Unit
Scuppers	Unit
_____" Steel Alloy Pipe	Linear Foot

SECTION 518 - BRIDGE DECK REHABILITATION

518.01 Description.

(a) *Repair of Concrete Deck.* This work shall consist of the removal and disposal of loose and disintegrated concrete, the preparation of the surface, cleaning or replacement of existing reinforcement steel, application of epoxy bonding coat and placing of concrete patch materials.

(b) *Membrane Waterproofing.* This work shall consist of the placing of a waterproofing membrane on the surface of the existing bridge deck prior to placing an overlay of bituminous concrete.

(c) *Latex Modified Concrete (LMC) Overlay.* This work shall consist of the construction of a latex modified concrete overlay.

(d) *Scarification.* This work shall consist of scarifying existing concrete bridge decks prior to repair of concrete deck or placing of LMC overlay.

MATERIALS

518.02 Materials.

(a) *Repair of Concrete Deck.* Class A concrete shall conform to Section 914. When Class A concrete is prescribed for Type B Repair, the coarse aggregate shall be Size No. 8.

Other materials shall conform to the following Subsections:

Epoxy Bonding Coat	912.24
Reinforcement Steel, Deformed Bars	915.01
Latex Emulsion Admixture	919.10
Quick-Setting Patch Materials	919.12

A quick-setting patching material products list is included in the Supplementary Specifications. Additional products will be considered for approval only after testing by the Department Laboratory and evaluation in the field, in service under all kinds of weather conditions. An extension of Contract Time will not be allowed due to delays caused by or in any way related to such testing and evaluation by the Department.

When LMC overlay is specified, epoxy resin patching material shall not be used. Other patching material systems shall not be used if the coefficient of thermal expansion of the patching material system, as determined in accordance with ASTM C 531, is 25 percent greater or less than the coefficient of the LMC mix to be used in the overlay.

(b) *Membrane Waterproofing.* A membrane waterproofing products list is included in the Supplementary Specifications. Additional products will be considered for approval only after testing by the Department Laboratory and evaluation in the field. An extension of Contract Time will not be allowed due to delays caused by or in any way related to such testing and evaluation by the Department.

(c) *Latex Modified Concrete Overlay.* Materials shall conform to Subsection 501.02 and the following:

- Coarse aggregate shall be Size No. 8.
- A latex emulsion admixture products list is included in the Supplementary Specifications. Additional products will be considered for approval only after the results of tests conducted by a testing agency have been verified by the Department Laboratory. An extension of Contract Time will not be allowed due to delays caused by or in any way related to such testing and evaluation by the Department.

EQUIPMENT

518.03 Equipment.

(a) *Latex Modified Concrete Overlay.* Latex modified concrete shall be mixed at the site in a continuous mobile mixer conforming to Subsection 405.08, Subpart *(d)*.

A self-propelled rotating cylinder-type finishing machine, capable of forward and reverse movement under positive control shall be used for finishing all larger areas of work. The machine shall be equipped with one or more rotating steel cylinders, augers and vibratory pans, and must be able to span the entire placement transversely. The machine shall travel on steel rails, pipe or other approach grade control in accordance with Subsection 501.12, Subpart *(e)*. Hand operated vibrators and screeds may be used to place and finish small areas of work.

(b) *Scarification.* The equipment shall be self-propelled and capable of scarifying a minimum of 1,000 square yards per day across the cutting path in one pass to a minimum depth of 1/4 inch. It shall be capable of establishing profile grades by referencing from existing grades and shall have a means for controlling cross slopes.

The equipment shall have a means for removing milled material from the surface and for preventing dust and other materials from escaping into the air.

The equipment shall have a floating type head that allows for deeper cutting in areas of deteriorated concrete. It shall have the capability of locking out the head float.

Pneumatic hammers, not heavier than the nominal 30-pound class, and triple-headed tampers fitted with star drills not less than 2 inches in diameter may be used to remove concrete surfaces adjacent to curbs and scuppers.

CONSTRUCTION

518.04 Repair of Concrete Deck. Repairs of concrete deck are classified as follows:

- Type A Repair shall consist of removing all delaminated and/or deteriorated deck concrete from 3/4 inch minimum to the top layer of the existing top reinforcement steel and placing of Type I quick-setting patch material to the level of the existing concrete deck or to the level of the scarified deck surface, if scarification is scheduled or directed.
- Type B Repair shall consist of removing all delaminated and/or deteriorated deck concrete to a minimum depth of 1 inch below the bottom of the top layer of existing reinforcement steel to a maximum depth of 50 percent of the thickness of the existing concrete deck and placing of Class A concrete or Type IA quicksetting patch material, whichever is specified, to the level of the existing concrete deck or to the level of the scarified deck surface, if scarification is scheduled or directed.

Latex modified concrete (LMC) overlay may be used for Type A or Type B repairs conforming to the provisions of Subpart *(b)* below.

- Type C Repair shall consist of removing all delaminated and/or deteriorated deck concrete for the full depth of the existing deck and placing Class A concrete or Type IA quick-setting patch material, whichever is specified, to the level of the existing concrete deck or to the level of the scarified deck surface, if scarification is scheduled or directed.

Prior to commencement of concrete removal, a field survey shall be performed for each stage of construction for the purpose of establishing existing grades and cross slopes and for determining proposed finished grades and cross slopes. The cross slopes where given on the Plans are theoretical and approximate and are not intended to be actual.

A minimum of three deck elevations in each span shall be taken for each stage of construction, at the centerline of the bearings and centerline of span along each lane line and gutter line before proceeding with concrete removal or scarification.

In addition, field measurements shall be taken that may be necessary to establish existing grades or cross slopes and to develop finished grades and cross slopes.

(a) Deck Preparation. Written notice shall be submitted not less than 14 calendar days in advance of when the site is available for a deck condition survey by the Department. Surveys will be scheduled during daylight hours of working days unless the working time is restricted in the Supplementary Specifications. Surveys will be performed only if the ambient temperature has been above 40 degrees F for a minimum of 72 hours prior to the beginning of the survey and only if the deck is dry. Lighting facilities shall be furnished and maintained for any survey work scheduled during the hours of dusk or darkness. In all cases, traffic controls required for the safe and convenient conduct of the survey shall be provided.

The deck condition survey will be made before scarification, if scheduled, and after the removal of any existing bituminous concrete overlay and waterproofing membrane. The survey may include, but not be limited to, the following procedures: visual inspection, coring samples for chloride analysis, delamination survey, and electrical-potential measurement (half-cell testing) as described in FHWA Report No. DP-33, Bridge Deck Evaluation Techniques. The data obtained will be used to determine the repair limits which will be designated as promptly as conditions permit.

(b) Construction Procedures. Repair areas shall be saw cut to a 3/4-inch depth prior to scarification, if scheduled, and prior to removal of deteriorated concrete in the designated areas.

During removal for Type C repairs, temporary shielding shall be provided to prevent debris from falling below the deck.

All loose and disintegrated concrete shall be removed from the areas to be repaired in such a manner and to such an extent as to expose a sound concrete surface. Sound concrete (beneath the disintegrated concrete) shall be removed for a depth of not less than 1/4 inch and not more than one inch, and the remainder of the area and all exposed reinforcement shall be cleaned and roughened by sandblasting. The work shall be done in such a manner as not to damage the concrete that is to remain.

Only pneumatic or hand tools shall be used in the removal of the disintegrated concrete and in preparing and shaping the areas to be repaired. The size of the hammers shall not exceed 30 pounds.

Hand chipping methods shall be used to remove concrete adjacent to exposed reinforcing steel. Care shall be taken so as not to damage or debond the reinforcement steel, or to shatter the concrete beyond the area to be repaired.

For Type B and C repairs, all corroded reinforcing bars shall be cleaned by sandblasting, waterblasting, or wire brushing. Those bars that have lost 25 percent or more of their original cross-sectional area shall be supplemented by splicing in new reinforcement steel of the same diameter. In supplementing existing bars, they shall be lapped at least 30 bar diameters and wired together. If necessary, additional chipping of concrete shall be done to provide for this lap. Where reinforcement is broken or missing, new bars shall be lapped at least 30 bar diameters. For Type A repair, where the bond between existing concrete and reinforcing steel has been destroyed, or where more than half the diameter of the steel is exposed, the concrete adjacent to the bar shall be removed to a depth in accordance with a Type B repair. A minimum of 1 inch clearance around the bar is required except where lower bar mats make this impractical.

In areas of Type C repairs, forms shall be provided to enable placement of the concrete or quick-setting patch material. These forms may be suspended from existing reinforcing bars by wire ties for small areas and, in the case of large area openings, they shall be supported by blocking from the beam flanges.

The sides of the concrete at the location of Type C repairs shall be inclined so that the top area of the repair is larger than the bottom.

When Class A concrete is specified for Type B and C repairs, all operations shall conform to the applicable provisions of Section 501 and the following:

- An epoxy bonding coat shall be applied to the surface of sound concrete in the repair area just prior to placing the Class A concrete.
- Traffic, equipment, or other loading will not be permitted on the deck slab when Class A concrete is used as a patch material until the concrete has cured 72 hours and the minimum strength for an additional individual test as defined in Section 914 exceeds 3000 pounds per square inch from two cylinders cast during placement.

When quick-setting patch materials are specified for Type A, B or C repairs, all operations shall conform to the manufacturer's recommendations. Two copies of the manufacturer's technical data sheets shall be submitted at the preconstruction meeting. A technical representative of the manufacturer shall be present on the site to provide guidance in the preparation and placement of the quick-setting patch material based on prevailing climatic and job conditions. The representative shall be present at least during one complete cycle of the procedures required for the initial placement.

When latex modified concrete is used for Type A or Type B repairs, the repair areas shall be brushed with a thin layer of LMC grout. The LMC shall be placed, spud vibrated, and compacted by hand methods concurrently with the LMC overlay operations in accordance with Subsection 518.06.

518.05 Membrane Waterproofing.

(a) *Deck Preparation.* Repair of concrete deck shall be performed in accordance with Subsection 518.04. The repairs shall be completed and accepted prior to installation of the membrane waterproofing.

(b) *Construction Procedures.* Requirements for cleaning and surface preparation of concrete on the existing bridge deck slabs, construction equipment, temperature and weather conditions, application of primer, and other operations pertaining to placing the membrane waterproofing may vary with the proprietary product. Two copies of the manufacturer's technical data sheets shall be

submitted at the preconstruction meeting. Construction shall be done in strict conformance to the manufacturer's recommendations. The manufacturer's technical representative shall be on the site for the first full day of the initial construction to recommend methods for surface preparation, priming, and installation of the membrane waterproofing based on prevailing climate and job conditions.

518.06 Latex Modified Concrete Overlay.

(a) *Storage of Materials.* When the concrete materials are stored on the Project site, they shall be maintained in accordance with Subsection 405.07.

Latex admixture shall be stored in enclosures which can protect it from freezing or from prolonged exposure to temperatures in excess of 85 degrees F. The manufacturer's recommendations shall be followed.

(b) *Design Mix.* At least 45 calendar days prior to the start of the LMC overlay placement, a mix design shall be submitted for approval and verification. Verification of the design mix includes the testing of properties specified for LMC. Trial batches shall be prepared of the same materials and proportions required by the mix designs being submitted for approval and verification. Department personnel will be present during verification batching to ensure that the proportions and ingredients batched are in accordance with the proposed mix design. At least three tests (six cylinders) for compression testing shall be prepared, cured, and delivered in accordance with AASHTO T 23 or AASHTO T 126, except that the demolded cylinders shall be air cured. Within 2 to 5 days after molding, the cylinders shall be delivered to the Department Laboratory where they will be tested for 7 and 28 day compressive strength.

Certification shall be furnished, in accordance with Subsection 106.04, that the manufacturer of the latex emulsion admixture has verified the compatibility of the proposed cement to be used in the LMC mix.

The latex modified concrete shall have the following design mix:

Cement, bags (cu ft)/cu yd	7.0
Latex emulsion admixture, gal/bags	3.5
Water, gal/bags	2.7 max
Air content, percent of plastic mix according to AASHTO T 152	6.5 max
Slump, inches	3.0 TO 6.0 max
Percent fine aggregate as percent of total aggregate, by weight	55 to 70
Weight ratio range (dry basis):	
cement	1.0
sand	2.5 to 3.1
coarse aggregate	1.4 to 2.0

The net water added shall be adjusted to control the slump within the prescribed limits and should produce net water-cement ratios of 0.30 to 0.40 by weight.

The slump will be measured 4 to 5 minutes after discharge from the mixer. During this waiting period, LMC shall not be placed.

The dry weight ratios are approximate but, due to gradation changes and/or variable specific gravities, may be adjusted by the Engineer within the weight ratio ranges.

(c) *Surface Preparation.* Within the 24 hour period of placing the LMC overlay, the entire surface which is to receive the overlay shall be cleaned by sandblasting or waterblasting to remove loosened chips of concrete, curing

compound and laitance from repair areas, and all other residue. Surface preparation shall be of such extent as to provide a clean, sound surface exposing mortar and coarse aggregate. Chipping with hand tools or pneumatic scabblers may be required to remove oil intrusions. The contact surfaces between the overlay and the curb surfaces and the edge of previously placed overlay shall also be blasted. All dust, small particles and other residue from the blasting operation shall be completely removed using air jets or a vacuum cleaner. Water blasted surfaces shall receive a final washing prior to placement of the LMC. The cleaned surface shall be protected by covering with a polyethylene film, 6 mil minimum thickness, until ready to place the overlay.

Sandblasting equipment shall be approved. If the surface has been scarified, the equipment shall be capable of removing any small chips of concrete which were partially loosened.

During the surface preparation for the placement of the LMC overlay, precautions shall be taken so that previously completed repair areas are not disturbed or damaged. Any damage shall be corrected without additional compensation.

Immediately prior to placement of the LMC overlay, the cleaned surface shall be thoroughly wetted for a period of not less than one hour. Just before the overlay is placed, any standing water in depressions, holes or areas of deteriorated concrete removal shall be blown out with compressed air.

Before the placement of LMC, the finishing machine shall make a dry run over the entire bridge deck to assure that the minimum thickness of overlay prescribed is attained. At least 48 hours of curing shall elapse prior to scarification or chipping of concrete for repair within 6 feet of the previously placed LMC.

(d) Joints. The location of construction joints shall be as prescribed or directed. A bulkhead of styrofoam or other approved material shall be installed at each deck joint to the required grade and profile prior to placing the LMC overlay.

(e) Weather and Temperature Restrictions. Latex modified concrete overlay shall not be placed between November 15 and March 15.

Latex modified concrete shall not be placed at air temperatures lower than 45 degrees F. It can be placed at 45 degrees F and rising, provided that the air temperature is forecast to remain above 45 degrees F for the first 12 hours of the curing period. At temperatures below 50 degrees F, a longer curing period will be required.

At least 30 calendar days prior to LMC placement, a plan of action for cold weather concreting shall be submitted if it is probable that the air temperature could fall below 35 degrees F at any time during the LMC placement or wet cure period. At temperatures above 85 degrees F or when dry and windy conditions occur, the Resident Engineer may direct that placements be made at night or during early morning hours.

(f) Proportioning and Mixing. Material for the LMC shall be mixed at the site in accordance with the requirements for the equipment used. The LMC as discharged from the mixer shall be uniform in composition and consistency and shall conform to the mix design requirements of Subpart *(b)* above. Mixing capability shall be such that placing and finishing can be accomplished in one continuous operation without any delay before the formation of the plastic surface film. A minimum of four test cylinders for compression testing will be made for each day's placement for each mixer unit in accordance with AASHTO T 23 except that the demolded cylinders are to be air cured.

518.06

(g) *Placing and Finishing.* The latex emulsion admixture manufacturer's technical representative shall be on the site for the first full day of the initial construction in order to recommend methods and operations based on prevailing climatic and job conditions. Enough mixers shall be used to assure that the placement of the LMC can be carried out in one continuous operation over the limits prescribed.

The LMC shall be deposited on the bridge deck directly from the mixer chute. A thin layer of LMC shall be brushed onto all horizontal and vertical surfaces of the wetted bridge deck with a polyethylene broom immediately prior to placement of the full thickness of the overlay.

The LMC shall be placed and struck off to approximately 1/4 inch above final grade. It shall then be consolidated and finished to the final grade by the finishing machine.

Spud vibration shall be required in deep pockets, edges and adjacent to joint bulkheads. Hand finishing with a float may be required along the edge of the placement or on small areas of repair. Edge tooling is required at joints except next to metal expansion dams, curbs and previously placed lanes.

A portable lightweight or wheeled work bridge shall be used behind the finishing operation for touchup work, surface texturing and curing cover placement.

A temporary construction dam or bulkhead shall be installed in case of delays in the placement operation exceeding 1 hour in duration. During delays of 1 hour or less, the placement may be protected from drying with several layers of wet burlap.

Adequate precautions shall be taken to protect freshly placed LMC from sudden or unexpected rain. All placing operations shall stop when it starts to rain. The Resident Engineer may order removal of any material damaged by rainfall.

When a tight, uniform surface has been achieved and before a plastic film forms, the deck slab surface shall be texture finished in accordance with Subsection 501.15 except that curing shall be in accordance with Subpart *(h)* below.

Testing for deck surface tolerance requirements shall be in accordance with Subsection 501.16.

(h) *Curing.* Promptly after the surface texturing, the overlay shall be covered with a single layer of clean, wet burlap as soon as the surface supports it without deformation.

Within one hour of covering with wet burlap, a layer of white polyethylene sheeting, 6 mil minimum thickness, shall be placed on the wet burlap and shall remain at least for 24 hours. The burlap shall be wet at all times prior to placing the polythylene sheeting. If, in addition to the overlay, LMC is also used for Type A and/or Type B repairs, as provided in Subsection 518.04, additional time shall be required for the wet cure for the increased depth of the placement. The additional time for wet cure shall be in accordance with the following:

Repair Area Percent of LMC Overlay Area In One Day's Placement		Minimum Additional Wet Cure Time
Type A	Type B	
20% or less	Less than 10%	12 hours
Greater than 20%	Less than 10%	18 hours
———	10% to 20%	24 hours
———	Greater than 20%	30 hours

After the wet cure period of 24 hours minimum has elapsed, the polyethelene sheeting and wet burlap shall be removed and the overlay shall be air cured so that the total curing time (wet and dry) is 14 days. Any period during which the air temperature falls below 50 degrees F shall not be counted in the curing time. After the deck has cured at least 14 days and the concrete in the deck has attained a strength of not less than 3000 pounds per square inch as determined from cylinders cast during placement of the deck, the deck shall then be sawcut grooved finished in accordance with Subsection 501.15, Subpart *(c)*.

(i) Opening to Traffic. Vehicular traffic of any kind will not be permitted on LMC overlay until the deck has been sawcut grooved finished.

518.07 Scarification. Provisions shall be made so that the existing transverse and longitudinal joints are not damaged below the limits of scarifications.

Saw cuts for repair of concrete deck, if scheduled, shall be completed in accordance with Subsection 518.04 before scarification. If, after scarification, other areas of deteriorated concrete are prescribed for repair beyond the initial saw cut penpheries, new saw cuts shall be made for the additional repair limits designated.

All concrete and other materials removed as a result of the scarifying operation shall be completely removed by hand, power broom, vacuum, or such other means, and disposed of. Flushing of this debris will not be permitted. Debris shall be removed at the end of each work day.

COMPENSATION

518.08 Methods of Measurement. Repair of concrete deck of the various types will be measured by the square foot.

Membrane waterproofing will be measured by the square yard.

Latex modified concrete overlay will be measured by the cubic yard except LMC used in Type A Repair or Type B Repair will not be measured.

Scarification will be measured by the square yard.

518.09 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Repair of Concrete Deck, Type ———	Square Foot
Membrane Waterproofing	Square Yard
Latex Modified Concrete Overlay	Cubic Yard
Scarification	Square Yard

Payment for the quantity of latex modified concrete overlay in excess of 125 percent of the estimated quantity will be made at 75 percent of the contract bid price and conflicting provisions of Subsection 104.05 do not apply.

Payment for reinforcement steel will be made in accordance with Section 501.

CONTENTS

SECTION 600 - INCIDENTAL CONSTRUCTION

SECTION 601 - UNDERDRAINS

601.01 Description. This work shall consist of the construction of underdrains and subbase outlet drains.

MATERIALS

601.02 Materials. Materials shall conform to the following Subsections:

Aggregates for Underdrains	901.14
Bituminized Fiber Pipe	913.02
Concrete Pipe	913.05
Corrugated Aluminum Alloy Underdrain Pipe	913.07
Corrugated Steel Underdrain Pipe	913.10
Plastic Drainage Pipe	913.12
Semicircular Steel Pipe for Underdrains	913.13
Vitrified Clay Pipe	913.16
Geotextiles	919.06
Salt Hay	919.13

Portland cement concrete for pipe plugs shall conform to Section 914 for miscellaneous concrete.

Ordering of materials for underdrains shall be deferred until such time during roadway excavation that the required quantity and lengths of underdrains will be determined.

CONSTRUCTION

601.03 Excavation and Backfilling. Excavation shall be in accordance with Subsection 207.04. Backfilling shall be in accordance with Subsection 207.06.

601.04 Laying of Pipe. Laying of pipe shall be in accordance with Subsection 602.04 and the following:

- Joints of bell and spigot type pipes shall be packed with burlap or salt hay to permit the flow of water but not the passage of backfill material into the pipe.
- All areas of bituminous coating which have been damaged shall be painted with two coats of hot asphaltic paint.
- All areas of polymer coating which have been damaged shall be repaired in accordance with the manufacturer's recommendations.

Dead ends of pipe underdrains shall be plugged with concrete in accordance with Subsection 613.05 or closed with a pipe cap.

COMPENSATION

601.05 Method of Measurement. Subbase outlet drains will be measured by the linear foot. One and one-half linear feet of subbase outlet drain will be allowed for each stone pocket.

Pipe for subbase outlet drains will be measured by the linear foot.

Underdrains of the various types will be measured by the linear foot.

601.06 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Subbase Outlet Drain	Linear Foot
_____" Corrugated Steel Underdrain Pipe	Linear Foot
Underdrain, Type _____	Linear Foot

Payment for rock excavation will be made in accordance with Section 207.

SECTION 602 - STORM DRAINS

602.01 Description. This work shall consist of the construction of storm drains for surface drainage.

MATERIALS

602.02 Materials. Materials shall conform to the following Subsections:

Ductile Iron Culvert Pipe	913.03
Ductile Iron Water Pipe	913.04
Concrete Pipe	913.05
Corrugated Aluminum Alloy Culvert Pipe and Pipe Arches	913.06
Corrugated Steel Culvert Pipe and Pipe Arches	913.08
Mortar and Grout	914.03
Gaskets	919.08

Portland cement concrete for pipe plugs, encasements or saddles shall conform to Section 914 for miscellaneous concrete.

Where corrugated metal culvert pipe is designated, corrugated aluminum alloy culvert pipe or corrugated steel culvert pipe may be used.

Where corrugated metal culvert pipe arch is designated, corrugated aluminum alloy culvert pipe arch or corrugated steel culvert pipe arch may be used.

End sections shall be of the same material as the pipe or pipe arch to which the end sections are attached.

CONSTRUCTION

602.03 Construction Requirements. Excavation, bedding, backfilling, and disposal of excess material shall conform to Section 207 and the following:

- Trench openings shall not remain open overnight, unless adequately protected, within or adjacent to roadways on which traffic is being maintained or within the normal limits of pedestrian access.
- When installing storm drains across private property, the topsoil and sod disturbed by excavation operations shall be salvaged for use in restoring the area to its original condition.
- Except where necessary to maintain flow, drains shall not be placed in embankment until it has been constructed to a height of at least 3 feet above the top of the pipe or to the top of the embankment, whichever is lower, and then a trench shall be excavated for placing of the pipe.
- Existing drainage flow during construction shall be maintained until proposed drainage facilities are completed and put into service.

602.04 Laying of Pipe. The laying of pipe shall begin at the downstream end of the pipe line. The lower segment of the pipe shall be in firm contact with the bedding throughout its full length. Bell or groove ends of pipe shall be placed facing upstream. Perforated pipe shall be laid with the perforations at the bottom.

All areas of polymer coating which have been damaged shall be repaired in accordance with the manufacturer's recommendations.

Where the ends of pipes are to enter existing concrete or masonry walls, the pipe shall be neatly cut to fit the inside face of the wall and the pipe shall be grouted in place. Where pipes are to enter below the paved invert of existing structures, the existing concrete shall be cut and shaped to form a new channel.

Where storm drains are to be constructed in two or more stages, a temporary pipe plug shall be constructed in the end of the pipe at the termination of each stage except where it is required to keep the pipe open for temporary drainage.

Pipe will be inspected before backfill is placed. Any pipe found to be out of alignment, excessively settled, or damaged shall be taken up and relaid or replaced.

602.05 Joining Pipe. Joints for rigid pipe shall be made with mortar, grout, or gaskets. Other types of joints recommended by the pipe manufacturer may be permitted. Corrugated pipe shall be joined by coupling bands.

For mortar joints, the pipe ends shall be cleaned and wetted with water before the joint is made. Stiff mortar shall be placed in the lower half of the bell or groove of the pipe section already laid and on the upper half of the spigot or tongue of the section to be laid. The two pipe sections shall then be tightly joined with their inner surfaces flush and even. Any voids occurring in the outside of the joint shall be filled. Lifting holes shall be filled with stiff mortar.

For pipes 36 inches and larger, the inside of the joint shall be finished smooth. For pipes smaller than 36 inches, the joint shall be cleared of protruding mortar. The completed mortar joints shall be protected against rapid drying if not immediately backfilled with earth. In cold weather, mortar for pipe joints shall be prepared and protected in accordance with Subsection 603.05.

Gaskets shall be installed to form a flexible watertight seal. Rubber and flexible plastic gaskets shall be installed in accordance with recommendations of the manufacturer.

602.06 Relaid Pipe. Existing pipes to be relaid which are outside the limits of excavation for new pipes shall be removed and the trenches shall be backfilled and compacted. The pipe shall be cleaned and relaid as specified for new pipe.

COMPENSATION

602.07 Method of Measurement. Pipe of the various sizes, kinds and classes will be measured by the linear foot except for the distance between inner faces of inlet and manhole walls. Pipes with sloped or skewed ends will be measured along the invert.

Note: Corrugated aluminum alloy culvert pipe which is designated to be heavier than 16 gauge will be measured with the quantity of 16 gauge pipe. Corrugated steel culvert pipe which is designated to be heavier than 14 gauge will be measured with the quantity of 14 gauge pipe.

End sections of the various sizes and kinds will be measured by the number of each.

Relaid pipe of the various sizes and kinds will be measured as specified above for pipe.

602.08 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
____" Ductile Iron Culvert Pipe	Linear Foot
____" Ductile Iron Water Pipe, Class ____	Linear Foot
____" Corrugated Aluminum Alloy Culvert Pipe	Linear Foot
____" Corrugated Steel Culvert Pipe	Linear Foot
____" Corrugated Metal Culvert Pipe	Linear Foot
____" Reinforced Concrete Culvert Pipe	Linear Foot
____" Reinforced Concrete Culvert Pipe, Class ____	Linear Foot
____" Corrugated Aluminum Alloy End Sections	Unit
____" Corrugated Steel End Sections	Unit
____" Corrugated Metal End Sections	Unit

_____" Reinforced Concrete End Sections	Unit
_____" x _____" Corrugated Aluminum Alloy Culvert Pipe Arch	Linear Foot
_____" x _____" Corrugated Steel Culvert Pipe Arch	Linear Foot
_____" x _____" Corrugated Metal Culvert Pipe Arch	Linear Foot
_____" x _____" Reinforced Concrete Culvert Pipe Arch, Class _____	Linear Foot
_____" x _____" Corrugated Aluminum Alloy End Sections	Unit
_____" x _____" Corrugated Steel End Sections	Unit
_____" x _____" Corrugated Metal End Sections	Unit
_____" x _____" Reinforced Concrete End Sections	Unit
Relaid (size and kind) Pipe	Linear Foot

Payment for rock excavation will be made in accordance with Section 207.

Payment for concrete for pipe encasements or saddles or for permanent pipe plugs will be made in accordance with Section 613.

SECTION 603 - INLETS AND MANHOLES

603.01 Description. This work shall consist of the construction of inlets and manholes.

MATERIALS

603.02 Materials. Portland cement concrete shall conform to Section 914. Other materials shall conform to the following Subsections:

Clay or Shale Brick	910.01
Concrete Block for Inlets and Manholes	910.02
Concrete Brick	910.04
Mortar and Grout	914.03
Reinforcement Steel	915.01
Castings for Drainage Structures	917.03
Epoxy Bedding and Bonding Compound	919.17

Aggregate for coarse aggregate bed shall conform to Subsection 901.03.

Ladder rungs shall conform to Subsection 915.01 Subpart *(b)* except that plain bars shall be furnished.

CONSTRUCTION

603.03 Excavation and Backfilling. Excavation shall be in accordance with Subsection 207.04. Backfilling shall be in accordance with Subsection 207.06.

603.04 Concrete Construction. Concrete construction shall be in accordance with Subsections 501.11 and 501.17.

603.05 Block and Brick Construction. Concrete block and brick shall be laid with staggered joints. All horizontal joints, all vertical joints of brick, and all keyways of vertical joints of concrete block shall be filled with mortar. All horizontal joints and, in brick, all vertical joints shall be not more than 3/8 inch wide. The outside wall shall be plastered with a minimum of 1/2-inch thickness of mortar troweled to a smooth finish.

When the working day temperature is below 40 degrees F, mortar shall be prepared by heating the mixing water and sand to produce mortar between 50 and 100 degrees F. Masonry shall be maintained above 32 degrees F for 24 hours by the use of a protective covering

Inlet and outlet pipes shall extend through the walls of manholes and inlets beyond the outer surface for a sufficient distance to allow for connections, but shall be cut off flush with the wall on the inside surface.

Inlets and manholes shall be so constructed around the pipes as to prevent leakage and form a neat connection.

603.06 Precast Concrete Inlets and Manholes. Precast concrete inlets and manholes may be used where there are no conflicts with existing underground structures and utilities which require changes in pipe location, size or type. Modifications to precast concrete inlets and manholes which may be required due to changes in pipe location, size or type are subject to approval and shall be made without additional compensation.

Reinforcement steel, if required for handling, shall have a minimum 2-inch cover. Handling devices, if used, shall be removable and the holes filled with concrete.

603.07 Inverts. Inverts shall be constructed to cause the least possible resistance to flow. The shape of the inverts shall conform uniformly to inlet and outlet pipes. A smooth and uniform finish is required.

603.08 Inlets. To provide temporary drainage, one or more blocks shall be omitted in selected course or courses of the structure. Prior to construction of base and surface courses at inlets where blocks are temporarily omitted, the required blocks shall be placed and the inlet walls completed.

Curb inlet castings shall be set to final grade after adjacent curb forms have been set and approved, and prior to the placement of concrete for the adjacent curb.

603.09 Castings and Fittings. Cast iron frames, grates, and covers shall be fitted together and match-marked to avoid rocking of covers and grates. All castings shall be set firm and snug and shall not rattle.

If castings are to be set in concrete or cement mortar, all anchors or bolts shall be in position before the concrete or mortar is placed. The casting shall not be disturbed until the mortar or concrete has set.

When castings are to be placed upon previously constructed masonry, the bearing surface of masonry shall be brought to line and grade in order to present an even bearing surface so that the entire face or back of the casting can come in contact with the masonry. Castings shall be set in mortar beds or anchored to the masonry as indicated.

Existing inlet and manhole castings shall be disposed of unless they are to be used on the Project.

603.10 Reconstruction and Conversion of Existing Structures.

(a) *Reclaimed Castings.* Inlets and manholes shall be constructed using existing castings reclaimed from manholes and inlets on the Project that are to be abandoned or removed. The castings shall be removed carefully from the existing drainage structures. All concrete and mortar and other adhering matter shall be removed from the castings. The reclaimed castings shall be stored carefully. Any castings which are required for use on the Project and which are lost, broken or damaged shall be replaced without additional compensation.

(b) *Reconstructing Inlets and Manholes.* This work shall consist of removing the existing castings, removal of walls and ladder rungs to the necessary depth, disposal of the masonry, reconstruction of the walls, installing existing ladder rungs if in good condition or new rungs, if required, and setting existing castings if in good condition or new castings, if required, at the specified grade.

(c) *Converting Existing Inlets into Manholes.* This work shall conform to Subpart (b) above except that one of the following may be required:

- Inlet walls may be removed or raised to the necessary elevation to allow the installation of a new manhole head, square frame and circular cover.
- Inlet walls may be removed or raised to the necessary elevation to allow construction of a concrete slab to accommodate the new frame.
- Inlet walls may be removed down to the existing footing upon which a circular manhole shall be constructed.

(d) *Resetting Castings.* Cast iron extension frames for inlets and extension rings for manholes may be used to raise existing structures to proposed grades and elevations. Before applying epoxy, the surfaces of the existing frame to receive the epoxy and the lower bearing surfaces and sides of the extension frames or rings shall be sand blasted or brushed clean with a mechanically-driven wire wheel to ensure adhesion of the epoxy to the surfaces. The prepared surfaces shall then be wiped with a rapid-evaporating degreasing agent such as 1, 1, 1 trichloroethane. The extension frame or ring shall be placed in the existing casting and checked for fit. Any excess void space shall be noted and extra epoxy shall be applied at that location. The epoxy shall be applied in accordance with the manufacturer's recommendations and the extension frame or ring shall be pressed firmly into the uncured epoxy to ensure uniform contact between the frame and epoxy. The grate or cover shall then be placed on the extension frame or ring in such a manner as not to change the position of the frame or ring. If existing grates or covers are loose and wobble after being set in the extension frames or rings, they shall be ground to obtain a tighter fit or they shall be replaced as directed.

When extension frames or rings are not used, castings of existing structures shall be removed and reset to new elevation. Masonry of existing structures shall be built up or removed as may be necessary to conform to required surface grades and elevations. Mortar shall attain a strength of 2500 pounds per square inch before the casting is exposed to traffic. Adjustment of grades and elevations in excess of 1 foot will be considered as reconstructing inlets and manholes.

(e) *Cast Iron Curb Pieces.* Cast iron curb pieces of existing inlets shall be removed and new curb pieces shall be installed. If the frame and grate are damaged by construction operations so that they cannot be used, they shall be replaced without additional compensation.

(f) *New Castings.* New castings shall be furnished and set on existing structures. Masonry of existing structures shall be added to or removed as may be necessary to conform to new surface grades and elevations.

COMPENSATION

603.11 Method of Measurement. Inlets, manholes and castings, of the various kinds and types, will be measured by the number of each.

603.12 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Inlets, Type ____	Unit
Inlets, Type ____, Using Existing Casting	Unit
Inlets, Type ____, Parallel Bar Grate	Unit
Inlets Converted to Manholes	Unit

Manholes	Unit
Manholes, ____' Diameter	Unit
Manholes, Using Existing Casting	Unit
Reconstructed Inlets, Type ____, Using Existing Casting	Unit
Reconstructed Inlets, Type ____, Using New Casting	Unit
Reconstructed Manholes, Using Existing Casting	Unit
Reconstructed Manholes, Using New Casting	Unit
Cast Iron Curb Pieces	Unit
Inlet Castings, Type ____	Unit
Inlet Castings, Type ____, Parallel Bar Grate	Unit
Manhole Castings	Unit
Manhole Covers	Unit
New Manhole Castings, Square Frame, Circular Cover	Unit
Parallel Bar Grates	Unit
Reset Castings	Unit

Payment for rock excavation will be made in accordance with Section 207.

SECTION 604 - SLOPE GUTTERS

604.01 Description. This work shall consist of the construction of portland cement concrete slope gutters.

MATERIALS

604.02 Materials. Portland cement concrete shall conform to Section 914. Other materials shall conform to the following Subsections:

Curing Materials	905.03
Preformed Expansion Joint Filler	908.01

CONSTRUCTION

604.03 Excavation and Backfilling. Excavation shall be in accordance with Subsection 207.04. Backfilling shall be in accordance with Subsection 207.06.

604.04 Preparation of Underlying Material. The underlying material shall be shaped and compacted to a firm, even surface. Unstable material shall be removed and replaced with acceptable material which shall be compacted.

604.05 Concrete Slope Gutters. Concrete slope gutters shall be constructed in accordance with Section 405 except the gutters shall have a fine hair brush finish and shall be finished to an even, smooth surface at the specified grade. Forms shall be left in place at least 24 hours after finishing. Expansion joints shall be 1/2-inch, preformed expansion joint filler placed at intervals of 20 feet.

COMPENSATION

604.06 Method of Measurement. Concrete slope gutters of the various thicknesses will be measured by the square yard.

604.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Concrete Slope Gutters, ____" Thick	Square Yard

SECTION 605 - CURBS

605.01 Description. This work shall consist of the construction of portland cement concrete curbs and granite curbs, and the resetting of granite curbs.

MATERIALS

605.02 Materials. Portland cement concrete shall conform to Section 914 except that concrete curb at driveways shall attain a strength of not less than 3000 pounds per square inch in 3 days. Other materials shall conform to the following Subsections:

Curing Materials	905.03
Preformed Expansion Joint Filler	908.01
Joint Sealer, Hot-Poured	908.02
Granite Curbs	910.06
Mortar and Grout	914.03
Reinforcement Steel	915.01

EQUIPMENT

605.03 Equipment.

(a) Compaction. Compaction of underlying material shall be accomplished by equipment in accordance with Subsection 203.04.

(b) Forms. Forms shall be of wood, metal, or other suitable material and shall extend for the full depth of the concrete. All forms shall be true to line, free from warp, and of sufficient strength to resist the pressure of the concrete without deforming. Curved forms of proper radius shall be used on all radial sections and shall be of an acceptable design. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.

(c) Finishing. Finishing equipment shall include floats, edgers, spades, tamps and small vibrators.

CONSTRUCTION

605.04 Excavation and Backfilling. Excavation shall be in accordance with Subsection 202.04. Backfilling shall be in accordance with Subsection 203.06.

605.05 Preparation of Underlying Material. Excavation for curbs shall be made to the required depth, and to a width that permits the installation and bracing of the forms. The underlying material shall be shaped and compacted to a firm, even surface. Unstable material shall be removed and replaced with acceptable material which shall be compacted.

605.06 Granite Curbs. Where concrete foundation is required, concrete as specified for manhole foundations shall be used.

Granite curbs shall be set with the top surface at the required grade. Joints shall be not more than 1/4 inch wide for dressed, and 3/8 inch wide for quarry-split curbs. The joints shall be pointed with 1:1 cement-sand mortar. Between granite curbs and adjacent concrete surface and concrete base course, expansion joints shall be provided and filled with 1/4-inch, preformed bituminous joint filler and sealed with hot-poured joint sealer.

605.07 Concrete Curbs.

(a) Limitations. The limitations of placing shall be as specified in Subsection 501.11 and the following:

- Placing of concrete shall be discontinued in time to allow finishing to be completed in daylight hours unless an artificial lighting system is provided.
- Concrete curb shall not be constructed from November 1 to March 15 unless the roadway in which the curb is located is closed to traffic for a minimum of 30 curing days as specified in Subsection 501.17, Subpart *(b)*.

(b) Mixing, Placing and Finishing Concrete. Construction requirements shall conform to Section 405 and the following:

- Where changes in the size or shape of curbs occur in a continuous section, the transition between sections shall be gradual.
- Immediately before placing the concrete, the underlying material shall be thoroughly dampened, and the forms given a coating of light oil or other material which can prevent adherence of the concrete to the forms and which does not discolor the concrete. Where removed and used again, the forms shall be thoroughly cleaned and treated each time before using.
- The concrete shall be placed immediately after mixing. The edges, sides, and faces shall be spaded or vibrated and the surface tamped to compact the concrete thoroughly and bring the mortar to the surface, after which the surface shall be finished smooth and even by means of a wooden float.
- Sleeves for sign or delineator posts installed in barrier curbs shall be filled with sand and sealed with hot-poured joint sealer immediately after installation and shall be resealed if and when posts are installed under this Contract.
- Concrete curbs shall be constructed in sections having uniform lengths of 20 feet. The length of these sections may be reduced where necessary for closures, but no section less than 6 feet will be permitted. The forms on the face of all curb shall be removed as soon as the concrete holds its shape and the surface shall then be finished with a fine hair brush to a smooth and even finish. Plastering will not be permitted. The top edges of curb shall be rounded. Edges where expansion joint material has been placed shall be finished with an edging tool having a radius of not over 1/4 inch.
- As soon as the forms are removed, the concrete shall be covered with wet burlap if finishing prevents the immediate application of curing compound. The concrete shall remain covered until it is to be finished, at which time the wet burlap shall be removed from that amount of concrete that can be immediately finished. As soon as finishing is complete, curing compound shall be applied.
- Any exposed surface or surfaces against which some rigid type of construction is to be made shall be left smooth and uniform so as to permit free movement of the curb.
- All tool marks shall be removed with a wetted brush or wooden float, and the finished surface shall present a uniform appearance.
- Care shall be taken to minimize damage to previously constructed areas. Any damage shall be repaired without additional compensation.

(c) *Joints.* Expansion joints shall be provided opposite joints in abutting concrete surface course and at approximately equal distances of not more than 20 feet between joints. Joints shall be filled with preformed expansion joint filler, 1/2 inch thick, which shall be flush with the top and face. Between concrete curbs and concrete surface or base course, 1/2-inch, preformed expansion joint filler shall be installed and the joint shall be sealed with hot-poured joint sealer.

(d) *Protection and Curing.* Immediately after finishing the concrete in accordance with Subpart *(b)* above, protection during cold weather and curing shall be performed in accordance with Subsection 501.17, Subpart *(b)*.

The curb shall be protected until finally accepted. During this period, any damage caused by construction operations or cold weather shall be repaired without additional compensation.

(e) *Curb Placed on Concrete Base or Concrete Surface.* When the curb is to be constructed upon concrete, all dirt, bituminous material, and other loose or adhering matter shall be removed from the surface. The curb shall be dowelled with steel dowels. The diameter of holes drilled in the concrete shall be not more than 3/4 inch greater than the diameter of the dowels. The dowels shall be set in grout. Transverse joints in dowelled curb shall be installed directly over transverse joints and over definite cracks in the concrete. Additional joints shall be installed between slab joints and cracks so as to divide the curb into sections of approximately equal lengths of not more than 20 feet. The joints shall be constructed as specified in Subpart *(c)* above.

(f) *Curb Placed on Bridge Decks.* Drilling of holes in the bridge deck outside the limits of the barrier curb to support the forms will not be permitted.

605.08 White Concrete Curbs. White concrete curbs shall be constructed as specified for concrete curb in Subsection 605.07 and as follows:

- Mixers and agitator trucks used for white concrete shall be used exclusively for that purpose during the time that the white concrete is being placed. The drums of such mixers and trucks shall be thoroughly washed and all cement and concrete shall be removed prior to using the drums for mixing white concrete.
- The fine hair brush finish is deleted from barrier curb if steel forms are used.

605.09 Precast White Concrete Barrier Curbs. Precast white concrete barrier curbs may be substituted for cast-in-place concrete barrier curb and shall be constructed as specified for cast-in-place curb. Dimensional tolerances shall conform to ASTM C 825.

Reinforcement steel, if used for handling, shall have a minimum 2-inch cover of concrete. Handling devices shall be removable and the holes shall be filled with white concrete.

COMPENSATION

605.10 Method of Measurement. Curbs of the various sizes and kinds will be measured by the linear foot along the face at the gutter line.

Note: Curbs in transition areas will be measured under the larger size.

Reset granite curb will be measured by the linear foot along the face at the gutter line.

605.11 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
_____" x _____" Concrete Barrier Curb	Linear Foot
_____" x _____" Concrete Barrier Curb, Doweled	Linear Foot
_____" x _____" Concrete Sloping Curb	Linear Foot

____" x ____" Concrete Sloping Curb, Dowelled	Linear Foot
____" x ____" Concrete Vertical Curb	Linear Foot
____" x ____" Concrete Vertical Curb, Dowelled	Linear Foot
____" x ____" White Concrete Barrier Curb	Linear Foot
____" x ____" White Concrete Barrier Curb, Dowelled	Linear Foot
____" x ____" White Concrete Barrier Curb, Bridge	Linear Foot
____" x ____" White Concrete Sloping Curb	Linear Foot
____" x ____" White Concrete Sloping Curb, Dowelled	Linear Foot
____" x ____" White Concrete Vertical Curb	Linear Foot
____" x ____" White Concrete Vertical Curb, Dowelled	Linear Foot
Granite Curb	Linear Foot
Reset Granite Curb	Linear Foot

SECTION 606 - BITUMINOUS CONCRETE CURB

606.01 Description. This work shall consist of the construction of bituminous concrete curb.

MATERIALS

606.02 Materials. Bituminous concrete shall conform to Section 903 and shall be Mix I-5 except that the composition of the mixture may include up to 20 percent of reclaimed asphalt pavement. Other materials shall conform to the following Subsections:

Tack Coat:	
Cut-back Asphalt, Grade RC-70 or RC-T	904.02
Emulsified Asphalt, Grade RS-1, SS-1 or SS-1h	904.03
Cationic Emulsified Asphalt, Grade CSS-1 or CSS-1h	904.03
Traffic Paint	912.35

EQUIPMENT

606.03 Equipment. The bituminous curb machine shall be self-propelled automatic machine or a paver with attachments that produces curb that is uniform in texture, shape and density. The weight of the machine shall be such that compaction is obtained without the machine riding above the surface on which curb is constructed.

CONSTRUCTION

606.04 Excavation and Backfilling. Excavation shall be in accordance with Subsection 202.04. Backfilling shall be in accordance with Subsection 203.06.

606.05 Preparation. When curb is constructed on a freshly laid bituminous surface, the curb may be laid only after the surface has been cleaned. When curb is constructed on a cured or aged concrete base, bituminous surface or bituminous-treated base, the surface shall be thoroughly swept and cleaned by compressed air. The surface shall be thoroughly dried and, immediately prior to placing of the bituminous mixture, shall receive a tack coat in accordance with Subsection 404.13. Tack coat application shall be prevented from spreading to areas outside of the area occupied by the curb.

606.06 Mixing and Placing. The preparation and mixing of the bituminous concrete shall conform to Section 903 and shall be placed with a bituminous curb machine.

Side forms are not required. Where the curb is to be placed on an existing surface that does not have a smooth grade, a method shall be used that provides the required curb line and grade.

When short sections of bituminous concrete curb with short radii are required, construction by means other than the automatic curb machine may be used as long as the resulting curb conforms to the curb as produced by the automatic machine.

606.07 Joints. Bituminous concrete curb construction shall be a continuous operation in one direction so as to eliminate curb joints. However, where conditions are such that this is not possible, the joints between successive days' work shall be carefully made in such a manner as to ensure a continuous bond between the old and new sections of the curb. Contact surfaces of previously constructed curb shall receive a thin, uniform coat of tack coat material just prior to placing the fresh curb material to the old joint.

606.08 Painting. Painting with traffic paint, if required, shall only be on curb which is clean and dry and which has reached the ambient temperature.

COMPENSATION

606.09 Method of Measurement. Bituminous concrete curb of the various sizes will be measured by the linear foot along the face at the gutter line.

606.10 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
_____" x _____" Bituminous Concrete Curb	Linear Foot

SECTION 607 - SIDEWALKS AND DRIVEWAYS

607.01 Description. This work shall consist of the construction of bituminous concrete sidewalks and driveways, and portland cement concrete sidewalks and driveways.

MATERIALS

607.02 Materials. Bituminous concrete shall conform to Section 903 except that the composition of the mixture for the top layer may also include up to 20 percent of reclaimed asphalt pavement. Portland cement concrete shall conform to Section 914 except that driveways shall attain a strength of not less than 3000 pounds per square inch in 3 days. Other materials shall conform to the following Subsections:

Soil Aggregate	901.09
Prime Coat:	
Cut-back Asphalt, Grade MC-30 or MC-70	904.02
Tack Coat:	
Cut-back Asphalt, Grade RC-70 or RC-T	904.02
Emulsified Asphalt, Grade RS-1, SS-1 or SS-1h	904.03
Cationic Emulsified Asphalt, Grade CSS-1 or CSS-1h	904.03
Curing Materials	905.03
Preformed Expansion Joint Filler	908.01
Reinforcement Steel	915.03

Dense graded aggregate for base course used with bituminous concrete sidewalk shall conform to Subsection 901.08.

CONSTRUCTION

607.03 Excavation and Backfilling. Excavation shall be in accordance with Section 202. Immediately after removing the side forms, the spaces along the edges of sidewalks and driveways shall be backfilled with suitable material. This material shall be placed in layers not exceeding 5 inches in loose thickness and shall be compacted until firm.

607.04 Preparation of Underlying Materials. The underlying material shall be shaped and compacted to a firm, even surface. Unstable material shall be removed and replaced with acceptable material which shall be compacted.

607.05 Bituminous Concrete Sidewalks and Driveways. Bituminous concrete sidewalks and driveways shall consist of a bituminous concrete surface on a base course.

(a) *Base Course.* Either soil aggregate or dense graded aggregate may be used for sidewalks and bituminous concrete and/or dense graded aggregate may be used for driveways and shall be constructed as follows:

- Soil aggregate base course or dense graded aggregate base course in accordance with Section 301.
- Bituminous concrete in accordance with Section 304.

(b) *Surface Course.* Bituminous concrete surface shall be constructed in accordance with Section 404 except that rollers shall weigh at least 1/2 ton.

607.06 Concrete Sidewalks and Driveways. Concrete sidewalks and driveways shall be constructed in accordance with Section 405 and the following:

(a) *Mixing and Placing Concrete.* Immediately before placing the concrete, the underlying material shall be thoroughly dampened and the forms given a coating of light oil. Where removed and used again, the forms shall be thoroughly cleaned and oiled each time before using. Mechanical spreaders are not required.

(b) *Finishing.* The concrete shall be struck off with a transverse template resting upon the side forms. After the concrete has been struck off to the required cross section, it shall be finished with floats and straightedges until a smooth surface has been obtained.

When the surface of the concrete is free from water and just before the concrete attains its initial set, the surface shall be gone over and finished with a wooden float and brushed with a wet, soft-haired brush. The surface of the concrete shall be so finished as to drain completely at all times. All edges shall be finished and rounded with an edging tool having a radius of 1/4 inch.

The surface shall be divided into blocks by use of a grooving tool. Grooves shall be so placed as to cause expansion joints to be placed at a groove line. The grooves shall be cut to a depth of not less than 1/2 inch. The edges of the grooves shall be finished with an edging tool having a radius of 1/4 inch.

(c) *Expansion Joints.* Expansion joints shall be 1/2 inch wide, placed at intervals of approximately 20 feet, and shall be filled with preformed expansion joint filler. Expansion joints shall be formed around all appurtenances such as manholes and utility poles extending into or through the concrete. Preformed expansion joint filler, 1/4 inch thick, shall be installed in these joints. Expansion joint filler shall be installed between concrete and any fixed structure, such as a building or bridge. The expansion joint material shall extend for the full depth.

The top and ends of expansion joint material shall be cleaned of concrete, and the expansion joint material shall be so trimmed as to be slightly below the surface of the concrete.

(d) *Protection and Curing.* Forms may be removed when removal does not damage the concrete. No pressure shall be exerted upon the concrete when removing forms. Protection during cold weather and curing shall be in accordance with Subsection 501.17, Subpart *(b)*.

Pedestrians will not be permitted upon concrete sidewalks or driveways until 24 hours after finishing concrete. Vehicles or loads shall not be permitted on any sidewalk, driveway, or median until the concrete has attained sufficient strength.

Such barricades and protection devices as are necessary shall be constructed and placed to keep pedestrians and other traffic off the sidewalk or driveway.

Any sidewalk or driveway damaged prior to Acceptance shall be repaired by removing concrete within groove limits and replacing it with concrete of the type and finish as is in the original construction. Damage caused by construction operations or cold weather shall be repaired without additional compensation.

COMPENSATION

607.07 Method of Measurement. Sidewalks of the various kinds and thicknesses will not be measured and payment will be made for the quantity in the Proposal adjusted for Change Orders except as provided for in Subsection 109.01.

Driveways of the various kinds and thicknesses will be measured by the square yard.

607.08 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Bituminous Concrete Sidewalk, ____" Thick	Square Yard
Concrete Sidewalk, ____" Thick	Square Yard
Concrete Sidewalk, Reinforced, ____" Thick	Square Yard
Bituminous Concrete Driveway, ____" Thick	Square Yard
Bituminous Concrete Driveway, Variable Thickness	Square Yard
Concrete Driveway, ____" Thick	Square Yard
Concrete Driveway, Reinforced, ____" Thick	Square Yard

SECTION 608 - ISLANDS

608.01 Description. This work shall consist of the construction of bituminous concrete islands and portland cement concrete islands.

MATERIALS

608.02 Materials. Bituminous concrete shall conform to Section 903 except that the composition of the mixture for the top layer may also include up to 20 percent of reclaimed asphalt pavement. Portland cement concrete shall conform to Section 914. Other materials shall conform to the following Subsections:

Prime Coat:
Cut-back Asphalt, Grade MC-30 or MC-70 . . . . . 904.02
Tack Coat:
Cut-back Asphalt, Grade RC-70 or RC-T 904.02

CONSTRUCTION

608.03 Preparation of Underlying Materials. The underlying material shall be shaped and compacted to a firm, even surface. Unstable material shall be removed and replaced with acceptable material which shall be compacted.

608.04 Bituminous Concrete Islands. Bituminous concrete islands shall conform to the construction requirements for bituminous concrete sidewalk in Subsection 607.05.

608.05 White Concrete Islands. White concrete islands shall conform to the construction requirements for concrete sidewalk in Subsection 607.06 except as follows:

- The concrete surface shall not be divided into blocks. Expansion joints shall not be provided except that when the island is constructed upon a concrete surface, expansion joints shall be installed directly over joints in the concrete surface and at approximately equal intervals of not more than 20 feet between the joints. Longitudinal expansion joints of the same width and type shall be provided between the island pavement and abutting curbs.

608.06 Sleeves. Sleeves for sign or delineator posts shall be filled with sand and sealed with hot-poured joint sealer immediately after installation and shall be resealed if and when the posts are installed under this Contract.

COMPENSATION

608.07 Method of Measurement. Islands of the various kinds and thicknesses will not be measured and payment will be made for the quantity in the Proposal adjusted for Change Orders except as provided for in Subsection 109.01.

608.08 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Bituminous Concrete Island, ____" Thick	Square Yard
White Concrete Island, ____" Thick	Square Yard

SECTION 609 - RUBBLE MASONRY AND RUBBLE RIPRAP WALLS

609.01 Description. This work shall consist of the construction of rubble masonry walls and rubble riprap walls.

MATERIALS

609.02 Materials. Materials shall conform to the following Subsections:

CONSTRUCTION

609.03 Excavation and Backfilling. Excavation and backfilling shall conform to Section 206.

609.04 Rubble Walls. Selected stones, rough squared and cut to the required pitch, shall be used at angles and ends of walls. The largest stones shall be used for the bottom courses of the wall and the size shall gradually decrease toward the top. The stones shall be laid so as to stagger joints and to bond together, with their bedding planes approximately horizontal. Not less than 25 percent of the face area shall be headers, uniformly distributed. The face stones shall have exposed faces parallel to the face of wall.

(a) *Dry Rubble Masonry Walls.* Face joints shall be not more than 2 inches in width and other joints shall be not more than 4 inches in width. Spaces between stones shall be filled with spalls, neatly fitted into place, except that no spalls shall be used in the face.

(b) *Mortar Rubble Masonry Walls.* The stones shall be laid in a bed of mortar and all spaces between stones shall be filled with mortar and packed with spalls except that no spalls shall be used in the face. All voids shall be filled with mortar. The face joints shall be not more than 1 inch wide and shall be pointed before the mortar has set.

609.05 Rubble Riprap Walls. Laying the stones in courses is not required. The larger stones shall be placed in the bottom of the wall and progressively smaller sizes shall be placed from the bottom to the top. The stones shall be of the size appropriate for the size of the wall and shall be placed so that there are a minimum of voids and a maximum stability of the wall.

COMPENSATION

609.06 Method of Measurement. Rubble walls of the various kinds will be measured by the cubic yard.

609.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Dry Rubble Masonry Walls	Cubic Yard
Mortar Rubble Masonry Walls	Cubic Yard
Rubble Riprap Walls	Cubic Yard

SECTION 610 - CULVERTS AND HEADWALLS

610.01 Description. This work shall consist of the construction of portland cement concrete culverts of less than 5 foot span and the construction of portland cement concrete headwalls.

MATERIALS

610.02 Materials. Portland cement concrete shall conform to Section 914. Other materials shall conform to the following Subsections:

Curing Materials	905.03
Preformed Expansion Joint Filler	908.01
Reinforcement Steel	915.01

Aggregate for coarse aggregate bed shall conform to Subsection 901.03.

CONSTRUCTION

610.03 Excavation and Backfilling. Excavation shall be in accordance with Subsection 207.04. Backfilling shall be in accordance with Subsection 207.06.

610.04 Mixing, Placing, Finishing, and Curing Concrete. Mixing, placing, finishing and curing of concrete, including placing of steel reinforcing, shall be in accordance with Section 501.

610.05 Precast Concrete Culverts and Precast Concrete Headwalls. Precast concrete culverts and precast concrete headwalls may be substituted for cast-in-place and shall be constructed as specified for cast-in-place. The dimensions of the precast culverts and precast headwalls shall be as shown for cast-in-place.

Precast structures shall be placed on a 6-inch bed of compacted coarse aggregate Size No. 57.

Reinforcement steel, if required for handling, shall have a minimum 2-inch cover Handling devices shall be removable and the holes filled with concrete.

COMPENSATION

610.06 Method of Measurement. Concrete culverts and headwalls will be measured by the cubic yard.

610.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Concrete Culverts	Cubic Yard
Concrete Headwalls	Cubic Yard

SECTION 611 - MONUMENTS

611.01 Description. This work shall consist of the construction of monuments, and the resetting of existing monuments and monument boxes.

MATERIALS

611.02 Materials. Portland cement concrete shall conform to Section 914.

CONSTRUCTION

611.03 Excavation and Backfilling. Excavation shall be in accordance with Subsection 207.04. Backfilling shall be in accordance with Subsection 207.06.

611.04 Monuments. Monuments shall be constructed in accordance with Section 501 and shall be set at the required location and elevation and in such a manner as to ensure that the monuments are held firmly in place. The top surface of the monument shall be horizontal and the disk shall be set in the true position.

Monuments shall be protected from disturbance and damage for the life of the Contract as specified in Subsection 107.16.

611.05 Resetting Monuments and Monument Boxes. Monuments and monument boxes that are to be relocated or reset shall not be moved or disturbed until they have been properly referenced. After having been referenced, they shall be reset. New Jersey Geodetic Control Survey monuments and National Geodetic Survey monuments shall not be reset or relocated until written approval is received.

Care shall be taken in raising and resetting monument boxes and protecting them until the surface course is laid. Any damage done to the boxes shall be repaired without additional compensation.

Construction requirements shall be as specified above for new monuments.

Information regarding monuments of the New Jersey Geodetic Control Survey and the National Geodetic Survey may be obtained from the Geodetic Control Survey Unit, New Jersey Department of Transportation, 1035 Parkway Avenue, Trenton, New Jersey 08625.

COMPENSATION

611.06 Method of Measurement. Monuments, reset monuments and reset monument boxes will be measured by the number of units.

611.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Monuments	Unit
Reset Monuments	Unit
Reset Monument Boxes	Unit

SECTION 612 - BEAM GUIDE RAIL

612.01 Description. This work shall consist of the installation, resetting or modification of beam guide rail.

MATERIALS

612.02 Materials. Materials shall conform to the following Subsections:

Rail Element	902.01
Posts and Spacers	902.02
Rub Rail	902.03
Miscellaneous Hardware	902.04
Timber Posts	918.01

Portland cement concrete for guide rail end treatment shall conform to Section 914.

CONSTRUCTION

612.03 Construction Requirements. Steel posts shall be driven to the required position. Posts shall be plumb, properly spaced, and to the prescribed line and grade.

The installation shall be made in such a manner that no unprotected end is exposed to approaching traffic. The quantity of existing beam guide rail or wire rope fence removed shall not exceed that which can be replaced within the same work day. No previously protected area shall remain unprotected at the end of the work day.

Prior to driving the posts, the location of underground electrical conduits which may conflict with the posts shall be determined. Post spacing may be adjusted by 6 inches or double spacers may be used, as approved, to eliminate such conflicts. A functional test of the electrical system shall be made prior to and upon completion of driving the posts. The functional test shall be in accordance with Subsection 701.16. Additional tests may be required if it is suspected that underground conduits have been damaged. Damage to the electrical conduit due to construction operations shall be located and repaired without additional compensation.

The top edge of rail elements shall be in a straight line or smooth curve, parallel to or concentric with the traveled way. Where a vertical transition is required, the top edge of rail elements shall form the chords of a smooth vertical curve. No punching, drilling, reaming, cutting, or welding of the rail elements will be permitted in the field.

612.04 Beam Guide Rail and Beam Guide Rail, Dual-Faced. Beam guide rail shall consist of furnishing and installing posts, spacers, rail elements, and attachments to structures.

612.05 Beam Guide Rail Element. Beam guide rail element shall consist of furnishing and installing beam guide rail element in accordance with Subsection 612.03.

612.06 Beam Guide Rail Posts. Beam guide rail posts shall consist of furnishing and installing spacers and new beam guide rail posts that are 6 feet long.

612.07 Additonal Length Beam Guide Rail Posts. Additional length beam guide rail posts shall consist of furnishing and installing spacers and new beam guide rail posts of various lengths in excess of 6 feet long.

612.08 Block Out Beam Guide Rail. Block out beam guide rail shall consist of furnishing and installing spacers on existing beam guide rail, relocating sufficient beam guide rail posts to provide a smooth transition to existing structures and attaching the beam guide rail to structures.

612.09 Rub Rail. Rub rail shall consist of furnishing and installing a steel channel or a bent plate on existing beam guide rail posts.

612.10 Guide Rail End Treatment. End treatment for guide rail shall consist of anchorages and breakaway cable terminals. End treatment for dual-faced guide rail shall consist of a median breakaway cable terminal or a steel end section on the ends of the rail elements.

Construction requirements shall be in accordance with Subsection 612.03 except that timber posts shall be used for breakaway cable terminals.

Excavation for timber post holes and concrete anchorages shall be in accordance with Subsection 207.04. Backfilling shall be in accordance with Subsection 207.06.

612.11 Reset Beam Guide Rail and Reset Beam Guide Rail, Dual-Faced. Reset beam guide rail shall consist of dismantling and removing the existing beam guide rail, salvaging, storing and protecting the materials determined by the Resident Engineer to be suitable for reuse, disposal of unsuitable and surplus materials, and resetting the beam guide rail with salvaged materials and with new materials as necessary. New bolts, nuts and washers, if necessary, shall be as specified for those used with new beam guide rail. Existing posts and rail elements broken or damaged during removal because of carelessness, negligence or the use of improper construction methods shall be replaced without additional compensation. Additional posts shall be installed where required. Payment will not be made for new posts until all available existing posts have been used.

Individual sections of guide rail shall be reset in the following sequence:

1. using existing posts,
2. using new posts furnished at no cost to the State, and
3. using new posts which will be paid for.

Wherever feasible, existing rail elements shall be used in guide rail sections or portions thereof that are reset with existing posts, and new rail elements shall be used in guide rail sections or in portions thereof where new guide rail posts are used. When it is necessary to use existing and new rail elements in the same guide rail section, a continuous length of each shall be installed.

Methods of resetting shall conform to the construction of new guide rail of the type being reset.

Where removal and storage are specified, the bolts, cables, and other hardware shall be removed from rails, posts, and other members. The components shall be sorted and stored at the locations specified. Rails shall be stacked and cable shall be free from kinks and rewound on cable spools. Care shall be exercised in handling and storing of the materials to ensure maximum salvage value. Any lost or missing beam guide rail components shall be replaced without additional compensation.

612.12 Beam Guide Rail on Bridges. Holes in the decks for expansion anchor bolts shall be drilled with a masonry drill. Drill bit sizes for expansion anchor bolt holes shall conform to ANSI Standards.

Holes shall be spaced and located to clear existing deck reinforcement and deck joints. Expansion anchor bolts shall be fastened to the concrete in accordance with the manufacturer's recommendations.

Precautions shall be taken so that concrete and existing utility conduits are not damaged during the drilling of the deck for expansion anchor bolts. Any damage to the existing concrete shall be repaired without additional compensation.

Welding shall conform to AWS D1.1 as modified by AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

COMPENSATION

612.13 Method of Measurement. Beam guide rail of the various kinds will be measured by the linear foot along the face of the rail excluding anchorages and breakaway cable terminals. Dual-faced beam guide rail will be measured by the linear foot along the face of one rail.

Beam guide rail element and rub rail will be measured by the linear foot along the face of the rail.

Beam guide rail anchorages will be measured by the number of units.

Breakaway cable terminals of the various kinds will be measured by the number of units.

Beam guide rail posts will be measured by the number of units.

Additional length beam guide rail posts of various lengths will be measured by the number of units.

Block out beam guide rail will be measured by the linear foot.

Reset beam guide rail of the various kinds will be measured as specified for new beam guide rail.

612.14 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Beam Guide Rail	Linear Foot
Beam Guide Rail, Bridge	Linear Foot
Beam Guide Rail, Dual-Faced	Linear Foot
Beam Guide Rail Element	Linear Foot
Beam Guide Rail Anchorages	Unit
Beam Guide Rail Posts	Unit
Additional Length Beam Guide Rail Posts, ____' Long	Unit
Block Out Beam Guide Rail	Linear Foot
Breakaway Cable Terminals	Unit
Median Breakaway Cable Terminals	Unit
Rub Rail	Linear Foot
Reset Beam Guide Rail with Existing Posts	Linear Foot
Reset Beam Guide Rail, Dual-Faced, with Existing Posts	Linear Foot

Separate payment will not be made for bridge attachments.

Separate payment will not be made for beam guide rail posts within the limits of new beam guide rail installations.

Separate payment will not be made for extra beam guide rail posts and rail elements at obstructions and bridge attachments within the limits of new beam guide rail installation.

SECTION 613 - MISCELLANEOUS CONCRETE

613.01 Description. This work shall consist of the construction of miscellaneous portland cement concrete items such as steps, pipe plugs, saddles and encasements.

MATERIALS

613.02 Materials. Portland cement concrete shall conform to Section 914. Other materials shall conform to the following Subsections:

Curing Materials	905.03
Preformed Expansion Joint Filler	908.01
Reinforcement Steel	915.01

CONSTRUCTION

613.03 Excavation and Backfilling. Excavation and backfilling shall be in accordance with Sections 202, 206 or 207.

613.04 Mixing, Placing, Finishing and Curing. Mixing, placing, finishing and curing of concrete including placing of reinforcement steel shall be in accordance with Section 405.

613.05 Pipe Plugs. The thickness of the plug shall be equal to the inside diameter of the pipe or 2 feet, whichever is less.

COMPENSATION

613.06 Method of Measurement. Miscellaneous concrete will be measured by the cubic yard.

613.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Miscellaneous Concrete	Cubic Yard

Payment for rock excavation will be made in accordance with Section 207.

SECTION 614 - FENCES

614.01 Description. This work shall consist of the construction of fence and gates, and the removal and resetting of fence.

MATERIALS

614.02 Materials. Materials shall conform to the following Subsections:

Chain-link Fence	907.02
Chain-link Farm-type Fence	907.03
Snow Fence	907.04

Zinc Chromate Primer 912.20
Mortar and Grout 914.03

Portland cement concrete for fence post foundations shall conform to Section 914.

Where aluminum-coated fence or PVC-coated fence is not designated, either kind may be used.

Gates shall be of the same materials as the fence to which the gates are attached.

CONSTRUCTION

614.03 Preliminary Work. Before beginning construction or placing of fences, clearing site shall be in accordance with Section 201. Any rock protruding above the ground surface and in the line of fence shall be removed to ground surface in accordance with Section 202.

614.04 Chain-link Fence. Fence and gates shall be erected in accordance with the construction requirements recommended by the manufacturer and the following:

- Terminal posts shall be set at the beginning and end of each continuous length of fence, at abrupt changes in vertical and horizontal alignment, and on each side of gate locations.
- Aluminum surfaces to be placed in contact with concrete shall be given a coat of zinc chromate primer.
- Posts to be set in concrete shall be installed in dug or drilled holes. Posts not requiring concrete foundation may be driven to the required depth if ground conditions permit or the posts shall be installed in holes dug or drilled to allow sufficient room for proper backfilling. When solid rock is encountered, any posts not required to be set in concrete shall be installed by drilling the rock to the required depth and grouting the post therein with grout composed of one part cement to two parts sand.
- Post holes for posts not requiring concrete foundations shall be backfilled with suitable material. Backfill shall be placed in layers not exceeding 4 inches and each layer shall be thoroughly tamped. When backfilling and tamping are completed, the posts and anchors shall be held securely in proper position.
- Pull shall not be applied to posts set in concrete foundations until the concrete has cured a minimum of 72 hours.
- Gates shall be equipped with locks and two sets of keys.

614.05 Removal and Reset Fence. Existing fence materials which are found not to be usable or are damaged by construction operations shall be disposed of and replaced with new materials of the same or equivalent type without additional compensation.

614.06 Temporary Fence. Temporary chain-link fence and snow fence required to enclose hazardous construction areas and to complement the permanent fencing shall be constructed as soon as practicable.

Temporary fence shall be constructed in accordance with the requirements for permanent fence except used materials may be used.

Gates necessary for the construction operations may be installed at selected locations and shall be kept padlocked except when in actual use during working hours.

Temporary fence shall be disposed of when no longer required on the Project.

COMPENSATION

614.07 Method of Measurement. Chain-link fence of the various kinds and sizes will be measured by the linear foot along the bottom line of the fabric deducting the width of gates.

Gates of the various kinds and sizes will be measured by the number of each.

Reset fence and temporary fence will be measured by the linear foot including gates.

614.08 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Chain-Link Fence, Aluminum-Coated Steel, _____' High	Linear Foot
Chain-Link Fence, PVC-Coated Steel, _____' High	Linear Foot
Chain-Link Fence, _____' High	Linear Foot
Chain-Link Farm-Type Fence	Linear Foot
Gates, Chain-Link Fence, Aluminum-Coated Steel, _____' Wide	Unit
Gates, Chain-Link Fence, PVC-Coated Steel, _____' Wide	Unit
Gates, Chain-Link Fence, _____' Wide	Unit
Gates, Chain-Link Farm-Type Fence, _____' Wide	Unit
Reset Fence	Linear Foot
Temporary Chain-Link Fence, _____' High	Linear Foot
Snow Fence	Linear Foot

SECTION 615 - PIPE RAILING

615.01 Description. This work shall consist of the construction of pipe railing on steps, walls or other similar appurtenances.

MATERIALS

615.02 Materials. Materials shall conform to the following Subsections:

Metal Railing:	
Aluminum Alloy	911.01
Structural Steel, Carbon	917.10
Aluminum-Pigmented Alkaline-Resistant Paint	912.02
Zinc Chromate Primer	912.20
Grout	914.03
Bolts and Bolting Material	917.01
Zinc Coating on Steel	917.12
Bearing Pad, Elastomeric	919.02
Caulking Compound	919.04

CONSTRUCTION

615.03 Construction Requirements. Pipe railing shall be constructed in accordance with Section 508 and the following:

(a) Posts Perpendicular to Rails. For railings in which the posts are to be perpendicular to the rails, standard or special fittings shall be used or the joints may be welded. Aluminum posts shall be bolted to the concrete foundation with corrosion-resistant steel bolts and the plates shimmed for railing alignment.

(b) *Posts Vertical to Rails.* For railings in which the posts are vertical to the rails, the railing shall be erected by one of the following methods:

- With Sleeves. The railing shall be placed in the concrete foundation and the posts grouted in the metal sleeves. The sleeves shall be flush with the top of the concrete and accurately positioned for the required post spacing and true alignment of the railing. The space between the posts and sleeves shall be completely filled with nonshrink grout of suitable consistency. Temporary protection against the collection of water and other foreign materials in the sleeves shall be provided by filling the sleeves with sand to within 1 inch of the top and sealing with bituminous material. The sand and bituminous material shall be completely removed just prior to grouting and setting of the railing.
- Without Sleeves. The railing shall be securely supported in its final position and the foundation concrete shall be placed around the posts.

COMPENSATION

615.04 Method of Measurement. Pipe railing will be measured by the linear foot along the top of the rail.

615.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Pipe Railing	Linear Foot

SECTION 616 - SLOPE PROTECTION

616.01 Description. This work shall consist of the construction of various kinds of slope protection.

MATERIALS

616.02 Materials. Portland cement concrete shall conform to Section 914 except that water shall be omitted for concrete bag slope protection. Other materials shall conform to the following Subsections:

Riprap Stones	901.17
Emulsified Asphalt, Grade RS-1	904.03
Curing Materials	905.03
Preformed Expansion Joint Filler	908.01
Joint Sealer	908.02
Concrete Block for Slope Protection	910.03
Granite Paving Block	910.08
Mortar and Grout	914.03
Reinforcement Steel	915.03
Bags	919.01

Coarse aggregate for bituminous-treated stone slope protection shall conform to Subsection 901.03.

Fine aggregate for the base course used with concrete or granite block slope protection shall conform to Subsection 901.13.

CONSTRUCTION

616.03 Preparation of Slopes. Immediately prior to the construction of the slope protection, the slopes or ground surface shall be trimmed conforming to the lines and grades and shall be thoroughly compacted by the use of mechanical or vibrating tampers or rollers.

616.04 Bituminous-Treated Stone Slope Protection. Bituminous-treated stone slope protection shall be constructed by placing broken stone and treating it with asphalt on the prepared foundation.

Coarse aggregate Size No. 3 or 4 shall be placed on the slope and compacted with a vibrating tamper until keyed together. Emulsified asphalt, grade RS-1, shall then be sprayed on the aggregate at the rate of 0.75 gallon per square yard, avoiding the formation of a surface mat. Immediately after this application and before the emulsion has set, approximately 20 pounds per square yard of coarse aggregate Size No. 8 shall be spread to fill the voids in the previous layer. The Size No. 8 aggregate shall be set by using a vibrating tamper. A second application of asphalt at the rate of 0.75 gallon per square yard shall then be applied.

After allowing sufficient time for the second application of asphalt to set, a spray application of brown paint, conforming to Subsection 814.02, shall be uniformly applied at the rate of 0.3 gallon per square yard.

616.05 Concrete Slope Protection. Concrete slope protection shall be constructed by placing concrete on the prepared foundation in accordance with Section 405 except that the concrete shall be of such consistency that it does not flow on the slope. Finishing shall be with a wood float followed by brushing with a wet, soft-hair brush to a neat and uniform surface.

Slope protection shall be scored for a depth of 1/2 inch on 6-foot centers, both ways. Scored edges shall be rounded to a 1/2-inch radius with an edging tool. A 1/2-inch premolded expansion joint filler shall be used wherever the concrete abuts any portion of a structure.

Edge beams and key beams shall be placed monolithically with the slab.

Forms, which are of wood or metal, shall be removed after the concrete has set 24 hours. The concrete shall be cured in accordance with Section 405.

616.06 Concrete Bag Slope Protection. Concrete bag slope protection shall be constructed by placing bags, filled approximately three quarters full with dry concrete mix, on the prepared foundation. The filled bags shall be securely fastened with hog rings, by sewing or other methods. Leaking bags shall not be used.

The bags of concrete mix shall be bedded by hand on the surface with the fastened ends in the same direction and with the joints staggered. The bags shall be rammed and packed against each other and tamped on the surface in such a manner as to form close contact and secure a uniform surface. Bags of concrete ripped or broken in placing shall be removed and replaced before the placed bags are soaked with water. Immediately after the bags of concrete are placed and tamped, they shall be thoroughly soaked by sprinkling with water applied under low pressure.

616.07 Concrete Block and Granite Block Slope Protection. Concrete block and granite block slope protection shall be constructed by placing blocks on a 2-inch layer of fine aggregate base course.

The base course shall be dry, clean, and free of adhering matter and frost when the block is placed thereon. The mortar for the cushion course shall be 1:3 cement-sand mortar, thoroughly mixed without water in a mechanically operated batch mixer of a size suitable for the work. The dry mortar shall be placed on the base course in a

uniform layer having a thickness of 2 inches. The layer shall be placed not more than 15 feet in advance of laying the blocks and shall be covered with the blocks without delay.

The blocks shall be set in straight rows with the longitudinal joints staggered one half the length of the block. The blocks in each row shall be of uniform width, and the joints at the surface shall be not less than 1/4 inch and not more than 1/2 inch in width. The blocks shall be set plumb and fully bedded on the mortar cushion without crowding it into joints. Rammers or tampers shall be of the type and weight that do not break the blocks. The best face of the block shall be uppermost.

Blocks which do not have a firm bedding or which have been damaged shall be taken up, reset and rerammed.

The surface shall be tested with a straightedge not less than 10 feet long, and blocks found to be above or below the grade shall be taken up, reset and rerammed. Fine aggregate, gravel or other material shall not be placed in the joints. Blocks shall be laid not more than 15 feet in advance of ramming.

Joints shall be filled with grout where specified. The grout shall be mixed in a mechanically operated batch mixer as hereinabove specified for mixing the cushion course, with only sufficient water to permit the grout to enter the joints to the full depth. The amount of water shall be kept constant in all batches. The mixing time shall not be less than 1 1/2 minutes, and the mixture shall be kept agitated until used. The joints shall be filled completely with grout so that an excess appears on the surface. The excess grout shall be swept or scraped into the joints. The grouting operation shall be repeated before initial set until the joints remain completely filled. The surface shall then be swept and all excess grout shall be removed before it has developed initial set. Grout shall not be applied when the temperature of the atmosphere or the blocks is below 40 degrees F or during rainy weather.

616.08 Riprap Stone Slope Protection. Riprap stone slope protection shall be constructed by placing riprap stones in close contact, firmly bedded in the slope. Open spaces between stones shall be filled with smaller stones of the same type and quality as the riprap stones, firmly rammed in place. The larger stones shall be used in the lower courses. The finished surface shall be even.

COMPENSATION

616.09 Method of Measurement. Slope protection of the various kinds will be measured by the square yard.

616.10 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Bituminous-Treated Stone Slope Protection	Square Yard
Concrete Slope Protection	Square Yard
Concrete Slope Protection, Reinforced	Square Yard
Concrete Bag Slope Protection	Square Yard
Concrete Block Slope Protection	Square Yard
Granite Block Slope Protection	Square Yard
Riprap Stone Slope Protection	Square Yard

SECTION 617 - TRAFFIC STRIPES

617.01 Description. This work shall consist of applying white or yellow traffic paint and glass beads on bituminous concrete or portland cement concrete.

Removal of traffic stripes or traffic paint shall consist of the removal of white or yellow stripes or painted areas from bituminous concrete and portland cement concrete.

MATERIALS

617.02 Materials. Materials shall conform to the following Subsections:

Traffic Paint	912.34
Glass Beads for Reflectorizing Traffic Paint	912.35

CONSTRUCTION

617.03 Surface Preparation. All dirt, oil, grease and other foreign material shall be removed from the areas upon which the traffic paint or stripes are to be placed.

617.04 Applying Paint and Beads. The paint shall be applied on thoroughly dry surfaces when the surface temperature is above 40 degrees F and applied at the rate of 300 to 330 linear feet per gallon of 4-inch wide stripes with film thickness of 0.015 inch.

The glass beads shall be applied over the wet paint in a uniform pattern and at the rate of 5 pounds per gallon of paint. The bead dispensers shall be of a type that mechanically and automatically give such performance.

Prior to Acceptance, additional applications of traffic stripes may be directed.

617.05 Opening to Traffic. Traffic striping or painting shall be completed and the paint shall be thoroughly dry before opening to traffic. The Engineer will determine when the traveled way is to be opened to traffic.

617.06 Removal of Traffic Stripes or Traffic Paint. Removal of stripes and painted areas shall be accomplished by a method that does not damage the bituminous or concrete surface. Obliterating stripes and painted areas by painting over them will not be permitted.

Debris from removal of traffic stripes and painted areas shall be disposed of in accordance with Subsection 201.09.

COMPENSATION

617.07 Method of Measurement. Traffic stripes will be measured by the linear foot for each 4-inch width of stripe, deducting the gaps, and including each successive application.

Traffic paint for painting solid areas, letters, arrows and other symbols will be measured by the square foot.

Removal of traffic stripes will be measured by the linear foot for each 4-inch width of stripe. The width of stripe in excess of 4 inches will be converted to equivalent linear feet of 4-inch stripe.

Removal of traffic paint from solid areas, letters, arrows and other symbols will be measured by the square foot.

617.08 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Traffic Stripes	Linear Foot
Traffic Paint	Square Foot
Removal of Traffic Stripes	Linear Foot
Removal of Traffic Paint	Square Foot

SECTION 618 - SIGNS

618.01 Description. This work shall consist of fabricating, furnishing, assembling and erecting signs and delineators.

Materials and construction operations not specifically covered in the Plans and Specifications shall be in accordance with the Manual on Uniform Traffic Control Devices for Streets and Highways, US Department of Transportion, Federal Highway Administration.

MATERIALS

618.02 Materials. Materials shall conform to the following Subsections:

Zinc Chromate Primer	912.20
Mortar and Grout	914.03
Reinforcement Steel	915.01
Aluminum	916.01
Aluminum Extruded Sign Panels	916.02
Paints	916.03
Reflective Sheeting	916.04
Legends, Borders and Accessories	916.05
Steel	916.06
Stainless Steel	916.07
Breakaway Sign Supports	916.09
Bendaway Sign Supports	916.10
Non-Breakaway Sign Supports	916.11
Overhead Sign Supports	916.12
Timber Sign Supports	916.13
Delineators	916.14

Portland cement concrete for sign post footings shall conform to Section 914.

CONSTRUCTION

618.03 Regulatory and Warning Signs. Regulatory and warning signs shall be fabricated of flat aluminum sheets and shall be covered with Type II reflective sheeting. Legends, borders, and accessories shall be Type B. Signs shall be fabricated in accordance with Subsection 916.08.

(a) Positioning Signs. The placement of signs shall be adjusted if they create interference in a sidewalk area. Sites at which the signs are to be erected shall be inspected immediately after grading of the area and prior to determining the sign post lengths.

(b) Mounting Signs. Signs shall be mounted on bendaway sign supports. Upon being notified that the signs have been installed, the Engineer will examine them at night. Should specular glare be apparent, the sign alignment shall be adjusted by shimming the sign. Signs mounted on two posts shall be shimmed either at all bolts on one of the posts, or at the proper upper or lower bolts on both posts. Signs mounted on a single post shall be shimmed

at either the upper or lower bolts, whichever best minimizes the glare. In all cases, shims shall be installed between the back of the sign and the post. Shims shall be used wherever necessary to prevent sagging of the center of a sign and to permit secure tightening of all nuts and bolts.

618.04 Guide Signs. Guide signs fabricated of flat aluminum sheets shall be covered with Type I or II reflective sheeting depending on the following:

- Guide signs 60 square feet or less shall be fabricated of flat aluminum sheets covered with Type I reflective sheeting. Legends, borders and accessories shall be Type B unless otherwise designated.
- Guide signs over 60 square feet shall be fabricated of flat aluminum sheets covered with Type II reflective sheeting. Legends, borders and accessories shall be Type A.

Guide signs shall be fabricated in accordance with Subsection 916.08.

Breakaway couplings will be furnished upon written request. The request shall be made at least 10 days prior to the time when needed for the Project and shall include the quantity for each type required.

(a) Positioning Signs. Sign faces shall be so positioned in relation to a line normal to the adjacent edge of traveled way that the sign face is rotated about its edge, nearest the traveled way, through an angle of 5 degrees, in the direction of travel. All signs shall be level and at the heights indicated.

(b) Mounting Signs. Signs mounted on breakaway, non-breakaway, or bendaway sign supports are designated as Type GA. Signs mounted on sign support structures are designated as Type GO or Type GOX. Type GO and Type GOX signs shall also include structural framing for lighting fixtures and for attaching sign panels to the supporting structures.

Upon notification that the signs have been installed, the Engineer will examine them at night. Should specular reflection from any sign be apparent, alignment shall be adjusted in accordance with the following:

- Signs mounted on breakaway and non-breakaway sign supports shall be adjusted by rotating the sign on the posts. Signs mounted on bendaway sign supports shall be adjusted as specified in Subsection 618.03, Subpart *(b)*.

618.05 Cleaning Signs. Before final inspection, all sign faces and support surfaces shall be cleaned of all foreign matter. Necessary measures shall be taken to provide that all signs, sign supports and sign sites are in good condition and have a good appearance.

618.06 Delineators. Delineators shall include reflector units mounted on bendaway sign supports. Reflectors shall show no sign of damage after being mounted.

Any delineators removed or damaged in any way prior to Acceptance shall be repaired or replaced without additional compensation.

COMPENSATION

618.07 Method of Measurement. Signs of the various sizes will be measured by the number of each.

Guide signs of the various types will be measured by the square foot.

Delineators of the various types will be measured by the number of posts.

618.08 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
_____" x _____" Signs	Unit
Guide Signs, Type _____	Square Foot
Delineators, Type _____	Unit

Payment for sign support structures will be made in accordance with Section 509.
Payment for sign illumination will be made in accordance with Section 704.

CONTENTS

SECTION 700 - ELECTRICAL

SECTION 701 - COMMON PROVISIONS

701.01 Description. These provisions are common to the work of traffic signals, highway lighting and sign lighting.

Materials and construction operations not specifically covered in the Plans and Specifications shall be in accordance with the accepted standards of the National Electrical Manufacturers Association, the Underwriters' Laboratories Inc., the National Electrical Code, or the American Society for Testing and Materials.

Plans may be diagrammatic but shall be followed as closely as actual conditions permit.

MATERIALS AND ELECTRICAL EQUIPMENT

701.02 Materials and Equipment. Portland cement concrete for foundations and junction boxes shall conform to Section 914. Other materials shall conform to the following Subsections:

Coarse Aggregate	901.03
Anchor Bolts	906.01
Bonding and Grounding Materials	906.02
Cable and Wire	906.03
Cable Racks	906.05
Conduits and Fittings	906.07
Electrical Tape	906.08
Multiple Lighting and Service Wire	906.13
Resin Splicing Kits	906.17
Paint:	
Foliage Green	912.05
Black Graphite	912.11
Rust-Inhibitive Primer	912.18
Grout	914.03
Reinforcement Steel	915.01

Frames and covers for junction boxes shall conform to Subsection 917.03

Bureau of Electrical Engineering NJ Specifications are available from the Bureau of Electrical Engineering, New Jersey Department of Transportation, 1035 Parkway Avenue, CN 600, Trenton, NJ 08625. All requests shall be made in writing.

CONSTRUCTION

701.03 Existing Systems. The operation of existing electrical systems, within the limits of the Project, which are not scheduled to be modified or removed shall not be interfered with in any manner.

The modification of existing traffic signal or highway and sign lighting systems shall be accomplished with minimum interference to the operation of the facilities. Ten days prior to the commencement of work on an existing system, a scheme of the proposed construction method and the provisions planned to maintain traffic at the work site shall be submitted for approval.

Traffic directors shall be used in accordance with Subsection 110.07.

It may be necessary to cut existing conduits, build new foundations, junction boxes or other structures over existing conduits, install new conduits in existing junction boxes or connect to existing conduits.

Existing foundations and junction boxes which are abandoned under the Contract shall be removed to a depth of 1 foot below grade. Should a foundation or junction box interfere with the installation of a new facility, it shall be completely removed. Backfilling shall be in accordance with Subsection 203.09. The Engineer may direct compaction to be in accordance with Subsection 203.10 except that the frequency may be increased. Debris shall be disposed of in accordance with Subsection 201.09.

Where existing systems are to be modified, the existing above ground equipment and materials shall be salvaged and incorporated into the revised system, or salvaged for other use by the Department and become the property of the State. Material required to be salvaged shall be stored at or near the site of the work for disposal by the Department.

Existing equipment and materials specified for reuse, or to be reserved for the Department, which are disturbed, damaged or removed from the Project in performing the work, shall be repaired or replaced with similar equipment and materials without additional compensation.

Relocation of any proposed foundation, junction box or conduit, required because of the relocation or interference with an existing utility facility, shall be accomplished only after approval. Additional conduit or wire may be required because of these relocations, however, no additional compensation will be made for any delay caused by these field problems.

Location of existing traffic signal system and highway lighting system conduits, when not shown on the Plans, will be furnished upon written request.

Existing highway lighting facilities and their replacements shall be functional during normal hours of operation except as otherwise approved.

Existing pressure detectors and frames which are abandoned shall be removed and disposed of in accordance with Subsection 201.09.

During the course of the construction, there may be locations where the Department, with its own or by other forces, may adjust or relocate existing traffic signal or highway lighting equipment under this Contract. Construction operations shall be arranged so as to permit the adjustment or relocation of these facilities.

701.04 Shop Drawings. Shop drawings shall be furnished for all electrical materials and equipment in accordance with Subsection 105.04.

A copy of the preapproved materials procedure is available, upon request, from the Bureau of Electrical Engineering, New Jersey Department of Transportation, 1035 Parkway Avenue, CN 600, Trenton NJ 08625.

Approval of the shop drawings for the precast foundations or junction boxes shall not be taken as an approval for the use in all locations.

701.05 Construction Stakes, Lines and Grades. The furnishing of lines, grades and bench marks shall be as specified in Subsection 105.11

701.06 Excavation and Backfill. Excavation and backfill for theconstruction of junction boxes, foundations, conduits, cables and other appurtenances shall conform to Section 207. The excavation shall include all materials and structures encountered. The excavation shall also include the restoration of areas damaged, with the exception of topsoiling, seeding and concrete sidewalk.

Trenching for conduit will be permitted only for such distances as can be installed and backfilled on the same day. Should a conduit installation not extend from junction box to junction box at the end of the workday, the conduit shall be capped.

The trench bottom for rigid nonmetallic conduit shall be prepared to eliminate lumps, ridges and hollows. The conduit shall be placed on bedding material that has been tamped by a flat-faced mechanical tamper or a vibratory soil compactor.

The sides of the trench around the conduit shall be filled with bedding material (center filled if more than one conduit in the trench) to the top of the conduit, then additional bedding material shall be hand placed over the conduit, to a depth of 6 inches, and hand tamped. From this point backfilling shall conform to Section 207.

If the excavations do not furnish sufficient material of the quality required for backfilling, the material necessary to make up the deficiency shall be supplied and placed.

For the purpose of establishing the exact location of existing conduits, and in order to preserve and protect the conduit, the Engineer may direct the excavation of test pits in accordance with Subsection 207.04.

701.07 Conduits. Conduit installed above ground shall be rigid metallic conduit except as required by Section 704.

Rigid metallic conduit installed under existing roadways that are not to be disturbed or removed during construction shall be classified as Type CUR and shall be installed by the jacking method.

Excavations for jacking shall be kept a minimum of 2 feet from the edge of pavement.

In the event that obstructions are encountered during the course of jacking, permission shall be obtained to make earth excavations for test pits to clear the obstruction. A minimum of two attempts shall be made to install conduit by the jacking method and if unsuccessful, a final attempt shall be made changing the procedure and location (both horizontal and vertical), and if the final attempt fails, then permission may be given for the open cut method.

When the open cut method is used, the maximum trench width shall not exceed 6 inches.

After the conduit has been installed in the trench, the trench shall be filled with concrete to within 6 inches of the surface of the existing pavement. Backfill in the remaining trench shall conform to the materials composition of the existing pavement.

Rigid metallic conduit installed in earth under proposed or reconstructed sidewalks, pavements, driveways or other obstructions, shall be classified as Type CUG. Rigid metallic conduit installed on utility poles shall be classified as Type CUG. Aluminum conduit shall not be utilized as Type CUG and shall not be embedded in concrete in bridge structures.

Rigid metallic conduit installations on bridges and other structures shall be provided with expansion joint fittings at all expansion joints.

At any location where conduits are installed in existing junction boxes, it may be necessary to cut additional holes in the junction boxes to admit the conduits.

Bonding bushings shall be threaded on the free ends of the conduit and locked in place with set screws.

Conduit installed in junction boxes shall be grouted in prior to the installation of wire or cables.

To facilitate the pulling of wire through the junction box, the conduits shall be installed in such a manner that the conduits in opposite walls of the box are in line with each other.

If the conduits cannot be installed with sufficient grade to provide drainage, T-drains shall be installed. T-drains shall consist of standard pipe tee and nipple for conduits.

All underground conduits entering meter cabinets and the wire entrance to the controller cabinet shall be thoroughly sealed with a compound conforming to NEC.

701.07

The ends of all conduits, whether shop or field cut, shall be reamed to remove all burrs and rough edges. Cuts shall be made square and true so that the conduits butt or come together for the full circumference thereof. Slip joints or running threads will not be permitted for coupling metallic conduit. When a standard coupling cannot be utilized for coupling metallic conduit, a UL approved concrete-tight compression coupling with a permanent stop shall be used. Couplings utilizing set screws will not be permitted. Reducing couplings shall not be used except for expansion joints on bridges and if required to adapt a service conduit to the meter cabinet.

Ungalvanized threads on metallic conduit resulting from field cuts and all places where the galvanizing on the conduit or fittings have been damaged shall be coated with a NEC approved compound which is electrically conductive and prevents oxidation.

All ends of the conduits shall be threaded, in conformance with NEMA standards, and the free ends shall be provided with grounded-type insulated bushings. Conduits with a diameter of less than 1 inch may be provided with impact-resistant plastic, insulating bushings and bond locknuts.

Metallic and nonmetallic conduit bends and elbows made in the field shall have a radius of not less than nine times the inside diameter of the conduit and all such bends shall be made without crimping, denting or otherwise damaging the conduit. Bends and elbows used in service conduits shall conform to the utility company requirements.

Field bends to rigid metallic conduit shall be made with an industry-accepted hydraulic conduit bender.

Field bends to rigid nonmetallic conduit shall be made with an industry-accepted flameless heater designed to distribute heat evenly over the section of conduit being bent. Internal supports shall be provided to prevent deforming of the conduit during the bending. Manufactured bends and elbows of identical material to the conduit may also be used.

All connections of rigid nonmetallic conduit shall be made in accordance with the manufacturer's directions, using solvents recommended by the manufacturer. Where rigid nonmetallic conduit is to be connected to rigid metallic conduit or other existing conduit, a suitable manufactured adapter shall be used.

Repairs will not be permitted to any rigid nonmetallic conduit fitting. Broken, chipped, cracked or impaired fittings shall be removed and replaced with new materials.

Damaged ends of rigid nonmetallic conduit may be cut off and the remainder of the undamaged conduit utilized on the Project, provided at least a 9-foot length of material remains. Other repairs to rigid nonmetallic conduit will not be permitted.

Where two or more rigid nonmetallic conduits are to be installed in a common trench, impact-resistant plastic spacers shall be utilized. The spacers shall be installed a maximum of 8 feet on centers, and shall provide a separation between conduits equal to at least 65 percent of the diameter of the conduit.

Immediately prior to the installation of cables, all conduit runs, including existing conduits which are to be utilized, shall be carefully rodded, swabbed, or otherwise cleaned to insure that the interior is free and clear of all obstructions.

Upon completion of any conduit run, and after the conduit has been cleaned, each conduit shall be gauged by pulling through a metal ball of a diameter not less than 85 percent of the nominal inside diameter of the conduit, to ascertain that the conduit is free of any obstruction or foreign material. If the ball fails to pass through the conduit, the defective conduit shall be repaired or replaced without additional compensation.

A 130-pound test nylon cord, marked in feet, shall be installed in each conduit run. The Engineer may utilize the cord to verify the conduit length.

701.08 Foundations. Concrete foundations shall be cast-in-placeexcept as provided in Subsection 701.10 and shall be constructed in accordance with Section 501.

Foundations shall rest on firm ground and shall be poured monolithically. Conduit and anchor bolts shall be placed in proper position and shall be held in place by means of a template until the concrete sets. Forms shall not be removed until the concrete has hardened properly and not less than 24 hours after the concrete has been placed. Exposed portions of foundations shall be neatly finished with a wood float followed by brushing with a wet, soft-haired brush. The tops of foundations shall be finished to an elevation of 1 inch above curb or sidewalk. Where curbs or sidewalks are not constructed or do not exist, the foundations shall be finished to an elevation of 2 inches above the surrounding lawn or earth.

Conduit installed in foundations shall be set plumb. The conduit shall terminate with a coupling flush with the top of the foundations and shall be provided with a close nipple. Conduit shall be provided with pipe caps during the placement of the concrete. When the finishing of the foundation is complete, the pipe caps shall be removed and insulated grounding bushings shall be installed. If the wiring is not immediately installed, the bushings shall be installed with push-penny plugs.

Anchor bolts installed in the foundation shall be set plumb.

701.09 Junction Boxes. Concrete junction boxes shall be constructed in accordance with Section 501 and the following:

- Forms for rectangular concrete junction boxes shall not be removed until the concrete has hardened properly and not less than 24 hours after the concrete has been placed. All exposed portions of junction boxes shall be neatly finished with a wood float followed by brushing with a wet, soft-haired brush. The junction box covers shall meet the grade of sidewalks or other surrounding area.
- Junction boxes shall also include four cable racks, ground rod and the coarse aggregate.

701.10 Precast Foundations and Junction Boxes. Precast foundations for lighting standards may be used, if approved, in areas where the slope is less than 22 to 1.

Precast junction boxes may be used, if approved, in areas where the junction box can be installed to conform to the surrounding grade.

If precast foundations or junction boxes are permitted, they shall be manufactured in accordance with Subsections 701.08 and 701.09 and they shall be furnished in accordance with Section 106.

701.11 Cable Rack Assembly. Cable rack assembly shall consist of four cable racks, including inserts or fasteners, installed in existing rectangular junction boxes as directed.

701.12 Bonding and Grounding. Traffic signals, highway and signlighting circuits, metallic conduits, above ground equipment and all other electrical equipment shall be bonded and grounded in accordance with the NEC and as may be required by the utility company.

Ground wire shall be installed in all junction boxes and secured to all conduit bushings and to the ground rod.

Ground wire shall be installed from all equipment enclosures and cabinets to the ground rod.

701.13 Cable and Wire. Cable and wire shall be installed in the conduit system and properly trained through the junction boxes to permit racking and connection to lighting standard assemblies, traffic signal standards, controller cabinets and to meter cabinet installations.

The circuit number of all cables and wires shall be identified by cable tags attached to each of the cables or wires in all the junction boxes and in the cabinets of the load centers or controller. The cable tags shall be secured to the cable or wire with nylon cable ties.

Where wiring is trained through existing junction boxes which are not equipped with cable racks, a cable rack assembly shall be furnished and installed. Bonding bushings and bonding wire shall also be provided on all metallic conduit ends within such junction boxes.

Wires and cables shall be pulled through conduits in such a manner as not to overstress or stretch any wire and precautions shall be taken not to score out, twist or damage the protective covering or insulation. In the pulling of wire or cable into conduits, where the strain on the wire or cable is likely to prove excessive, wire lubricant shall be used. Without exception, all cables and wires in junction or pull boxes shall be provided with an adequate amount of slack formed around the interior of the box.

After cables have been installed and pending permanent splicing, the end of each section of cable in junction boxes and service panels or cabinets shall be carefully sealed, using rubber tape, and painted with a sealing type of waterproof compound. All cables in junction boxes shall be placed on cable racks while waiting to be permanently spliced.

One coil (minimum of 3 feet) of slack wire shall be provided in all standard bases to allow for the proper connection of all wiring.

In rectangular junction boxes, slack shall be provided as follows:

Type of Conduit	Allowable Slack in Feet
Rigid Metallic	7
Rigid Nonmetallic	9

The allowable slack shall be the average amount of slack, however, certain locations and conditions may require additional slack.

The slack shall be formed around the interior of the junction box. Conductors shall be secured to the cable racks using nylon cable ties having a minimum tensile holding strength of 120 pounds. In all circular junction boxes one coil (minimum 8 feet) of slack wire secured in a loop with nylon cable ties shall be provided and placed in the bottom of the box.

Loop detector leads shall provide for an allowable amount of slack of 5 feet in rectangular junction boxes and 3 feet in circular junction boxes.

All conductors in standard bases, junction boxes, meter cabinets and controller cabinets shall be grouped and tagged with cable identification tags.

701.14 Electrical Installations. Electrical installations shall conform to the NEC and the utility company.

701.15 Connection with Utility Services. Underground conduits and electrical conductors shall be installed extending from a meter cabinet or junction box to a point on the service pole and a sufficient length of conductors for extension to the overhead utility service shall be supplied in accordance with the requirements of the utility company and subject to its approval. The extensions of the conductors from this point on the pole and connections with overhead utility service shall be made by the utility company.

The service conduit shall be located and installed in accordance with the utility company requirements. The utility company shall be notified and all required applications for inspection shall be completed. The location of the service conduit on the service pole and meter within the meter cabinet shall be verified with the utility company.

The meter socket shall be provided by the utility company or shall be supplied as required by the utility company's regulations. The dimensions of the socket and meter shall be verified to assure proper installation in the cabinet and conformance with utility company requirements.

701.16 Testing. When each wiring system is completed and before any connection is made to operating equipment, the following tests shall be performed on each circuit in the presence of the Engineer to determine whether the installations are in acceptable working order:

- Tests for continuity.
- Tests for ground.
- Tests for insulation resistance shall be performed between circuit wires and from circuit wires to ground. Upon completion of the electrical system with fuses removed, or devices removed from the circuit, and before energizing, the insulation resistance shall not be less than 150 megohms between conductors or between conductor and ground on those circuits with a total single conductor length of 1,500 feet and over, no less than 175 megohms for those circuits with a single conductor length of less than 1,500 feet.

Tests shall be performed on the system as a whole. Circuits shall be complete, including all splicing from the control cabinet to all the devices it services.

Four copies of wire and wiring test results shall be furnished identifying the observed readings with their respective circuits. The test results shall be identified with the Project title, the date of the test, and the atmospheric conditions.

Electrical circuits and component parts, with the exception of traffic signals, shall be energized for a minimum of ten consecutive periods of normal operation. Temporary service shall be provided if required to perform this part of the testing. Any defective material discovered during the test period shall be replaced.

In addition, traffic signal and system loop detectors shall be tested as follows:

- The complete loop wire and detector lead shall be checked for continuity using a suitable tester.

Prior to placing the sealant, an insulation resistance test shall be performed on the loop and lead wire to assure that the resistance to ground is 10 megohms or greater. If the resistance to ground is less than 10 megohms, corrective measures as necessary shall be made until the desired readings are obtained.

An inductance test shall be performed to determine the inductance of the loop. A tabulation of all test results for all loops shall be submitted in writing.

Traffic signal control equipment including, but not limited to, controllers, loop sensors, load switches, monitors, coordination units, telephone interconnect units and interface modules shall be bench tested as a complete assembly according to the timing schedule for each location. The test, which shall provide the routinizing of all functions of the equipment, shall be considered complete only after 168 hours of continuous trouble-free operation. Approval is required of the test procedure and location. Equipment which does not pass the bench test shall be repaired or replaced and, when corrected, shall be scheduled for retesting.

701.17 Painting. Ungalvanized exposed steel for poles, structures, junction box frames and cast iron junction box covers installed on or in structures shall be painted with one shop coat of rust-inhibitive primer. Ungalvanized steel interior junction box bolts and the exposed portions of foundation bolts and metallic conduits shall be field painted with one coat of rust-inhibitive primer. In addition, all such steel and cast iron shall be painted with a field coat of rust-inhibitive primer tinted to distinguish it from the shop or initial field coat, and a final coat of paint. All surfaces of removable covers shall be painted.

Methods of cleaning and painting shall be as specified for structural steel in Subsection 503.15. The final field coat, however, shall be black graphite paint, foliage green paint or shall match the color of the adjacent concrete.

701.18 Topsoiling and Seeding. Topsoiling and fertilizing and seeding shall be in accordance with Sections 806 and 808.

COMPENSATION

701.19 Method of Measurement. Conduit of the various kinds, types and sizes will be measured by the linear foot including the lengths of conduit abandoned from all attempts made to bypass obstructions using proper jacking methods.

Ground wire installed in conduit will be measured by the linear foot.

Wire of the various kinds and gauges, including slack, will be measured by the linear foot.

Cable rack assemblies installed in existing junction boxes will be measured by the number of units.

Junction boxes of the various kinds and sizes, and foundations of the various kinds and types will be measured by the number of each.

Junction box frames and covers installed in bridge structures will be measured by the number of units.

701.20 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
_____" Flexible Metal Conduit	Linear Foot
_____" Rigid Metallic Conduit, Type _____	Linear Foot
_____" Rigid Nonmetallic Conduit	Linear Foot
Ground Wire, No. _____ AWG	Linear Foot
Multiple Lighting Wire, No. _____ AWG	Linear Foot
Service Wire, No. _____ AWG	Linear Foot
Cable Rack Assemblies	Unit
Foundations, Type _____	Unit
Junction Box Foundations	Unit
_____" Junction Boxes	Unit
_____" x _____" Junction Boxes	Unit
Junction Box Frames and Covers	Unit

Payment for traffic directors will be made in accordance with Section 110.

Payment for clearing site will be made in accordance with Section 201.

Payment for test pits will be made in accordance with Section 207.

Payment for concrete sidewalks and driveways will be made in accordance with Section 607.

Payment for topsoiling and fertilizing and seeding will be made in accordance with Sections 806 and 808.

Separate payment will not be made for ground wire installed in junction boxes, standard bases, meter cabinets and equipment enclosures.

Separate payment will not be made for multiple lighting wire installed in lighting arm and lighting standard assemblies, traffic signal assemblies and sign lighting assemblies.

SECTION 702 - TRAFFIC SIGNALS

702.01 Description. This work shall consist of furnishing and installing completely wired traffic signal systems.

A complete traffic signal installation is generally composed of two systems, one underground and the other above ground.

The underground installation consists of conduits, junction boxes and foundations for standards, pedestals, push button stations and meter cabinets and the installation of detectors.

The above ground installation consists of meter cabinets, traffic signal controllers, signal standards, mast arms, pedestals, signal heads, lamps, pedestrian push button assemblies, wire and wiring, bonding and grounding, connection to utility service and testing.

Temporary traffic signals, where required, shall consist of furnishing and installing temporary traffic signal systems during the various stages of construction.

Terms used are in accordance with NEMA Standard Publication No. TS-1-1976, Part 1, entitled Traffic Control Systems.

MATERIALS AND ELECTRICAL EQUIPMENT

702.02 Materials and Equipment. Materials and equipment shall conform to Section 701 and to the following Subsections:

Lamps	906.09
Loop Detector Lead	906.10
Loop Wire	906.11
Cabinets	906.12
Panel Boards and Circuit Breakers	906.14
Pedestals, Poles, Transformer Bases and Mast Bracket Arms	906.15
Traffic Signal Cable	906.19

The following materials and equipment shall conform to the Bureau of Electrical Engineering NJ Specifications listed below:

Coordinating Unit	EB-COR-4
Joint Sealant	EB-JS-1
Loop Detector Sensor	EB-LD-3
Optically Programmed Traffic Signal Head	EB-TS-2
Pedestrian Signal Head	EB-PS-1
Push Button Assembly	EB-PPB-1
Traffic Signal Head	EB-TS-1
Traffic Signal Controller:	
Eight Phase	EB-TSC-ITB-8
Fixed Time Controller Master and Local Pretimed 3-Dial Expansible Traffic Controllers	2548-04

(a) Controller Assembly. Each actuated controller shall be furnished and installed with the following equipment which shall be connected to the back panel of the controller cabinet:

- Single circuit solid state flasher.

- Loop detector sensors. A maximum of two loops shall be connected to a sensor channel.

All equipment required to perform the required signal operation shall be furnished and installed. The controller shall be completely wired to the terminal blocks in the meter cabinet.

A technician representing the controller manufacturer shall be present at the site when each traffic signal controller is placed into operation and upon assumption of maintenance by the Department.

(b) *Meter Cabinets.* Meter cabinets shall consist of cabinets, meters, control and distribution facilities, the grounding of all equipment, internal wire and wiring to component parts, photoelectric control unit and wire and wiring to the same. The metering facilities shall conform to all utility company requirements.

(c) *Pedestal Assemblies.* Pedestal assemblies shall consist of furnishing and installing a pedestal pole with base and slip fitter cap, miscellaneous fittings and hardware, traffic signal head and traffic signal cable from the terminal block of each face to the base of the standard.

(d) *Pedestrian Signal Assemblies.* Pedestrian signal assemblies shall be of the following types:

- Type W-1 shall consist of furnishing and installing one pedestrian signal head with pole clamp mounting, miscellaneous fittings, the drilling of the standard, installing the grommet and traffic signal cable from the terminal block of the face to the base of the standard.
- Type W-1-OP shall consist of furnishing and installing one optically programmed pedestrian signal head with pole clamp mounting, miscellaneous fittings, the drilling of the standard, installing the grommet and traffic signal cable from the terminal block of the face to the base of the standard.

(e) *Push Button Assemblies.* Push button assemblies shall include the complete push button and housing, traffic signal cable from terminals of the push button to the base of the standard, and instruction sign. The signs shall be in conformance with the MUTCD. The legend for the sign shall be Push Button for Green Light except if WALK - DON'T WALK indications are used, the legend shall be Push Button for WALK Signal. Push buttons shall operate on logic ground.

(f) *Push Button Standard.* Push button standard shall consist of a traffic signal pedestal complete with all mounting hardware and raintight pole cap.

(g) *Traffic Signal Cable.* Traffic signal cable shall be multi-conductor cable conforming to Subsection 906.19 and shall consist of furnishing and installing the cable, all required splicing, cable tags, and providing slack cable in the standards, pedestals, meter cabinets and controller cabinets.

(h) *Traffic Signal Assemblies.* Traffic signal assemblies shall consist of traffic signal arm, furnished and installed on a traffic signal standard complete with mast arm hanger and spider assemblies, or mounting bracket assembly, as required, safety chains, traffic signal heads, miscellaneous hardware and fittings, and traffic signal cable from the terminal block of each face to the base of the traffic signal standard.

Traffic signal assemblies designated with the letter M shall consist of assemblies having a traffic signal arm of the aluminum mast arm type.

Traffic signal assemblies designated with the letters MK shall consist of assemblies having a traffic signal arm of the aluminum mast arm type which shall fit a 9-inch, outside diameter, pole top.

Traffic signal assemblies designated with the letters TA shall be assemblies having a traffic signal arm of the aluminum trombone type. A mast arm hanger and safety chains are not required.

Traffic signal assemblies designated with the letter S shall be assemblies having a traffic signal arm of the steel type. Signal mounting bracket assemblies shall be furnished with all steel mast arms.

Traffic signal assembly Type C-1 shall consist of one traffic signal head with pole clamp mounting furnished and installed on a traffic signal standard. The item shall also include miscellaneous fittings, the drilling of the standard, installing the grommet, and traffic signal cable from the terminal block of each face to the base of the standard.

Traffic signal assembly Type C-1-OP shall consist of one optically programmed traffic signal head with pole clamp mounting furnished and installed. The item shall also include miscellaneous fittings, the drilling of the standard, installing the required grommet, and traffic signal cable from the terminal block of each face to the base of the standard.

Traffic signal assembly Type MM-1 shall consist of a midmounted traffic signal head furnished and installed on a mast arm, complete mounting hardware, drilling the arm, grommet, midmount bracket assembly, safety chain, one traffic signal head, and traffic signal cable from the terminal block of each face to the base of the traffic signal standard.

Traffic signal assembly Type MM-1-OP shall consist of an optically programmed traffic signal head furnished and installed on a mast arm, complete mounting hardware, drilling the arm, grommet, midmount bracket assembly, safety chain, one optically programmed traffic signal head, and traffic signal cable from the terminal block of the face to the base of the traffic signal standard.

(i) *Traffic Signal Standards.* Aluminum traffic signal standards shall be installed complete with a separate bolt-on transformer base of one of the following types:

- A 8-inch Type TB-30 base with through bolts shall be furnished with all traffic signal standards mounted on 11-inch bolt circles.
- A 20-inch Type TB-20 base shall be furnished with all traffic signal standards mounted on 15-inch bolt circles.
- A 24-inch Type TB-K base shall be furnished with all traffic signal standards mounted on 22-inch bolt circles.

A separate transformer base is not required for steel traffic signal standards.

Ground studs shall be furnished and installed in all transformer bases or in the standard. Ground wire shall be installed and shall extend to the ground rod.

(j) *Loop Detector.* Loop detector shall consist of cutting of loop trench, cleaning loop trench, furnishing and installing the wire within the loop trench and, from the termination of the loop trench to the nearest junction box, splicing of wire to the loop detector leads, testing, drilling and repairing the curb and furnishing and installing the sealant.

(k) *Loop Detector Lead.* Loop detector lead shall consist of furnishing and installing of wire specified in Subsection 906.10, connection of the wire to the terminals of the loop detector panel and splicing of the wire to the loop detector.

CONSTRUCTION

702.03 Construction Requirements. The provisions of Section 701 shall apply.

When modifications are made to an existing traffic signal system, as-built prints shall be updated and maintained. The as-built prints shall be stored in the controller cabinet for each system for use by Department maintenance personnel.

Traffic signal standards shall be securely bolted to the foundations and shall be erected with sufficient rake as to assume a vertical position after all attachments and appurtenances are in place. Shims shall be installed to a maximum of 1/4 inch.

Mounting fittings shall provide the proper clearance to aim and adjust the traffic control device. Fittings and mounting hardware not shown on the Plans shall conform to the recommendations of the manufacturer.

Factory installed wrapping shall remain on the poles and bracket arms for as long as recommended by the manufacturer. Every effort shall be made to install the standards and arms with the wrapping in place and every precaution shall be taken to maintain the standard and other equipment in their original factory appearance. In all cases, the ropes, slings or other equipment used to erect the standard and other equipment shall be carefully placed to prevent scratching or abrasions. All abrasions and scratches shall be refinished.

Traffic signal pedestals and meter cabinets shall be securely bolted to the foundations in a vertical position, using stainless steel hardware.

Pedestrian push button assemblies and instruction signs shall be accurately positioned on traffic signal standards, traffic signal pedestals, controller cabinets or meter cabinets. Pedestrian push-button assemblies shall be securely fastened with stainless steel vandal-resistant hardware.

Controller cabinets shall be securely fastened to the top of meter cabinets and foundations, with stainless steel hardware, in a perpendicular position. When a controller cabinet is installed on the top of a meter cabinet, the joint between the cabinets shall be sealed with a neoprene gasket and the wireway sealed as specified in Subsection 701.07.

Traffic signal faces shall be assembled using a wrench specifically designed for that purpose. All mounting fittings shall be specifically designed to function with the unit and provide the proper clearance to aim and adjust the signal face.

Ray directors of the specified cut-off angle shall be installed inside the signal visor. The entire ray director shall be dull black and shall be attached to the visor, after proper aiming, with stainless steel sheet metal screws.

Field adjustments of ray directors and optically programmed signal heads shall be made to limit the visibility of the signal indication. Programming of the indications is subject to approval.

Attachments of the visors, backplates or adaptors shall conform and readily fasten to existing mounting surfaces without affecting the water and light integrity of the signal head.

Traffic signal assemblies shall be wired as indicated. Each signal face shall be individually wired from the terminal block to the base of the pedestal or standard, using the specified colors for each signal section.

Wire used in traffic signal assemblies, from the face to the base of the standard, shall be traffic signal cable.

Each wire termination shall be made with an insulated locking spade terminal.

All terminations in meter cabinets or controller cabinets shall be attached to barrier type terminal blocks. All terminal blocks shall be identified. All spare wires shall be terminated and identified as such.

Where joints or splices are necessary they shall be made with a compression solderless connector and be secured mechanically and electrically with the proper tool. The conductors shall be thoroughly cleaned and with a minimum of the insulation removed. All joints and splices located in pole bases shall be insulated with insulating tape and shall provide one and one-half times the insulation equivalent to that of the original conductor. The taped joints and splices shall be thoroughly coated with an electrical grade sealant and bonding compound.

Where joints or splices are necessary in junction boxes, they shall be as specified above and insulated with resin splicing kits.

Loop detector leads shall be installed continuously from the controller to the junction box nearest to the loop. Splices will not be permitted in the loop detector lead. The connection of the loop detector lead to the loop wire shall be made with a compression solderless connector and be secured mechanically and electrically, with a proper tool. The conductors shall be cleaned with a minimum of insulation removed. All joints and splices shall be insulated with a resin splicing kit.

Traffic signal circuits shall be color coded and wired as follows:

Two Conductor Cable

Function	Color	Number
Pedestrian Push Button	Black	1
Neutral	White	2

Five Conductor Cable (Traffic Signal)

Face	Color	Number
Spare	Black	1
Neutral	White	2
Red	Red	3
Green	Green	4
Yellow	Orange	5

Five Conductor Cable (One Pedestrian Signal)

Face	Color	Number
Spare	Black	1
Neutral	White	2
Don't Walk	Red	3
Walk	Green	4
Spare	Orange	5

Ten Conductor Cable (Traffic Signal)

Face	Color	Number
Green Arrow (spare)	Black	1
Neutral (1)	White	2
Red (1)	Red	3
Green (1)	Green	4
Yellow (1)	Orange	5
Arrow Neutral (spare)	Blue	6
Neutral (2)	White-Black	7
Red (2)	Red-Black	8
Green (2)	Green-Black	9
Yellow (2)	Orange-Black	10

Ten Conductor Cable (Two Pedestrian Signals)

Face	Color	Number
Spare	Black	1
Neutral (1)	White	2
Don't Walk (1)	Red	3
Walk (1)	Green	4
Spare	Orange	5
Spare	Blue	6
Neutral (2)	White-Black	7
Don't Walk (2)	Red-Black	8
Walk (2)	Green-Black	9
Spare	Orange-Black	10

The signal conductor wire from the traffic signal assemblies to the base of the standards shall be color coded as follows:

Indication	Color	Face	Color
Red	Red	Green Arrow	Orange
Yellow	Yellow	Walk	Blue
Green	Green	Don't Walk	Brown
Neutral	White	Push Button	Black

Where loop detectors are to be installed, it shall be necessary to saw cut in the roadway a channel of the dimensions and shape indicated. An access channel shall be saw cut from each loop to the edge of the roadway. The corners of the loops shall be cut diagonally to assure a clean smooth radius. All cuts shall be accomplished in a single pass with a circular pavement-cutting saw.

The channel shall be blown free of debris and moisture after the trench has been cut. If the loop wire is not immediately installed, a filler shall be installed to prevent the channel from collapsing.

The wire forming the loop shall be continuous throughout its length, and installed without splices or joints. The loop wire shall extend from the channel to the nearest junction box. At this point it shall be connected to the loop detector leads as specified hereinbefore.

The loop detector wire shall be installed in the following manner. After the channel is blown free of debris and moisture, the turns of wire shall be laid in the channel so that there are no kinks or curls, and no straining or stretching of the insulation around the corners of the channel or in the junction box. A piece of wood with rounded corners shall be used to seat the wire in the bottom of the channel. After the wire is placed, it shall be rechecked for slack, raised portions or tightness. If any of the foregoing are found, they shall be corrected.

The two wires, which form the lead-in wires, shall be twisted together from the loop channel to the nearest junction box.

After testing the loop, the channel shall be sealed with a joint sealant applied in accordance with the manufacturer's instructions. The joint sealant shall not be placed in the channel at temperatures below 45 degrees F or during precipitation of any kind. The channel shall be completely filled with the joint sealant and there shall be no air bubbles below the surface. Joint sealant which is accidentally applied to the roadway shall be removed. The joint sealant must be sufficiently hardened before traffic is permitted to move over the area.

At those locations where the saw cuts are in a roadway that slopes, the joint sealant shall be applied in a manner that prevents the joint sealant from running out of the trench and on to the roadway.

When the roadway in the area of the loop detectors is to be resurfaced, work shall be scheduled to install the loop detector immediately below the top layer of the surface course. The joint sealant must be hardened before the installation of the pavement.

If a loop is installed on a grade steeper than 3 percent, the joint sealant shall be sealant Type 1.

702.04 Temporary Traffic Signal System. Construction of the temporary traffic signal system shall be in accordance with Subsection 702.03. Electric service for the temporary system shall be obtained from the utility company.

Above ground traffic signal equipment, which has been designated for removal, may be used in temporary traffic signal systems.

As-built prints of the temporary traffic signal system shall be updated and maintained. The as-built prints shall be stored in the controller cabinet for each system for use by Department maintenance personnel.

The Department will assume maintenance of the temporary traffic signal system in accordance with Subsection 702.05.

Upon removal of the temporary traffic signal system, above ground equipment and material shall be salvaged for use by the Department and shall become the property of the State. Material required to be salvaged shall be stored at or near the work for disposal by the Department.

702.05 Assumption of Maintenance. A traffic signal system at an intersection is to be considered as a separate entity, and maintenance and operational responsibility for the signal may be accepted by the Department prior to Completion. Thirty days prior to activation of the traffic signal system, the Resident Engineer shall be notified in order that the system may be inspected to ensure that it conforms to the Contract requirements. Maintenance assumption will be considered only after all testing has been completed, defects corrected, all indications are operational and properly aimed, cables tagged, controller fully operational performing all timing functions required, and all other items of work associated with the signal are completed.

Assumption of maintenance by the Department shall not be considered as Acceptance as described by the Subsection 105.23.

If an existing signal or temporary equipment was in operation before the new facility was installed, it shall, upon assumption by the Department for maintenance responsibility, be immediately removed and stored at or near the site of the work for disposal by the Department in accordance with Subsections 701.03 and 702.04.

Interconnected systems will not be assumed for maintenance until all work associated with the system is complete and all facilities totally operational.

COMPENSATION

702.06 Method of Measurement. Loop detectors will be measured by the linear foot of sawcut in which the wire is installed.

Loop detector leads and traffic signal cables will be measured by the linear foot.

Controller assemblies of the various phases and meter cabinets of the various types will be measured by the number of each.

Pedestal, pedestrian and traffic signal assemblies and standards of the various types will be measured by the number of each.

Push button assemblies and standards will be measured by the number of units.

Temporary traffic signal systems at the various locations will not be measured and payment will be made on a lump sum basis.

702.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Loop Detector	Linear Foot
Loop Detector Lead	Linear Foot
Controller Assemblies, ____ Phase	Unit
Meter Cabinets, Type ____	Unit
Pedestal Assemblies, Type ____	Unit
Pedestrian Signal Assemblies, Type ____	Unit
Push Button Assemblies	Unit
Push Button Standards	Unit
Traffic Signal Assemblies, Type ____	Unit
Traffic Signal Cable, ____ Conductor	Linear Foot
Traffic Signal Standards, Type ____	Unit
Temporary Traffic Signal System (Location)	Lump Sum

Payment for junction boxes, conduits, ground wire and service wire will be made in accordance with Section 701.

Payment for new traffic signal equipment, conduits, foundations and other materials used in the temporary system which are to become part of the permanent system will be made in accordance with Section 701 or this Section, as appropriate.

SECTION 703 - HIGHWAY LIGHTING

703.01 Description. This work shall consist of furnishing and installing complete multiple type highway lighting systems.

A complete highway lighting installation is generally composed of two systems, one underground and the other above ground.

The underground installation consists of conduits, junction boxes and concrete foundations for lighting standards and meter cabinets.

The above ground installation consists of lighting standards and brackets, luminaires, lamps, meter cabinets, standard and bracket wire and wiring from luminaires to multiple lighting wires, multiple lighting wire and wiring from lighting standard bases to meter cabinet, connections, extension to utility service, grounding rods, bonding and grounding.

MATERIALS AND ELECTRICAL EQUIPMENT

703.02 Materials and Equipment. Materials and equipment shall conform to Section 701 and to the following Subsections:

Cable Connectors	906.04
Cast Boxes and Fittings	906.06
Lamps	906.09
Cabinets	906.12
Panel Boards and Circuit Breakers	906.14
Pedestals, Poles, Transformer Bases and Mast Bracket Arms	906.15
Photoelectric Controls	906.16
Aluminum Alloys	911.01

The following materials and equipment shall conform to the Bureau of Electrical Engineering NJ Specifications listed below:

High Pressure Sodium Luminaires:	
Conventional Type	EB-LHPS-2

703.02

Offset Type	EB-LHPS-3
High Mast Type	EB-LHPS-4
Vertical Mounted Type	EB-LHPS-6
Underdeck Luminaires High Pressure Sodium:	
Wall Mounted Type	EB-UHPS-1
Pendant Type	EB-UHPS-2
Low Pressure Sodium Luminaires	EB-LLPS-1
Mercury Vapor Luminaires	EB-LMV-1
Photoelectric Control Unit	EB-PEC-1

(a) *Cast Junction Boxes.* Cast junction boxes shall consist of furnishing and installing a cast junction box and cover, mounting hardware and equipment bosses.

(b) *Lighting Standard Assemblies.* Lighting standard assemblies shall consist of a lighting pole, transformer base, bracket arm, conventional type luminaire with lamp and ballast, cable connectors (fused and/or nonfused), and two color coded No. 10 AWG wires extending from the ballast terminals of each fixture to the distribution wire in the adjacent junction box.

Lighting standard assemblies designated with letters SB are units intended for mounting on structures. The transformer base is omitted, and a reinforced handhold is provided in the shaft.

Lighting standard assemblies Type L-E-S-40 are units which shall be provided with an offset type mounted luminaire. The bracket arm is omitted and replaced with an appropriate slipfitter mounting adapter. The pole shall be furnished with an internally mounted vibration dampener.

Lighting standard assemblies designated with the letter T shall have two bracket arms with luminaires mounted on one lighting standard.

(c) *Lighting Arm Assemblies.* Lighting arm assemblies designated with the letter A shall consist of a bracket arm on a traffic signal standard or existing standard, a luminaire, lamp, cable connectors (fused and nonfused), and two No. 10 AWG color-coded wires extending from the ballast terminals to the distribution wires in the adjacent junction box or the base of the standard.

(d) *Lighting Assemblies.* Lighting assemblies designated with the letter R shall consist of the replacement of an existing luminaire and wiring. The item shall include furnishing and installing a luminaire, lamp, ballast, cable connectors (fused and nonfused), and two No. 10 AWG color-coded wires extending from the ballast terminals to the distribution wires in the adjacent junction box.

Lighting assemblies Type L-R-E shall consist of the replacement of an existing luminaire and wiring and shall include furnishing and installing an offset type mounted luminaire, lamp, ballast, cable connectors (fused and nonfused), and two No. 10 AWG color-coded wires extending from the ballast terminals to the distribution wires in the adjacent junction box. A dampening device shall be provided as recommended by the manufacturer.

(e) *Meter Cabinets.* Meter cabinets shall consist of cabinets, meters, control and distribution facilities, the grounding of all equipment, internal wire and wiring to component parts, photoelectric control unit and wire and wiring to the same. The metering facilities shall conform to all utility company requirements.

(f) *Underdeck Lighting Assemblies.* Underdeck lighting assemblies shall consist of an underdeck luminaire, lamp, and two color-coded No. 10 AWG wires from the terminals in the luminaire to the distribution cables in the adjacent junction box.

Underdeck lighting assemblies designated with the letter W or P are wall mounted and pendant mounted respectively.

Underdeck lighting assemblies Type L-R-U shall consist of the replacement of an existing luminaire and wiring and shall include furnishing and installing an underdeck luminaire, lamp, ballast, cable connectors, and two No. 10 AWG color-coded wires extending from the ballast terminals to the distribution wires in the adjacent junction box.

(g) Wire. No. 10 AWG wire utilized in lighting arm and lighting standard assemblies, and underdeck lighting assemblies shall be multiple lighting and service wire.

CONSTRUCTION

703.03 Construction Requirements. The provisions of Section 701 shall apply.

The connection of the bonding wire to the bases of lighting standards shall be done by means of ground studs.

Lighting poles shall be securely bolted in a vertical position to foundations installing shims, if necessary, of 1/4 inch maximum thickness. Brackets shall be securely attached to poles and shall be placed perpendicular to centerline of roadway. Luminaires shall be securely attached to ends of bracket arms and shall be accurately plumbed, with luminaire reflector properly and accurately placed.

Factory installed wrapping shall remain on the standards and brackets for as long as recommended by the manufacturer. Every effort shall be made to install the standards and brackets with the wrapping in place and every precaution shall be taken to maintain the standard and other equipment in their original factory appearance. If the wrapping must be removed, the equipment must be maintained in its original factory appearance. In all cases the ropes, slings or other equipment used to erect the standard and other equipment, shall be carefully placed to prevent scratching or abrasions. All abrasions and scratches shall be refinished.

Underground conduits entering meter cabinets or transformer enclosures shall be thoroughly sealed with a compound conforming to NEC.

Lighting standard assemblies shall be tagged with the area, circuit, and applicable lamp number.

Sufficient color-coded, single-conductor multiple lighting wire shall be furnished and installed for lighting circuits. Conductors shall be run through the conduits properly trained through the junction boxes to permit racking and connection to lighting standard assemblies and to meter cabinet installations.

The circuit number of all cables shall be identified by cable identification tags attached to each cable in all junction boxes and at the meter cabinets of the load centers. The tags shall be secured to the cable with nylon cable ties.

Where multiple lighting wiring is trained through existing junction boxes which are not equipped with cable racks, cable racks shall be furnished and installed.

Splices necessary to form continuous circuits, complete and ready for operation, shall be made. Splices on all cables and in all boxes shall be made by means of a C Type copper pressure connector, made secure mechanically and electrically, with the proper tool. The conductors shall be cleaned and with a minimum of insulation removed.

Splices in multiple lighting wire shall be made with resin type electrical splicing kits. Electrical splicing kits shall be of the in-line or tap type and shall be used as follows:

- An in-line type splicing kit shall be utilized for joining a single conductor to another in order to form one continuous through conductor.

- A tap or Wye type splicing kit shall be used where it is necessary to obtain a tap connection at a through conductor or where it is necessary to join together more than two conductors.

Precaution shall be taken to keep the conductors and splicing connector centered within the mold, so as to have an even amount of resin surrounding the splice.

Exposed rigid metallic conduits shall be installed parallel with or at right angles to the lines of the structure and shall be supported. Should any surface on which the conduit is installed be damaged, it shall be restored.

Concealed rigid metallic conduits shall be installed in as direct a line as possible and shall be rigidly supported.

When electrical boxes are fastened to masonry with any type of expansion fasteners, they shall be of sufficient size and strength to provide adequate support. Mounting bolts and anchors shall be stainless steel.

Conduits entering electrical boxes shall be secured to the box with lock nuts on the inside and outside if a boss is not provided.

Wire for underdeck lighting assemblies shall extend from the fixture to cast junction boxes.

703.04 Assumption of Maintenance. When all testing has been completed, defects corrected and all light units in the total system are operational, a request in writing may be made to the Department to assume maintenance responsibility for the lighting system before all other work of the Project is complete. After inspection and concurrence, and provided all work associated with the lighting system is complete, the Department may assume routine maintenance responsibility for the lighting.

Should the Engineer open a section of roadway to traffic and direct that highway lighting be made operational, the Department will assume maintenance responsibility of the selected portion of the lighting system provided all testing has been completed, defects corrected and associated circuit cables tagged.

Assumption of maintenance by the Department shall not be considered as Acceptance as described by the Subsection 105.23.

COMPENSATION

703.05 Method of Measurement. Cast junction boxes of the various sizes will be measured by the number of each.

Lighting assemblies, lighting arm assemblies, lighting standard assemblies, meter cabinets and underdeck lighting assemblies, of the various types, will be measured by the number of each.

703.06 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
____" x ____" x ____" Cast Junction Boxes	Unit
Lighting Assemblies, Type ____	Unit
Lighting Arm Assemblies, Type ____	Unit
Lighting Standard Assemblies, Type ____	Unit
Meter Cabinets, Type ____	Unit
Underdeck Lighting Assemblies, Type ____	Unit

Payment for junction boxes, foundations, conduit, multiple lighting wire, ground wire and service wire will be made in accordance with Section 701.

SECTION 704 - SIGN LIGHTING

704.01 Description. This work shall consist of furnishing and installing complete wired multiple type sign lighting systems.

A complete sign illumination installation is generally composed of two systems, one underground and the other above ground.

The underground installation consists of conduits, junction boxes and concrete foundations for meter cabinets.

The above ground installation consists of sign luminaires with lamp, meter cabinets, flexible and rigid conduit and fittings, wire, sign service cabinet with control equipment, conduit and wire to the nearest junction box.

MATERIALS AND ELECTRICAL EQUIPMENT

704.02 Materials and Equipment. Materials and equipment shall conform to Section 701 and to the following Subsections:

Cast Boxes and Fittings	906.06
Lamps	906.09
Cabinets	906.12
Panel Board and Circuit Breakers	906.14
Photoelectric Controls	906.16

The following materials and equipment shall conform to the Bureau of Electrical Engineering NJ Specifications listed below:

Photoelectric Control Unit	EB-PEC-1
Sign Luminaires	EB-SL-1

(a) Sign Lighting Assemblies. Sign lighting assemblies shall consist of fixtures, conduit, fittings, wire and wiring, sign service cabinet, hardware, bonding and grounding, painting, testing, sign tag indicating sign structure number and, if required, a photoelectric control unit and wire and wiring, and all other equipment and material necessary for sign illumination.

Sign service cabinets shall consist of the cabinet and all control and distribution facilities, the grounding of all equipment, all internal wire and wiring to all component parts, and if required, a photoelectric control unit and wire and wiring.

(b) Meter Cabinets. Meter cabinets shall consist of cabinets and meters, control and distribution facilities, grounding of all equipment, internal wire and wiring to component parts, photoelectric control unit and wire and wiring to the same. The metering facilities shall conform to all utility company requirements.

CONSTRUCTION

704.03 Construction Requirements. The provisions of Sections 701 and 703 shall apply.

Sign luminaires shall be placed perpendicular to the sign face and securely bolted to the sign support.

All underground conduits entering sign service cabinets, meter cabinets, or transformer enclosures shall be thoroughly sealed with a compound conforming to NEC.

Sufficient color-coded, single conductor multiple lighting wire shall be furnished and installed for sign circuits. Conductors shall be run through the conduits, properly trained through the junction boxes to permit racking and connection to sign service cabinets and to meter cabinet installations.

Splices necessary to form continuous circuits, complete and ready for operation, shall be made. Splices on all cables shall conform to Subsection 703.03.

A minimum of two circuits shall be utilized for each sign panel and fixtures shall be distributed alternately.

Wire for sign luminaires shall be No. 10 AWG and extend from the fixture to sign service cabinet.

Electrical outlet, junction, pull and device boxes shall be furnished and installed where required to facilitate the pulling, supporting or connecting of wires and cables.

Each conduit entering metal boxes, except threaded boxes, exposed to the weather, shall be securely fastened with two lock nuts, two flat washers, a lead washer, and bushing. Where boxes are aluminum, the lock nuts and flat washers shall be stainless steel. Ground bushings shall be the insulated bushing type. Bushing caps shall be furnished and remain in place until just before conductors are installed. Continuous ground shall be secured by bonding where required.

Exposed rigid metallic conduits shall be installed parallel with or at right angles to the lines of the structure and shall be supported. Concealed rigid metallic conduits shall be installed in as direct a line as possible and shall be rigidly supported.

Aluminum conduits to be installed exposed on tubular aluminum sign structures shall be supported with clamps or bands, with stainless steel saddles.

In the installation of boxes, cabinets and conduits, there may be conditions which would result in the union of dissimilar metals, which under the atmospheric condition prevailing, are injurious to the installation, therefore the following shall be accomplished:

- Aluminum conduit to steel conduit shall be separated by a stainless steel coupling.
- Aluminum flexible conduit to steel coupling shall be separated by a stainless steel nipple and coupling.
- Aluminum conduit to steel or cast iron boxes shall be separated by a short stainless steel nipple with stainless steel couplings.
- Aluminum boxes or cabinets resting on or against concrete surfaces shall have the contact surfaces painted with bitumastic coating.

COMPENSATION

704.04 Method of Measurement. Sign lighting assembly at each sign support structure will not be measured and payment will be made on a lump sum basis.

Meter cabinets of the various types will be measured by the number of each.

704.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Sign Lighting Assembly, Structure No. ____	Lump Sum
Meter Cabinets, Type ____	Unit

Payment for rigid metallic conduit, rigid nonmetallic conduit, flexible metal conduit, service wire, multiple lighting wire, ground wire, foundations and junction boxes will be made in accordance with Section 701.

CONTENTS

SECTION 800 - LANDSCAPING

SECTION 801 - SELECTIVE THINNING

801.01 Description. This work shall consist of the removal of live and dead trees, both standing and fallen, shrubs, and other vegetation and debris designated for removal, to clean up unsightly areas, to produce irregular foliage lines, and to create a natural transition between the artificial edge of the woods left by the clearing of the site and the undisturbed woods.

MATERIALS

801.02 Materials. Materials shall conform to the following Subsections:

Topsoil	909.10
Miscellaneous Materials	909.11

CONSTRUCTION

801.03 Construction Requirements. All trees, shrubs and other vegetation to be removed within the prescribed areas will be designated. Trees shall be carefully felled to prevent damage to adjacent vegetation, structures and property. Trees, stumps and all debris shall be removed in a manner that does not unduly compact or disturb the soil.

In open areas, stumps shall be completely removed to 6 inches below the existing ground surface. The stump hole shall be backfilled with topsoil to eliminate depressions. In wooded areas, stumps shall be cut off at the existing ground surface. Live stumps shall be treated with herbicide immediately after cutting. If suckering occurs, the herbicide treatment shall be continued until no signs of growth recur.

Within the areas of selective thinning, trees that may have died subsequent to thinning and prior to Acceptance shall be removed. Such tree removal shall be considered as part of the work of selective thinning and shall be performed at no cost to the State.

Any damage to other vegetation or to structures or property shall be repaired without additional compensation. Damage to existing trees shall be repaired in accordance with Subsection 803.02 and damage to existing grass areas shall be reconstructed in accordance with Subsection 808.03.

All trees within the areas designated for selective thinning shall have all dead and undesirable limbs removed up to a height of 16 feet.

All cleared material, stumps, and debris resulting from selective thinning shall be disposed of in accordance with Subsection 201.09.

COMPENSATION

801.04 Method of Measurement. Selective thinning will be measured by the acre.

801.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Selective Thinning	Acre

SECTION 802 - SELECTIVE CLEARING

802.01 Description. This work shall consist of the removal of live and dead trees, both standing and fallen, shrubs and other vegetation, and debris to create bays in wooded areas, establishing new vegetation limits along roadsides and to open views.

MATERIALS

802.02 Materials. Materials shall conform to the following Subsections:

Topsoil	909.10
Miscellaneous Materials	909.11

CONSTRUCTION

802.03 Construction Requirements. All vegetation to remain within selective clearing limits will be designated. The Engineer shall be notified 24 hours before work is to begin.

Trees shall be carefully felled to prevent damage to adjacent vegetation, structures and property. Stumps of trees, shrubs and vines shall be completely removed to 6 inches below the existing ground surface. If suckering occurs prior to Acceptance, herbicides shall be applied or mechanical operations performed to ensure that regrowth does not occur. Stump holes shall be backfilled with topsoil to eliminate depressions.

All cleared material, stumps, and debris resulting from selective clearing shall be disposed of in accordance with Subsection 201.09.

Existing vegetation to remain, damaged by construction operations, shall be repaired by proper dressing, cutting, and tracing methods at no cost to the State.

COMPENSATION

802.04 Method of Measurement. Selective clearing will be measured by the acre.

802.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Selective Clearing	Acre

SECTION 803 - TRIMMING EXISTING TREES

803.01 Description. This work shall consist of the removal of all defective or undesirable limbs and the repair of all injuries or wounds on existing trees.

CONSTRUCTION

803.02 Construction Requirements. All trees to be trimmed will be designated. All tree trimming work shall be supervised by a person competent in the work required, as determined by the Engineer.

All dead, dying, diseased, interfering, objectionable and weak branches on the main trunk, as well as those within the leaf areas, shall be removed. Healthy low branches shall not be removed, unless directed.

All cuts shall be made sufficiently close to the trunk or parent limb, without cutting into the branch collar or leaving a protruding stub, so that closure can readily start. Clean cuts shall be made at all times.

Branches too heavy to handle shall be precut to prevent splitting or peeling the bark. Where necessary, to prevent tree or property damage, branches shall be lowered to the ground by ropes or equipment.

On trees known to be diseased, tools shall be disinfected with methyl alcohol at 70 percent (denatured wood alcohol diluted appropriately with water) or a commercial bleach after each cut where there is a danger of transmitting the disease on tools.

Old injuries shall be inspected. Those not closing properly and where the callus growth is not already completely established shall be traced.

In lifting the lower bottom branches of trees for underclearance, care shall be given to symmetrical appearance, and cuts shall not be made so large that they prevent normal sap flow.

All waste material and debris resulting from trimming existing trees shall be disposed of in accordance with Subsection 201.09.

COMPENSATION

803.03 Method of Measurement. Trimming existing trees will be measured by the number in each diameter category, measured 4 1/2 feet above the ground.

803.04 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Trimming Existing Trees, Over _____" to _____" Diameter	Unit

SECTION 804 - TREE REMOVAL

804.01 Description. This work shall consist of the removal of designated trees.

MATERIALS

804.02 Materials. Topsoil shall conform to Subsection 909.10.

CONSTRUCTION

804.03 Construction Requirements. Trees to be removed will be designated. Each tree designated for removal shall be completely removed except for the stump which is to be cut off 6 inches below the existing ground surface. Stump holes shall be backfilled with topsoil. If necessary, trees shall be felled in sections to prevent damage to adjacent vegetation, structures, utility wires and property.

Any damage to other vegetation, structures, utility wires or other property shall be repaired at no cost to the State. Damage to existing trees to remain shall be repaired in accordance with Subsection 803.02. Grass areas damaged as a result of tree removal shall be reconstructed in accordance with Subsection 808.03.

All branches, limbs, trunks and other debris resulting from tree removal shall be disposed of in accordance with Subsection 201.09.

COMPENSATION

804.04 Method of Measurement. Removal of trees will be measured by the number in each diameter category, measured 4 1/2 feet above the ground.

804.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Tree Removal, Over _____" to _____" Diameter	Unit

SECTION 805 - PREPARATION OF EXISTING SOIL

805.01 Description. This work shall consist of the preparation of existing soil for seeding.

MATERIALS

805.02 Materials. Topsoil shall conform to Subsection 909.10.

CONSTRUCTION

805.03 Construction Requirements. The surface of the existing soil to be prepared shall first be cleared of all stumps, brush, weeds and debris. It shall next be cultivated to a depth of 3 to 4 inches to prepare a seed bed. The entire area shall then be brought to a smooth grade, free from any depressions that would collect water. If necessary, additional topsoil shall be used to fill depressions except where depressions exceed 8 inches in depth, subsoil shall be added and covered with 4 inches of topsoil.

All waste material and debris resulting from preparation of existing soil shall be disposed of in accordance with Subsection 201.09.

COMPENSATION

805.04 Method of Measurement. Preparation of existing soil will be measured by the acre.

805.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Preparation of Existing Soil	Acre

Payment for topsoil will be made in accordance with Section 813.

SECTION 806 - TOPSOILING

806.01 Description. This work shall consist of the preparation and placement of topsoil stripped from the site of the Project and the furnishing, preparation and placement of topsoil required in excess of that obtained from stripping.

MATERIALS

806.02 Materials. Topsoil shall conform to Subsection 909.10.

CONSTRUCTION

806.03 Construction Requirements. Storage of topsoil shall conform to Subsection 202.03. The storage piles of topsoil and the areas from which stored topsoil has been removed, within the right-of-way limits of the Project, shall be fertilized and seeded in accordance with Section 808.

Topsoil shall not be placed until the area to be topsoiled has been approved. All stones, 2 inches or larger in any dimension, and other debris such as wires, cables, tree roots, pieces of concrete, clods, and lumps shall be removed and the surface scarified to provide an improved bond between slope and topsoil. Slopes steeper than 2:1 shall not be bladed smooth.

The topsoil shall be spread on a previously prepared surface in a uniform layer to produce the prescribed compacted thickness.

Topsoiled areas outside the limits of work shall be protected against damage caused by the delivery, handling and/or storage of materials, by washouts due to drainage diversion, by workmen, or by equipment. Any such damage shall be repaired by grading, fertilizing, seeding and mulching at no cost to the State.

Where either embankment or excavation slopes become eroded during the work and before Acceptance, repairs shall be made at no cost to the State.

COMPENSATION

806.04 Method of Measurement. Topsoiling of the various thicknesses will be measured by the square yard. Reduction in quantity will not be made for areas designated for planting pits.

806.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Topsoiling, _____" Thick	Square Yard

SECTION 807 - TURF REPAIR STRIP

807.01 Description. This work shall consist of regrading and repair of the area immediately adjacent to the surface course, including fertilizing and seeding, wood cellulose fiber mulching, and placing incidental topsoil.

MATERIALS

807.02 Materials. Materials shall conform to the following Subsections:

Fertilizer	909.02
Limestone, Pulverized	909.03
Mulch	909.04
Topsoil	909.10

Seed mixture shall be Type A-3 conforming to Subsection 909.06.

CONSTRUCTION

807.03 Construction Requirements. Soil and vegetation immediately adjacent to the surface course shall be removed by blading or other means, to facilitate resurfacing, and shall be windrowed adjacent to the shoulder. After resurfacing is completed, the soil shall be replaced in accordance with Subsection 806.03, adding incidental topsoil as may be required. Fertilizing and seeding shall be in accordance with Subsection 808.03. Wood cellulose fiber mulch then shall be applied at the minimum rate of 1200 pounds per acre.

COMPENSATION

807.04 Method of Measurement. Turf repair strip will be measured by the linear foot.

807.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Turf Repair Strip	Linear Foot

SECTION 808 - FERTILIZING AND SEEDING

808.01 Description. This work shall consist of furnishing and placing of pulverized limestone, fertilizer and seed mixtures.

MATERIALS

808.02 Materials. Materials shall conform to the following Subsections:

Fertilizer	909.02
Limestone, Pulverized	909.03
Seed Mixtures	909.06

CONSTRUCTION

808.03 Construction Requirements. Fertilizing and seeding shall be carried out as soon as a unit or portion of the Project, such as a structure, an interchange or a section of roadway has been completed for partial acceptance as provided under Subsection 105.21. Planting beds shall not be fertilized or seeded.

When the soil to be seeded has a pH value of less than 5.8, sufficient pulverized limestone shall be evenly spread to increase the soil pH value to 6.5.

Recommended amounts (pounds per acre) of total oxides (calcium and magnesium) to raise the pH of a 4 inch layer of different soil textural classes to approximately 6.5 are as follows:

Soil (pH)	Loamy Sand	Sandy Loam	Loam	Silty Loam
5.7	300	600	900	1200
5.3-5.6	600	1035	1500	1800
4.9-5.2	900	1500	2100	2400
4.5-4.8	1200	1800	2700	3000
4.1-4.4	1500	2100	3300	3600

The quantity of pulverized limestone required shall be in proportion to its magnesium and calcium oxide content.

The fertilizer for establishing turf shall be limited to one selection throughout the Project. Fertilizer shall be applied in the quantity necessary to yield 60 pounds of nitrogen per acre (30 pounds at the time of seeding and an additional application of 30 pounds approximately 6 months after seeding). The second application shall be made during March or September. The Engineer may adjust the 6-month period depending upon the date of the initial seeding.

(a) Soil Preparation. All areas to be seeded shall be cultivated to provide a reasonably firm but friable seedbed. The depth of cultivation shall be 3 to 4 inches. On slopes steeper than 3:1, the Engineer may direct the depth of cultivation to be reduced. All areas to be seeded shall meet the specified finish grades and shall be free of any weed or plant growth, stones of 2 inches or larger in any dimension and other debris.

(b) Optimum Seeding Seasons. Seeding should be completed from March 1 to May 15 and from August 15 to October 15.

When weather and soil conditions are suitable, the Engineer may permit seeding at other times for soil erosion control and sediment control.

The Engineer shall be notified 24 hours prior to the seeding operation.

(c) Application. Seed mixtures shall be sown at the rate of 100 pounds per acre.

Seed and fertilizer may be placed by either of the following methods:

- *Hydraulic Method.* The seed and fertilizer shall be mixed in water and then applied under pressure at the specified rates. Any area inadequately covered shall be retreated.
- *Dry Method.* Mechanical seeders, seed drills, landscape seeders, cultipaker seeders, and fertilizer spreaders may be used when seed and fertilizer are applied in dry form. Fertilizer in dry form shall be spread separately at the rates specified.

Hand operated seeding devices may be used when seed and fertilizer are applied in dry form on areas which are inaccessible to mechanical seeders.

Finished seeded areas shall be smooth and shall conform to the prescribed lines and elevations. All seeded areas shall be mulched as specified in Section 811.

(d) *Care During Construction.* Seeded areas shall be protected and maintained until Acceptance. Any damage to seeded areas caused by pedestrian or vehicular traffic or other causes, except for conditions as covered in Subsection 107.18, shall be repaired at no cost to the State.

When a satisfactory stand of grass, practically weed free and containing plants in reasonable proportion to the various kinds of seed in the grass seed mixture, is not established on areas of seeding, the deficient areas shall be mowed, refertilized, reseeded, and remulched at no cost to the State, until a satisfactory stand of grass is established.

COMPENSATION

808.04 Method of Measurement. Fertilizing and seeding of the various types will be measured by the square yard.

808.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Fertilizing and Seeding, Type ____	Square Yard

Payment will not be made for areas of fertilizing and seeding disturbed by construction operations, beyond the prescribed grading limits in islands and medians, and between prescribed grading limits and the right-of-way line.

SECTION 809 - TOPSOIL STABILIZATION

809.01 Description. This work shall consist of furnishing, placing and stapling matting on soil surfaces which have been prepared and seeded.

MATERIALS

809.02 Materials. Materials shall conform to the following Subsections:

Topsoil Stabilization Matting	909.09
Miscellaneous Materials	909.11

CONSTRUCTION

809.03 Construction Requirements. Before the matting is placed in position, the soil shall be smooth, soft, and free of depressions, clods, mounds, stones or other debris which may prevent the matting from making complete contact with the soil. After the soil has been properly shaped, fertilized and seeded, the matting shall be laid out flat and anchored securely with staples, so that the matting is in contact with the soil at all points.

When topsoil stabilization matting is required in swales or medians, the matting may be installed in multiple widths.

When jute matting is being laid, the higher end shall be turned under 6 inches and buried in a vertical position. Where laid end to end, the upper end of each downhill strip shall be buried 6 inches deep in vertical position with the uphill strip overlapping for a distance of 6 inches to form a smooth, shingle-like effect. Where laid parallel, the matting shall overlap from 3 to 6 inches.

When excelsior matting is being laid, the material shall be unrolled in the direction of the flow of water. Where laid end to end, the adjoining ends shall be butted snugly. Where laid parallel, the matting shall be butted snugly.

Bulging seams in either matting material shall be cut and joints formed as described above.

Staples shall be placed along the outer edges of the matting and in a parallel row down the center of the strip. Staples shall be spaced 24 to 26 inches apart in the rows except along overlapping edges where they shall be 12 to 13 inches apart. Staples shall be driven at an angle of approximately 30 degrees from horizontal.

In addition to the above requirements, staples shall be placed 12 inches apart across the matting at 50-foot intervals and at critical locations such as at inlets, check slots, if required, overlapping joints and ends. The staples shall be driven flush with the surface of the matting and care shall be taken so as not to form depressions or bulges in the surface of the matting. If any staples become loosened or raised, or if any matting becomes loose, torn or undermined, satisfactory repairs shall be made immediately at no cost to the State.

COMPENSATION

809.04 Method of Measurement. Topsoil stabilization matting will be measured by the square yard.

809.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Topsoil Stabilization Matting	Square Yard

SECTION 810 - SODDING

810.01 Description. This work shall consist of furnishing and placing of topsoil and sod.

MATERIALS

810.02 Materials. Materials shall conform to the following Subsections:

Fertilizer	909.02
Limestone, Pulverized	909.03
Sod	909.08
Topsoil	909.10
Pegs	909.11

CONSTRUCTION

810.03 Construction Requirements. Prior to placing the sod, 4 inches of topsoil shall be placed in accordance with Subsection 806.03.

A 1-2-2 ratio fertilizer, applied at a rate necessary to yield 50 pounds of nitrogen per acre, and pulverized limestone, if necessary, shall be incorporated into the topsoil.

Sod shall be harvested and, within 36 hours, delivered and placed. Sod shall be laid with staggered joints and pressed closely together. The ends of sod strips shall be matched so that the ends and sides always lie flush with each other. Sod shall be pressed into the underlying soil by hand tamping and rolling. Then the sodded areas shall be thoroughly watered.

Watering shall be performed as necessary until a firm root mass is established. Each watering shall be performed until water infiltrates through the root zone and into the topsoil zone. Watering shall be performed in a manner that provides equal distribution and coverage to all areas sodded.

Sod shall not be transplanted when the moisture content (excessively wet or dry) may adversely affect its survival. If the upper 1/2 inch of topsoil is dry, the soil shall be lightly moistened immediately prior to laying the sod.

The finished surface shall be smooth, even, and to the prescribed lines and contour. Sod that is other than alive and healthy shall be replaced immediately without additional compensation.

On slopes, placing sod shall start at the bottom. At the top of slopes the upper edge of the sod strips shall be turned into the soil and covered with topsoil. On slopes steeper than 3:1, sod shall be held in place with pegs driven flush with the surface of the sod. The pegs shall be not more than 1 foot apart. No less than two pegs shall be used for each strip of sod.

With each delivery of sod, a delivery slip shall be submitted with the date of harvest and a New Jersey Department of Agriculture certification.

After a firm root mass is established and before the turf reaches the height of 3 inches, the area shall be mowed with a machine that does not produce ruts, contribute to soil compaction or, in any way, damage the sod. Mowing shall be performed as directed. At the time of Acceptance, all sod shall be alive, healthy and established.

COMPENSATION

810.04 Method of Measurement. Sodding will be measured by the square yard.

810.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Sodding	Square Yard

Payment for mowing will be made in accordance with Section 812.
Payment for watering will be made in accordance with Section 813.

SECTION 811 - MULCHING

811.01 Description. This work shall consist of furnishing and spreading mulch and the binding of straw mulch.

MATERIALS

811.02 Materials. Materials shall conform to the following Subsections:

Binders	909.01
Mulch	909.04

CONSTRUCTION

811.03 Construction Requirements. Seeded areas shall be mulched within 7 days. Seeded areas shall be mulched with straw uniformly spread in a layer 1 to 1 1/2 inches thick, loose measurement, and shall be bound in place with one of the following binders:

- *Emulsified Asphalt.* Emulsified asphalt shall be applied at the rate of 240 gallons per acre.
- *Fiber Mulch.* Fiber mulch shall be mixed with water and applied by hydraulic equipment. The fiber mulch shall be used as recommended by the manufacturer except that no less than 400 pounds of the dry product shall be used per acre. The mixture shall be evenly distributed over the straw mulch.
- *Synthetic Plastic Emulsion.* Synthetic plastic emulsion shall be applied by hydraulic pressure equipment at a rate of 30 gallons (264 lbs) of undiluted material per acre. The synthetic binder shall be diluted in water at a ratio of 1:15. Application of synthetic binder shall not be made during rain or in freezing weather.
- *Vegetable-Based Gels.* Vegetable-based gels shall be mixed with water and applied by hydraulic pressure equipment. The vegetable gels shall be used as recommended by the manufacturer except that no less than 40 pounds of the dry material shall be thoroughly mixed in 750 gallons of water per acre. Application of vegetable gels shall not be made during rain or in freezing weather.

When immediate protection of newly graded slopes is necessary at other than during optimum seeding seasons, straw mulch shall be applied with a temporary seed mixture.

Straw mulch shall be left in place and allowed to disintegrate.

If, prior to Acceptance, any straw mulch is displaced before the grass has made a growth of 1 1/2 inches, the area shall be refertilized, reseeded and remulched without additional compensation.

The specified plant pits of individual trees or shrubs and the entire beds, where material is planted in beds, shall be mulched with a 3- to 4-inch layer of wood chips, stone or gravel, as directed. If, prior to Acceptance, any mulch is displaced, the planting area shall be remulched without additional compensation.

COMPENSATION

811.04 Method of Measurement. Mulching of the various kinds will be measured by the square yard.

811.05 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Gravel Mulching	Square Yard
Stone Mulching	Square Yard
Straw Mulching	Square Yard
Wood Chip Mulching	Square Yard

SECTION 812 - MOWING

812.01 Description. This work shall consist of mowing grass areas within the right-of-way.

CONSTRUCTION

812.02 Construction Requirements. Grass shall be mowed when it attains a height of 10 to 12 inches. The grass and other growth shall be mowed to a height of 3 to 4 inches. Hand mowing methods and light equipment shall be used in areas where the use of heavy equipment might be injurious to the turf or soil.

When the cuttings resulting from the mowing operation are excessive, the cuttings shall be removed in accordance with Subsection 201.09.

COMPENSATION

812.03 Method of Measurement. Mowing will be measured by the acre each time the area is mowed.

812.04 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Mowing	Acre

SECTION 813 - PLANTING

813.01 Description. This work shall consist of furnishing, delivering and planting trees, shrubs, seedlings, vines and ground cover plants.

Planting shall be the initial planting.

Replantings shall be those plantings required after the initial plantings have died or become unacceptable prior to acceptance of the plantings.

Replacement plantings shall be those required in accordance with Subsection 109.14.

MATERIALS

813.02 Materials. Materials shall conform to the following Subsections:

Limestone, Pulverized	909.03
Mulch	909.04
Plant Materials	909.05
Topsoil	909.10
Miscellaneous Materials	909.11
Water	919.15

CONSTRUCTION

813.03 Construction Requirements. Complete information shall befurnished, in writing, concerning the source of supply for all plant material. Plant materials shall be available for inspection in the nursery before it is dug. Inspection prior to moving nursery material shall not be considered as approval. All plant materials shall comply with State and Federal laws controlling inspection for plant diseases and insect infestations, and all required certificates shall be submitted.

Plant material shall be carefully handled and packed to prevent injuries during transit. The roots of all plants shall be protected with wet straw, moss, or other suitable material until planted. If not planted on the day of delivery, all bare root material shall be heeled-in, watered and kept shaded or covered until planted. Work shall be

coordinated to prevent delays in planting that may expose the roots of plant materials to the air, sun, or freezing conditions. Planting shall be in accordance with standard nursery practice.

(a) Planting Seasons. Broad leaf and coniferous evergreen trees, shrubs, vines and ground covers shall be planted from March 1 to May 1 and from August 15 to December 1. Deciduous trees, shrubs, vines and perennials shall be planted from March 1 to May 1 and from October 15 to December 1.

(b) Layout. Plant material locations and bed outlines shall be staked. The Engineer may adjust plant material locations to meet field conditions.

(c) Planting Beds. Existing vegetation within proposed planting beds shall be sprayed, during the growing season, with glyphosate at the manufacturer's recommended rates. A second application shall be applied 5 days after the first application, where necessary. The dead vegetation shall be mowed as closely as possible to existing ground or turned into the soil.

(d) Excavation for Plant Pits and Beds. Prior to excavating for plant pits and beds, the areas shall conform to the prescribed lines and grades.

All sod, weeds, roots and other objectionable material unsuitable for backfill shall be immediately removed from the site and disposed of in accordance with Subsection 201.09.

The minimum planting pit sizes for bare root plant materials shall be as follows:

Height of Plant (Feet)	Diameter (Inches)	Depth (Inches)
1 to 4	25	16
over 4 to 5	27	17
over 5 to 6	28	18
over 6 to 8	30	19
over 8 to 10	33	20
over 10 to 12	36	22
over 12 to 14	44	26

Planting pits for B & B plant materials shall provide a space for not less than 6 inches of backfill below and around the ball. Planting pits for containerized plant material shall provide space for not less than 4 inches of topsoil below and around the root-earth mass. If topsoil from the excavation of planting pits is of good quality, it shall be saved and reused.

Planting pits for seedlings, vines, ground covers, and perennials shall be not less than 12 inches in diameter and 12 inches deep.

Planting pits shall not remain open more than 10 days in advance of planting on slopes steeper than four units horizontal to one vertical.

In medians or other areas close to the roadway where a hazardous condition may result, planting pits shall not remain open beyond the close of the working day unless adequate precautions are taken to warn of their presence and protect the public from injury.

(e) Setting Plants. All plants shall be set approximately plumb and at the same depth at which they were grown in the nursery.

For all planting during an extension of the spring planting season, the plant material shall be moved with roots balled; the trunk, branches and foliage shall be sprayed with an antidesiccant which shall be mixed and applied according to the directions of the manufacturer; and the trees and shrubs shall be trimmed and thinned to reduce the amount of foliage and help balance the loss of roots due to transplanting.

Backfill and root placement for the various root conditions are as follows:

- *Bare Root Stock.* Topsoil shall be placed in the plant pit to the required depth. Bare root plants shall then be placed in the center of the plant pit and the roots properly spread out in a natural position. All broken or damaged roots shall be cleanly cut back to sound root growth. Topsoil shall then be carefully worked around and over the roots and thoroughly and properly settled by firming or tamping. Thorough watering or puddling shall accompany backfilling. Earth saucers or water basins at least 4 inches in depth shall be formed about individual plants with a diameter equal to that of the plant pit.
- *Balled and Burlapped Stock.* Balled and burlapped plants shall be placed carefully in the prepared pits on the required depth of tamped topsoil so as to rest in a firm, upright position. Plants shall be handled and moved only by the ball. Topsoil shall then be filled in around the plant ball to half the depth of the ball, then tamped and thoroughly watered. The burlap shall then be either cut away and removed from the upper half of the ball or loosened and folded back, after which the remainder of the backfill shall be placed. Earth saucers or water basins shall then be provided and the plant thoroughly watered.
- *Containerized Plant Material.* Immediately prior to planting containerized plant material, the root-earth mass shall receive three vertical cuts, spaced equidistantly about the perimeter. Each cut, about 1/2 inch deep, shall begin at the top of the root-earth mass and continue to the bottom. Topsoil shall then be filled in around the root mass to half the depth, tamped and thoroughly watered, after which the remainder of the topsoil shall be placed. Earth saucers or water basins shall then be provided and the plant thoroughly watered.

(f) *Watering.* The initial watering at the time of planting shall be at the rate of 15 gallons per square yard of plant pit area. All plants shall be watered once a week thereafter until the work is accepted.

Each watering, after the first, shall provide 5 gallons of water per square yard in the plant pit basin.

More than one watering per week may be required during planting operations or during periods of excessive dryness.

If the basin constructed around each plant does not function properly, it shall be repaired at no cost to the State. All damage to grass, plants, stakes, guys, mulch or watering basins shall be repaired at no cost to the State.

(g) *Tree Protection.* Tree protectors shall be installed to a height of 2 feet above the ground surface on all newly planted Malus and Crataegus species to prevent damage from bark consuming rodents.

(h) *Pruning.* Deciduous trees and shrubs shall be pruned to remove one third to one half of the previous season's growth.

Pruning shall be done before planting in such a manner as to preserve the natural character of each plant. All pruning shall be done by experienced personnel with properly conditioned equipment and in keeping with accepted horticultural practice.

(i) *Mulching.* All beds shall be treated with a pre-emergence herbicide such as oryzalin, oxadiazon or trifluralin. The herbicide shall be applied prior to the placing of any mulching materials. Planting beds in areas flatter than 4:1 shall also be cultivated to a depth of 6 inches. All plant material shall be mulched in accordance with Section 811. The beds shall be neatly edged.

(j) *Planting.* At the time of acceptance of the planting, all planting areas shall be free of weeds and a minimum of 95 percent of the plants, as determined by the Engineer, shall be alive and healthy. Unacceptable plant material (5 percent or less) shall be replanted during the next planting season. The date for beginning the plant establishment period for the replanted material is retroactive to the initial acceptance of the planting.

813.04 Restoration and Cleanup. Where existing grass areas have been damaged during planting operations, the disturbed areas shall be restored in accordance with Subsection 808.03 at no cost to the State.

All roots, sod, weeds, debris, spoil piles, containers and other unsuitable material shall be disposed of in accordance with Subsection 201.09.

813.05 Plant Establishment Period and Replacements. The acceptability of the plant material furnished and planted as specified will be determined at the end of a period of establishment during which all possible means shall be employed to preserve the plants in a healthy growing condition. Planting will be determined as established 1 year from the date of acceptance of the planting. The dates of planting acceptance are June 1 for the spring planting and December 1 for the fall planting. Care during the establishment period may include watering, weeding, spraying with insecticides or fungicides, pruning, repair and adjustment of guys and stakes.

All plants that are not alive and healthy at the end of the plant establishment period shall be replaced in kind, quantity and size with acceptable live, healthy plants installed as originally specified. The Engineer may permit substitute varieties of plants to be used.

Replacement planting shall conform to the requirements for initial planting except as follows:

- Existing wood chips shall be removed and may be reused if salvagable and conforming to Subsection 909.04.
- Backfilling may be made with excavated material which does not contain wood chips or other objectionable material.
- Replacement plantings shall be made at no cost to the State.

Replacement of evergreen materials shall be made from March 1 to May 1 and from August 15 to December 1. Replacement of deciduous material shall be made from March 1 to May 1 and from October 15 to December 1.

All stakes, guys and guy wires shall be removed 2 weeks prior to the conclusion of the 1 year plant establishment period.

At the conclusion of the 1 year plant establishment period, all weeds, debris and damaged plant material shall be removed and disposed of in accordance with Subsection 201.09. Holes resulting from the theft of plants shall be filled. All planting beds shall be treated with a pre-emergence herbicide.

COMPENSATION

813.06 Method of Measurement. Planting of ground covers, seedlings, shrubs, trees or vines, of the various kinds and sizes, will be measured by the number of each.

Topsoil for backfill will be measured by the cubic yard as determined by computing the volume of the specified planting pits and deducting the volume of the specified plant balls or plant containers. Deduction will not be made for the volume of the root system of bare root plant material.

Watering will be measured in units of 1000 gallons (MG). Water may be measured by means of meters, by actual measurement in tanks, tank trucks, or other containers, or by computation based on weight.

813.07 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit* Unit
(Genus, species, variety, root & size)	
Topsoil	Cubic Yard
Watering	MG

Payment for plants rendered unacceptable by the random inspection of root system, as specified in Subsection 909.05, will be made at one half the price bid.

SECTION 814 - NONVEGETATIVE SURFACES

814.01 Description. This work shall consist of the construction of nonvegetative surfaces consisting of broken stone, washed gravel, color-coated bituminous-treated broken stone, or color-coated bituminous concrete surface course.

MATERIALS

814.02 Materials. Bituminous concrete surface course shall conform to Section 903 and shall be Mix I-5. Bituminous binder shall be emulsified asphalt, grade RS-1, conforming to Subsection 904.03. Aggregates shall conform to the following Subsections:

Broken Stone	901.04
Washed Gravel	901.05
Dense Graded Aggregate	901.08

Color coating, where required, shall be formulated with a pure acrylic vehicle and shall be durable, weather resistant, and suitable for use on bituminous surfaces. The tint shall be lusterless brown matching color chip No. 30277, Table II, of Federal Standard 595A, Colors Volume I.

CONSTRUCTION

814.03 Broken Stone Surface. Broken stone, approximately aggregate size No. 2, shall be spread in the specified uniform layer conforming to the proposed grade.

814.04 Washed Gravel Surface. Washed gravel, approximately aggregate size No. 2, shall be spread in the specified uniform layer conforming to the proposed grade.

814.05 Color-Coated Bituminous-Treated Stone Surface. On the shaped and compacted surface, broken stone, aggregate size No. 3, shall be placed at the specified depth and then compacted with a vibrating tamper until keyed together. Emulsified asphalt shall be sprayed upon the graded aggregate at the approximate rate of 0.75 gallons per square yard, avoiding formation of a surface mat. After penetration and before the emulsion has set, approximately 20 pounds per square yard of size No. 8 aggregate shall be spread to fill in the voids. A vibrating tamper shall be used to set the size No. 8 aggregate and then a second application of binder shall be applied at the rate of 0.75 gallons per square yard.

After the binder course is set, the color coating shall be sprayed uniformly over the aggregate at the rate of 0.3 gallons per square yard. The coating shall be reapplied to any missed spots or areas to obtain a uniform coating.

Spilling of the bituminous material or the color coating on adjacent areas shall be avoided.

Traffic is not permitted on the color-coated surface until it is dry.

814.06 Color-Coated Bituminous Concrete Surface. Dense graded aggregate base course, 2 inches thick, shall be constructed in accordance with Subsection 203.09 except that density control method shall not apply.

Bituminous concrete surface course, 2 inches thick, shall be constructed in accordance with Section 404. Where irregularities or obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture shall be spread, raked, and luted by hand tools to give the required compaction.

The final color coat shall be applied uniformly at a rate of 0.3 to 0.5 gallons per square yard, by spraying, brush, or squeegee over the bituminous concrete surface course. The surface shall be clean and dry at the time of application. The coating shall be reapplied to any missed spots or areas to obtain a uniform coating.

Spilling of the color coating on adjacent surfaces shall be avoided.

Traffic is not permitted on the color-coated surface until it is dry.

COMPENSATION

814.07 Method of Measurement. Nonvegetative surfaces of the various kinds and thicknesses will be measured by the square yard.

814.08 Basis of Payment. Payment will be made under:

Pay Item	*Pay Unit*
Broken Stone Surface, _____" Thick	Square Yard
Washed Gravel Surface, _____" Thick	Square Yard
Color-Coated Bituminous-Treated Stone Surface, _____" Thick	Square Yard
Color-Coated Bituminous Concrete Surface	Square Yard

CONTENTS

SECTION 900 - MATERIALS

SECTION 901 - AGGREGATES

901.01 General. Aggregates from a single source shall be used in any one construction item unless otherwise authorized.

Gradations of aggregates in the various tables of this and other Sections are the percentages passing by weight.

901.02 Stockpiles. The area for each stockpile shall be of adequate size, reasonably uniform in cross section, well drained and cleared of foreign materials.

Stockpiles at portland cement concrete and bituminous concrete mixing plants shall be of sufficient size to provide for a minimum of 1 day's operations. The aggregate stockpiles shall be placed on a firm, hard surface such as a compacted aggregate or stabilized base, bituminous or concrete surface and shall be constructed by placing the aggregates in layers not more than 3 feet thick.

Aggregates from the haulway areas shall not be used. The piles shall be located so that there is no contamination by foreign material and no intermingling of aggregates from adjacent piles. Aggregates from different sources and of different gradings shall not be stockpiled near each other unless a bulkhead is placed between the different materials. Aggregates of different gradings and from different sources for use in blends shall be blended by proportion through the weigh hoppers. Aggregates found segregated or contaminated will be rejected for use. A rejected stockpile may be reconstructed for further evaluation. Aggregates shall be removed from stockpiles in a manner such as to prevent segregation.

Aggregates which require washing shall not be used sooner than 24 hours after washing or until the surplus water has drained out and the material has a uniform moisture content.

Stockpiles of reclaimed asphalt pavement to be used in bituminous concrete mixes shall not exceed 15 feet in height. Stockpiles shall be covered or otherwise protected to prevent buildup of moisture in the stockpile.

Steel-tracked equipment will not be permitted on the stockpiles.

901.03 Coarse Aggregate. Coarse aggregate shall be broken stone, washed gravel, blast furnace slag and boiler slag conforming to Subsections 901.04, 901.05, 901.06 and 901.07 and shall be graded as shown in Subsection 901.21, Table 901-1.

901.04 Broken Stone. The broken stone shall be uniform in texture and quality, and shall conform to Subsections 901.01, 901.02 and 901.03 and to the following quality requirements:

	Maximum Percent
Weathered and decomposed stone	5
Broken stone other than that classification approved for use	5
Flat or elongated pieces for graded material No. 57 and larger (length greater than 4 times maximum thickness or width)	7
Absorption in cold water	
No. 8 and larger	1.7
Nos. 89 and 9	1.8
Sodium sulfate soundness, loss	
Ledge rock	10
Graded sizes	10
Adherent fines in coarse aggregates	
Bituminous concrete	1.5
Portland cement concrete	1.0

The percent of wear (Los Angeles Test) shall be as follows for various uses:

	Maximum Percent
Bituminous concrete surface course, top layer	40
Bituminous concrete surface course, bottom layer	45
Bituminous-stabilized base course	45
Concrete surface course and bridge decks	40
Concrete, other	50
Dense graded aggregate base course	50

Types of rock permissible for use in white concrete shall be free from dirt and discoloring matter.

The geologic classifications are as follows:

- Argillite shall mean a thoroughly indurated and cohesive rock composed predominantly of silt size or smaller particles of clay, quartz and feldspar or the fine grained thermal recrystallization products of this assemblage (hornfels). It shall be bedded thickly enough so as not to break into thin pieces at planes of stratification.
- Carbonate rock shall mean a thoroughly indurated and cohesive rock composed predominantly of calcite and dolomite, bedded thickly enough so as not to break into thin pieces at planes of stratification. Minerals insoluble in hot hydrochloric acid shall be discrete grains of quartz, clay and mica.
- Gneiss shall mean a metamorphic rock consisting principally of quartz and feldspar. It shall have a dense structure and shall not break into thin pieces at lines of stratification and shall have a uniform distribution of minerals.
- Granite shall mean an equigranular or porphyritic igneous rock consisting principally of quartz and feldspar. It shall be of medium or fine grain texture.
- Quartzite shall mean a metamorphic rock composed principally of quartz. It shall be quarried so that only the nonarkosic, uniformly compacted quartzites are included in the graded products, and shall not be schistose in structure.
- Trap rock shall mean either basalt or diabase. It shall have a uniform distribution of constituent minerals.

901.05 Washed Gravel. Washed gravel shall be either crushed or uncrushed as specified. The gravel shall conform to Subsections 901.01, 901.02 and 901.03 and to the following quality requirements:

	Percent	
Sodium sulfate soundness, loss	10	maximum
Soft particles as determined by scratch hardness test (see Note)	5	maximum
Absorption in cold water		
No. 8 size and larger	1.7	maximum
Nos. 89 and 9	1.8	maximum
Clay lumps, organic material, coal and other foreign or deleterious matter (Percent by weight or volume whichever is greater)	0.5	maximum
Sea salt	0.2	maximum
Crushed gravel material with at least one fractured face (Nicked gravel is not considered crushed)	60	minimum
Adherent fines in coarse aggregates		
Bituminous concrete	1.5	maximum
Portland cement concrete	1.0	maximum

The percent of wear determined in accordance with the Los Angeles Test shall be as specified for the various uses, except that the percent maximum loss for quartz gravel shall be 50 percent. Quartz gravel shall mean a material composed of natural pebbles of which the overwhelming majority are coarsely crystalline quartz. The individual crystals within each pebble shall be intergrown into a tenacious, nonporous, interlocking texture which fractures as a single unit.

Note - When the sodium sulfate soundness and scratch hardness tests total 10 percent or more, a petrographic analysis will be made to determine the amount of unsound and weathered material. Unsound and weathered materials shall not be more than 10 percent by weight.

901.06 Blast Furnace Slag. Blast furnace slag shall be the air-cooled residue resulting from the production of pig iron and shall consist of tough, durable, angular fragments uniform in density, absorption, quality, and shall be free from flux stone, dirt or other objectionable material. The slag shall conform to Subsections 901.01, 901.02 and 901.03 and to the following quality requirements:

Weight per cubic foot (loose measure), lbs	60	minimum
Percentage of wear (Los Angeles Test)	50	maximum
Sulfur, percentage by weight	1	maximum

901.07 Boiler Slag. Boiler slag shall be the fused water-cooled residue from the combustion of pulverized or powdered coal used in electric generating plants or from refuse incinerating plants, the color of which shall be black or nearly black. The gradation of boiler slag shall conform to Size No. 10.

The boiler slag shall conform to Subsections 901.01, 901.02 and 901.03 and the following quality requirements:

Weight per cubic foot (loose measure), lbs	85	minimum
Specific gravity (bulk)	2.80	minimum
Absorption in cold water, percent	1.2	maximum
Percentage of wear (Los Angeles Test)	50	maximum

901.08 Dense Graded Aggregate. Dense graded aggregate shall consist of broken stone conforming to Subsection 901.04, crushed gravel conforming to Subsection 901.05 or blast furnace slag conforming to Subsection 901.06 except that at least 90 percent of all fragments shall contain at least one face resulting from fracture, and shall conform to the following requirements and gradation:

- The moisture content of dense graded aggregate immediately prior to placement shall be 6 plus or minus 2 percent based on dry weight. If dense graded aggregate is to be paid for on a tonnage basis, the moisture content shall not exceed 8 percent when delivered to the Project.

Sieve size	Percent
1 1/2"	100
3/4"	55-90
No. 4	25-60
No. 50	5-25
No. 200	3-12

- When tested in accordance with AASHTO T 90, the portion passing the No. 40 sieve shall be nonplastic.

Dense graded aggregate may be produced from recycled concrete aggregate which shall conform to the gradation and plasticity requirements above and to the following:

- Composition

	Percent by Weight	
	Minimum	**Maximum**
Portland cement concrete	90 (Note 1)	
Bituminous concrete		10 (Note 2)
Brick, mica, schist and other friable material		4 (Note 2)
Wood		0.1 (Note 2)

  Note 1 - In order to meet the minimum requirement, broken stone or crushed gravel may be added. Broken stone shall conform to Subsection 901.04. Crushed gravel shall conform to Subsection 901.05 except that it need not be washed.

  Note 2 - The percent shall be determined by separating the material retained on the No. 4 sieve and expressing that amount as a percentage of the total weight of material retained on the No. 4 sieve.

- Resistance to Degradation. The loss shall not exceed 50 percent when tested in accordance with AASHTO T 96 (Los Angeles Machine).
- Soundness. The loss shall not exceed 15.0 percent when tested in accordance with AASHTO T 104 by the use of sodium sulfate.
- Prior to use, test results certifying compliance to the above requirements shall be submitted to and verified by the Department Laboratory.
- A quality control plan shall also be submitted for approval and shall include the following:
  - The assignment of quality control responsibility to specifically named individuals.
  - Performance of regularly scheduled inspection procedures including inspection of the source concrete for the recycled concrete aggregate.
  - Provisions for the prompt implementation of control and corrective measures.
  - Provisions for liaison with the Engineer at all times.
  - Performance of necessary quality control tests.

    The quality control procedure shall include performance of the following tests while stockpiles of recycled concrete aggregate are being produced:

    1. Gradation. Testing in accordance with AASHTO T 27 and T 11 shall be performed at least once a day.
    2. Composition. Continuous visual inspection and removal of objectionable material to ensure compliance.
    3. Soundness of aggregate in accordance with AASHTO T 104 and resistance to degradation in accordance with AASHTO T 96 shall be performed a minimum of once every 2 weeks.

901.09 Soil Aggregate. Soil aggregate shall be natural or prepared mixtures consisting predominately of hard durable particles or fragments of stone, slag, gravel or sand and containing some silt-clay or stone dust.

901.09

Soil aggregate obtained from subaqueous sources and placed by methods other than hydraulically shall first be placed in a stockpile and drained, and shall not be placed in its final location until the Engineer has determined that the moisture content is not excessive.

(a) Definitions of Constituent Materials. Stone shall be crushed or naturally angular particles of rock, a natural solid mineral matter occurring in large masses or fragments, which shall pass a 2 inch sieve and be retained on a No. 8 sieve. The stone shall conform to Subsection 901.04.

Slag shall be blast furnace slag conforming to Subsection 901.06.

Gravel shall be rounded particles of rock which shall pass a 4 inch sieve and be retained on No. 8 sieve.

Sand shall be granular material resulting from weathering processes, grinding or crushing of rock and shall pass a No. 8 sieve and be retained on the No. 200 sieve.

Stone dust shall be fine soil or mineral particles, or both, which shall pass the No. 200 sieve. Silt-clay shall be fine soil particles which shall pass the No. 200 sieve.

(b) Composition of Soil Aggregate. The composite mixture of any type of soil aggregate specified herein shall be free from elements or chemicals which, in the presence of water, would produce detrimental effects to pavements, structures, or utility lines, and be free from organic matter, wood, garbage, metal, debris or lumps of clay.

Designations I-1, I-2, I-3, I-4, I-9, I-10, I-11, I-12 and I-13 shall consist of bank-run sand and gravel, commercial sand and gravel combined, blast furnace slag or stone except blast furnace slag will not be permitted when in contact with concrete.

Designation I-5 shall be hard, durable gravel or stone mixed with sand, stone dust or silt-clay so that it can be compacted into a hard, dense mass. The composite mixture shall contain, by weight, a total of not more than 25 percent of shale, slate, schist, or soft and decomposed aggregate as determined by lithologic analysis.

Designation I-5 may be produced from recycled concrete aggregate conforming to the composition and quality requirements specified for recycled concrete aggregate in Subsection 901.08 and to the gradation requirements of Subsection 901.21, Table 901-2.

Designations I-6, I-7 and I-8 shall consist of clean, free-draining sand, gravel or stone.

Designations I-1, I-2, I-3, I-4, I-5, I-9 and I-10 shall comply with the gradation requirements specified in Subsection 901.21, Table 901-2 after being tested for materials which break down as determined in accordance with Section 990, NJDOT A-8.

(c) Gradation. Soil aggregate shall be graded as shown in Subsection 901.21 Table 901-2 for the various designations. The gradation requirements shall apply to the material after it has been placed and compacted on the Project. Where compaction is not prescribed, the requirements for any given type shall apply to the material at the time it is placed.

(d) Combining and Mixing. If bank-run or other materials conforming to the requirements specified hereinabove are not available, materials that conform thereto may be produced by combining and mixing, and by washing if necessary. Materials may be combined and mixed on the grade only with

approval. The blending on the grade shall be performed by a traveling high speed rotor mixer capable of cutting and thoroughly mixing to a minimum depth of 6 inches.

901.10 Aggregates for Bituminous Concrete.

(a) Coarse Aggregate. Coarse aggregate for top layer of bituminous concrete surface course (total retained on No. 8 sieve) shall be broken stone or crushed gravel. Broken stone shall conform to Subsection 901.04 except that carbonate rock may be used for the top layer only in shoulder areas, parking areas or driveways. Crushed gravel shall conform to Subsection 901.05 except that it need not be washed and it shall contain not more than 50 percent of total carbonates (30 percent on Federally-funded projects) as determined by Section 990, NJDOT A-5.

Coarse aggregate for bottom layer of bituminous concrete surface course (total retained on No. 8 sieve) shall be broken stone or crushed gravel conforming to Subsection 901.04 or 901.05 respectively except that the gravel need not be washed.

(b) Reclaimed Asphalt Pavement (RAP). Reclaimed asphalt pavement shall pass a 2 1/2 inch sieve.

The bituminous material contained in the RAP shall be asphalt cement free from solvents or other contaminating substances.

When tested, the coarse aggregate contained in the RAP shall conform to the requirements of Subsection 901.04 for broken stone and to the requirements of Subsection 901.05 for gravel.

When tested, the fine aggregate contained in the RAP shall conform to the quality requirements in Subpart *(c)*.

(c) Fine Aggregate. Fine aggregate for top and bottom layers of bituminous concrete surface course and for bituminous concrete shoulders shall be stone sand or natural sand.

Stone sand shall be manufactured from an aggregate source conforming to Subsection 901.04, however, not more than 15 percent based on the oven dry weight shall pass the No. 200 sieve. When the percent passing the No. 200 sieve exceeds 15 percent, use of the stone sand will be permitted if blended with another approved sand so that the combination contains no more than 15 percent passing the No. 200 sieve based on stockpile samples theoretically combined. Each sand source shall be fed into the plant through a separate cold feed hopper.

Natural sand shall consist of material composed of predominantly angular particles of quartz or other hard durable minerals conforming to the following quality and gradation requirements:

	Maximum Percent
Mica	2.0
Absorption, cold water	2.0
Sodium sulfate soundness, loss	5.0
Clay and clay lumps as determined by AASHTO T 88	5.0
Sieve Size	**Percent**
3/8"	100
No. 4	95-100
No. 8	80-100

Natural fine aggregates for top layer of the surface course shall be washed and graded products. After washing, not more than a total of 5 percent based on oven dry weight shall pass the No. 200 sieve.

In lieu of the above requirements for gradation and washing, the appropriate provisions of ASTM C 33 may be substituted, except that not more than a total of 5 percent based on oven dry weight shall pass the No. 200 sieve.

901.11 Aggregates for Bituminous-Stabilized Base Course. Aggregates for bituminous-stabilized course shall conform to Subsection 901.10 for bottom layer of bituminous concrete surface course.

Crushed gravel conforming to Subsection 901.05 may be used for stone mix except that the gravel need not be washed.

Soil aggregate may be used for gravel mix and shall contain, by weight, a total of not more than 25 percent of shale, slate, schist, and soft and decomposed aggregate as determined by lithologic analysis.

Any aggregate blended with soil aggregate of a gravel or stone mix shall conform to Subsection 901.04, 901.05 or 901.10.

The soil aggregates shall be free of vegetable matter, lumps or balls of clay, adherent films of clay or other matter that may prevent thorough coating with bituminous material. The portion passing the No. 40 sieve shall be nonplastic.

901.12 Aggregates for Bituminous Surface Treatment.

(a) Coarse Aggregate. Coarse aggregate for cover material for bituminous surface treatment shall conform to Subsection 901.03.

(b) Fine Aggregate. Fine aggregate for cover material for bituminous surface treatment shall be composed of natural sand, hard durable pebbles, crushed stone or stone sand, to be mixed in such proportions that the material conforms to the grading requirements specified below:

Sieve Size	Percent
1"	100
No. 8	65-100
No. 50	10-30
No. 200	0-7

901.13 Aggregates for Portland Cement Concrete, Mortar, and Grout.

(a) Coarse Aggregate. Coarse aggregate shall be broken stone or washed gravel conforming to Subsection 901.04 or 901.05 respectively, except that carbonate rock shall not be used for concrete surface courses, bridge decks and parapets.

Carbonate coarse aggregate shall not be used with carbonate fine aggregate material except that for white portland cement concrete, carbonate coarse aggregate may be used with the fine aggregate conforming to Subpart *(c)*.

Carbonate aggregates will be permitted to be used with portland cement having an alkali content of less than 0.7 percent. Carbonate aggregates in portland cement concrete shall have a verifiable record of performance over a period of at least 5 years. When no performance record is available, carbonate materials will be evaluated by petrographic analysis and geologic studies to determine if a potential exists for expansive reaction with alkalis.

Coarse aggregate shall be the size or sizes shown in Subsection 914.05, Tables 914-1 and 914-2.

Broken stone and washed gravel for use in white concrete shall be free from dirt and discoloring matter and shall conform to Subsections 901.04 and 901.05 respectively. Broken stone shall be washed and the gravel rewashed when so directed. The coarse aggregate shall be washed at least 24 hours before use.

(b) *Fine Aggregate.* Fine aggregate for any type or class of concrete and for mortar shall be a washed and processed material composed of quartz or other hard durable particles. The fine aggregate shall be predominantly angular in shape and be free of soft particles. The material shall conform to Subsection 901.02 and the following gradation and quality requirements:

Sieve Size	Percent
3/8"	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10
No. 200	0-3
No. 200 (white concrete-natural sand)	0-5
No. 200 (white concrete-stone sand)	0-7

The fine aggregate shall have not more than 45 percent retained between any two consecutive sieves, and its fineness modulus shall be not less than 2.3 and not more than 3.1 for concrete and shall be not less than 2.0 and not more than 3.1 for white concrete as defined in AASHTO M 6 and shall conform to the following quality requirements:

	Maximum Percent
Mica	2.0
Sea salt	0.2
Absorption, cold water	2.0
Sodium sulfate soundness, loss	5.0

Fine aggregate shall be tested for organic impurities and shall be rejected if it produces a color darker than the standard. The mortar-making properties of the fine aggregate shall be not less than 100 percent of those of standard Ottawa sand.

(c) *Fine Aggregate for White Concrete and Mortar.* Fine aggregate for white concrete and mortar shall conform to the applicable provisions of Subpart *(b)* and to the following:

- The fine aggregate shall be a crushed white marble or calcite or clean, washed natural sand, free from dirt and discoloring matter. It shall contain not more than 0.75 percent of ferric oxide.
- When the coarse aggregate used in the manufacture of white concrete has a reflectance value of 20 percent or more, the fine aggregate shall have a reflectance value of not less than 40 percent. When the coarse aggregate has a reflectance value of less than 20 percent, the fine aggregate shall have a reflectance value of 45 percent or more.

(d) *Fine Aggregate for Grout.* Fine aggregate for grout shall conform to the requirements in Subpart *(b)* above except that it shall be so graded that 100 percent of the material passes the No. 8 sieve and the mortar prepared from this material shall have a strength of not less than 75 percent of the strength of mortar prepared similarly with standard Ottawa sand.

901.14 Aggregates for Underdrains. Coarse aggregate shall be of broken stone, washed gravel, or blast furnace slag conforming to Subsection 901.04, 901.05 or 901.06 respectively. Soil aggregate shall conform to Subsection 901.09.

901.15 Mineral Filler. Mineral filler for bituminous concrete shall be broken stone conforming to Subsection 901.04, fly ash conforming to Subsection 919.07 or other inert mineral matter, free from lumps and foreign materials.

Mineral filler shall be of such quality that a bituminous mixture containing the filler shall retain 70 percent of its initial strength after an immersion cycle of 14 days when prepared in accordance with AASHTO T 167 and tested in accordance with AASHTO T 165.

The mineral filler shall conform to the following grading requirements:

Sieve Size	Percent
No. 50	95-100
No. 200	70-100

901.16 Grit. Grit for spreading over the epoxy seal coat shall be a subangular natural 98 percent silica sand or boiler slag conforming to Subsection 901.07 except that boiler slag shall not be used for riding surfaces. The particle size shall be such that 90 percent of the total sample (by weight) falls between No. 4 and No. 30 sieve with 0 percent passing the No. 30 sieve.

901.17 Riprap Stones. Riprap stones shall consist of rock conforming to Subsection 901.04 and weighing not more than 150 pounds each, with at least 90 percent of the stones weighing more than 25 pounds each, but not more than 40 percent weighing more than 100 pounds each.

901.18 Rubble Stones. Rubble stones shall consist of hard, durable rock meeting the geologic classifications in Subsection 901.04 or other hard durable rock. They shall be sound, free from weathered or decomposed pieces, shattered ends and structural defects.

Rubble Masonry. The face stones for mortar rubble and dry rubble masonry walls shall be not less than 8 inches thick. The width shall be not less than 1.5 times the thickness and the length not more than 3 times the thickness and not less than 1.5 times the width.

Rubble Riprap. The rubble stones for rubble riprap walls shall be as specified above for rubble masonry walls except that they may be of random size within a range appropriate for the construction of walls of the cross sectional design.

901.19 Sampling. Sampling will be performed in accordance with the following:

Aggregates:	
Coarse, Size No.	
1	150 pounds for each 1000 tons
2 & 24	100 pounds for each 1000 tons
3 & 357	90 pounds for each 1000 tons
4 & 467	70 pounds for each 1000 tons
5, 56 & 57	50 pounds for each 500 tons
6, 67 & 68	30 pounds for each 500 tons
7 & 78	20 pounds for each 250 tons
8, 89, 9 & 10	10 pounds for each 250 tons
Dense graded	In accordance with AASHTO T 2 for each 500 cubic yards
Fine	10 pounds for each 500 tons
Soil Designation:	
I-1, I-2, I-3, I-4, I-5, I-6, I-7, I-8, I-9, I-10	In accordance with AASHTO T 2 for each 500 cubic yards

I-11, I-12, I-13	In accordance with AASHTO T 2 for each 500 cubic yards (See Note)
Borrow Excavation, Zone 3	In accordance with AASHTO T 2 for each 2000 cubic yards
Mineral Filler	1 quart from each source
Rubble Stones	Subject to test and inspection prior to shipment

Note - After initial 10,000 cubic yards have been sampled, then one sample for each 2,000 cubic yards except if any sample fails or is borderline, then revert to one sample for each 500 cubic yards.

901.20 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

AASHTO	
T 2	Sampling Aggregates
T 11	Amount of Material Finer than No. 200 Sieve in Aggregate
T 19	Unit Weight and Voids in Aggregate
T 21	Organic Impurities in Sands for Concrete
T 27	Sieve Analysis of Fine and Coarse Aggregates
T 37	Sieve Analysis of Mineral Filler
T 84	Specific Gravity and Absorption of Fine Aggregate
T 85	Specific Gravity and Absorption of Coarse Aggregate
T 89	Determining the Liquid Limit of Soils
T 90	Determining the Plastic Limit and Plasticity Index of Soils
T 96	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
T 112	Clay Lumps and Friable Particles in Aggregate
T 113	Lightweight Pieces in Aggregate
T 165	Effect of Water on Cohesion of Compacted Bituminous Mixtures
NJDOT	
A-1	Mortar-Making Properties of Fine Aggregate
A-2	Determination of Reflectance Value of Aggregates
A-3	Soundness of Aggregates by Use of Sodium Sulfate
A-4	Determination of Percentage of Mica in Fine Aggregate
A-5	Determination of Percentage of Carbonates in Crushed Gravel by Petrographic Analysis
A-6	Determination of Percentage of Adherent Fines Present in Coarse Aggregate
A-7	Shale, Schist, Slate, and Soft and Decomposed Particles in Soil Aggregate
A-8	Rapidly Determining the Breakdown in Sizes of Soil Aggregate
A-9	Scratch Hardness Test for Coarse Aggregate Particles
US ARMY CORPS of ENGINEERS	
CRDC-119	Determination of Percentage of Flat and Elongated Pieces

901.21 Tables. Tables referenced in the Specifications are as follows:

901.21

Table 901-1 Standard Sizes of Coarse Aggregate

Size Number	Nominal Size Square Openings (1)	Amounts finer than each laboratory sieve (square openings), percentage by weight														
		4	3½	3	2½	2	1½	1	¾	½	3/8	No. 4	No. 8	No. 16	No. 30	No. 100
1	3½ to 1½	100	90–100		25–60		0–15		0–5							
2	2½ to 1½			100	90–100	35–70	0–15		0–5							
24	2½ to ¾			100	90–100		25–60		0–10	0–5						
3	2 to 1				100	90–100	35–70	0–15		0–5						
357	2 to No. 4				100	95–100		35–70		10–30		0–5				
4	1½ to ¾					100	90–100	20–55	0–15		0–5					
467	1½ to No. 4					100	95–100		35–70		10–30	0–5				
5	1 to ½						100	90–100	20–55	0–10	0–5					
56	1 to 3/8						100	90–100	60–75	15–35	0–15	0–5				
57	1 to No. 4						100	95–100		25–60		0–10	0–5			
6	¾ to 3/8							100	90–100	20–55	0–15	0–5				
67	¾ to No. 4							100	90–100		20–55	0–10	0–5			
68	¾ to No. 8							100	90–100		30–65	5–25	0–10	0–5		
7	½ to No. 4								100	90–100	40–70	0–15	0–5			
78	½ to No. 8								100	90–100	40–75	5–25	0–10	0–5		
8	3/8 to No. 8									100	85–100	10–30	0–10	0–5		
89	3/8 to No. 16									100	90–100	20–55	5–30	0–10	0–5	
9	No. 4 to No. 16										100	85–100	10–40	0–10	0–5	
10	No. 4 to 0 (2)										100	85–100				10–30

(1) In inches, except where otherwise indicated. Numbered sieves are those of the United States Standard Sieve Series.
(2) Screenings.

Table 901-2 Standard Soil Aggregate Gradations
New Jersey Interagency Engineering Committee

	GRADATION DESIGNATIONS—Percentage by weight passing square mesh sieves												
SIEVE SIZE	I-1	I-2	I-3	I-4	I-5	I-6	I-7	I-8	I-9	I-10	I-11	I-12	I-13
4"	100		100						100	100	100	100	100
2"	70-100	100		100	100				80-100	80-100	80-100		
1"				60-100		100	100						
¾"	50-95	65-100	60-100		70-100				60-100	60-100	60-100	70-100	
½"				40-100		80-100	80-100	100					
No. 4	30-60	40-75	30-100	25-100	30-80			95-100	40-100	40-100	40-100		30-100
No. 8				20-100		45-100	35-100						
No. 16				15-85		30-90	25-90	45-70	20-70	20-70			
No. 50	5-25	5-30	5-35	8-45	10-35	0-20	5-50	5-25	5-35	5-40	0-75	0-75	
No. 100						0-3	0-8		0-20	0-30			
No. 200	0-7	0-7	0-5	5-10	5-12		0-2	0-5	0-8	0-20	0-9	0-5	0-12

901.21

SECTION 902 - BEAM GUIDE RAIL

902.01 Rail Element. Rail element shall be steel conforming to AASHTO M 180, Class A, Type I in Table 1 and the weight of zinc coating shall conform to Type I in Table 2.

902.02 Posts and Spacers. Posts and spacers shall be structural steel conforming to AASHTO M 183 and shall be galvanized in accordance with AASHTO M 111.

902.03 Rub Rail. Rub rail shall be steel channels or bent plate of structural steel conforming to AASHTO M 183 and shall be galvanized in accordance with AASHTO M 111.

902.04 Miscellaneous Hardware. Guide rail end treatment cables shall conform to AASHTO M 30, Type I with Class A coating and the swaged fitting shall be fabricated from forged steel conforming to AASHTO M 102.

Connections or splices, nuts, bolts, washers and plates shall conform to AASHTO M 180 except as follows:

- Nuts for guide rail end treatment shall conform to ASTM A 563, Grade A.
- Plates and rods for guide rail end treatment shall be structural steel conforming to AASHTO M 183.
- Washers, bolts and plates for guide rail on bridges shall be structural steel conforming to AASHTO M 183.
- Plates for guide rail on bridges, and plates and rods for guide rail end treatment shall be galvanized in accordance with AASHTO M 111.
- Bolts and nuts may be mechanically galvanized in accordance with AASHTO M 298, Class 50, Type I.

902.05 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Rails, posts, spacers and miscellaneous hardware	Subject to inspection prior to shipment

902.06 Certification of Compliance. Manufacturer's certification for all materials shall be submitted in accordance with Subsection 106.04 and shall include certification that the 1 1/8-inch diameter expansion anchor bolt with 5 1/2 inch embedment has minimum pull out strength of 20,000 pounds.

SECTION 903 - BITUMINOUS CONCRETE

903.01 Composition of Mixtures. Composition of the mixture for the top layer of bituminous concrete surface course shall be coarse aggregate, fine aggregate, mineral filler and asphalt cement and may also include up to 10 percent reclaimed asphalt pavement.

Composition of the mixture for the bottom layer of bituminous concrete surface course shall be coarse aggregate, fine aggregate, mineral filler and asphalt cement and may also include up to 20 percent of reclaimed asphalt pavement.

Composition of the mixture for bituminous-stabilized base course shall be as specified above for the bottom layer of bituminous concrete surface course.

Materials shall conform to the following Subsections:

Aggregates for Bituminous Concrete	901.10
Aggregates for Bituminous-Stabilized Base Course	901.11
Mineral Filler	901.15
Asphalt Cement	904.01

The several mineral constituents shall be combined in such proportions that the resulting mixture meets the grading requirements in Subsection 903.05, Table 903-1. In calculating the percentage of aggregates of the various sizes, the bituminous material is excluded.

903.02 Formula for Job Mix. A job mix formula for each mixture shall be submitted on forms supplied by the Department, which shall include a statement naming the source of each component and a report showing the results of the applicable tests specified in Subsection 903.05, Table 903-5.

The job mix formula for each mixture shall establish the percentage of dry weight of aggregate passing each required sieve size and an optimum percentage of asphalt cement based upon the weight of the total mix. The optimum percentage of asphalt cement shall be determined in accordance with the Asphalt Institute Mix Design Methods for Asphalt Concrete, Manual Series Number 2 (MS-2) Marshall method and shall produce a mixture that conforms to Subsection 903.05, Table 903-5. The job mix formula, including the tolerances shown in Subsection 903.05, Table 903-2 for manual batch plants, shall be within the master range specified in Subsection 903.05, Table 903-1 except that for top layer mixes, when the optimum percentage of asphalt cement is less than specified, the Engineer may approve the use of the optimum asphalt content provided it is not below the lower limit of the master range listed in Subsection 903.05, Table 903-1. When plotted on a 0.45 power grading accumulation chart as used by the Department, the aggregate gradation for the job mix formula shall produce a grading curve with no abrupt changes and approximately parallel to the curve of the grading limits specified in Subsection 903.05, Table 903-1.

In addition, three Marshall specimens (for each mix specified) molded according to the composition, including asphalt content proposed in the job mix formula, shall be submitted with the mix design forms. The Engineer reserves the right to be present at the time of molding the Marshall specimens. The submitted specimens will be used to verify the properties of the job mix formula.

At the discretion of the Engineer, the submission of Marshall specimens for verification of the properties of the job mix formula will not be required if the previous year's approved design for a particular mix is submitted with written certification that the same source and character of materials are to be used. When a previous year's design is approved for use, the initial lot provision of Subsection 903.03 shall not apply and the first lot of the particular mix shall be lot No. 1 and is subject to reductions for nonconformance.

The job mix formula for each mixture shall be in effect until modification is approved.

The job mix formula which includes reclaimed asphalt pavement shall also include the following based on the weight of the total mixture:

Percentage of reclaimed asphalt pavement
Percentage of asphalt cement in the reclaimed asphalt pavement
Percentage of new asphalt cement
Total percentage of asphalt cement
Percentage of each type of new aggregate

For mixes containing reclaimed asphalt pavement, the job mix formula shall also establish the target percentage of dry weight of aggregate passing each required sieve

size and the target percentage of recoverable bitumen (bituminous material) to be present in the recycled bituminous mixture when discharged from the plant and when tested in accordance with Section 990, NJDOT B-4.

The job mix formula containing up to 20 percent of reclaimed asphalt pavement, may be established by modifying a previously approved mix design to allow for the introduction of reclaimed asphalt pavement except that the Marshall design procedure and the specimens will not be required.

When unsatisfactory results for any specified characteristic of the work make it necessary, a new job mix formula may be established for approval. In such instances, if corrective action is not taken, the Engineer reserves the right to require an appropriate adjustment.

Should a change in sources or properties of materials be made, a new job mix formula shall be established and approved before the new material is used.

Quality control testing shall be performed by the producer to keep the mix within the specified tolerances.

When two consecutive lot samples or three out of five consecutive lot samples of any mix or combination of mixes fail to conform to the job mix formula for the No. 8 sieve, No. 200 sieve, or the asphalt content or the gradation for the remaining sieves falls outside the ranges listed in Subsection 903.05, Table 903-1, work will be stopped until corrective action is taken.

The temperature of the mixture at discharge from the plant or surge and storage bins shall be maintained at a minimum of 15 degrees above the laydown temperature. In no case shall the mixture temperature exceed 325 degrees F.

The moisture content of the mixture at discharge from the plant shall not exceed 1.0 percent. Moisture determinations are based on the weight loss on heating for 1 hour in an oven at 280 plus or minus 5 degrees F of an approximately 1500 gram sample of mixture. A minimum of one sample per lot but not less than two samples per day will be tested for moisture. Samples for moisture determinations will be obtained in accordance with Section 990, NJDOT B-3.

The total mineral aggregate and bituminous material shall be so combined and mixed that at least 95 percent of the coarse aggregate particles are entirely coated with asphalt as determined by AASHTO T 195. At the option of the Engineer, random samples will be obtained from each of five trucks and the adequacy of the mixing will be determined on the average of particle counts made on these five test portions. If the above requirement is not fully met, mixing time shall be increased as necessary to obtain the required degree of coating.

Resistance to plastic flow for bituminous mixtures when combined in the proportions of the job mix formula shall conform to Subsection 903.05, Table 903-5 when tested in accordance with AASHTO T 245 except reference to 1 inch maximum size aggregate is deleted and except that 75 blows of the compaction hammer are to be used on specimens for Mix I-2, I-3 and I-4.

903.03 Sampling and Testing.

(a) Manual Batch and Drum Mix Plants. Five random samples will be taken from each lot of approximately 3000 tons of each type of mix. When a lot of bituminous concrete is necessarily less than 3000 tons, samples will be taken at random for each type of mix at the rate of one sample for each 600 tons or fraction thereof.

At the manual batch plants and drum mix plants, the bituminous mixture will be sampled and tested for compliance.

To determine the quantity of bitumen and the gradation of the aggregate in bituminous concrete mixtures for acceptance testing purposes, extractions at the sampling rate specified will be performed each day for each type mixture in accordance with Section 990, NJDOT B-4.

The producer's quality control technician shall be present during periods of mix production for the sole purpose of quality control testing and to assist the Department's representative in order to ensure compliance.

(b) *Fully Automated Batch Plants.* Under the supervision of the Engineer, five random samples shall be taken from each lot of approximately 3000 tons of each type of mix. When a lot of bituminous concrete is necessarily less than 3000 tons, samples shall be taken at random for each type of mix at the rate of one sample for each 600 tons or fraction thereof.

Acceptance testing for gradation and asphalt content will be performed using bin samples and printed weigh tickets in accordance with Section 990, NJDOT B-6.

If, at any time, the automatic proportioning or recording devices become inoperative or inaccurate, sampling and acceptance testing will be performed in accordance with the requirements for manual batch plants.

(c) *General Sampling and Testing Requirements.* Acceptance testing of bituminous concrete will be performed in a timely manner.

The Department will not perform the composition control testing or other routine test functions in the absence of or in lieu of the plant laboratory technician.

Acceptance testing does not preclude the Engineer from requiring disposal of any batch or shipment without further testing which is rendered unfit for its intended use due to contamination, segregation, improper temperature or incomplete coating of the aggregate. For other than improper temperature, visual inspection of the material by the Engineer is considered sufficient grounds for such rejection.

When materials are rejected for any of the above reasons, except for improper temperature, samples will be taken for testing. Should such testing indicate that the material was erroneously rejected, payment will be made for the rejected material.

Bituminous mixtures processed through a surge or storage system will be inspected visually to assure that they are essentially free of lumps of cold material. Any batch or shipment of material found to be so contaminated will be rejected and shall be disposed of.

(d) *Conformance to Job Mix Formula.* Conformance to the job mix formula will be determined on the basis of extraction samples taken and tested at the mixing plant for manual batch and drum mix plants and will be determined by plant print-out tickets and hot bin samples for fully automated batch plants.

The average of test results for the five samples or less for a lot shall conform to the job mix formula within the applicable tolerances of Subsection 903.05,Tables 903-2 and 903-3. Also the range of test results samples from a lot shall be within the applicable tolerances of Subsection 903.05, Table 903-4. Payment for any lot which does not comply with these requirements will be reduced in accordance with Subsection 903.05, Table 903-6. The Engineer may order the removal of any material subject to the maximum reduction shown in Subsection 903.05, Table 903-6.

(e) *Conformance to Control Stability Requirements.* Control stability will be determined on the basis of samples taken and tested at the mixing plant. Conformance to the control stability requirements specified in Subsection 903.05,

Table 903-5 will be determined from the average of five stability determinations for each lot of material. The material for the stability determinations will be obtained in accordance with Section 990, NJDOT B-3 at the mixing plant at the same time that the random samples are taken for measurement of conformance to the job mix formula and tested for resistance to plastic flow. Payment for any lot which does not comply with the specified stability requirements will be reduced in accordance with Subsection 903.05, Table 903-7. The Engineer may order the removal of any material subject to the maximum reduction shown in Subsection 903.05, Table 903-7.

(f) *Initial Production Lot.* Reductions for nonconformance to job mix formula and control stability requirements will not be applied to the initial lot each year for each type of mix, also these reductions will not be applied to the initial lot when a new job mix formula is approved in which a change of aggregate producer has caused the maximum specific gravity to change by more than 0.04 as determined by the Engineer. The above waiver does not apply when the average result of the job mix formula conformance samples of the initial lot varies outside those limits for the No. 8 or No. 200 sieve or asphalt content shown in Subsection 903.05, Table 903-1 or the control stability shown in Subsection 903.05, Table 903-5. In this case, the entire initial lot is subject to nonpayment. For the purpose of applying this requirement, if the job mix formula for a top course mix has its asphalt content at the lower limit of Subsection 903.05, Table 903-1, then the lower limit shall be decreased by 0.45 percent.

The initial lot each year is defined as the plant's production, up to 1000 tons, for the first day in a calendar year. In the event the first day's production does not reach 400 tons, the initial lot is to be extended until the 400-ton level is reached or the Project is completed.

(g) *Plants Producing for Multiple Projects.* When a plant is producing bituminous concrete or bituminous-stabilized base course for two or more Department Projects at the same time, only one common set of lots for stability and job mix formula will be established and the samples taken for each lot shall apply to each Project on which a part of that lot was used.

903.04 Bituminous Concrete Patch. Bituminous concrete for patching may be used either as a hot mixture direct from a mixing plant or cold from a stockpile at temperatures as low as 15 degrees F. In addition, all mixtures shall be sufficiently workable to allow spreading and raking for a period of at least 6 months when stockpiled and shall be sufficiently stable after compaction to carry traffic without undue marking or displacement.

(a) *Materials.* Materials shall conform to the following Subsections:

Aggregates for Bituminous Concrete (Note 1)	901.10
Mineral Filler	901.15
Cut-back Asphalt, Grade MC-250 or MC-800 (Note 2)	904.02
Inverted Emulsified Asphalt, Grade IEMC-250 or IEMC-800	904.04

Note 1 - Aggregates for bottom layer of bituminous concrete surface course.

Note 2 - Grades MC-250 and MC-800 shall contain an anti-stripping additive.

(b) *Composition of Mixture.* The bituminous concrete shall be composed of aggregates and bituminous materials combined in such proportions that the resulting composite blend meets the following:

Sieve Size	Total Percent
1/2"	100
3/8"	80 -100
No. 4	55 - 75
No. 8	30 - 60
No. 50	10 - 30
No. 200	4 - 10
Residual Bitumen Content	5.5- 7.5

In calculating the percentages of aggregates of the various sizes, the bituminous material is excluded.

Note - Material passing the No. 200 sieve may consist of fine particles of the aggregate or mineral filler, or both. Material passing the No. 40 sieve shall be nonplastic when tested in accordance with AASHTO T 90. Composition of mixture shall be determined in accordance with Section 990, NJDOT B-4 except that the material shall be dried at 280 degrees F for a period of 3 hours prior to beginning the extraction procedure.

(c) *Preparation of Mixture.* The aggregate shall be surface dry at the time of mixing, however, its temperature shall not exceed 250 degrees F. The temperature of the bituminous material shall not exceed 170 degrees F. The temperature of the components and the mixing time shall be such that a minimum of 90 percent of the aggregate is coated when tested in accordance with Section 990, NJDOT B-8.

903.05 Tables. Tables referenced in the Specifications are as follows:

903.05

Table 903-1 Bituminous Concrete Mixtures

New Jersey Interagency Engineering Committee
Standard Bituminous Concrete Mixture Design Table

Mix Designation and Nominal Maximum Size of Aggregate.

	Base Course			Surface Course, Bottom Layer		Surface Course, Top Layer		
Mix	I-1	I-2		I-3		I-4	I-5	I-6
Size	1"	1 1/2"		1"		3/4"	3/8"	No. 4
Sieve Size	Grading of total aggregate (coarse plus fine, plus filler if required). Amounts finer than each laboratory sieve (square opening) weight percent.							
2"	---	100						
1 1/2"	100	90-100		100				
1"	90-100	80-100		90-100		100		
3/4"	60-80	65-95	(NA)	75-90	(NA)	98-100		
1/2"	---	50-85		60-80		88-98	100	
3/8"	15-40	40-75	(NA)	50-70	(NA)	65-88	80-100	100
No. 4	0-10	25-60		25-60		35-65	55-75	80-100
No. 8	---	20-50		15-45		25-50	30-60	65-100
No. 16	---	---		---		18-40	20-45	40-80
No. 30	---	---		---		12-30	15-35	20-65
No. 50	---	8-30		3-18		10-25	10-30	7-40
No. 100	---	---		---		---	---	5-20
No. 200	---	4-12		1-7		3-10	4-10	4-10
	Asphalt Cement, Percent by Weight of Total Mixture							
	2.5-3.1	3.5-8		4-8.5		4.5-9.5	5-10	7-12

Note 1 - Material passing the No. 200 sieve may consist of fine particles of the aggregate or mineral filler, or both. Material passing the No. 40 sieve shall be nonplastic when tested in accordance with AASHTO T 90.
Note 2 - Design requirements - the maximum size of coarse aggregate shall be no more than one-half of the proposed lift thickness.
Note 3 - Mix I-1 is not subject to the design requirements specified elsewhere.
Note 4 - (NA) Denotes not applicable for NJDOT Mix.

Table 903-2 Tolerances from Job Mix Formula for Average of Five Samples

Gradation Mix No.	I-2	I-3	I-4	I-5	I-6
Sieve Size All Plants	**Tolerance Percentage** (Plus or Minus)				
No. 8	4.5	4.0	4.0	4.0	4.0
No. 200	1.4	1.4	1.4	1.4	1.4
Asphalt (Manual Batch and Drum Mix Plant)	0.45	0.45	0.45	0.45	0.45
Asphalt (Fully Automated Batch Plants)	0.15	0.15	0.15	0.15	0.15

Table 903-3 Tolerances from Job Mix Formula for Average of N Samples from a Short Lot

Gradation Mix No.		I-2	I-3	I-4	I-5	I-6
Number of Samples	**Sieve Size All Plants**	**Tolerance Percentage** (Plus or Minus)				
4	No. 8	5.0	4.5	4.5	4.5	4.5
4	No. 200	1.6	1.6	1.6	1.6	1.6
Asphalt (Manual Batch and Drum Mix Plants)		0.50	0.50	0.50	0.50	0.50
Asphalt (Fully Automated Batch Plants)		0.15	0.15	0.15	0.15	0.15
3	No. 8	6.0	5.0	5.0	5.0	5.0
3	No. 200	1.8	1.8	1.8	1.8	1.8
Asphalt (Manual Batch and Drum Mix Plants)		0.60	0.60	0.60	0.60	0.60
Asphalt (Fully Automated Batch Plants)		0.20	0.20	0.20	0.20	0.20
2	No. 8	7.0	6.5	6.5	6.5	6.5
2	No. 200	2.2	2.2	2.2	2.2	2.2
Asphalt (Manual Batch and Drum Mix Plants)		0.70	0.70	0.70	0.70	0.70
Asphalt (Fully Automated Batch Plants)		0.25	0.25	0.25	0.25	0.25

Table 903-4 Tolerances for Range of Five Samples or Less

Gradation Mix No.	I-2	I-3	I-4	I-5	I-6
Sieve Size All Plants	**Tolerance Percentage**				
No. 8	16.0	13.0	13.0	13.0	13.0
No. 200	4.8	4.8	4.8	4.8	4.8
Asphalt (Manual Batch and Drum Mix Plants)	1.5	1.5	1.5	1.5	1.5
Asphalt (Fully Automated Batch Plants)	0.4	0.4	0.4	0.4	0.4

Note - For any one characteristic the range is the absolute difference between the smallest and largest value in the lot.

Table 903-5 Design and Control

Gradation Mix No.	I-2		I-3	I-4	I-5	I-6
	Stone	Gravel				
Criteria	**Test Limits**					
Design Stability, minimum lbs	1500	1100	1500	1500	1200	--
Control Stability, minimum lbs	1200	800	1200	1200	900	--
Flow Value, 0.01"	6-18	6-18	6-18	6-16	6-16	--
Design Voids in mineral aggregate, minimum %	12	12	13	14	16	18
Design Air Voids, (Note 1), %	2-5	2-5	2-5	2-5	2-6	2-6
Control Air Voids, average of 5 cores (Notes 1 and 2), %	2-8	2-8	2-8	2-8	2-8	2-8

Note 1 - As determined from the values for the maximum specific gravity of the mix and the bulk specific gravity of the compacted mixture. Maximum specific gravity of the mix will be determined in accordance with AASHTO T 209. Bulk specific gravity of the compacted mixture will be determined in accordance with Section 990, NJDOT B-9.

Note 2 - As determined by the Engineer from drilled pavement cores taken by the Department.

Table 903-6 Reduction per Lot due to Nonconformance to Job Mix Formula and Range in the Characteristics of Asphalt Content or Aggregate Passing No. 8 or No. 200 Sieve. (See Note 1)

Deviation of average of 5 samples or less from a lot beyond applicable tolerances in Tables 903-2 and 903-3 above. (Percent of tolerance in Table 903-2 above for the applicable type plant)	Reduction Per Lot
1 to 50	2%
51 to 100	5%
Over 100	10%

Deviation of sample range beyond applicable tolerance in Table 903-4 above. (Percent of tolerance in Table 903-4 above for the applicable type plant)	Reduction Per Lot
Greater than 0	5%

Note 1 - Where more than one reduction due to nonconformance to job mix formula is applicable to a lot, only the greatest single reduction will be used.

Table 903-7 Reduction Per Lot Due to Nonconformance to Stability Requirements

Deviation of 5-sample average below control stability of Table 903-5(lbs.)	Reduction Per Lot
1 to 150	2%
151 to 300	5%
Over 300	10%

SECTION 904 - BITUMINOUS MATERIALS

904.01 Asphalt Cement. Asphalt cement shall conform to AASHTO M 226, Table 2. Grade AC-20 shall be used except that an asphalt of lower viscosity grade may be directed to be used when conditions are such as to cause rapid cooling of the mixture or when the mixture contains reclaimed asphalt pavement.

904.02 Cut-back Asphalts. Cut-back asphalt of the rapid curing (RC) types shall conform to AASHTO M 81.

Grade RC-T shall conform to AASHTO M 81 and the following:

	Minimum	Maximum
Water, % by weight		0
Viscosity, Furol at 104°F, sec		40.0
Distillation, % by volume of total distillate to 680°F		
to 320°F	35.0	
to 374°F	55.0	
to 437°F	75.0	
to 500°F	85.0	
to 600°F	90.0	

Asphalt residue from distillation		
to 680°F, % by volume, by difference	45.0	
Tests on residue from distillation		
Penetration at 77°F, 100 gms, 5 sec	80.0	140.0
Ductility at 77°F, cms	100.0	

Cut-back asphalt of the medium curing (MC) types shall conform to AASHTO M 82.

Except when used as a penetrating prime coat, the use and storage of cut-back asphalts shall conform to NJAC 7:27-16 *et seq* which includes the following limitations:

- Shall be used only from October 15 through April 15.
- When used for repairs, shall be a cold mix, stockpile material.
- There shall be no emissions of volatile organic substances (VOS) under conditions of normal use.

904.03 Emulsified Asphalts. Emulsified asphalts of the rapid setting (RS), medium setting (MS) and slow setting (SS) types shall conform to AASHTO M 140. Cationic emulsified asphalts of the rapid setting (CRS), medium setting (CMS) and slow setting (CSS) types shall conform to AASHTO M 208.

904.04 Inverted Emulsified Asphalts. Inverted emulsified asphalt of the medium curing (IEMC) type shall be prepared using a suitable grade of medium curing cut-back asphalt conforming to Subsection 904.02, with the necessary water and emulsifier required. The inverted asphalt emulsion shall not be miscible with water in any proportion, shall remain homogeneous after 15 hours at 0 degrees F and shall conform to the following:

	IEMC-250	IEMC-800
Kinematic viscosity at 140°F (60°C), centistokes	250-500	800-1200
Settlement, 7 days, % max	1	1
Distillation, by weight		
Asphalt content, % min	65	67
Water, %	3-12	3-12
Solvent (by difference), % min	15	12
Residue from distillation		
Absolute viscosity at 140°F (60°C), poises	300-1200	300-1200
Ductility at 77°F (25°C), cm min	100	100
Solubility in trichloroethylene by weight, % min	98	98

Inverted emulsified asphalts shall contain not more than 8 percent volatile organic substances (VOS), by volume, and shall be used for mixed-in-place construction. Other limitation requirements and the use and storage of inverted emulsified asphalts shall conform to Subsection 904.02.

904.05 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

AASHTO	
T 40	Sampling Bituminous Materials
T 44	Solubility of Bituminous Materials in Organic Solvents
T 47	Loss on Heating of Oil and Asphaltic Compounds
T 48	Flash and Fire Points by Cleveland Open Cup
T 49	Penetration of Bituminous Materials
T 51	Ductility of Bituminous Materials

T 53	Softening Point of Asphalt (Bitumen) and Tar in Ethylene Glycol (Ring and Ball)
T 55	Water in Petroleum Products and Bituminous Materials by Distillation
T 59	Testing Emulsified Asphalt
T 78	Distillation of Cut-Back Asphaltic (Bituminous) Products
T 111	Inorganic Matter or Ash
T 179	Effect of Heat and Air on Asphalt Materials (Thin-Film Oven Test)
T 201	Kinematic Viscosity of Asphalts
T 202	Viscosity of Asphalts by Vacuum Capillary Viscometer
NJDOT	
B-1	Determination of Asphalt Content of Inverted Emulsified Asphalt.

904.06 Temperature-Volume Correction Factors. Temperature-volume correction factors which shall be used to convert the volume of bituminous materials, measured at the temperature at the point of use, to the volume at 60 degrees F are found in the following tables:

904.06

Table 904-1 Temperature-Volume Correction Factors for Bituminous Materials

Asphalt Cement, all Grades.
Cut-Back Asphalt, Grades RC-800, RC-3000, MC-800, MC-3000.
Inverted Emulsified Asphalt, Grade IEMC-800.

Temp	Factor	Temp	Factor	Temp	Factor	Temp	Factor
40	1.0070	85	0.9913	130	0.9758	175	0.9604
41	1.0067	86	0.9909	131	0.9754	176	0.9601
42	1.0063	87	0.9906	132	0.9751	177	0.9597
43	1.0060	88	0.9902	133	0.9747	178	0.9594
44	1.0056	89	0.9899	134	0.9744	179	0.9590
45	1.0053	90	0.9896	135	0.9740	180	0.9587
46	1.0049	91	0.9892	136	0.9737	181	0.9584
47	1.0046	92	0.9889	137	0.9734	182	0.9580
48	1.0042	93	0.9885	138	0.9730	183	0.9577
49	1.0038	94	0.9882	139	0.9727	184	0.9574
50	1.0035	95	0.9878	140	0.9723	185	0.9570
51	1.0031	96	0.9875	141	0.9720	186	0.9567
52	1.0028	97	0.9871	142	0.9716	187	0.9563
53	1.0024	98	0.9868	143	0.9713	188	0.9560
54	1.0021	99	0.9864	144	0.9710	189	0.9557
55	1.0017	100	0.9861	145	0.9706	190	0.9553
56	1.0014	101	0.9857	146	0.9703	191	0.9550
57	1.0010	102	0.9854	147	0.9699	192	0.9547
58	1.0007	103	0.9851	148	0.9696	193	0.9543
59	1.0003	104	0.9847	149	0.9693	194	0.9540
60	1.0000	105	0.9844	150	0.9689	195	0.9536
61	0.9997	106	0.9840	151	0.9686	196	0.9533
62	0.9993	107	0.9837	152	0.9682	197	0.9530
63	0.9990	108	0.9833	153	0.9679	198	0.9526
64	0.9986	109	0.9830	154	0.9675	199	0.9523
65	0.9983	110	0.9826	155	0.9672	200	0.9520
66	0.9979	111	0.9823	156	0.9669	201	0.9516
67	0.9976	112	0.9819	157	0.9665	202	0.9513
68	0.9972	113	0.9816	158	0.9662	203	0.9509
69	0.9969	114	0.9813	159	0.9658	204	0.9506
70	0.9965	115	0.9809	160	0.9655	205	0.9503
71	0.9962	116	0.9806	161	0.9652	206	0.9499
72	0.9958	117	0.9802	162	0.9648	207	0.9496
73	0.9955	118	0.9799	163	0.9645	208	0.9493
74	0.9951	119	0.9795	164	0.9641	209	0.9489
75	0.9948	120	0.9792	165	0.9638	210	0.9486
76	0.9944	121	0.9788	166	0.9635	211	0.9483
77	0.9941	122	0.9785	167	0.9631	212	0.9479
78	0.9937	123	0.9782	168	0.9628	213	0.9476
79	0.9934	124	0.9778	169	0.9624	214	0.9472
80	0.9930	125	0.9775	170	0.9621	215	0.9469
81	0.9927	126	0.9771	171	0.9618	216	0.9466
82	0.9923	127	0.9768	172	0.9614	217	0.9462
83	0.9920	128	0.9764	173	0.9611	218	0.9459
84	0.9916	129	0.9761	174	0.9607	219	0.9456

Table 904-1 (continued)

Temp	Factor	Temp	Factor	Temp	Factor	Temp	Factor
220	0.9452	265	0.9302	310	0.9154	355	0.9008
221	0.9449	266	0.9299	311	0.9151	356	0.9005
222	0.9446	267	0.9296	312	0.9148	357	0.9002
223	0.9442	268	0.9293	313	0.9145	358	0.8998
224	0.9439	269	0.9289	314	0.9141	359	0.8995
225	0.9436	270	0.9286	315	0.9138	360	0.8992
226	0.9432	271	0.9283	316	0.9135	361	0.8989
227	0.9429	272	0.9279	317	0.9132	362	0.8986
228	0.9426	273	0.9276	318	0.9128	363	0.8982
229	0.9422	274	0.9273	319	0.9125	364	0.8979
230	0.9419	275	0.9269	320	0.9122	365	0.8976
231	0.9416	276	0.9266	321	0.9118	366	0.8973
232	0.9412	277	0.9263	322	0.9115	367	0.8969
233	0.9409	278	0.9259	323	0.9112	368	0.8966
234	0.9405	279	0.9256	324	0.9109	369	0.8963
235	0.9402	280	0.9253	325	0.9105	370	0.8960
236	0.9399	281	0.9250	326	0.9102	371	0.8957
237	0.9395	282	0.9246	327	0.9099	372	0.8953
238	0.9392	283	0.9243	328	0.9096	373	0.8950
239	0.9389	284	0.9240	329	0.9092	374	0.8947
240	0.9385	285	0.9236	330	0.9089	375	0.8944
241	0.9382	286	0.9233	331	0.9086	376	0.8941
242	0.9379	287	0.9230	332	0.9083	377	0.8937
243	0.9375	288	0.9227	333	0.9079	378	0.8934
244	0.9372	289	0.9223	334	0.9076	379	0.8931
245	0.9369	290	0.9220	335	0.9073	380	0.8928
246	0.9365	291	0.9217	336	0.9070	381	0.8924
247	0.9362	292	0.9213	337	0.9066	382	0.8921
248	0.9359	293	0.9210	338	0.9063	383	0.8918
249	0.9356	294	0.9207	339	0.9060	384	0.8915
250	0.9352	295	0.9204	340	0.9057	385	0.8912
251	0.9349	296	0.9200	341	0.9053	386	0.8908
252	0.9346	297	0.9197	342	0.9050	387	0.8905
253	0.9342	298	0.9194	343	0.9047	388	0.8902
254	0.9339	299	0.9190	344	0.9044	389	0.8899
255	0.9336	300	0.9187	345	0.9040	390	0.8896
256	0.9332	301	0.9184	346	0.9037	391	0.8892
257	0.9329	302	0.9181	347	0.9034	392	0.8889
258	0.9326	303	0.9177	348	0.9031	393	0.8886
259	0.9322	304	0.9174	349	0.9028	394	0.8883
260	0.9319	305	0.9171	350	0.9024	395	0.8880
261	0.9316	306	0.9167	351	0.9021	396	0.8876
262	0.9312	307	0.9164	352	0.9018	397	0.8873
263	0.9309	308	0.9161	353	0.9015	398	0.8870
264	0.9306	309	0.9158	354	0.9011	399	0.8867
						400	0.8864

Table 904-2 Temperature-Volume Correction Factors for Bituminous Materials

Cut-Back Asphalt, Grades RC-T, RC-70, RC-250, MC-30, MC-70, MC-250.
Inverted Emulsified Asphalt, Grade IEMC-250.

Temp	Factor	Temp	Factor	Temp	Factor	Temp	Factor
40	1.0080	85	0.9901	130	0.9725	175	0.9551
41	1.0076	86	0.9897	131	0.9721	176	0.9547
42	1.0072	87	0.9893	132	0.9717	177	0.9543
43	1.0068	88	0.9889	133	0.9713	178	0.9539
44	1.0064	89	0.9885	134	0.9709	179	0.9536
45	1.0060	90	0.9881	135	0.9705	180	0.9532
46	1.0056	91	0.9877	136	0.9701	181	0.9528
47	1.0052	92	0.9873	137	0.9697	182	0.9524
48	1.0048	93	0.9869	138	0.9693	183	0.9520
49	1.0044	94	0.9865	139	0.9690	184	0.9517
50	1.0040	95	0.9861	140	0.9686	185	0.9513
51	1.0036	96	0.9857	141	0.9682	186	0.9509
52	1.0032	97	0.9854	142	0.9678	187	0.9505
53	1.0028	98	0.9850	143	0.9674	188	0.9501
54	1.0024	99	0.9846	144	0.9670	189	0.9498
55	1.0020	100	0.9842	145	0.9666	190	0.9494
56	1.0016	101	0.9838	146	0.9662	191	0.9490
57	1.0012	102	0.9834	147	0.9659	192	0.9486
58	1.0008	103	0.9830	148	0.9655	193	0.9482
59	1.0004	104	0.9826	149	0.9651	194	0.9478
60	1.0000	105	0.9822	150	0.9647	195	0.9475
61	0.9996	106	0.9818	151	0.9643	196	0.9471
62	0.9992	107	0.9814	152	0.9639	197	0.9467
63	0.9988	108	0.9810	153	0.9635	198	0.9463
64	0.9984	109	0.9806	154	0.9632	199	0.9460
65	0.9980	110	0.9803	155	0.9628	200	0.9456
66	0.9976	111	0.9799	156	0.9624	201	0.9452
67	0.9972	112	0.9795	157	0.9620	202	0.9448
68	0.9968	113	0.9791	158	0.9616	203	0.9444
69	0.9964	114	0.9787	159	0.9612	204	0.9441
70	0.9960	115	0.9783	160	0.9609	205	0.9437
71	0.9956	116	0.9779	161	0.9605	206	0.9433
72	0.9952	117	0.9775	162	0.9601	207	0.9429
73	0.9948	118	0.9771	163	0.9597	208	0.9425
74	0.9944	119	0.9767	164	0.9593	209	0.9422
75	0.9940	120	0.9763	165	0.9589	210	0.9418
76	0.9936	121	0.9760	166	0.9585	211	0.9414
77	0.9932	122	0.9756	167	0.9582	212	0.9410
78	0.9929	123	0.9752	168	0.9578	213	0.9407
79	0.9925	124	0.9748	169	0.9574	214	0.9403
80	0.9921	125	0.9744	170	0.9570	215	0.9399
81	0.9917	126	0.9740	171	0.9566	216	0.9395
82	0.9913	127	0.9736	172	0.9562	217	0.9391
83	0.9909	128	0.9732	173	0.9559	218	0.9388
84	0.9905	129	0.9728	174	0.9555	219	0.9384

Table 904-2 (Continued)

Temp	Factor	Temp	Factor	Temp	Factor	Temp	Factor
220	0.9380	265	0.9212	310	0.9047	355	0.8884
221	0.9376	266	0.9208	311	0.9043	356	0.8881
222	0.9373	267	0.9205	312	0.9039	357	0.8877
223	0.9369	268	0.9201	313	0.9036	358	0.8873
224	0.9365	269	0.9197	314	0.9032	359	0.8870
225	0.9361	270	0.9194	315	0.9029	360	0.8866
226	0.9358	271	0.9190	316	0.9025	361	0.8863
227	0.9354	272	0.9186	317	0.9021	362	0.8859
228	0.9350	273	0.9182	318	0.9018	363	0.8856
229	0.9346	274	0.9179	319	0.9014	364	0.8852
230	0.9343	275	0.9175	320	0.9010	365	0.8848
231	0.9339	276	0.9171	321	0.9007	366	0.8845
232	0.9335	277	0.9168	322	0.9003	367	0.8841
233	0.9331	278	0.9164	323	0.9000	368	0.8838
234	0.9328	279	0.9160	324	0.8996	369	0.8834
235	0.9324	280	0.9157	325	0.8992	370	0.8831
236	0.9320	281	0.9153	326	0.8989	371	0.8827
237	0.9316	282	0.9149	327	0.8985	372	0.8823
238	0.9313	283	0.9146	328	0.8981	373	0.8820
239	0.9309	284	0.9142	329	0.8978	374	0.8816
240	0.9305	285	0.9138	330	0.8974	375	0.8813
241	0.9301	286	0.9135	331	0.8971	376	0.8809
242	0.9298	287	0.9131	332	0.8967	377	0.8806
243	0.9294	288	0.9127	333	0.8963	378	0.8802
244	0.9290	289	0.9124	334	0.8960	379	0.8799
245	0.9286	290	0.9120	335	0.8956	380	0.8795
246	0.9283	291	0.9116	336	0.8952	381	0.8792
247	0.9279	292	0.9113	337	0.8949	382	0.8788
248	0.9275	293	0.9109	338	0.8945	383	0.8784
249	0.9272	294	0.9105	339	0.8942	384	0.8781
250	0.9268	295	0.9102	340	0.8938	385	0.8777
251	0.9264	296	0.9098	341	0.8934	386	0.8774
252	0.9260	297	0.9094	342	0.8931	387	0.8770
253	0.9257	298	0.9091	343	0.8927	388	0.8767
254	0.9253	299	0.9087	344	0.8924	389	0.8763
255	0.9249	300	0.9083	345	0.8920	390	0.8760
256	0.9245	301	0.9080	346	0.8916	391	0.8756
257	0.9242	302	0.9076	347	0.8913	392	0.8753
258	0.9238	303	0.9072	348	0.8909	393	0.8749
259	0.9234	304	0.9069	349	0.8906	394	0.8746
260	0.9231	305	0.9065	350	0.8902	395	0.8742
261	0.9227	306	0.9061	351	0.8899	396	0.8738
262	0.9223	307	0.9058	352	0.8895	397	0.8735
263	0.9219	308	0.9054	353	0.8891	398	0.8731
264	0.9216	309	0.9050	354	0.8888	399	0.8728
						400	0.8724

904.06

Table 904-3 Temperature-Volume Correction Factors for Bituminous Materials

Emulsified Asphalt, all Grades

Temp	Factor	Temp	Factor	Temp	Factor	Temp	Factor
40	1.0050	75	0.9963	110	0.9876	145	0.9792
41	1.0048	76	0.9960	111	0.9874	146	0.9790
42	1.0045	77	0.9958	112	0.9872	147	0.9787
43	1.0043	78	0.9955	113	0.9869	148	0.9785
44	1.0040	79	0.9953	114	0.9867	149	0.9782
45	1.0038	80	0.9950	115	0.9864	150	0.9780
46	1.0035	81	0.9948	116	0.9862	151	0.9778
47	1.0033	82	0.9945	117	0.9860	152	0.9775
48	1.0030	83	0.9943	118	0.9857	153	0.9773
49	1.0028	84	0.9940	119	0.9855	154	0.9770
50	1.0025	85	0.9938	120	0.9852	155	0.9768
51	1.0023	86	0.9935	121	0.9850	156	0.9766
52	1.0020	87	0.9933	122	0.9847	157	0.9763
53	1.0018	88	0.9930	123	0.9845	158	0.9761
54	1.0015	89	0.9928	124	0.9843	159	0.9758
55	1.0013	90	0.9925	125	0.9840	160	0.9756
56	1.0010	91	0.9923	126	0.9838	161	0.9754
57	1.0008	92	0.9920	127	0.9835	162	0.9751
58	1.0005	93	0.9918	128	0.9833	163	0.9749
59	1.0003	94	0.9915	129	0.9830	164	0.9747
60	1.0000	95	0.9913	130	0.9828	165	0.9744
61	0.9998	96	0.9910	131	0.9826	166	0.9742
62	0.9995	97	0.9908	132	0.9823	167	0.9739
63	0.9993	98	0.9905	133	0.9821	168	0.9737
64	0.9990	99	0.9903	134	0.9818	169	0.9735
65	0.9988	100	0.9901	135	0.9816	170	0.9732
66	0.9985	101	0.9899	136	0.9814	171	0.9730
67	0.9983	102	0.9896	137	0.9811	172	0.9728
68	0.9980	103	0.9884	138	0.9809	173	0.9725
69	0.9978	104	0.9891	139	0.9806	174	0.9723
70	0.9975	105	0.9889	140	0.9804	175	0.9721
71	0.9973	106	0.9886	141	0.9802	176	0.9718
72	0.9970	107	0.9884	142	0.9799	177	0.9716
73	0.9968	108	0.9881	143	0.9797	178	0.9713
74	0.9965	109	0.9879	144	0.9794	179	0.9711

SECTION 905 -
CONCRETE ADMIXTURES AND CURING MATERIALS

905.01 Air-Entraining Admixtures. Air-entraining admixtures for portland cement concrete shall conform to AASHTO M 154 except that the tests for bleeding and volume change will not be required.

Before the admixture is approved for use, the test results and certification shall be furnished in accordance with Subsection 905.02.

The Department will test for uniformity through the use of infrared spectrophotometry, pH values, specific gravity and solids content.

All bulk storage tanks shall be inside a heated area with an ambient temperature of not less than 32 degrees F. Air-entraining admixture that has been allowed to freeze shall not be reused until agitated and retested.

905.02 Chemical Admixtures. Chemical admixtures for portland cement concrete shall conform to AASHTO M 194 except that the use of such admixtures shall not introduce more than 1 percent of air entrainment. Chlorides shall not be added in the admixture for prestressed concrete.

The chemical admixtures shall be the following types:

Type A - Water-reducing admixtures
Type B - Retarding admixtures
Type D - Water-reducing and retarding admixtures

Before the admixture is approved for use, the results of tests conducted by a testing agency, which is inspected at regular intervals by the Cement and Concrete Reference Laboratory shall be submitted and verified by the Department. Certification may be required periodically from the manufacturer stating that the material is identical with that originally approved and has in no way been changed or altered.

The Department will test for uniformity through the use of infrared spectrophotometry, pH values, specific gravity and solids content.

Chemical admixtures that have been allowed to freeze shall not be reused until agitated and retested.

905.03 Curing Materials. Curing materials for portland cement concrete shall conform to the following:

- Burlap cloth made from jute or kenaf shall conform to AASHTO M 182, Class 4.
- Liquid membrane-forming compounds shall conform to AASHTO M 148, Type 1-D, clear or translucent with fugitive dye, or Type 2, white pigmentec.
- White polyethylene sheeting shall conform to AASHTO M 171 for white opaque polyethylene film.
- White burlap-polyethylene sheeting shall conform to AASHTO M 171.
- Waterproof paper shall conform to AASHTO M 171.
- Hay or straw shall conform to Subsection 919.13 and when used for insulation in cold weather, it shall be dry and shall not be reused unless otherwise approved.

905.04 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Admixtures:	
Air-entraining	1 gallon from each source

Chemical	1 gallon from each source
Curing Materials:	
Burlap	1 square yard from each source
Liquid Compound	1 quart from each lot
Polyethylene Sheeting	1 foot strip (cut across full width) from each source
Waterproof Paper	1 foot strip (cut across full width) from each source

905.05 Certification of Compliance. Manufacturer's certification for polyethylene sheeting shall be submitted in accordance with Subsection 106.04.

SECTION 906 - ELECTRICAL MATERIALS

906.01 Anchor Bolts. Anchor bolts shall conform to ASTM A 576 and the top 6 inches shall be galvanized in accordance with ASTM A 153.

906.02 Bonding and Grounding Materials.

Bushings for rigid metallic conduit with a diameter of 1 inch or more shall be constructed of hot-dipped galvanized or electro-galvanized malleable iron, with a bakelite, nylon or some type of heat-resistant plastic, molded and locked into the bushing. The lug shall be constructed of aluminum, bronze, copper or other corrosion-resistant metal. The set screws, lug mounting and binding screws shall be stainless steel. Threadless bushings may be utilized at specific locations, where the conduit is not threaded.

Insulating bushings for rigid metallic conduit with a diameter of less than 1 inch shall be constructed of molded high-impact thermoset plastic with a high dielectric and mechanical strength. The conduit shall be bonded with bonding locknuts.

Bushings made of materials which support combustion shall not be used.

Ground wire may be bare or insulated. The conductor shall be seven strand, soft-drawn copper conforming to ASTM B 8. Bare conductors shall be tinned. Insulated conductors shall be covered with an insulation that meets or exceeds the requirements of UL Type THW.

Ground rods shall be 5/8 inch in diameter and 12 feet long, composed of steel core with copper covering, thoroughly welded so that an interlocking crystalline union is secured between the two metals. The minimum thickness of the copper on the cylindrical portion of the rod shall average not less than 0.010 inch.

906.03 Cable and Wire. The manufacturer shall furnish the Engineer and the Contractor all splicing and terminating information necessary for proper installation of the cables and wires.

All conductors shall be of stranded copper and they shall conform to the standard rules of the American Institute of Electrical Engineers and of the National Board of Fire Underwriters. No conductors shall be smaller than No. 14 American wire or Brown and Sharpe gauge.

All conductors shall be soft annealed copper wire in accordance with ASTM B 3 for tin-coated conductors or ASTM B 189 for lead-coated or lead-alloy-coated conductors.

All conductors shall have Class B concentric stranding.

906.04 Cable Connectors. Cable connectors shall be fused for use on line wires and nonfused on neutral wires. The connectors shall be a waterproof inline type connector and shall be composed of a line side and a load side housing, each made of water-resistant synthetic rubber. Each housing shall include a section to form a watertight seal around the cable, an interior arrangement to receive and retain the copper fuse contacts, and a watertight seal section at the point of disconnection.

The contacts shall be spring loaded, designed for a maximum current of 30 amperes at 600 volts and shall have a 90 percent minimum conductivity. The contacts shall be suitable for gripping a cartridge-type midget fuse. The fuse shall be 13/32 inch in diameter and 1 1/2 inches in length and shall be rated at 5 amperes. The contacts shall be fully annealed and compressed onto the cable. The cable diameter shall determine the size of each housing. Each side of the housing shall be permanently marked load side or line side.

906.05 Cable Racks. Cable racks shall be a molded polycarbonate cable rack. The cable rack shall have a dielectric strength of less than 2 microamps at 100,000 volts. The polycarbonate used in the construction of the rack shall be fire retardant with an SE-1 rating. The cable rack shall be 3 inches wide and 36 inches long in ground installed junction boxes or 12 inches in structures. The cable rack shall contain three saddle arms with a capacity of 2 inches.

As an alternative, steel cable racks may be used and shall consist of a steel channel, welded steel supports, a clip, and porcelain insulator for each support. All steel components shall be hot-dipped galvanized. The cable rack shall be approximately 24 inches long in ground installed boxes with three supports and 7 inches long in junction boxes located on structures with one support. Support holes on the channel shall be spaced approximately 1 1/2 inch on centers. The cable supports shall be designed with an interlocking feature at the rear of the support to prevent tilting and, when installed, to extend approximately 4 inches from the rack. The porcelain insulator required on each support shall be constructed with a hook bottom groove to prevent slipping.

906.06 Cast Boxes and Fittings. Cast boxes shall be provided with suitable cover of like material held in place with stainless steel fasteners and sealed with a weatherproof neoprene gasket.

Cast boxes shall be provided with mounting lugs. All mounting hardware shall be stainless steel. Cast iron boxes shall conform to Subsection 917.03. All surfaces of cast iron boxes and covers shall be hot-dip galvanized.

Aluminum boxes and covers shall conform to Subsection 911.01.

Junction boxes for underdeck lighting shall be cast iron of approved design, suited and adapted to the specific location and the number of conduits, nipples, etc. connected thereto. Boxes shall be flush-type when installed in a structure or surface-mounted-type in all surface applications. The cover shall have a neoprene gasket and shall be secured with stainless steel screws. Where required, the box shall have busses to provide at least five full threads or a UL-approved watertight rigid conduit hub at each entry point of the conduit.

Pull boxes and pull fittings exposed on sign structures shall be cast aluminum. Boxes shall be of approved design, suited and adapted to the specific location and the number and arrangement of conduits, etc. connecting herewith. Boxes shall have external lugs for mounting and internal mounting buttons for mounting equipment.

906.07 Conduits and Fittings. Conduits and fittings exposed on sign structures shall be aluminum conduit conforming to standards for rigid metallic conduit of the Underwriters Laboratories, Inc. Fittings and accessories for aluminum conduit shall be made of aluminum or stainless steel.

Conduits and fittings used as a raceway for the installation of wires and cables shall conform to the following:

(a) Rigid Nonmetallic Conduit. Rigid nonmetallic conduit shall be polyvinyl chloride conduit and shall be made from virgin polyvinyl resins conforming to ASTM D 1784, Type 1, Grade 1. The conduit shall exceed all the property requirements including impact strength, chemical resistance and flammability as listed in UL 651 and NEMA TC 2. The rigid nonmetallic conduit shall be Type II, Schedule 40 suitable for direct burial. Fittings shall also be made from high-impact polyvinyl chloride. They shall be of the socket type and be joined to the conduit using polyvinyl chloride solvent cement. Fittings including couplings shall conform to NEMA TC 3.

Solvent cement used for joining polyvinyl chloride conduit shall be a heavy-bodied cement complying with ASTM D 2564 and shall be applied with a natural bristle or nylon brush.

(b) Rigid Metallic Conduit. Rigid metallic conduit and fittings shall be steel and shall conform to UL 6, ASA C-80.1, Federal Specification W-W-C-581.

Steel conduit shall be manufactured from a milled steel tubing with a wall thickness similar to Schedule 40 pipe. The conduit shall be hot-dipped galvanized inside and out, throughout its entire length, including the threads. Minimum weight of galvanized coating shall be one ounce per square foot. The couplings supplied shall be electro-galvanized.

Manufactured rigid metalic conduit sweep elbows shall conform to UL 6 and to Subsection 906.02.

Aluminum conduit and fittings shall be fabricated from a copper-free, corrosion-resistant aluminum alloy, conforming to Federal Specification W-W-C-540, ASTM B 429, ASME Specification SB-241 and Subsection 911.01.

(c) Flexible Metal Conduit. Flexible metal conduit shall consist of a spirally wound metal core covered with a polyvinyl chloride jacket. It shall be manufactured in accordance with Federal Specification W-W-C-566, and shall comply with the National Electrical Code for liquidtight, flexible, metal conduit. Associated fittings shall be of like material and provide positive grounding and a liquidtight seal. Flexible metal conduit shall have a steel core.

Flexible metal conduit for use on sign structures shall have an aluminum core with a neoprene jacket.

906.08 Electrical Tape.

Friction tape shall be the self-sticking, rubber-impregnated, woven cotton fabric type.

Insulating tape shall be self-bonding and designed for use with cross-linked polyethylene or rubber-insulated wire and cable. When installed, it shall provide a permanent electrical and watertight seal.

Jacket tape shall be a conformable vinyl, plastic electrical tape which is flame retardant, water resistant and cold weather pliable. It shall be heavy duty with a minimum tensile strength of 20 pounds per inch, a minimum adhesion of 20 ounces per inch and a minimum thickness of 8.5 mils.

906.09 Lamps.

(a) Traffic Signal. Traffic signal lamps shall be 120/125 volts and clear. The 135 watt lamp shall be rated for 6000 hours of life and the 60 watt lamp shall be rated for 8000 hours of life. The lamps shall meet or exceed the beam candlepower requirements of the Institute of Transportation Engineers signal lamp standard. The lamps shall also comply with the following:

Indication Size	*Wattage*	*Rated Initial Lumens*	*Center Length*
8 inch	60	595	2 7/16 inches
12 inch	135	1750	3 inches
Pedestrian	60	595	2 7/16 inches

(b) *Highway Lighting.* High pressure sodium lamps shall have electrical, physical and photometric characteristics that conform to ANSI Standards. The lamps shall also be rated for 24,000 hours of average life (based on 10 hours per start) and be equipped with borosilicate glass, have a mogul base, a universal burning position and shall be of the following ANSI designation, initial lumen rating and nominal lamp voltage:

Designation	*Wattage*	*Lumens*	*Voltage*
S55	150	16,000	55
S50	250	27,500	100
S51	400	50,000	100

Mercury vapor lamps shall have electrical, physical and photometric characteristics that conform to ANSI Standards. The lamps shall also be rated for 24,000 hours of average life (based on 10 hours per start), and be equipped with borosilicate glass, have a mogul base, a universal burning position and shall be of the following ANSI designation, initial lumen rating in vertical burning position:

Designation	*Wattage*	*Lumens*
H37-5KC/W	250	11,400
H33-1GL/W	400	22,000

(c) *Sign Lighting.* Lamps for sign luminaires shall be 250 watt, phosphor-coated mercury lamps conforming to ANSI H 37-KC-R250/DX.

906.10 Loop Detector Lead. Loop detector lead shall conform to Subsection 906.03 and to the Bureau of Electrical Engineering Specification EB-LDL. Only one type of loop detector lead will be permitted on the Project.

906.11 Loop Wire. The loop wire shall be single conductor conforming to UL 44 for Type XHHW insulation.

The loop wire shall be a thermoplastic single conductor wire with a 1/4-inch PVC tube or 1/4-inch, high-density, polyethylene tube extruded over the loop detector wire and shall be manufactured in conformance with ICEA Publication No. S-61-402/NEMA Publication No. WC5, and shall conform to the following:

- The conductor shall be No. 14 AWG soft-drawn copper wire with 19 wire (Class C) stranding or 7 wire (Class B) stranding conforming to ASTM B 3 and ASTM B 8.
- The insulation shall conform to Underwriters' Laboratories, Inc. for type THHN/THWN or XHHW and shall be rated for 600 volts.
- The extruded polyvinyl chloride tubing shall be UL listed FR-1 rated at 105 degrees C, with a minimum wall thickness of 30 mils. It shall be chemical resistant and oil resistant with a moisture absorption of less than 1 percent. The high-density polyethylene tubing shall be UL listed with a minimum wall thickness of 30 mils.

906.12 Cabinets. Cabinets shall be aluminum alloy conforming to Subsection 911.01.

The door of all meter and control equipment cabinets, other than traffic signal cabinets, shall be labeled with a permanent reflective metallic sign indicating the voltage and the word **DANGER.** The sign shall be applied on a 0.040 inch minimum thickness aluminum alloy sheet. The lettering shall be approximately 1 1/2 inches high and shall be red on a white background. The sign shall be installed with four stainless steel vandalproof screws.

A weatherproof print of the system field wiring shall be sealed in plastic and attached to the inside of the door of each meter cabinet, control equipment and controller cabinet.

906.13 Multiple Lighting and Service Wire. Multiple lighting and service wire shall conform to Subsection 906.03 and to the following:

- Wire shall conform to IPCEA-NEMA Standards Publication for Cross-linked-thermosetting-polyethylene-insulated Wire and Cable for the Transmission and Distribution of Electric Energy, IPCEA Publication No. S-66-524 and NEMA Publication No. WC 7 and Underwriters' Laboratories Type RHW-USE.
- Insulation shall be a heat-resistant, moisture-resistant submarine compound conforming to IPCEA Publication No. S-66-524 and NEMA Publication No. WC 7 except the thickness of insulation for all conductors shall be that required for 600 volts rated circuit voltage in accordance with Table 3-1 for Cross-linked-thermosetting-polyethylene-insulated Power Cables, Column A.

906.14 Panel Boards and Circuit Breakers.

(a) Traffic Signals. Panelboards shall be single-phase, three-wire, 120/240 volt, with 70-ampere main-rated busses, conforming to Federal Specification W-P-115A, Type 1, Class 2. Circuit breakers shall be UL listed and shall comply with NEMA Standards. They shall conform to Federal Specification W-C-375B, Class 10A.

(b) Highway and Sign Lighting. Panelboard and circuit breakers shall conform to the following:

- Panelboards for 120/240 volt installations shall be single-phase, three-wire with 100 ampere main-rated busses, conforming to Federal Specification W-P-115A, Type 1, Class 1. Circuit breakers shall be UL listed and shall comply with NEMA Standards. They shall conform to Federal Specification W-C-375B for Class 10A or Class 10B.
- Panelboards for 240/480 volt installations shall be single-phase, three-wire and shall have main busses, rated as designated, and shall conform to Federal Specification W-P-115A, Type 1, Class 1. Circuit breakers shall be UL listed and shall comply with NEMA Standards. They shall conform to Federal Specification W-C-375B for Class 13B.
- Panelboards for 480 volt installations shall be the size and type indicated and shall conform to Federal Specification W-P-115A, Type 1, Class 1. Circuit breakers shall be UL listed and comply with NEMA Standards. They shall be manually-operated, molded-case units conforming to Federal Specification W-C-375B for Class 13B.

906.15 Pedestals, Poles, Transformer Bases and Mast Bracket Arms. Pedestals, poles, transformer bases and mast bracket arms for traffic signal and highway lighting shall be fabricated with materials in accordance with the appropriate ASTM Standard. The items shall also be manufactured in conformance with the AASHTO Standard

Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. All welds shall be made by welders certified as prescribed in Section IX of the ASME Boiler and Pressure Vessel Code. Copies of the certifications shall be presented upon request. The items shall be manufactured under a quality control program which conforms to the General Requirements for a Quality Program of American Society for Quality Control.

Aluminum poles, lighting, bracket arms and traffic signal mast arms shall have a rotary, sand-polish finish giving a nonreflecting outer surface. The external surfaces of the transformer bases and shoe bases shall have a satin-type finish. Steel poles and steel traffic signal arms shall be hot-dipped galvanized in accordance with ASTM A 123.

Where wire or cable passes through a hole or runs along a surface at any point through or on the complete assembly, such holes and surfaces shall be deburred and void of any sharp edges or protuberances that may in any way damage the wire or cable. Rubber grommets shall be provided and installed in the entrance hole to the shaft and mast arms where mid-mounted traffic signals are installed.

All hardware, bolts, nuts, and washers used in the installation of the aluminum traffic standards shall be stainless steel. Hardware used for steel traffic signal standards shall conform to ASTM A 675, Grade 90, and shall be galvanized in accordance with ASTM A 153. Leveling nuts shall conform to ASTM A 307.

Standards and mast bracket arms shall be tested by the manufacturer to assure compliance with specified material and strength requirements. The testing shall also assure that the items have been manufactured in conformance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. Five copies of the certification stipulating that the items meet the strength and material requirements shall be submitted.

All aluminum poles and mast bracket arms shall be factory wrapped to protect them during shipment.

Fabrication operations for aluminum alloy structures not specifically covered in these Specifications shall be in accordance with Section 10, ANSI/AWS D1.2-83 for Class 1 structures.

906.16 Photoelectric Controls. Photoelectric controls shall be rated for the control or lighting circuit voltage indicated. Mounting hardware shall be provided to allow the unit to be installed in whatever type of location is indicated and the mounting shall conform to the EEI-NEMA Standards for physical and electrical interchangeability of light sensitive control devices.

906.17 Resin Splicing Kits.

(a) Traffic Signals. Resin splicing kits shall be of a type having a soft plastic sealing packet. The resin splicing kits shall meet or exceed the conductor's insulation voltage rating.

(b) Highway Lighting. Resin splicing kits shall be of a type having a rigid molded plastic casing. The casing shall be capable of being split laterally to allow insertion of the conductors. The resin splicing kits shall meet or exceed the conductor's insulation voltage rating and be suitable for use with the insulation material.

906.18 Single Conductor Signal Wire. Single conductor signal wire shall conform to Subsection 906.03 and to the following:

- Signal wire shall conform to IPCEA-NEMA Standards Publication for Thermoplastic-insulated Wire and Cable for the Transmission and Distribution of Electrical Energy, IPCEA Publication No. S-61-402, NEMA Publication No. WC 5. All wire shall be single conductor and conform to Underwriters' Laboratories Type THW or, as an alternate, Type THWN.

  The insulation shall consist of polyvinyl chloride compound extruded concentrically over the conductor conforming to IPCEA Publication No. S-61-402, NEMA Publication No. WC 5, Part 3.8, polyvinyl chloride 75 degrees C.

All traffic signal wire shall be color coded with continuous color compound for circuit identification in conformance with IPCEA Publication No. S-61-402, NEMA Publication No. WC 5, Part 5.

906.19 Traffic Signal Cable. Traffic signal cable shall conform to Subsection 906.03 and to the Bureau of Electrical Engineering Specification EB-TS-CABLE. Only one type of traffic signal cable will be permitted on the Project.

906.20 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Electrical materials, components and assemblies	Subject to job site inspection

906.21 Certification of Compliance. Manufacturer's certification for all materials, components and assemblies shall be submitted in accordance with Subsection 106.04.

SECTION 907 - FENCE

907.01 Barbed Wire. Barbed wire shall conform to ASTM A 121.

907.02 Chain-Link Fence. Chain-link fence shall conform to AASHTO M 181 and the following:

- Carriage bolts with elastic stop nuts shall be zinc coated by the electroplating process and shall be Type RS conforming to ASTM A 164.
- Bonded-type PVC-coated fabric shall also be zinc coated with the weight as specified for extruded type.
- Gate fabric shall be the same material used in the adjacent fence.
- Gate locking devices, stops and keepers may be galvanized malleable iron or steel except plunger bars may be tubular or bar steel.
- Posts, rails, wire fabric ties, stretcher bars and railing and post sleeves for chain-link fence on bridges shall be Alloy 6061 T6.

907.03 Chain-Link Farm-Type Fence. The materials for chain-link farm-type fence shall conform to AASHTO M 181.

907.04 Snow Fence. The materials for snow fence shall conform to the following:

- Wires shall be stay-cable type, of not less than 12 1/2 gauge. All wires making up the stay-cables shall be galvanized snow fence wire.
- Wooden pickets shall be made from cedar, spruce, maple or other satisfactory species of wood and shall be unpainted. The pickets shall be free from knots greater than one half the diameter of the width of the pickets supplied.

- Posts shall be made of high carbon steel and be a flanged leg channel section or flanged leg U-bar section having a uniform thickness of metal of not less than 1/8 inch or shall be other section of equal strength. The posts shall weigh not less than 2 pounds per linear foot, exclusive of ground plate and shall be so designed that the posts can be driven easily into the ground. Each post shall be equipped with not less than eleven riveted lugs. Posts shall not be equipped with punched or welded lugs. Posts shall be galvanized.

907.05 Sampling and Testing Methods. Sampling and testing will be performed in accordance with AASHTO M 181.

907.06 Certification of Compliance. Mill certification for chain-link fence materials shall be submitted in accordance with Subsection 106.04.

SECTION 908 - JOINT MATERIALS

908.01 Preformed Expansion Joint Filler. Preformed fillers for joints shall conform to AASHTO M 33, AASHTO M 153 Type II, and AASHTO M 213 and shall be punched to admit the dowels. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely, and held accurately to shape by stapling or other positive fastening.

908.02 Joint Sealers. Hot-poured joint sealer shall conform to AASHTO M 301. Cold-applied joint sealer shall conform to ASTM D 1850.

908.03 Preformed Elastomeric Joint Sealer (Compression Type).

(a) Requirements. Sealers shall be preformed and manufactured from vulcanized elastomeric compound using polychloroprene as the only base polymer. The material shall conform to the physical properties in Tables 908-1 and 908-2 below.

Table 908-1 Tests for Identification

Properties	ASTM Test Procedure	Physical Requirements
Tensile strength, min psi (kg/cm^2)	D 412	2000 (141)
Elongation at break, min %	D 412	250
Hardness, Type A durometer (Test made with durometer in durometer stand)	D 2240	55 ± 5
Permanent set at break, max %	D 412	10
Oven or heat aging, 70 hrs/212°F	D 573	
Tensile strength, change max %		+ 10 to -20
Elongation, change max %		-20
Hardness, Type A, points change		0 to + 10
Ozone resistance 20% strain, 300 pphm in air, 70 hrs/104°F (40°C) (Wipe with solvent to remove surface contamination)	D 1149	No cracks
Oil swell, ASTM oil #3, 70 hrs/212°F, Weight change, max %	D 471	+ 45

908.03

Table 908-2 Tests for Qualification

Properties	Section 990 Test Procedure	Physical Requirements
High temperature recovery 70 hrs/212°F under Z % of nominal width	NJDOT J-2	85% min (no cracking or sticking)
Low temperature recovery 72 hrs/+14°F under 50% of nominal width	NJDOT J-2	88% min (no cracking or sticking)
Low temperature recovery 22 hrs/-20°F under 50% of nominal width	NJDOT J-2	83% min (no cracking or sticking)
Pressure deflection at 80% of nominal width and at 73°F + 2°F min contact unit pressure, psi.	NJDOT J-2	3.5

The limit of safe compressibility, an inherent characteristic of each sealer, is the borderline between closure of essentially all of the air voids and the beginning of solids compression and is indicated on the pressure-deflection curve by rapid and considerable increase of pressure.

At the limit of safe compressibility, the ratio of the sealer width to its nominal width multiplied by 100 shall be less than or equal to a value Z. Z (in percent) is the maximum permitted degree of sealer compression used in the joint sealing design and shall be calculated as follows:

$$Z\ (\text{percent}) = \frac{\text{Minimum Sealer Width}}{\text{Nominal Sealer Width}} \times 100$$

The value of Z (in percent) shall be not more than 50.

The ratio of compression sealer height to width shall never be less than 1. The accepted width and height of a sealer shall be not less than nominal; the height of a sealer may be in excess of nominal but by not more than 1/4 inch. The dimensional tolerances shall be determined on the basis of the limit of safe compressibility of sealers.

The minimal contact unit pressure at 80 percent of nominal width for all sizes of bridge sealers shall be not less than 3.5 pounds per square inch on the return side of the third successive test run or cycle of the pressure deflection test. The amounts of contact unit pressure (psi) are based on the actually measured length (6 in) and height (h) of the sealer's test sample; they shall be established on the basis of three successive test runs or cycles, performed on the compression testing machine conforming to ASTM E 4. Calculate contact unit pressure as follows:

$$\text{Unit Pressure (psi)} = \frac{\text{Total Pressure}}{\text{Actual Contact Area}} = \frac{P}{6.0 \times h}$$

If splicing of a sealer is unavoidable, the sealer at the splice point shall have no significant misalignment at its sides or top. A misalignment at the bottom not to exceed half of the bottom wall thickness will be permitted.

At the sealer's place of manufacture, each sealer splice shall be subjected to the 180 degree bend test described in Section 990, NJDOT J-2. The same test will be performed at random at stockpile locations or construction sites.

(b) *Sampling.* A lot shall consist of a quantity represented by not more than 1 day's production of each cross section and size of sealer.

Samples will be taken at random from each lot at least 3 weeks in advance of the product's delivery to the Project.

In instances of stockpiling, samples will be taken at random from every lot.

The minimum lengths of samples for testing purposes shall be in accordance with Table 908-3 below. In all tests, the material to be tested shall be furnished from standard production.

The supplier may elect to have the sealer sampled and inspected in accordance with one of the following:

- Sampling of Stockpiles. The supplier will be permitted to stockpile only upon receipt of written approval. A representative from the Department will sample each lot and size for acceptance testing and the sample will be marked for identification with the representative's seal. Shipment to the Project will be permitted only after approval. The Department shall be notified by the supplier of the lot number and quantity shipped to the Project so that an inventory can be maintained.
- At the Project Site. The Contractor shall notify the Engineer when the sealer has arrived at the Project. Shipment shall be made to allow at least 3 weeks for sampling and testing prior to the sealer being incorporated into the Project. The supplier shall ensure that each lot and size shipped includes sufficient length for testing in accordance with Table 908-3 below.
- Manufacturer's Submission. The manufacturer shall submit, for each lot and size of material, the required length, plus an extra 4 inches, for testing in accordance with Table 908-3 below. The sealer from which the sample is taken shall be marked to indicate from which end the test piece was cut. The extra 4 inches of the submitted sample is to be cut from the marked end of the sample and, after approval by the Department Laboratory, will be taken to the Project site and matched to the end of the length sent to the Project. Upon verification that the cut ends match, the material will be approved for use.

Table 908-3 Minimum Lengths of Samples for Testing

Sealer Size Width	Minimum Lengths
Less than 2"	84"
Less than 3" to 2" inclusive	66"
Less than 4" to 3" inclusive	50"
4" and larger	42"

(c) *Acceptance Testing.* The acceptance testing of the preformed elastomeric joint sealer is based on the following:

- Preformed elastomeric compression sealers shall not be installed prior to approval.
- In new construction, field splicing of sealers will not be permitted. For reconstruction projects, field splices may be permitted. In such case, splicing shall be accomplished through vulcanization or as specified below for factory bonding.

- If shop splicing of sealer is unavoidable, splicing shall be accomplished either through factory vulcanization or through cold cured factory bonding using a high-strength rapid-bonding adhesive.

(d) Certification. Manufacturer's name or trademark and lot number shall be marked on the joint sealer itself to identify each shipment and shall be accompanied by the manufacturer's certification indicating conformance to the test requirements including the value of Z (in percent) and 180 degree bend tests results. The certification shall be furnished in accordance with Subsection 106.04, except that the sample shall be submitted directly to the Department Laboratory with a copy of the certification.

908.04 Reinforced Elastomeric Expansion Dam.

(a) Scope. This specification covers the material requirements for preformed elastomeric sealing products to be utilized in bridge deck expansion joints with the base polymer being as stipulated below. The requirements for other components of an expansion dam are also provided.

(b) Elastomeric Sealer Requirements. Sealers shall be preformed and manufactured from vulcanized elastomeric compound using polychloroprene as the only base polymer. The material shall conform to the physical properties prescribed in Table 908-4 below.

Table 908-4 Tests for Identification

Properties	ASTM Test Procedure	Physical Requirements
Tensile strength, min psi (kg/cm^2)	D 412	2000 (141)
Elongation at break, min %	D 412	350
Hardness, Type A durometer (Test made with durometer in durometer stand)	D 2240	55 ± 5
Permanent set at break, max %	D 412	10
Oven or heat aging, 70 hrs/212°F	D 573	
Tensile strength, change max %		+ 10 to -20
Elongation, change max %		-20
Hardness, Type A, points change		0 to + 10
Ozone resistance 20% strain, 300 pphm in air, 70 hrs/104°F (40°C) (Wipe with solvent to remove surface contamination)	D 1149	No cracks
Oil swell, ASTM oil # 3, 70 hrs/212°F, Weight change, max %	D 471	+ 45

(c) Metal Components and Sealant. Reinforcement metal embedded in the elastomeric dam shall be steel or aluminum alloy. The sealant, which shall be furnished by the elastomeric dam manufacturer, shall conform to Federal Specification TT S 00230. Binder for the epoxy grout shall conform to Federal Specification MMM B 350A. The grout shall conform to Federal Specification MMM G 650A.

(d) *Shop Splicing.* If shop splicing of a sealer is unavoidable, the sealer at the splice point shall have no significant misalignment at its sides or top.

(e) *Sampling.* A lot shall consist of a quantity represented by not more than 1 day's production of each cross section and size of elastomeric sealer component of an expansion dam.

Samples will be taken at random from each lot at least 3 weeks in advance of the product's delivery to the Project.

In instances of stockpiling, samples will be taken at random from every lot. The minimum lengths of samples for testing purposes shall be 2 feet. In all tests, the material to be tested shall be furnished from standard production.

A 1 quart sample of sealant to be used with the expansion dam shall be submitted along with the elastomeric sealer specimens.

(f) *Acceptance Testing.* Reinforced elastomeric expansion dams shall not be installed prior to securing approval of the material from the Department Laboratory.

The acceptance testing of the preformed elastomeric sealer component is based on the following:

- Field splicing of sealers will not be permitted unless such splicing is designated.
- If splicing of sealer is so designated, splicing shall be accomplished either through vulcanization or through cold cured bonding using a high-strength rapid-bonding adhesive.

(g) *Certification.* Manufacturer's name or trademark and lot number shall be marked on the joint sealer itself to identify each shipment and shall be accompanied by the manufacturer's certification indicating conformance to the test requirements including the 180 degree bend test results.

The certification shall be furnished in accordance with Subsection 106.04 except that the samples shall be submitted directly to the Department Laboratory with a copy of the certification.

908.05 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Preformed expansion joint filler	3 foot length from each lot
Joint sealers:	
Hot-poured rubber asphalt	10 pounds from each lot
Cold-applied	1 quart from each lot
Preformed elastomeric joint sealer	In accordance with Subsection 908.03
Reinforced elastomeric expansion dam	In accordance with Subsection 908.04

908.06 Certification of Compliance. Manufacturer's certification for joint sealer shall be submitted in accordance with Subsection 106.04. Manufacturer's certification for preformed elastomeric joint sealer and for reinforced elastomeric expansion dam shall be submitted in accordance with Subsection 908.03 and 908.04.

SECTION 909 - LANDSCAPING MATERIALS

909.01 Binders. Binders for mulch shall be one of the following:

- Emulsified asphalt, Grades CSS-1, CSS-1h, SS-1 or SS-1h conforming to Subsection 904.03.
- Fiber mulch made from wood or plant fibers containing no growth- or germination-inhibiting materials.
- Synthetic plastic emulsion shall be miscible with all normally available water when diluted to any proportions. After drying, the synthetic plastic binder shall no longer be soluble or dispersible in water but shall remain tacky until the grass seed has germinated. The plastic binder shall be physiologically harmless and shall not have phytotoxic or crop-damaging properties.
- Vegetable based gels which can be classified as naturally occurring powder-based hydrophilic additives formulated to provide gels, which, when applied under curing conditions shall form membraned networks of water insoluble polymers. The vegetable gel shall be physiologically harmless and shall not have phytotoxic or crop damaging properties.

909.02 Fertilizer.

Fertilizer for establishing turf shall have a commercial designation of 10-20-10 or any 1-2-1 ratio fertilizer containing a minimum 5 percent nitrogen, 10 percent available phosphoric acid and 5 percent soluble potash.

If the fertilizer is to be applied with mechanical spreader in the dry form, a minimum of 75 percent shall pass a No. 8 sieve and a minimum of 75 percent shall be retained on a No. 16 sieve, and the maximum free moisture content shall be 2 percent.

Fertilizer for establishing sod shall be any 1-2-2 ratio fertilizer containing a minimum of 5 percent nitrogen, 10 percent available phosphoric acid and 10 percent soluble potash.

Each delivery of fertilizer shall be accompanied by a delivery slip showing the weight and a certified chemical analysis of the composition of the fertilizer.

909.03 Limestone, Pulverized. Pulverized limestone shall be composed of not less than 85 percent calcium and magnesium carbonates to not less than 40 percent calcium and magnesium oxides.

Each delivery of pulverized limestone shall be accompanied by a delivery slip indicating its weight and certified analysis of its chemical composition and gradation, including calcium and magnesium oxide equivalents, which shall be furnished at the time of delivery.

909.04 Mulch.

Straw shall be stalks of oats, wheat, rye, or barley relatively free from seeds, noxious weeds, and other foreign material.

Wood cellulose fiber shall consist of wood cellulose fibers having no growth- or germination-inhibiting materials.

Wood chips shall be produced by a wood chipping machine. Wood chips shall be hard and shall not contain leaves, twigs, branches, wood shavings, dirt, stones, clods of turf, or other foreign material or debris. Wood chips shall not exceed 3 inches in any dimension.

Selected wood chips produced from clearing operations that are reasonably in conformance with the above are acceptable.

Samples of wood chips shall be submitted for approval before delivery to the Project. Inspection of each shipment of wood chips will be made upon delivery to the Project.

Each shipment of wood chips shall be accompanied by a delivery slip which shall be furnished at the time of delivery.

Stone shall be coarse aggregate, approximately Size No. 4, conforming to Subsection 901.04. Sample shall be submitted for approval of size and color.

Gravel shall be uncrushed washed gravel, approximately Size No. 4, conforming to Subsection 901.05. Sample shall be submitted for approval of size and color.

909.05 Plant Materials. Plant materials shall be trees, shrubs, vines, seedlings, ground covers and plants of all descriptions conforming to the American Standard for Nursery Stock sponsored by the American Association of Nurseymen Inc. Hortus III shall be the authority for all plant names. They shall be healthy and vigorous, with well-developed branch and root systems, and shall be free from disfiguring knots and gall, sun scald injuries, bark abrasions and other objectionable disfigurements. Plant materials that are weak and thin or which have been cut back from larger grades to meet certain specified requirements, will not be accepted. All plant materials shall conform to State and Federal laws relating to inspection for diseases and infestation, and inspection certificates shall be filed with the Engineer. Substitute varieties of plants may be permitted.

(a) Ball Sizes for Nursery Grown Trees and Shrubs. The ball sizes of nursery grown trees and shrubs shall be as shown in the following tables:

Shade Trees

Caliper (Inches)	*Minimum Diameter (Inches)*
1/2 - 3/4	12
3/4 -1	14
1-1 1/4	16
1 1/4 -1 1/2	18
1 1/2 -1 3/4	20
1 3/4 -2	22
2-2 1/2	24
2 1/2 -3	28
3-3 1/2	32
3 1/2 -4	38
4-4 1/2	42
4 1/2 -5	48
5-5 1/2	54

Deciduous Shrubs

Height (Feet)	*Minimum Diameter (Inches)*
1-1 1/2	8
1 1/2 -2	9
2-3	10
3-4	12
4-5	14
5-6	16
6-7	18
7-8	20
8-9	22
9-10	24
10-11	26

909.05

Small Trees

Height (Feet)	*Minimum Diameter (Inches)*	*Caliper (Inches)*	*Minimum Diameter (Inches)*
2-3	10	3/4 -1	16
3-4	12	1-1 1/2	18
4-5	14	1 1/2 -1 3/4	20
5-6	16	1 3/4 -2	22
		2-2 1/2	24
		2 1/2 -3	28
		3-3 1/2	32
		3 1/2 -4	38
		4-4 1/2	42
		4 1/2 -5	48
		5-5 1/2	54

Columnar Conifers

Regular Growing Type

Height (Feet)	*Minimum Diameter (Inches)*
1 1/2 -2	10
2-3	12
3-4	13
4-5	14
5-6	16
6-7	18
7-8	20
8-9	22
9-10	24
10-12	27
12-14	30
14-16	33
16-18	36
18-20	40

Rapid Growing Type

Height (Feet)	*Minimum Diameter (Inches)*
1 1/2 -2	8
2-3	9
3-4	11
4-5	12
5-6	14

Conifers

Spreading, Semi-spreading and Globe or Dwarf Type		Cone and Broad Upright Type	
Spread (Feet)	*Minimum Diameter (Inches)*	*Height (Feet)*	*Minimum Diameter (Inches)*
1 1/2 -2	10	1 1/2 -2	10
2-2 1/2	12	2-3	12
2 1/2 -3	14	3-4	14
3-3 1/2	16	4-5	16
3 1/2 -4	18	5-6	20
4-5	21	6-7	22
5-6	24	7-8	24
6-7	28	8-9	27
7-8	32	9-10	30
8-9	36	10-12	34
		12-14	38
		14-16	42
		16-18	46
		18-20	50

Broadleaf Evergreens

Spreading, Semi-spreading and Globe or Dwarf Type		Cone and Broad Upright Type	
Spread (Feet)	*Diameter (Inches)*	*Height (Feet)*	*Minimum Diameter (Inches)*
1 1/2 -2	10	1 1/2 -2	10
2-2 1/2	12	2-3	12
2 1/2 -3	14	3-4	14
3-3 1/2	16	4-5	16
3 1/2 -4	18	5-6	20
4-4 1/2	21	6-7	22
		7-8	24
		8-9	27
		9-10	30
		10-12	34
		12-14	38
		14-16	42
		16-18	46
		18-20	50

(b) *Ball Sizes for Collected Trees and Shrubs.* The ball sizes of collected trees and shrubs shall be equal to that specified for the next larger size for nursery grown trees and shrubs.

All trees, grown in plantations or reforestation plantations, or trees that have been grown without the benefit of root pruning, shall be considered collected material and shall be balled accordingly.

(c) *Ball Depths.* Balls shall be of sufficient depth to encompass the fibrous and feeding root system necessary for the full recovery of the plant and shall conform to the following requirements:

Diameter of ball, inches	Up to 20	Over 20 to 30	Over 30 to 48
Minimum depth of ball, percentage of diameter	75	67	60

These dimensions may vary according to site and type of plant material as provided in the American Standard for Nursery Stock.

(d) *Collected Plant Material.* Collected or salvaged plant material shall be confined to specific items as indicated.

(e) *Inspection.* Plant materials may be inspected where they are growing. Certain items selected shall be marked with a seal furnished by the Engineer. The plant materials will be inspected upon arrival at the site of the Project. Notice shall be given not less than 24 hours before the material is to be on the Project. Materials arriving with broken seals, broken or loose balls, insufficient protection, or which have been damaged in transit will not be accepted. Random inspection of the root system of the plant material may be made by the Engineer by breaking open the earth balls. Necessary assistance shall be given when inspections are made.

(f) *Shipment.* All bare root materials shall be completely dormant when they are dug. Immediately before shipment, plant materials shall be dug with care to prevent injury to fibrous roots. Plant material marked B&B shall be balled and burlapped.

The following plant material shall be drum laced or machine dug with wire baskets:

Shade trees - 1 1/4 inch caliper and larger
Small trees - 1 1/2 inch caliper and larger
Columnar conifers - 6 feet and taller
Spreading, semi-spreading, and globe or dwarf type conifers - 3 1/2 feet in diameter and larger
Cone and broad upright type conifers - 5 feet and taller
Spreading, semi-spreading, and globe or dwarf type broadleaf evergreens - 3 1/2 feet spread and larger
Cone and broad upright type broadleaf evergreens - 5 feet and taller

Materials used for burlapping and tying shall be biodegradable. Nonbiodegradable materials such as plastic or nylon shall not be used.

Material which is shipped in open vehicles shall be thoroughly protected from drying out due to exposure to the wind and sun. Material shipped in enclosed vans or boxcars shall be adequately ventilated. Each shipment shall be accompanied by an invoice giving the date and origin of shipment, the botanical names, sizes, grades and quantities of plants. A copy of the invoice shall be furnished at the time of delivery.

909.06 Seed Mixtures.

(a) Grass seed mixtures shall be as follows:

Type A Grass Seed Mixture

Kind of Seed	Minimum Purity, Percent	Minimum Germination, Percent	Percent of Total Weight of Mixture
Kentucky Bluegrass	85	75	20
Red Fescues (Creeping or Chewings)	95	80	35
Kentucky 31	95	80	20
Redtop	92	85	10
Perennial Ryegrass	98	85	10
White Clover	97	90	5

Type A-3 Grass Seed Mixture

Kind of Seed	Minimum Purity, Percent	Minimum Germination, Percent	Percent of Total Weight of Mixture
Tall Fescue (Rebel or Falcon)	95	80	60
Kentucky Bluegrass (Kenblue, South Dakota or Park)	85	75	10
Chewings Fescue (Highlight or Jamestown)	95	85	20
Perennial Ryegrass (Linn)	98	85	10

Type A-4 Grass Seed Mixture

Kind of Seed	Cultivar	Percent of Total Weight of Mixture
Spread Fescue	Fortress	30
Chewings or Hard Fescue	Banner or Jamestown	30
Kentucky Bluegrass	Kenblue	30
Perennial Rye	Manhattan	10

All grass seed in the above mixture shall be certified seed.

The Department has royalty free license to use the proprietary seed mixtures Fortress and Banner. Seed producers shall be notified when seed purchased is to be used on a Department Project and is not to be subject to royalties.

Type B Grass Seed Mixture

Kind of Seed	Minimum Purity, Percent	Minimum Germination, Percent	Percent of Total Weight of Mixture
Redtop	92	85	10
Red Fescues (Creeping or Chewings)	95	80	40
Blackwells Switchgrass	95	85	10
Red Canary Grass	96	80	10
Weeping Love Grass	95	85	10
Perennial Ryegrass	98	85	5
Kentucky 31	95	80	15

Type D Grass Seed Mixture

Kind of Seed	Minimum Purity, Percent	Minimum Germination, Percent	Percent of Total Weight of Mixture
Kentucky bluegrass	85	75	50
Red Fescues (Creeping or Chewings)	95	85	35
Redtop	92	85	5
Perennial Ryegrass	95	90	10

Type F Grass Seed Mixture

Kind of Seed	Minimum Purity, Percent	Minimum Germination, Percent
Perennial Ryegrass	95	90

(b) Shipment. Each shipment of grass seed mixture shall be accompanied by a certified weight slip and an analysis of the composition, purity and germination of the seed mixture, certified by the seed house and furnished at the time of delivery.

(c) Sampling and Testing. Sampling and testing shall be done in accordance with the New Jersey State Seed Law (Revision of 1963), PL 1963, c.29 (C.4:8-17.13 *et seq*) and with the Rules and Regulations for Testing Seeds adopted by the Association of Official Seed Analysis.

909.07 Composted Sewerage Sludge. Composted sewerage sludge shall consist of a stabilized, screened mixture of wood chips and sewerage sludge processed in accordance with NJDEP Interim Guidelines on General Conditions for the Processing and Distribution of Sewerage Sludge Compost. Composted sewerage sludge shall be obtained from facilities operating in compliance with a New Jersey Pollutant Discharge Elimination System Permit or under an approved NJDEP Memorandum of Agreement. The compost product must be registered with the New Jersey Department of Agriculture in conformance with the New Jersey Commercial Fertilizer and Soil Conditioner Act of 1970.

The average water content of the stabilized composted sludge shall not exceed 55 percent by weight. The composted sewerage sludge shall have a minimum organic content of 50 percent, by weight, and pH of not less than 6.0.

Shipments of composted sewerage sludge shall be accompanied by delivery slips with the certified weight and the name of the producer or supplier.

909.08 Sod. Sod shall be machine cut at a uniform soil thickness of 5/8 plus or minus 1/4 inch at the time of cutting. Measurement for thickness shall exclude top growth and thatch. Individual strips of sod shall be of a uniform width. Broken strips and torn or uneven strips may be rejected. Standard size strips of sod shall be strong enough to support their own weight and retain their size and shape when suspended vertically from the upper 10 percent of the strip.

Sod shall be Kentucky bluegrass blend or Kentucky bluegrass-fescue blend, inspected and certified by the New Jersey Department of Agriculture.

909.09 Topsoil Stabilization Matting. Topsoil stabilization matting shall be one of the following:

- Excelsior mat shall be wood excelsior, 48 plus or minus 1 inch in width and weighing 0.8 pounds per square yard plus or minus 5 percent. The excelsior material shall be covered with a netting to facilitate handling and to increase strength and shall be biodegradable.
- Jute mat shall be cloth of a uniform plain weave of undyed and unbleached single jute yarn, 48 plus or minus 1 inch in width and weighing an average of 1.2 pounds per linear yard of cloth with a tolerance of plus or minus 5 percent, with approximately seventy-eight warp ends per width of cloth and forty-one weft ends per linear yard of cloth. The yarn shall be of a loosely twisted construction having an average twist of not less than 1.6 turns per inch and shall not vary in thickness by more than one half its normal diameter.

909.10 Topsoil. Topsoil shall not contain stones, lumps, roots or similar objects larger than 2 inches in any dimension and shall have not less than a 5.8 pH value. When the topsoil has less than a 5.8 pH value, it shall be increased by applying pulverized limestone at a rate necessary to attain a 6.5 pH value.

Material stripped from the following sources shall not be considered suitable for use as topsoil:

- Soils having less than 4.1 pH value.
- Chemically contaminated soils.
- Areas from which the original surface has been stripped and/or covered over such as borrow pits, open mines, demolition sites, dumps and sanitary landfills.
- Wet excavation.

Topsoil furnished from sources outside the limits of the Project shall have a minimum organic content of not less than 2.75 percent by weight. When the organic content is less than 2.75 percent, it shall be increased by adding peat or composted sewerage sludge, conforming to Subsection 909.07, at a rate necessary to attain this minimum organic content. The organic content of soils will be determined in accordance with AASHTO T 194 except that the sample is to be taken from oven-dried soil passing a No. 10 sieve.

The organic content of all topsoil used for planting shall conform to the requirements specified above.

The gradation of the topsoil furnished from sources outside the limits of the Project will be determined using the Bouyoucos Hydrometer Analysis conforming to AASHTO T 88. The gradation of the topsoil shall be within the following:

- Not more than 20 percent of the material submitted from an off-site sample shall be retained on a No. 10 sieve.
- If more than one-half the sand is smaller than 0.5 mm:

	Percent
Sand (2.000 mm to 0.050 mm)	40-80
Silt (0.050 mm to 0.005 mm)	0-30
Clay (0.005 mm and smaller)	0-30

- If more than one-half the sand is larger than 0.5 mm:

	Percent		Percent
Sand (2.000 mm to 0.050 mm)	40-80	or	40-75
Silt (0.050 mm to 0.005 mm)	0-30		0-30
Clay (0.005 mm and smaller)	15-30		0-30

Material outside these ranges is not suitable for use as topsoil.

909.11 Miscellaneous Materials.

Antidesiccant shall be of the polyvinyl type.

Cedar posts shall be of white cedar and shall have a diameter of not less than 2 inches nor more than 3 inches at the thinner end. Wooden posts shall be nominal size 2 by 2 inches, of solid, reasonably knot-free lumber, and may be permitted as an alternate for white cedar posts. The length of either post shall be one-half the height of the plant to be supported, plus a minimum of 24 inches for setting in the ground. The maximum overall length of any post shall be 8 feet.

Chain-lock tree ties shall be black polyvinyl chloride, nominal 1-inch width by 0.15-inch thick.

Guy wire shall be 14 gauge steel wire.

Herbicides shall be 2-4D or 2-4D and MCPP mixed in oil. The application of the herbicides shall conform to NJAC 7:30-1 *et seq.*

Hose shall be 1/2 inch corded rubber or plastic hose.

Log or timber deadmen for anchoring wire rope guys shall be 2 feet long and 6 to 8 inches in diameter.

Peat (known as sedge or reed peat) shall consist of partially decomposed plant residues resulting from anaerobic activity in water-saturated areas. Peat shall not contain gravel, debris or toxic compounds. The average water content of the peat shall not exceed 65 percent, by weight. Peat shall have a minimum organic content of 75 percent, by weight. The inorganic material shall consist only of sand, silt and clay. Peat with less than a 4 pH value will not be accepted. The pH (hydrogen ion concentration), organic content, and moisture content will be determined in accordance with Section 990, NJDOT M-1. Samples of peat will be taken by the Department at the source and must be approved before any deliveries are made. All shipments of peat shall be accompanied by delivery slips, with certified weight and name of supplier indicated, which shall be furnished at the time of delivery.

Pegs for fastening sod on slopes shall be of wood lath, not less than 9 inches long, or of similar pieces of wood.

Staples for anchoring topsoil stabilization matting shall be made of 12-inch lengths of No. 8 plain iron wire.

Tree protectors shall be one of the following:

- Plastic, wrap-around-the-trunk type, dark brown, dark gray or dark green in color.

- Wire mesh, 1/4 by 1/4 inch mesh, forming a 6-inch diameter cylinder around the trunk with the abutting edges fastened together with wire.

Wire rope for guying trees shall be 3/8 inch galvanized wire rope. Each guy shall be supplied with one galvanized iron turnbuckle.

Wood guy stakes shall be nominal size 2 by 4 inch lumber with a minimum length of 24 inches of solid and reasonably knot-free wood or 2 1/2-inch diameter minimum length of 24 inches of white cedar. The diameter of the cedar stakes shall be measured at the thinner end. The stakes shall be pointed on the thinner end. All guy stakes shall be notched 4 inches from the top for fastening the wire guys.

909.12 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Binder, Bituminous	In accordance with Subsection 904.05
Composted sewerage sludge	Subject to job site inspection and in accordance with Subsection 909.07
Fertilizer	In accordance with Subsection 909.02
Limestone, Pulverized	1 quart from each source and in accordance with Subsection 909.03
Miscellaneous:	
Chain-lock tree ties	Subject to job site inspection and in accordance with Subsection 909.11
Peat	Subject to job site inspection and in accordance with Subsection 909.11
Mulch:	
Gravel	Subject to job site inspection and in accordance with Subsection 909.04
Stone	Subject to job site inspection and in accordance with Subsection 909.04
Straw	Subject to job site inspection
Wood cellulose fiber	Subject to job site inspection
Wood chips	In accordance with Subsection 909.04
Plant materials	In accordance with Subsection 909.05
Seed mixtures	In accordance with Subsection 909.06
Sod	Subject to job site inspection
Topsoil	10 pounds from each source

SECTION 910 - MASONRY UNITS

910.01 Clay or Shale Brick. Clay or shale brick shall conform to AASHTO M 114, Grade MW, with the following modifications:

- The length of the brick shall be not less than 7.75 and not more than 8.25 inches, the width shall be not less than 3.50 and not more than 3.88 inches and the depth shall be not less than 2.10 and not more than 2.38 inches.
- The maximum water absorption, by 5 hour boiling, shall be 14 percent based on the average of five bricks, and 16 percent for individual bricks.

910.02 Concrete Block for Inlets and Manholes. Concrete block for inlets and manholes shall be solid, precast segmental concrete masonry units. Portland cement shall conform to ASTM C 150. Other materials shall conform to the following Subsections:

Aggregates for portland cement concrete, mortar and grout 901.13
Water 919.15

The blocks shall be either rectangular in shape, or curved blocks with the inside and outside surfaces curved to the required radii, whichever is appropriate for the shape of the structure. The length shall be not less than 12 inches and not more than 18 inches. The height shall be not less than 5 inches and not more than 8 inches. The width shall be not less than 6 inches.

For the reduction of cross sectional area of the cones or tops of manholes, blocks may be of special shapes and heights. Blocks of special shapes and heights may be used in the top courses of all structures so that the head castings shall be set at the required elevation on a mortar bed not more than 1/2 inch thick without cutting the blocks.

All blocks shall have an interlocking-type joint at the ends so as to form a strong, rigid structure and shall be sound and free from cracks or other defects.

At the place of manufacture, the blocks shall be stocked in such a manner as to facilitate inspection and sampling of the units.

910.03 Concrete Block for Slope Protection. Concrete block for slope protection shall be solid concrete units 16 inches long, 8 inches wide and 4 inches thick, with a tolerance of plus or minus 3/8 inch. All faces shall be true to shape, true in relation to each other and each shall have a dense uniform surface. The block shall be made from materials specified in Subsection 910.02.

Compressive strength and absorption tests shall be made on three blocks. The blocks tested shall have a minimum compressive strength of 2500 pounds per square inch at 28 day age and the maximum water absorption for any individual specimen shall not exceed 8 percent.

At the place of manufacture, the blocks shall be stocked in such a manner as to facilitate inspection and sampling of the units.

910.04 Concrete Brick. Concrete brick shall conform to Subsection 910.02 except that the sizes and shapes shall be as specified in Subsection 910.01.

910.05 Concrete Crib Members. The concrete shall conform to Section 914 and the following:

- All members shall be protected against the loss of moisture after casting. Live steam shall be employed as a means of applying moisture and controlled heat to freshly cast concrete members. Waterproof covering and framework shall be furnished to enclose crib members, in order that curing temperatures can be controlled.
- Live steam shall be introduced into the kiln or enclosure through a series of steam jets which are to be evenly spaced. In no case shall the steam impinge directly on the concrete or forms.
- After the concrete is placed in the forms, live steam may be introduced into the kiln or enclosure provided that the temperature within the kiln or enclosure shall not exceed 100 degrees F for the first 3 hours. Thereafter, the application of live steam shall be controlled so that the temperature does not rise faster than 1 degree F per minute, and shall be kept controlled at 130 degrees F for not less than 10 hours. After these curing periods, the steam may be shut off, however, the enclosure shall remain closed for 1 hour before removing members from forms. Recording thermometers shall be provided to record curing temperatures in kiln or enclosure. The crib members shall be reinforced with No. 3 deformed steel bars conforming to Subsection 915.01, Subpart *(a)*.

A plastic or galvanized metal chair shall be used to provide minimum concrete cover of 1 inch. A tolerance of 1/4 inch, plus or minus, will be allowed in the overall dimensions of crib members.

- Any devices cast in the units for handling purposes shall be of corrosion resistant material, except that aluminum will not be permitted. They shall be located on the rear face of the members and shall be removable flush with the face after erection.

910.06 Granite Curbs. Granite curbs shall be new or used and shall be medium grained with uniform texture and distribution of minerals, unstratified, unlaminated and free from seams and evidence of weathering. The granite shall comply with the geologic classification and quality requirements of Subsection 901.04. Used material shall be free of bituminous or cement grout coatings or other foreign materials. Curb stones shall be from one quarry and of the same color and texture.

Quarry-split stone for curbs shall have the top face machine-finished or dressed to an even surface without depressions or projections of more than 3/8 inch below or above the plane of the face. Edges shall be straight and even, and the ends shall be cut square for the entire depth of exposed curb face. Curb stones shall be so dressed that joints can be made not more than 3/8 inch wide from top to gutter line and not more than 1 inch wide below the gutter line.

Dressed stone for curbs shall be dressed to an even, smooth finish on the top face, on the front face for the entire depth of the exposed curb face, on the back face to a depth of 2 inches, and on the ends to a depth of 1 inch. The projections and depressions on the various faces shall not be greater than the following:

	Depression inches	Projection inches
Top	1/4	1/4
Front, dressed part	1/4	1/4
Front, undressed part	1 1/2	1/2
Back, dressed part	1/2	1/2
Back, undressed part	1 1/2	1 1/2
Ends, dressed part	1/4	1/4
Ends, rough-dressed part	1/2	1/4
Ends, undressed part	1 1/2	1/4

The rough-dressed part of end faces shall extend 1 inch below the gutter line. The back edge of the top shall be parallel to the front face. The top and front faces shall be sloped, and the front edge shall be rounded. The stones shall have the width specified at the top, and the bottom width shall be not less than 1 and not more than 3 inches greater than the top width. The stones shall be furnished in lengths of not less than 4 and not more than 8 feet.

Staight-cut stone may be used for curved curb having a radius of not less than 50 feet, but shall be dressed to true radius after being set in place. For smaller radii the stone shall be cut to the required radius, and the ends shall be cut so that the joints can be made not more than 1/4 inch wide for full depth.

910.07 Granite Facing for Pier Shafts. Granite facing for pier shafts shall be of a quality, color and texture matching as closely as possible the color range of the granite commonly known as Chelmsford White or Chelmsford Gray. The granite shall be sound, durable and free from flaws, discoloration and structural defects. A reasonable variation in color and texture and occasional irregular distribution of the component minerals of the granite, termed waves or knots will be permitted, if, in the judgment of the Engineer, they do not impair the architectural qualities or affect the structural properties of the granite. The granite shall come from quarries which have

ample production capacity both as to quantity and quality. Certification shall be submitted in accordance with Subsection 106.04. Evidence that the granite proposed for use has satisfactorily withstood long exposure in environments similar to that at the location of the Project shall be included in the certificates.

Duplicate samples shall be submitted and shall be 12 by 12 inches to indicate the range of color, texture and surface finish of the granite to be furnished. After approval of such samples, one set of samples will be returned for guidance. All granite used in the Project shall match these samples.

All granite furnished shall be capable of withstanding a crushing stress of 20,000 pounds per square inch on 2 1/2 inch diameter cores tested air-dry. The number of cores to be furnished for such tests shall be as specified in the supplementary specifications.

910.08 Granite Paving Block. Granite paving block shall be new or used granite block of good quality. Blocks shall be free of all bituminous and cement grout coatings and other foreign matter.

910.09 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Brick	10 units from 10,000 units
Block	In accordance with ASTM C 140 (See Note 1)
Crib Members	Subject to inspection prior to shipment
Granite:	
Curbs	2-foot end section from each source
Facing	In accordance with Subsection 910.07

Note 1 - Concrete block for inlet and manholes shall have compressive strength and absorption requirements conforming to ASTM C 139.

SECTION 911 - NON-FERROUS METALS

911.01 Aluminum Alloys. Aluminum alloys shall conform to the following:

Component	ASTM	ASTM Alloy and Temper
Castings, Sand	B 26	356-T6
Die Castings, Permanent Mold	B 108	356-T6
Extruded Bars, Rods, Shapes and Pipe	B 221	6061-T6
Pipe	B 241	6061-T6
Plates and Sheets	B 209	6061-T6
Rolled Shapes, Rods and Bars	B 211	6061-T6
Shim Material Made of Sheet or Plate	B 209	1100- O
Tube, Drawn	B 210	6061-T6
Tube, Extruded	B 221	6061-T6
Washers, made of Sheet, Alloy Clad	B 209	2024-T3

Bolts, nuts, set screws and pins shall be made from rods conforming to ASTM B 211, Alloy 2024 T4 with No. 205 Alumilite Finish. Bolt heads and nuts shall be American Standard, Regular Series, hexagonal, semi-finished, conforming to ANSI B 18.2. Threads shall be American Standard, Coarse Series, Class 2 Fit, conforming to ANSI B1.1. The finished bolts and nuts shall be heat treated to a T4 temper and given an anodic coating of not less than 0.0002 inch thickness and shall be chromate sealed.

911.02 Bearing and Expansion Plates. Cast bronze bearing and expansion plates shall conform to AASHTO M 107, Alloy UNS No. C91100. Rolled copper-alloy bearing and expansion plates shall conform to AASHTO M 108, Alloy UNS No. C51000 or C51100.

911.03 Flashing for Construction and Expansion Joints. Copper for flashing shall weigh 16 ounces per square foot and shall conform to ASTM B 152, Type UNS No. C 11000.

Nickel-copper alloy sheeting for flashing shall conform to ASTM B 127. The sheeting shall be cold-rolled deep-drawing and spinning quality.

911.04 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Aluminum alloys	In accordance with applicable ASTM test methods
Bearing and expansion plates	1 unit from each source
Copper flashing	1 square foot from each source

911.05 Certification of Compliance. Mill certification for copper flashing shall be submitted in accordance with Subsection 106.04.

SECTION 912 - PAINTS AND COATINGS

912.01 Paint. Ready-mixed paint shall consist of pigment ground to the required consistency in a ball, pebble or roller mill, or by other methods, with vehicle, forming a paste to which shall be added other ingredients that may be required. Mixing or dispersion apparatus is not acceptable as a grinding medium.

The paint shall be well ground and shall not settle or cake in the container to the extent that it cannot be readily broken up with a paddle to a smooth, uniform paint of good brushing consistency. The paint, when brushed on a smooth, vertical, metallic surface shall dry hard and elastic to full oil gloss within the specified period without running, streaking, cracking or sagging.

The percentages of all materials required are in terms of net weight. The shade of tint of the finished paint shall be approved prior to shipment. The paint and ingredients shall conform to the requirements hereinafter specified for each kind of paint.

(a) Methods of Test and Inspection. The ready-mixed paint and paint materials shall be analyzed in accordance with Federal Specification TT-P-141.

(b) Samples and Certified Analyses. Samples and a certified analysis of any ingredients to be used or any paint manufactured shall be furnished by the manufacturer within 10 days after request is made. The Engineer may require the manufacturer of the paint to certify the use of the specific materials and components in the quantities specified herein where such materials or components are not readily identifiable in the finished paint.

(c) Containers and Shipment. The paint shall be shipped in previously unused containers plainly marked with the name or kind, color, net weight and volume of the contents, and shall show the name, address and lot or batch number of the manufacturer, and date of approval if the paint has been inspected at the

source of manufacture by the Engineer. Containers must conform to Federal Specification PPP-P 1892. Containers shall be labeled in accordance with Interstate Commerce Commission Standard Regulations for flammables.

912.02 Aluminum-Pigmented Alkaline-Resistant Paint. Aluminum-pigmented alkaline-resistant paint shall conform to Federal Specification TT-C-1079b.

912.03 Basic Lead Silico Chromate, Primer. Basic lead silico chromate, primer for shop coat or touch up coat shall conform to AASHTO M 229, Type V.

912.04 Basic Lead Silico Chromate, Intermediate. Basic lead silico chromate maroon intermediate coat shall conform to the following:

Materials	
Raw linseed oil	Federal Specification TT-L-215
Alkyd resin solution	Federal Specification TT-R-266, Type I, Class A and B
Manganese naphthenate, 6%	ASTM D 600, Class B
Paint thinner	Federal Specification TT-T-291
Basic lead silico chromate	ASTM D 1648
Zirconium catalyst	5.9 to 6.1% zirconium, as metal
Siliceous red iron oxide as Fe_2O_3 (Note 1)	85% minimum (Note 2)

Note 1 - This oxide shall have the typical reddish color of iron oxide. This material shall not be a venetian red (calcium sulphate base) type of iron oxide.

Note 2 - The remainder shall be silica and silicates.

	Percent by Weight	
Pigment Composition	**Minimum**	**Maximum**
Basic lead silico chromate	63.6	--
Iron oxide as Fe_2O_3	--	30.0
Silica and silicates	--	6.0
Organo montmorillonite (The organo montmorillonite shall be predampened with 30-35% methanol-water (95-5))	0.4	0.8

Vehicle Composition. The vehicle shall consist of not less than 59.0 percent nonvolatile vehicle, the balance to be combined drier and thinner. The nonvolatile vehicle shall be composed of two parts raw linseed oil to one part alkyd resin solids, respectively by weight, and shall contain a minimum of 7.7 percent phthalic anhydride. Small quantities of grinding and wetting aids may be used.

Paint Composition. When tested in accordance with Federal Standard-141 and applicable methods of test, the finished paint shall consist of:

	Minimum	**Maximum**
Pigment, %	62.0	--
Vehicle, %	--	38.0
Weight per gallon, lbs	14.7	--
Water, %	--	0.5

Coarse particles and skins, % (Total residue retained on 325 sieve based on paint)	--	1.0
Fineness of grind (Hegman)	4	--
Viscosity, Stormer, KU	73	85
Viscosity, grams, Stormer	155	220
Drying time:		
Set to touch, hours	--	5
Dry to handle, hours	--	18
Dry to recoat, hours	--	36

Color. The color of the finished paint (dry film) shall match color chip or sample furnished by the Department Laboratory.

912.05 Basic Lead Silico Chromate, Finish Coat (Foliage Green). Foliage green paint shall be a basic lead silico chromate-chromium oxide foliage green alkyd paint conforming to the following.

Materials

Chromium oxide green	ASTM D 263, Type A
Titanium dioxide, (rutile, non-chalking)	ASTM D 476, Type IV TiO_2, 93% minimum purity
Alkyd resin solution	Federal Specification TT-R-266 Type I, Class A
Cobalt naphthenate, 6%	ASTM D 600, Class B
Basic lead silico chromate	ASTM D 1648
Zirconium catalyst	5.9 to 6.1% zirconium, as metal
Mineral spirits	ASTM D 235

	Percent by Weight	
Pigment Composition	**Minimum**	**Maximum**
Basic lead silico chromate	40.0	50.0
Titanium dioxide	20.0	30.0
Chromium oxide green	25.0	35.0
Phthalocyanine blue or green (no chrome green permitted)	--	As required
Organo montmorillonite (The organo montmorillonite shall be predampened with 30-35% methanol-water (95-5))	0.5	0.7

Vehicle Composition. The liquid shall consist of not less than 45.0 percent nonvolatile vehicle by weight, the balance to be combined drier and thinner. The nonvolatile vehicle shall be composed of 1 part raw linseed oil to 7.1 parts alkyd resin solids, by weight, and shall contain a minimum of 20.0 percent phthalic anhydride. Small quantities of grinding and wetting aids may be used.

Paint Composition	**Minimum**	**Maximum**
Pigment (by weight), %	33.5	--
Vehicle (by weight), %	--	66.5
Weight per gallon, lbs	10.2	--
Water, %	--	0.5
Coarse particles (residue retained on 325 mesh sieve), %	--	1.0

Fineness of grind, Hegman	3	--
Viscosity, KU	65	80
Drying time:		
Set to touch, hours	--	2
Dry hard, hours	--	8

Color. The color of the finished paint (dry film) shall match color chip No. 24172 of Federal Standard-595.

912.06 Finish Coat (Lake Blue). Lake blue finish coat paint shall conform to the following requirements:

Materials	
Titanium dioxide (rutile, unextended)	ASTM D 476, Type IV TiO_2, 93% minimum purity
Zinc oxide	ASTM D 79, American Process Type
Shading pigments	Phthalocyanine blue or green
Thinners	Mineral spirits ASTM D 235
Driers	ASTM D 600, Class B
Suspending agent (aluminum stearate)	Federal Specification MIL-A-15206B
Long oil soya alkyd resin	Federal Specification TT-R-266B, Type I or II

	Percent by Weight	
Pigment Composition	**Minimum**	**Maximum**
Titanium dioxide	77.0	79.0
Zinc oxide	9.0	11.0
Shading pigments	--	12.0
Suspending agent	0.5	2.0

	Percent by Weight	
Vehicle Composition	**Minimum**	**Maximum**
Long oil soya alkyd resin (solids)	55.0	59.0
Thinners and driers	41.0	45.0
Paint Composition		
Pigment (by weight), %	16.0	20.0
Vehicle solids (by weight), %	44.0	48.0
Thinner and drier (by weight), %	32.0	40.0
Total solids (by weight), %	60.0	68.0
Weight per gallon, lbs	8.9	--
Viscosity, Stormer, KU	70	80
Fineness of grind (Hegman)	5	--
Flash Point TCC, deg F	100	105
Drying time:		
Dry to touch, hours	4	6
Dry through, hours	8	12

Color. Lake blue paint color shall match color chip No. 25189 of Federal Standard-595.

912.07 Basic Lead Silico Chromate, Finish Coat (Brown). Paint shall conform to the following:

Materials	
Basic lead silico chromate	ASTM D 1648
Iron oxide Fe_2O_3	ASTM D 3721, D 3722 or D 3724
Titanium dioxide (rutile)	ASTM D 476, Type IV TiO_2, 93% minimum purity
Barium sulfate (barytes)	ASTM D 602

	Percent by Weight	
Pigment Composition	**Minimum**	**Maximum**
Basic lead silico chromate	35.0	--
Total iron oxide as Fe_2O_3	21.0	--
Titanium dioxide	10.0	20.0
Barytes	--	15.0
Tinting materials (including lampblack, phthalocyanine blue and yellow iron oxide)	3.0	7.0
Organo montmorillonite (The organo montmorillonite shall be predampened with 30-35% methanol-water (95-5))	0.5	1.0

Vehicle Composition. The liquid shall consist of not less than 48.0 percent nonvolatile vehicle by weight, the balance to be driers and volatile thinners. The alkyd resin solids shall conform to Federal Specification TT-R-266, Type 1. The drier catalyst shall be 0.13 percent zirconium, 0.02 percent cobalt and 0.05 percent calcium as metals based on the nonvolatile vehicle by weight introduced as soluble organic metal salts.

The nonvolatile vehicle solids shall be a mixture of approximately 95.7 percent alkyd resin solids and 4.3 percent raw linseed oil. On analysis, these solids shall show not less than 21.5 percent phthalic anhydride.

Rosin or rosin in derivatives shall not be present. Small amounts of wetting and grinding aids and antioxidants may be used.

Paint Composition	**Minimum**	**Maximum**
Pigment (by weight), %	55.0	--
Vehicle (by weight), %	--	44.5
Weight per gallon, lbs	13.3	--
Water, %	--	0.5
Coarse particle and skins, % (total residue retained on 325 sieve based on paint)	--	1.0
Fineness (North Standard)	4.5	--
Viscosity, grams, Stormer	140.0	200.0
Viscosity, KU	70.0	82.0
Drying time:		
Set to touch, hours	--	2
Dry hard, hours	--	18

Color. The color of the finished paint (dry film) shall match color chip No. 30111 of Federal Standard-595. Tinting colors such as yellow iron oxide, phthalocyanine blue, or lampblack are permitted in order to match the color.

Typical Formulation. A typical fomulation to make approximately 107 gallons (US) of the above paint is as follows:

	Pounds
Basic lead silico chromate	300
Siliceous red iron oxide (85% Fe_2O_3)	225
Rutile titanium dioxide	130
Barytes	122
Lampblack	1.35
Phthalocyanine blue	3.45
Light yellow iron oxide (synthetic)	28.9
Bentone R 38 (Note 1)	4.0
Long oil alkyd resin solution	438
Raw linseed oil	13.9
Mineral spirits	166
Zirconium catalyst (6% Zr)	7.1
Cobalt naphthenate (6% Co)	1.0
Calcium naphthenate (4% Ca)	3.8
Antiskinning agent (Note 1)	1.5
Methyl alcohol-water (95-5)	1.2

Note 1 - Infrared spectra on file with Department Laboratory.

912.08 First Finish Coat (Off-Gray). Off-gray paint shall conform to Subsection 912.09 except that tinting color to be added to the paint shall give it an off-gray color to distinguish it from the concrete gray top coat.

912.09 Final Finish Coat (Gray). Gray paint shall conform to Federal Specification TT-P-102e. Appropriate tinting color shall be added to the paint to give the paint a gray concrete color matching the color of dry adjacent concrete.

912.10 Aluminum Paint, Finish Coat. Aluminum paint shall conform to AASHTO M 69, Type II.

912.11 Graphite Paint, Finish Coat, Black. Graphite paint, black shall be a ready-mixed, linseed oil, black graphite paint intended for outside use on either wood or metal. Only natural crystalline flake graphite will be permitted.

Pigment. The pigment shall consist of graphite of the natural crystalline flake variety, siliceous matter, and gas carbon black or lampblack. The pigment on analysis shall show not less than 40 or more than 60 percent graphitic carbon. The gas carbon black or lampblack shall be not less than 5 and not more than 10 percent of the total pigment. Ground coal and powdered shale are not permitted.

Suggested Weight Formula	**Percent**
Pigment	
Natural crystalline flake graphite (containing about 55% graphitic carbon)(Note 1)	95
Gas carbon black	5
Total	100

Note 1 - Infrared spectra on file with the Department Laboratory.

Vehicle	
Boiled linseed oil	85
Drier	5
Mineral spirits	10
Total	100
Paint	
Pigment	40
Vehicle	60
Total	100

Weight per gallon of paint, 10 pounds

Volume Analysis

One gallon of paint contains:	**Gallon**
Dry graphite	0.195
Dry carbon black	0.013
Total pigments	0.208
Linseed oil	0.654
Total nonvolatile	0.862
Mineral spirits and drier	0.138
Total paint	1.000

Other volume characteristics of paint:	**Percent**
Pigment in paint	21
Oil in paint	65
Pigment in nonvolatile	24

The above volume figures shall mean that 1 gallon of this paint when delivered shall contain 0.862 gallon total nonvolatile or film-forming materials, and in the dry film there shall be approximately 24 percent by volume of pigment and 76 percent by volume of oil. For the above reasons, paint is to be supplied by volume. 231 cubic inches equals 1 gallon.

Liquid in Ready-mixed Paint. Liquid in the ready-mixed paint shall contain not less than 85 percent linseed oil, the balance to be combined drier and thinner. The thinner shall be turpentine, volatile mineral spirits, or any mixture thereof.

Ready-mixed Paint. Ready-mixed paint shall consist of the pigment and the liquid described above. It shall be well ground, shall not settle badly or cake in the container, shall be readily broken up with a paddle to a smooth, uniform paint of good brushing consistency, and shall dry within 24 hours to a full oil gloss, without running or sagging. The weight per gallon shall be not less than 9 1/2 pounds.

The paint shall consist of:

	Minimum	**Maximum**
Pigment, %	35	42
Liquid, % (containing at least 85% linseed oil)	58	65
Water, %	--	0.5
Coarse particles and skins, % (total residue retained on No. 325 based on pigment)	--	5.0

When the two coats of graphite paint are specified, the first coat shall contain no carbon black or lampblack pigment.

912.12 Vinyl Wash Primer. Vinyl wash primer shall conform to Federal Specification DOD-P-15328.

Packaging and Labeling. The label shall state that the primer is to be packaged so that the acid component can be mixed with the resin in the resin component container. The resin and acid components shall be separately packaged, and the packages shall be of such type as to prevent attack by the components.

The label shall state that 1 part by volume of the acid component is to be added slowly with constant stirring to 4 parts by volume of the resin component just before use and the mixed components must be used within 8 hours. It shall further state that the mixed material is intended for spray application in dry film thicknesses of 0.3 to 0.5 mils.

912.13 Vinyl Shop Primer. Vinyl shop primer shall conform to the following requirements:

Paint Characteristics	Minimum	Maximum
Pigment, %	48.0	--
Vehicle, %	--	52.0
Weight per gallon, lbs	10	13
Viscosity, KU	70	105
Total solids, %	67.0	--
Non-volatile vehicle, %	39.0	--
Water, %	--	1.0
Drying time:		
Dry to touch, minutes	--	20
Dry through, hours	--	5
Fineness of grind, Hegman	4	--

Compatibility: The paint shall be compatible so that when one part paint is mixed with one part of methyl ethyl ketone, no curdling, livering or separating is noted.

Pigment	Minimum	Maximum
Basic lead silico chromate, % (ASTM D 1648)	65.0	--
Barium sulfate, (barytes), % (ASTM D 602)	--	35.0
Vehicle Solids		
Alkyd resin long oil, % TT-R-226 Type I or II	--	40
Vinyl resin, %	60	--

Vinyl resin shall be hydroxyl modified poly (vinyl chloride-vinyl acetate) copolymer containing, by weight:

Polyvinyl chloride, %	89.5	91.5
Polyvinyl alcohol, %	5.2	6.5
Viscosity (solution of 20% by weight of resin in 1:1 mibk: toluene at 25°C) cps	80	150

Solvent. Solvent shall be methyl ethyl ketone conforming to ASTM D 740.

Dry Film Characteristics. All tests shall be conducted in accordance with Federal Test Standard No. 141.

Adhesion. Not more than 10 percent of the total cross-hatches shall fail because of insufficient adhesion.

Chemical Resistance. The shop primer shall not be affected, other than discoloration, after exposure for 4 days at 77 plus or minus 5 degrees F to:

10% sulfuric acid solution
10% sodium hydroxide solution
10% sodium chloride solution
Distilled water

Salt Spray Resistance. The shop primer shall show no deterioration after exposure to 5 percent salt spray solution for 300 hours. The rust in the cross scribed area shall not exceed 1/16 from the scribe.

Accelerated Weathering. The shop primer shall show no more than a No. 8 chalk after 300 hours exposure. Other than color changes, no visible degradation shall have occurred.

912.14 Vinyl Intermediate Coat. Vinyl intermediate coat shall conform to the following requirements:

The paint shall be tinted with a commercial, pure, synthetic iron oxide.

Paint Characteristics	**Minimum**	**Maximum**
Pigment, %	28.0	--
Vehicle, %	--	72.0
Weight per gallon, lbs	11.0	13.0
Viscosity, KU	70	105
Non-volatile vehicle, %	32	--
Water, %	--	1.0
Drying time:		
Dry to touch, minutes	--	20
Dry through, hours	--	5
Fineness of grind, Hegman	4	--

Compatibility: The paint shall be compatible so that when one part of paint is mixed with an equal part of recommended solvent, no curdling, livering, or separating occurs.

Pigment	**Minimum**	**Maximum**
Basic lead silico chromate, % (ASTM D 1648)	85.0	--
Barium sulfate, % (ASTM D 602)	--	15.0
Vehicle solids		
Vinyl resin A, %	65	--

Vinyl resin A shall be a hydroxyl-modified poly (vinyl chloride-vinyl acetate) copolymer containing by weight:

Polyvinyl chloride, %	89.5	91.5
Polyvinyl alcohol, %	5.2	6.5
Viscosity (solution of 20% by weight of resin in 1:1 mibk: toluene at 25°C) cps	80	150
Vinyl resin B, %	20	--

Vinyl resin B shall be a poly (vinyl chloride-vinyl acetate) copolymer containing by weight:

Polyvinyl chloride, %	84.0	87.0
Viscosity (solution of 25% by weight of resin in 65-35 toluene: mek at 25° C) cps	150	200
Phthalate plasticizer, %	15	--

The plasticizer shall be mixed isomers of phthalate esters with a formula weight equal to 446, specific gravity equal to 0.9675 at 20 degrees C, boiling point equal to 261 degrees C and viscosity at 20 degrees C of 113 centipoises.

Solvent. Solvent shall be a mixture of:

60% methyl ethyl ketone, ASTM D 740
20% cyclohexanone
20% xylene, ASTM D 846

Flexibility. No failure shall be noted when bent over a 1/2 mandrel.

Other Requirements. The Dry Film Characteristics, Adhesion, Chemical Resistance, Salt Spray Resistance and Accelerated Weathering requirements shall conform to Subsection 912.13.

912.15 Vinyl Intermediate Coat or Alternate Shop Primer. This specification covers an alternate vinyl shop primer and intermediate field primer for application to steel conforming to the following requirements:

Paint Characteristics	**Minimum**	**Maximum**
Pigment, %	48	--
Vehicle, %	--	52
Weight per gallon, lbs	11.8	13.0
Viscosity, KU	70	105
Total solids, %	58.0	--
Water, %	--	1.0
Drying time:		
Dry to touch, minutes	--	20
Dry through, hours	--	4
Fineness of grind, Hegman	4	--

Compatibility: The paint shall be compatible so that when one part of paint is mixed with an equal part of recommended solvent, no curdling, livering, or separating occurs.

Pigment		
Basic lead silico chromate, % (ASTM D 1648)	85.0	--
Barium sulfate, (barytes), % (ASTM D 602)	--	15.0
Vehicle solids		
Tricresyl phosphate, % (ASTM D 363)	--	15
Vinyl resin, %	85	--

Vinyl resin shall be a hydroxyl-modified poly (vinyl chloride-vinyl acetate) copolymer containing by weight:

Polyvinyl chloride, %	89.5	91.5
Polyvinyl alcohol, %	5.2	6.5
Viscosity (solution of 20% by weight of resin in 1:1 mibk: toluene at 25°C), cps.	80	150

Solvent. Solvent shall be a mixture of:
60% methyl isobutyl ketone, ASTM D 1153
40% toluene, ASTM D 362

Other Requirements. The Dry Film Characteristics, Adhesion, Chemical Resistance, Salt Spray Resistance and Accelerated Weathering requirements shall conform to Subsection 912.13. Flexibility requirement shall conform to Subsection 912.14.

912.16 Vinyl Finish Coat (Green or Blue). The ingredients to be used in this top coat are not totally specified, however, the finished product shall comply with all requirements cited herein. The composition formula of this top coat shall be approved prior to use.

Zone 2 System. Zone 2 system shall conform to the following:

Paint Characteristics	**Minimum**	**Maximum**
Pigment, %	8	--
Vehicle, %	--	92
Weight per gallon, lbs	8.0	10.0
Viscosity, KU	80	100
Total solids, %	33	--
Water, %	--	1.0
Drying time:		
Dry to touch, minutes	--	20
Dry through, hours	--	3
Fineness of grind, Hegman	6	--

Compatibility: The paint shall be compatible so that when one part of paint is mixed with an equal part of recommended solvent, no curdling, livering or separating occurs.

Pigment/Binder: The pigment/binder ratio by weight shall be 1.0/1.65. The ratio by volume shall be 1.0/5.25.

Pigment
Antimony oxide, min. 10%
Phthalocyanine green or blue as required for tint
Titanium dioxide, ASTM D 476, Type III or IV balance

Vehicle solids	**Minimum**	**Maximum**
Vinyl resin, %	85	--

Vinyl resin shall be a poly (vinyl chloride-vinyl acetate) copolymer containing by weight:

Polyvinyl chloride, %	84.0	87.0

Viscosity (solution of 25% by weight of resin in 65:35 toluene: mek at 25°C) cps	150	200
Phthalate plasticizer, %	--	15

The plasticizer shall be mixed isomers of phthalate esters with a formula weight equal to 446, specific gravity equal to 0.9675 at 20 degrees C, boiling point equal to 261 degrees C and viscosity at 20 degrees C of 113 centipoises.

Solvent. Solvent shall be a mixture of:

50% methyl isobutyl ketone, ASTM D 1153
50% toluene, ASTM D 362

Color. Color for green finish coat shall match color chip No. 24172 of Federal Standard-595. Color for blue finish coat shall match color chip No. 25189 of Federal Standard-595.

Accelerated Weathering. The vinyl finish coat shall show no more than a No. 6 chalk after 500 hours exposure. Color change after 500 hours shall not be more than 5 National Bureau Standards Units.

Other Requirements. The Dry Film Characteristics, Adhesion, and Chemical Resistance requirements shall conform to Subsection 912.13. Flexibility requirement shall conform to Subsection 912.14.

Zone 3B System. Zone 3B shall conform to the requirements for Zone 2 System except vehicle solids and solvent shall be in accordance with the following:

Vehicle solids	**Minimum**	**Maximum**
Vinyl resin, %	85	--
Vinyl resin shall be hydroxyl-modified poly (vinyl chloride-vinyl acetate) copolymer containing by weight:		
Polyvinyl chloride, %	89.5	91.5
Polyvinyl alcohol, %	5.2	6.5
Viscosity (solution of 20 % by weight of resin in 1:1 mibk:toluene at 25° C), cps	80	150
Phthalate plasticizer, %	--	15

The plasticizer shall be mixed isomers of phthalate esters with a formula weight equal to 446, specific gravity equal to 0.9675 at 20 degrees C, boiling point equal to 261 degrees C, and viscosity at 20 degrees C of 113 centipoises.

Solvent. Solvent shall be a mixture of:

60 % methyl isobutyl ketone, ASTM D 1153
40 % toluene, ASTM D 362

912.17 Zinc-Rich Primer, Organic Vehicle. Organic zinc-rich primer is a one-package primer whose mechanism of drying is that of solvent release. The zinc-rich primer is intended for use only on open steel structures exposed to the air. It is not intended for use in confined spaces such as the interior of tanks, silos or similar structures because of the danger of possible explosion and toxic hazards. The coating shall be applied by brushing or spraying. Because of rapid drying characteristics, best surface appearance is obtained by spray.

Materials. The raw materials for use in the paint formula shall conform to the specification designated by Federal serial number or paint material code number.

912.17

Paint Characteristics. Paint shall be homogenous, free of contaminant and of a consistency suitable for use in the capacity for which it is specified. Finished paint shall be properly dispersed in the vehicle according to the requirements of the paint. The dispersion shall be of such nature that the pigment does not settle badly, does not liver or curdle. Any settlement of pigment in the paint shall be a thoroughly wetted, soft, mushy mass permitting the complete and easy vertical penetration of a paddle. Settled pigment shall be easily redispersed, with minimum resistance to the sidewise manual motion of the paddle across the bottom of the container, to form a smooth uniform product of the proper consistency. The manufacturer shall include in the paint the necessary additives for control of sagging, pigment settling, leveling, and other qualities of a satisfactory working material. The paint shall possess satisfactory properties in all respects which affect its application and curing.

There shall be no evidence of incompatability when one volume of the thinner described under "application of coating" is mixed with four volumes of the paint.

The necessary additives to prevent gas formation in the containers during storage shall be incorporated into the formulated paint.

	Minimum	Maximum
Pigment, % by weight	62.3	--
Vehicle, % by weight	--	37.7
Volatiles at 105°C, % by weight	28	32
Weight per gallon, lbs	17.2	18.0
Viscosity, KU at 77°F	100	120
Metallic zinc of extracted pigment by Federal Test Method No. 141, Method 7221, % by weight	90.2	--
Drying time at 77°F, 50% relative humidity, 6 mil wet thickness:		
Dry to touch, minutes	--	45
Dry through, hours	--	5
Storage life, years	1	--

	Percent by Weight	
Pigment Composition	*Type I Red Tint*	*Type II Gray*
Zinc dust ASTM D 520, Type 1	95.0 min	95.0 min
Red iron-oxide (Note 1)	1.5 max	--
Zinc oxide ASTM D 79	--	1.5 max
Thixotropes & additives	3.5 max	3.5 max
Note 1:		
Fe_2O_3, %	98.5 min	
Oil absorption	21	--
Specific gravity	5.15	--
Fineness through 325 mesh screen, %	99.0 min	--

The average particle size of the pigment shall not exceed 9 microns as determined by the Fisher subsieve sizer. The red iron oxide must first be ground into a portion of the vehicle to provide a Hegman grind sufficient to produce the specified color of the finished paint.

Vehicle Composition	Percent by Weight
Polyaryl ether (Note 1)	19.0
Ethylene glycol monoethyl ether acetate MIL-E-7125	66.8
Toluene, ASTM D 362	14.2

Note 1: Polyhydroxy polyalkaryl polyether of the following properties:

Specific gravity	1.18
Viscosity of 40% solids in mek Brookfield RVF, 20 rpm No. 5 spindle, centipoises	5500 to 7700
Reduced viscosity (0.2 gm/100 ml dimethylformamide)	0.4 to 0.6
Ultimate tensile strength, psi	9000 to 9500
Ultimate tensile elongation, %	50 to 100
Softening temperature, deg F	212
Bulking value, lbs per gal	9.83

Infrared Characteristic Curve of Primer Vehicle. When dried upon a potassium bromide disc, a film of the primer shall have infrared absorption maximums at the same wavelengths and to the same relative degree as that shown on the Infrared Curve on file with the Department Laboratory.

Properties of Cured Coating. When applied to a plate glass panel with a 6 mil gap clearance doctor blade and cured for 15 days at 77 plus or minus 5 degrees F and 50 plus or minus 5 percent relative humidity, the coating shall have a pencil hardness of B minimum.

When applied by air or airless spray to a minimum dry film thickness of 1.5 mils on sandblasted steel having an anchor profile pattern of 1.0 to 1.5 mils, the mixed paint shall completely wet the surface of the steel with no evidence of dry spray particles or sagging.

When applied to a wet film thickness of 6 mils on a metal panel corresponding to Federal Specification QQ-S-698 (the panel being previously cleaned by sandblasting to produce a 1.0 to 1.5 mil anchor pattern, and cured for 15 days at a relative humidity of 50 plus or minus 5 percent and tested according to the conical mandrel test, Federal Test Method Standard No. 141, Method 6222) there shall be no loosening of the film above the point of the longest continuous crack.

When a steel panel is sandblasted to white metal and coated with 3 or 4 mils dry film thickness of this coating and cured for 15 days at 75 degrees F and 50 plus or minus 5 percent relative humidity and diagonally scribed to expose bare steel, there shall be no underfilm corrosion on the surface of the panel extending beyond the scribed lines after 1000 hours when tested according to ASTM B 117.

Patents. The use of patented materials, equipment, devices or processes shall conform to Subsection 107.06.

Manufacturing and Packaging. The finished paint shall be furnished in new 5 gallon, round, steel containers of 24 gauge minimum. The containers shall have lug type crimp lids with ring seals and be equipped with ears and bails. The containers shall meet the United States Department of Transportation Hazardous Materials Shipping Regulations. The containers shall be lined so as to prevent attack by the paint. The lining shall not come off the can as skins.

Finished paint shall not be used until at least 7 days have elapsed from the date of its manufacture.

All containers of paint shall be labeled showing the exact title of the specification, manufacturer's name, date of manufacture, State lot number, and manufacturer's batch number.

Precautions concerning the handling and the application of paint shall be shown on the the label of paint and solvent containers.

912.18 Rust-Inhibitive Primer. Rust-inhibitive primer for use on metal surfaces shall conform to Federal Specification TT-P-618.

912.19 Zinc Chromate-Iron Oxide Paint. Zinc chromate-iron oxide paint shall conform to SSPC No. 11.

912.20 Zinc Chromate Primer. Zinc chromate primer shall conform to Federal Specification TT-P-645a.

912.21 Zinc Dust-Zinc Oxide Paint Primer. Zinc dust-zinc oxide paint primer shall conform to Federal Specification TT-P-641g, Type I, II or III.

912.22 Coal Tar Epoxy-Polyamide Paint (Black or Dark Red). Coal tar epoxy-polyamide paint shall conform to SSPC No. 16. This specification covers a two-component coal tar-epoxy black (or dark red) paint which employs a coal-reacting polyamide resin and an aromatic tertiary polyamide catalyst as curing agent.

912.23 Masonry Paint. Paint for application on exposed concrete surfaces shall conform to Federal Specifications TT-P-95c, Type II or TT-P-97d, Type II.

912.24 Epoxy Bonding Coat. Epoxy bonding coat shall be a two-component, epoxy-resin bonding system for application to portland cement concrete. The coating shall conform to ASTM C 881. The system type, grade, and class shall depend on the condition of intended use. Color shall be clear or gray to match the color of the adjacent concrete.

912.25 Epoxy Waterproofing Seal Coat. Epoxy waterproofing seal coat shall be a two-component, epoxy-resin, waterproofing system for application to portland cement concrete. The coating shall conform to ASTM C 881. The system type, grade, and class shall depend on the condition of intended use. Color shall be gray to match the color of the adjacent concrete.

912.26 Gray Finish Coat, Interior Walls. Gray paint for interior walls shall conform to Federal Specification TT-P-29j, Type I and shall match color chip No. 26492 of Federal Standard-595.

912.27 Gray Finish Coat, Interior Floors. Gray paint for interior concrete floors shall conform to Federal Specification TT-P-91 and shall match color chip No. 26314 of Federal Standard-595.

912.28 Red Finish Coat. Red finish coat paint shall conform to Federal Specification TT-E-489e, Class A, and shall match color chip No. 11105 of Federal Standard-595.

912.29 White Paint, Interior. Interior white paint shall conform to Federal Specification TT-P-29, Type I and shall be tinted to match color chip No. 27875 of Federal Standard-595.

912.30 White Paint, Exterior. Exterior white paint shall conform to Federal Specification TT-E-489e, Class A, and shall be tinted to match color chip No. 17875 of Federal Standard-595.

912.31 Yellow Finish Coat. Yellow finish coat paint shall conform to Federal Specification TT-E-489e, Class A, and shall match color chip No. 13538 of Federal Standard-595.

912.32 Green Enamel Paint. Green enamel paint shall conform to Federal Specification TT-E-489e, Class A, gloss, synthetic (for exterior and interior surfaces). The tint shall match color chip No. 14062 of Federal Standard-595.

912.33 Lime-Yellow Enamel Paint. Lime-yellow enamel paint shall conform to Federal Specification TT-E-489a, Class A, and shall match color chip No. 13670 of Federal Standard-595.

912.34 Traffic Paint. Traffic paint shall be based on a vehicle composed of pure drying alkyd, chlorinated rubber and chlorinated paraffin, with appropriate pigments, stabilizers and flow control agents and shall be the type specified. The vehicle and pigment shall be prepared and blended so that the resulting paint shall be uniform in composition and of the required consistency.

Preparation. The specified components shall be dispersed in a suitable amount of vehicle. The grinding shall be performed by either a High-R-Speed mill, roller mill, pebble mill, or high speed disc disperser similar to that manufactured by Cowles-Morehouse or Hockmeyer. The resultant paste shall have a fineness of not less than 4 as determined on a Hegman grind gauge (Federal Standard No. 141A, Method 4411). The remainder of the vehicle, additional thinners and stabilizers, when required, shall then be added to produce a paint having the specified consistency. The equipment to be used in preparation and manufacture of the paint is subject to approval.

Physical Properties.

- *Consistency.* Forty-eight hours after the paint has been prepared and placed in the containers, it shall have a consistency of 70 to 80 KU for use in spray type equipment. Consistency shall be determined according to ASTM D 562.
- *Drying Time.* The paint shall dry to no-pick-up in not more than 5 minutes for white traffic paint or 6 minutes for yellow traffic paint without glass beads when tested in accordance with ASTM D 711. The film shall be applied at a wet film thickness of 0.015 inches (15 mils).
- *Flexibility and Adhesion.* A film of paint having a wet film thickness of 0.015 inches shall be applied with a doctor blade to a tin panel 3 by 5 inches weighing 0.39 to 0.51 pounds per square foot, previously cleaned with toluene and lightly buffed with steel wool. After drying in a horizontal position at room temperature (70 to 80 degrees F) for 18 hours, the coated panel shall be baked in an oven at 122 plus or minus 4 degrees F for 2 hours, removed and allowed to cool to room temperature. It shall then be bent rapidly with the painted surface uppermost over a 1/2 inch diameter mandrel and examined without magnification. The paint shall adhere firmly to the panel and any evidence of cracking or flaking of the film shall be cause for rejection of the paint.
- *Water Resistance.* The paint shall show no softening or blistering when tested in conformance with Section 990, NJDOT P-1.
- *Light Resistance.* The paint shall show resistance to discoloration or darkening when tested by the method prescribed by Federal Specification TT-P-115.

Stabilizer Composition. An anti-settling agent shall be added at the rate of 2 pounds to each 100 gallons of finished paint.

An anti-skinning agent shall be added at the rate of 3 pounds to each 100 gallons of finished paint.

Chlorinated rubber stabilizer shall be propylene oxide or equal. This shall be added to the finished paint just before closing and sealing the drum. The proportion shall be 2 percent by weight of propylene oxide or equal based on the chlorinated rubber.

Vehicle Composition. The vehicle shall consist of medium drying oil phthalic alkyd resin, chlorinated paraffin, chlorinated rubber and methyl ethyl ketone. The vehicle, as separated from the pigment, shall have a nonvolatile content of at least 41.0 percent for white and 40.5 percent for yellow. Formulation of the vehicle, excluding solvents, shall be as follows:

42% alkyd resin solution
33% chlorinated rubber
25% chlorinated paraffin

Alkyd resin shall contain 33 to 37 percent phthalic anhydride and 48 to 55 percent oil acids based on the solid resin. The oil shall be of vegetable origin, either alkali-refined soybean oil or linseed oil or mixture of the two, with fatty acids having an iodine value of 115 minimum. The resin shall have an acid number of 8 maximum. No recovered oils or fatty acid derivatives shall be used. No oils or resin other than the above shall be present.

The alkyd resin solution shall be supplied at 60 plus or minus 1 percent solids in VM and P naphtha. The alkyd resin solution must tolerate 500 percent dilution with VM and P naphtha. A solution containing 100 grams of 20 centipoise chlorinated rubber, 130 grams of the 60 percent alkyd solution, and 290 grams of methyl ethyl ketone shall be clear, transparent and show no separation after 24 hours storage in a three-quarters full test tube at 80 plus or minus 5 degrees F.

The alkyd resin, at 45 percent solids basis (reduced from 60 percent solids with VM and P naphtha) shall have a Gardner color of 9 maximum and a Gardner viscosity of D to G. A cast film of the alkyd, 3 mils thick, shall set to touch in not more than 90 minutes.

Phthalic anhydride shall be determined in accordance with Federal Standard No. 141A, Method 7021.

Iodine number of fatty acids shall be determined in accordance with Federal Standard No. 141A, Method 5061.

Chlorinated rubber shall have the following properties:

	Minimum	Maximum
Fixed chlorine, % min	65.0	--
Color, Gardner, 20% by weight in toluene,	--	4
Viscosity, 20% by weight in toluene, cps	9	25

Chlorinated paraffin shall comply with Military Specifications C-429. The chlorinated paraffins may be Chlorafin 40 (Hercules Incorporated), Chlorowax 40 (Diamond), Cereclor 42 (ICI) or equal.

Methyl ethyl ketone shall conform to ASTM D 740.

Driers shall be 0.06 percent cobalt (metal) and 1.0 percent lead (metal) based on resin solids.

Paint Composition. White traffic paint, Type IV, when tested in accordance with Federal Test Method Standard No. 141A and applicable methods of tests, shall consist of:

	Minimum	Maximum
Pigment, % by weight, Method 4021	48.0	50.0
Vehicle, % by difference	50.0	52.0
Weight per gallon, lbs, Method 4184	11.9	--
Nonvolatile vehicle, % by weight	41.0	--
Total solids in paint, % by weight	69.5	--
Pigment composition, % by weight		
Titanium dioxide, ASTM D 476 Type III rutile, 94% minimum purity	34.0	36.0
Magnesium silicate, ASTM D 605	30.0	32.0
Calcium carbonate, ASTM D 1199 Type GC, Grade II	25.0	27.0
Zinc oxide, ASTM D 79	8.0	10.0

Yellow traffic paint, Type IV, when tested in accordance with Federal Test Method Standard No. 141A and applicable methods of tests, shall consist of:

	Minimum	Maximum
Pigment, % by weight, Method 4021	50.0	52.0
Vehicle, % by difference	48.0	50.0
Weight per gallon, lbs, Method 4184	12.4	--
Nonvolatile vehicle, % by weight	40.5	--
Total solids in paint, % by weight	70.5	--
Pigment composition, % by weight		
Medium chrome yellow, ASTM D 211 Type III	34.0	36.0
Magnesium silicate, ASTM D 605	11.0	13.0
Calcium carbonate, ASTM D 1199, Type GC, Grade II	53.0	55.0

The color shall match color chip No. 33538 of Federal Standard-595.

912.35 Glass Beads for Reflectorizing Traffic Paint. Glass beads for reflectorizing traffic paint shall conform to the following when tested in accordance with Section 990, NJDOT P-2.

Spherical Particles. The beads shall contain not less than 70 percent spherical particles. They shall be essentially free from sharp angular particles and particles showing milkiness or surface scoring or scratching.

Grading. The beads shall meet the following grading requirements:

Sieve Size Passing	Retained On	Percent by Weight
--	No. 16	0
No. 16	No. 20	0-2
No. 20	No. 30	5-28
No. 30	No. 50	35-65
No. 50	No. 100	15-40
No. 100	--	0-5

Index of Refraction. The beads when tested by the Liquid Immersion Method shall show an index of refraction within the range of 1.50 to 1.65.

Chemical Stability. Beads which shown any tendency toward decomposition, including surface etching, when exposed to atmospheric conditions, moisture dilute acids or alkalies or paint film constituents, shall be rejected.

Packaging. The beads shall be packaged in 50-pound moisture-resistant bags conforming to the packaging and marking requirements of AASHTO M 247.

912.36 Sampling and Testing Methods. Sampling and testing will be performed in accordance with Subsection 912.01 and the following:

Paint	
Driers	1 pint from each lot
Pigments	1 pint from each lot
Ready-mixed	Two 1-pint cans from each lot
Resin	1 pint from each lot
Stabilizers	1 pint from each lot
Thinners	1 quart from each lot
Varnish	1 pint from each lot
Vehicles	1 quart from each lot
Epoxy components	Sufficient quantities from each component to make 1 gallon
Glass beads	1 quart from each lot

SECTION 913 - PIPE

913.01 Aluminum Alloy Structural Plate for Pipe, Pipe Arches and Arches. Aluminum alloy structural plate pipe and the bolts and nuts shall conform to AASHTO M 219.

913.02 Bituminized Fiber Pipe. Bituminized fiber pipe shall conform to AASHTO M 177 for the specified diameters. Either Type TJ or Type BJ joint may be furnished.

913.03 Ductile Iron Culvert Pipe. Ductile iron culvert pipe shall conform to AASHTO M 64 or shall be ductile iron pipe conforming to ANSI Specification A 21.51 with push-on joint and Table 913-1 below:

Table 913-1 Ductile Iron Culvert Pipe

Nominal Inside Diameter inches	Thickness Class	Nominal Thickness inches	Nominal Weight Lbs per Ft
12	2	0.37	48.7
14	1	0.36	55.5
16	1	0.37	65.3
18	1	0.38	75.4
20	1	0.39	86.0
24	2	0.44	115.7
30	5	0.59	186.3
36	5	0.68	256.7
42	6	0.83	361.4
48	6	0.93	461.7
54	6	1.05	584.3

913.04 Ductile Iron Water Pipe. Ductile iron water pipe shall conform to ANSI Specification A 21.6, A 21.8 or A 21.51 as prescribed in the Supplementary Specifications. All pipe flanges and fittings shall conform to ANSI Specification B 16b, Class 250.

913.05 Concrete Pipe. Concrete pipe shall conform to the AASHTO Specifications cited below except that the concrete shall be made from portland cement conforming to ASTM C 150 and other materials conforming to the following Subsections:

Aggregates for Portland Cement Concrete 901.13
Water 919.15

Reinforced concrete culvert, storm drain and sewer pipe shall conform to AASHTO M 170.

Reinforced concrete culvert pipe shall be Class III, Wall B unless otherwise designated.

Elliptical reinforcing will not be permitted in circular pipe.

Reinforced concrete arch culvert storm drain and sewer pipe shall conform to AASHTO M 206.

Perforated concrete pipe shall conform to AASHTO M 175.

Porous concrete pipe shall conform to AASHTO M 176.

913.06 Corrugated Aluminum Alloy Culvert Pipe and Pipe Arches. Corrugated aluminum alloy culvert pipe and pipe arches shall conform to AASHTO M 196 for Types I and II, and the following:

Type I. The sheet metal gauge (thickness) for the various sizes of pipe shall be as specified below:

- Corrugated aluminum alloy culvert pipe and pipe arches shall be fabricated from 16 gauge (0.064 inch thick) sheet metal except where other gauges are designated.

Only helical corrugations will be permitted except that annular corrugations shall be used where designated.

The pipe shall be field jointed with locking bands conforming to AASHTO M 196 except that coupling bands with projections (dimples) are not permitted.

Type II. The sheet metal gauge (thickness) shall conform to that of the equivalent size of Type I pipe.

913.07 Corrugated Aluminum Alloy Underdrain Pipe. Corrugated aluminum alloy underdrain pipe shall conform to AASHTO M 196 for Type III.

The sheet metal gauge (thickness) for the various sizes as listed below shall be as follows:

Size (Diameter)	Gauge (Thickness)
6"	18 (0.048")
8"	18 (0.048")

913.08 Corrugated Steel Culvert Pipe and Pipe Arches. Corrugated steel culvert pipe and pipe arches shall conform to AASHTO M 36 for Types I and II.

Special sections, such as elbows and flared end sections shall be of the same gauge as the conduit to which they are joined, and shall conform to AASHTO M 36.

Type I. The sheet metal gauge (thickness) for the various sizes of pipe shall be as follows:

- Corrugated steel culvert pipe and pipe arches shall be fabricated from 14 gauge (0.079 inch thick) sheet metal except where other gauges are designated.

Only helical corrugations will be permitted for Type I pipe except that annular corrugations shall be used where designated.

The pipe shall be field jointed with locking bands conforming to AASHTO M 36 except that coupling bands with projections (dimples) are not permitted.

Corrugated steel culvert pipe and coupling bands, elbows and flared end sections shall have a polymeric coating as specified in AASHTO M 246, Type B, (interior 0.010 inches and exterior 0.003 inches).

For testing coated pipe, a section of pipe of the specified diameter and length shall be furnished upon request.

Type II. The sheet metal gauge (thickness) shall conform to that of the equivalent size of Type I pipe.

Corrugated steel culvert pipe and coupling bands, elbows and flared end section shall have a polymeric coating as specified in AASHTO M 246, Type B, (interior 0.010 inches and exterior 0.003 inches).

For testing coated pipe, a section of pipe of the specified diameter and length shall be furnished upon request.

913.09 Corrugated Steel Sewer Pipe and Pipe Arches. Corrugated steel sewer pipe and pipe arches shall conform to AASHTO M 190, Type D.

913.10 Corrugated Steel Underdrain Pipe. Corrugated steel underdrain pipe shall conform to AASHTO M 36 for Type III .

The sheet metal gauge (thickness) for the various sizes as listed below shall be as follows:

Size (Diameter)	Gauge (Thickness)
6"	18 (0.052")
8" and larger	16 (0.064")

Corrugated steel underdrain pipe shall be bituminous coated or polymeric coated. When polymeric coating is used, the pipe and coupling bands shall conform to AASHTO M 246, Type B (interior 0.010 and exterior 0.003 inches). When bituminous coating is used, pipe and coupling bands shall conform to AASHTO M 190, Type A.

913.11 Fiberglass Pipe. Fiberglass pipe and fittings shall conform to ASTM D 2996 Designation Code RTRP-11AE-5112. Pipe and fittings with Class C or Class F liners are acceptable. The finish color shall be concrete gray.

913.12 Plastic Drainage Pipe. Corrugated polyethylene drainage pipe shall conform to AASHTO M 252. Polyvinyl chloride (PVC) drainage pipe shall conform to ASTM D 2729.

913.13 Semicircular Steel Pipe for Underdrains. Semicircular steel pipe for underdrains shall conform to AASHTO M 36 for Type III, A. Pipe and connecting bands shall be bituminous coated or polymer coated. Bituminous coating shall be in accordance with AASHTO M 190, Type A. Polymer coating shall be in accordance with AASHTO M 246, Type B (interior 0.010 inches and exterior 0.003 inches).

913.14 Steel Alloy Pipe for Bridge Storm Drains. Steel alloy pipe and fittings shall be of alloy steel conforming to the chemical analysis of ASTM A 333, Grade 9. Ductile iron pipe conforming to ASTM A 377 (ANSI A 21.51) may be furnished as an alternate. The pipe shall be zinc coated (galvanized) in accordance with ASTM A 123. Steel pipe and fitting shall be connected by welding prior to galvanizing.

Ductile iron pipe fittings shall conform to ASTM A 48, Class 30. Pipe bends shall be of the long radius type. Pipe joints shall be formed using groove-type couplings consisting of a housing clamp keyed into a groove cut around the full pipe circumference. A gasket of molded or extruded butyl or EPDM shall be provided to create a

sealed joint. Bolts shall be of track type conforming to ASTM A 183 with oval necks and heavy hexagon standard nuts. The assembly shall be painted in accordance with Subsection 503.15, Subpart *(a)*. First finish coat color shall be off-gray.

913.15 Structural Steel Plate for Pipe, Pipe Arches and Arches. Conduits, bolts and nuts for connecting plates shall conform to AASHTO M 167.

913.16 Vitrified Clay Pipe. Clay pipe shall be standard strength, extra strength, standard strength perforated and extra strength perforated and shall conform to AASHTO M 65.

913.17 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the appropriate AASHTO and ASTM methods and the following:

Corrugated steel culvert pipe and pipe arches	In accordance with Subsection 913.08

913.18 Certification of Compliance. Manufacturer's certification for all pipe shall be submitted in accordance with Subsection 106.04.

SECTION 914 - PORTLAND CEMENT CONCRETE, MORTAR AND GROUT

914.01 Composition of Portland Cement Concrete. Portland cement concrete shall be composed of portland cement, coarse aggregate, fine aggregate, admixtures and water. Portland cement concrete except white concrete may include fly ash.

Materials shall conform to the following Subsections:

Aggregates	901.13
Admixtures:	
Air-Entraining	905.01
Chemical	905.02
Fly Ash	919.07
Portland Cement	919.11
Water	919.15

A water-reducing admixture may be used. A water-reducing and retarding admixture or a water-reducing admixture and a retarding admixture may be used when the ambient temperature reaches 75 degrees F.

For bridge deck slabs, parapets and bridge sidewalk slabs, the use of these admixtures shall be in accordance with Subsection 501.03.

914.02 Portland Cement Concrete Design, Control and Acceptance Testing Requirements.

(a) General Requirements. The coarse aggregate size, slump, and entrained air for each item and class of concrete shall be as specified in Subsection 914.05, Tables 914-1 and 914-2. The concrete shall be designed to conform to Subsection 914.05, Table 914-3. Any of the coarse aggregate sizes in Subsection 914.05, Tables 914-1 and 914-2 may be used for a particular type of construction. Coarse aggregate sizes 357 and 467 shall be produced by weight proportioning directly into the mixer from sizes 3 and 57, and sizes 4 and 67 respectively. Conformance to gradation will be determined on the basis of separate tests on the component sizes prior to proportioning. If the size selected creates a clearance problem with reinforcement steel, a smaller size aggregate shall be used.

(b) *Proportioning and Verification.* At least 45 days prior to the start of concrete placement, trial batches of concrete shall be prepared of the same materials and proportions proposed for use on the Project.

The designs shall be computed and set up in accordance with ACI Standard 211.1 or 211.2, as applicable. Each mix design shall be submitted on portland cement concrete mix design forms furnished by the Department giving the source of materials and test data.

Department personnel shall be present at the time of verification batching to confirm that the proportions and ingredients batched are in accordance with the proposed mix designs. At least six 6 by 12 inch compression test cylinders shall be prepared from each batch and cured in accordance with AASHTO T 23 or AASHTO T 126. Within 2 to 5 days after molding, the cylinders shall be delivered to the Department Laboratory where testing will be performed for 7 and 28 day compressive strength.

At least one trial mix shall be designed to equal or exceed the required verification strengths listed in Subsection 914.05, Table 914-3 for each class of concrete included on the Project. A single mix design may satisfy the requirements for more than one class of concrete and any mix design failing to meet a specific verification requirement may later be approved for use on the Project if the field strengths and degree of quality control warrant.

At the Department's option, verification may be done on an annual basis for a concrete plant rather than on a project-to-project basis provided the properties and proportions of the materials do not change. If the job is the continuation of work in progress during the previous construction season and written verification is submitted that the same source and character of materials are to be used, the Engineer may waive the requirement for the design and verification of previously approved mixes.

Concrete furnished on the Project shall conform to the approved mix design. If another previously approved mix design is to be used, the Engineer shall be notified at least 1 day prior to such change.

Change in the sources, types or proportions of materials shall not be made until approved and the requirements for verification specified herein have been satisfied. The Engineer may waive this requirement if the materials, other than portland cement, or proportions are not appreciably different from those used with a previously approved mix design.

The requirement to verify a new design as a result of a change in the source of portland cement may be waived only by the Engineer.

Classes A, B and C concrete may be designed to achieve early strength requirements by increasing the cement content. Alternatively, an existing approved mix design may serve as a high-early-strength mix. Additional verification tests for high-early-strength mixes are not required but will be performed if requested. Before actual loading is applied in the field, the requirements of Subsections 405.19 and 501.24 shall be met.

If fly ash is added, its weight shall not exceed 15 percent of the minimum cement content and shall not be greater than 125 percent of the weight of cement replaced.

The combined weight of fly ash and cement content shall be used to determine compliance with the cement factor and water-cement ratio requirements listed in Subsection 914.05, Table 914-3.

914.02

If it is the opinion of the Engineer that the mix properties are such that concrete of unacceptable quality is likely to be produced, the work may be ordered stopped until the cause has been determined and the necessary corrective action has been taken. The corrective action may range from a minor adjustment of proportions to the establishment of a new mix design.

(c) *Acceptance Testing Procedures for Slump and Air Entrainment.* The Engineer will perform sampling and testing for slump and air entrainment.

Slump and air-entrainment tests are at the rate specified for strength tests in Subsection 914.05, Table 914-4 and will be performed on the same samples of material from which the compressive test cylinders have been molded. While these tests are being performed, discharge from the truck is to be halted. Discharge from other trucks not scheduled for test may proceed.

For slump or air entrainment or both, if the measured value is outside the ranges specified in Subsection 914.05, Table 914-1 or 914-2, a second test will be performed on a different portion of material from the same load. If the average of the two test results for either slump or air entrainment exceeds the upper limit, the load of concrete will be rejected and removed from the Project site. If the average of the two test results for either slump or air-entrainment falls below the lower specification limit, a single addition of mix water or air-entraining agent or both will be permitted provided that this additional step can be accomplished without exceeding the time or revolution limits specified in Subsection 405.08. When an air-entraining agent is added, it shall be diluted with water prior to addition to the drum. Following the addition of mix water or air-entraining agent or both, the drum shall be rotated at the recommended mixing speed for a minimum of 20 revolutions.

Following the addition of either mix water or air-entraining agent or both, the original test results are to be disregarded and a single test for both slump and air entrainment will be performed. Further additions of mix water or air-entraining agent will not be permitted. If the measured values for slump and air entrainment are not within the ranges specified in Subsection 914.05, Tables 914-1 and 914-2, the load of concrete will be rejected and removed from the Project site.

Each truck load of concrete containing fly ash will be tested for slump and air entrainment. Except for concrete containing fly ash used in prestressed beams and superstructure concrete (deck slabs, sidewalks and parapets), the rate of testing for slump and air entrainment may be reduced if, in the opinion of the Engineer, uniformity is achieved.

(d) *General Acceptance Testing Requirements for Strength.* The Engineer will perform sampling and testing for strength.

A sufficient number of curing facilities for the storage and curing of concrete test cylinders on the Project site for the first 24 hours, as required by AASHTO T 23, shall be provided for the sole use of the Engineer. The curing facilities shall be provided with a minimum-maximum thermometer and shall be securable with lock and key.

An initial strength test result is defined in Subsection 914.05, Table 914-4. The required rate of sampling and the acceptance testing criteria of Subsection 914.05, Table 914-4 must be met. If either of the cylinders comprising a test shows definite evidence (other than low strength) of improper sampling, molding, handling, curing or testing, it is to be discarded and the strength of the remaining cylinder then is considered the test result. If the difference in compressive strength between two cylinders comprising a test equals or exceeds 600 pounds per square inch, the lower value is to be

disregarded and the higher value is taken as the test result. If both cylinders comprising a test must be discarded, the lot will be evaluated on the basis of the reduced number of tests. If a batch of concrete from which compression cylinders have been prepared is rejected because it fails to meet the slump or air-entrainment requirements of this Subsection, the cylinders obtained from that batch will be discarded.

If additional unscheduled compression cylinders are taken, as permitted by Subsection 106.03, they are to be included with the regularly scheduled compression cylinders and the lot will be evaluated on the basis of the increased number of tests.

(e) *Acceptance Testing for Strength for Pay-Adjustment Items.* The list of concrete pay items, if any, which are subject to pay adjustment and the base prices may be found in the Bridge portion of the Supplementary Specifications.

The amount of pay adjustment in dollars is the product of the item base price times the lot quantity times the percent pay adjustment. The percent pay adjustment is given by Equation (1).

Equation (1):

$$PPA = 2.0 - 0.2\ PD$$

In which

PPA = Percent Pay Adjustment

PD = Percent Defective (Estimate of percent of lot below the class design strength by the use of Equation (2) and Subsection 914.05, Table 914-5)

Equation (2):

$$Q = (\text{Average Lot Strength} - \text{Class Design Strength}) \div S$$

In which

Q = Quality index for pay adjustment computations

S = Standard deviation of the strength test results for the lot as computed by Equation (3)

Equation (3):

$$S = \sqrt{\frac{\Sigma (Xi - ALS)^2}{(N - 1)}}$$

In which

Σ = Summation

Xi = Individual test result (Average strength of a test cylinder pair)

ALS = Average lot strength

N = Number of test results for the lot

Note - When only a single test result is available, the standard deviation is assumed to be S = 300 psi.

When it is necessary to estimate the percentage of material below the retest limit to check the rejection criteria in Subsection 914.05, Table 914-4, Equation (4) is used with Subsection 914.05, Table 914-5. All other terms are as previously defined.

Equation (4):

$$Q_{reject} = (\text{Average Lot Strength} - \text{Retest Limit}) \div S$$

Provided that no individual test result falls below the retest limit (psi) listed in Subsection 914.05, Table 914-4, the acceptability of a lot is based upon the estimated percentage of concrete having a 28-day compressive strength less than the class design strength specified in Subsection 914.05, Table 914-3. To be eligible for 100 percent payment, a lot must have no more than 10 percent of the material below the class design strength.

For lots with percent defective levels less than 10 percent, Equation (1) awards positive pay adjustments to be added to the Contract price. For lots having percent defective levels greater than 10 percent but not exceeding the rejection limit in Subsection 914.05, Table 914-4, Equation (1) assesses negative pay adjustments to be subtracted from the Contract price.

Whenever an initial test result falls below the retest limit in Subsection 914.05, Table 914-4, the concrete will be re-evaluated by coring or other suitable means. When this provision is applied to Class P concrete, each beam or pile in the steam bed will be evaluated separately.

When re-evaluation is accomplished by a method other than coring, the results will be used only to determine what further action is to be taken. If any of the non-core tests results are below the class design strength, the Engineer has the option to core. If this option is waived, the Contractor may elect to core, at no cost to the State, or to accept the pay adjustment computed from the initial cylinder tests. If the Contractor elects to core, the coring shall be performed as directed and the Department will test the cores. If none of the non-core test results is below the class design strength, the Engineer may elect either to core or to accept the lot at 100 percent payment.

When cores are taken, final disposition of the lot is based on the core results. Pay adjustment will be computed using the core test results provided that the estimated percentage of material below the retest limit does not exceed the maximum allowable percentage in Subsection 914.05, Table 914-4. If the maximum allowable percentage is exceeded, the Engineer may:

(1) Require the Contractor to remove and replace the defective lot at no cost to the State,

(2) Allow the Contractor to leave the defective lot in place and receive a percent pay adjustment (PPA) of minus 50 percent, or

(3) Allow the Contractor to submit of a plan, for approval, for corrective action to be performed at no cost to the State. If the plan for corrective action is not approved, either option (1) or (2) may be applied.

(f) Acceptance Testing for Strength for Non-Pay-Adjustment Items. This Subpart applies to all concrete items in Subsection 914.05, Tables 914-1 and 914-2 that are not subject to pay adjustment and other requirements in accordance with Subpart *(e)* and that are not accepted on the basis of Certificates of Compliance. The lot is eligible for 100 percent payment provided that all initial test results equal or exceed the retest limit for non-pay-adjustment items in Subsction 914.05, Table 914-4. Whenever one or more individual test results fall below the retest limit, the lot will be re-evaluated by coring or other suitable means and is subject to pay adjustment and all other provisions in accordance with Subpart *(e)* except that the amount of pay adjustment is the product of the unit bid price times the lot quantity times the percent pay adjustment given by Equation (1).

914.03 Mortar and Grout. Mortar and grout shall consist of one part portland cement to two parts fine aggregate unless otherwise specified. Water shall be added to form the proper consistency. Mortar and grout shall not be retempered or used after it has begun to set.

Materials shall conform to the following Subsections:

Aggregates	901.13
Portland Cement	919.11
Water	919.15

Where nonmetallic or nonshrink grout is specified, the grout shall conform to the Corps of Engineers CDR-C 621 with the following amendments:

- The grout shall be of a plastic consistency.
- The color of the hardened grout, where visible, shall match the color of the adjacent hardened concrete.
- The minimum compressive strength of 2-inch cubes when cured shall be as follows:

Curing Procedure	Strength (PSI)
24 hour air cure at 75° F	2500
7 day air cure at 75° F	6000
7 day air cure, 10 day water submersion	6000
7 day air cure, 24 hour water submersion, 25 cycles freeze-thaw	6000

The grout shall have a minimum working life of 30 minutes from the time the water is added and shall contain not more than 0.05 percent chlorides or 5.0 percent sulfates by weight.

The grout shall not contain any corrosion-promoting agents.

Epoxy and other types of nonmetallic or nonshrink grout may be used.

914.04. Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

AASHTO

T 22	Compressive Strength of Cylindrical Concrete Specimens (Including the Annex providing for use of neoprene caps)
T 23	Making and Curing Concrete Test Specimens in the Field
T 24	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
T 119	Slump of Portland Cement Concrete
T 121	Weight Per Cubic Foot, Yield and Air Content (Gravimetric) of Concrete
T 126	Making and Curing Concrete Test Specimens in the Laboratory
T 141	Sampling Fresh Concrete
T 152	Air Content of Freshly Mixed Concrete by the Pressure Method
T 196	Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM

C 567	Unit Weight of Structural Lightweight Concrete
C 311	Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete. (See note)
	Note - The Department may modify the sampling rate for individual and composite samples.

NJDOT

C-1	Determination of Yield of Concrete Produced by Continous-Mixing-Type Truck Mixers

914.05 Tables. Tables referenced in the Specifications are as follows:

Table 914-1 Requirements for Roadway Concrete Items

Cast-In-Place Items	Conc Class	Slump (Inch)	Percent Air Entrainment for Coarse Aggregate Size Numbers 357	467	57	67	8
Surface Course, Bridge Approach Slabs, Bridge Approach Transition Slabs	B	2 ± 1	5.0 ± 1.5	5.0 ± 1.5	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Base Course	C	2 ± 1	5.0 ± 1.5	5.0 ± 1.5	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Inlet & Manhole Walls, Headwalls, Misc Conc	C	3 ± 1	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Inlet & Manhole Top Slabs, Sidewalks, Driveways, Islands	B	3 ± 1	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Slope Gutters, Vertical Curb, Sloping Curb, Barrier Curb & Base	B	4 ± 1	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
White Concrete Vertical, Sloping & Barrier Curb, White Concrete Islands	B	4 ± 1	---	---	7.0 ± 2.0	7.0 ± 2.0	8.0 ± 2.0
Foundations for:							
Inlets & Manholes	C	3 ± 1	6.5 max	6.5 max	7.5 max	7.5 max	8.5 max
Electrical Items	C	3 ± 1	---	---	7.5 max	7.5 max	8.5 max
Signs	B	3 ± 1	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Junction Boxes	C	3 ± 1	---	---	7.5 max	7.5 max	8.5 max

914.05

Table 914-1 (Continued)

Cast-in Place Items	Conc Class	Slump (Inch)	Percent Air Entrainment for Coarse Aggregate Size Numbers 357	467	57	67	8
Footings for: Fence Posts Guide Rail End Treatment	C	3 ± 1	---	---	7.5 max	7.5 max	8.5 max
Culverts	A	3 ± 1	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Monuments	A	3 ± 1	---	---	7.5 max	7.5 max	8.5 max
Slope Protection	C	2 ± 1	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Precast Items							
Culverts	A	3 ± 1	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Inlets & Manholes, Junction Boxes, Headwalls	B	3 ± 1	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
White Concrete Barrier Curb	B	3 ± 1	---	---	7.0 ± 2.0	7.0 ± 2.0	8.0 ± 2.0

914.05

Table 914-2 Requirements for Structural Concrete Items

Cast-in-Place Items	Conc Class	Slump (Inch)	Percent Air Entrainment for Coarse Aggregate Size Numbers 357	4	467	57	67	8
Nonreinforced Footings	B	3 ± 1	6.5 max	6.5 max	6.5 max	7.5 max	7.5 max	8.5 max
Reinforced Footings	B	3 ± 1	---	---	6.5 max	7.5 max	7.5 max	8.5 max
Abutments, Walls Solid Shaft Piers, Pylons	B	3 ± 1	---	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
White Concrete Barrier Curb, Bridge	B	4 ± 1	---	---	---	7.0 ± 2.0	7.0 ± 2.0	8.0 ± 2.0
Piles	B	3 ± 1	---	---	---	7.5 max	7.5 max	8.5 max
Columns and Caps for Piers, Arch Spans, Rigid Frames, Culverts	A	3 ± 1	---	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Decks, Sidewalks, Concrete Patch, Parapets, Curbs	A	3 ± 1	---	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Seal (Tremie) Concrete	S	7 ± 2	---	---	---	7.5 max	7.5 max	8.5 max
Prestressed Items								
Beams	P, P-1 & P-2	2 ± 1	---	---	---	5.0 ± 1.5	5.0 ± 1.5	5.0 ± 1.5
Piles	P	2 ± 1	---	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Precast Items								
Crib Wall Members	A	3 ± 1	---	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Piles	B	3 ± 1	---	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Culverts	P	3 ± 1	---	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5
Modular Bin Units	P	2 ± 1	---	---	---	6.0 ± 1.5	6.0 ± 1.5	7.0 ± 1.5

Table 914-3 Mix Design Requirements

	Class of Concrete						
	A	**B**	**C**	**S**	**P**	**P-1**	**P-2**
Class Design Strength (28 days, psi)	4200	3700	3200	2000	5500	6000	6500
Verification Strength (28 days, psi)	5000	4500	4000	---	6000	6500	7000
Maximum Water/Cement Ratio							
lb/lb	0.443	0.488	0.532	0.577	Note 1	Note 1	Note 1
gals/bag	5.0	5.5	6.0	6.5	Note 1	Note 1	Note 1
Minimum Cement Content							
lb/cy	611	564	517	658	Note 1	Note 1	Note 1
bags/cy	6.5	6.0	5.5	7.0	Note 1	Note 1	Note 1

Note 1 - In accordance with PCI Manual

Table 914-4 Lot Sizes, Sampling Rates, Retest and Rejection Limits

	Class of Concrete						
	A	B	C	S	P	P-1	P-2
Lot Size, Maximum	One Day's Production				One Day's Production of a Single Steam Bed		
Pay-Adjustment Items							
Initial Sampling Rate	6/Lot	5/Lot	4/Lot	---	6/Lot	6/Lot	6/Lot
Retest Limit, psi	3600	3000	3000	2000	5000	5500	6000
Retest Sampling Rate, min	6/Lot	6/Lot	6/Lot	6/Lot	6/unit or Load Test		
Rejection Limit, percent	10	10	20	20	5	5	5
Non-Pay-Adjustment Items							
Initial Sampling Rate	3/Lot	2/Lot	1/Lot	1/Lot	---	---	---
Retest Limit, psi	4000	3600	3100	2000	---	---	---

Note 1 - The lot sizes are maximums and, at the option of the Engineer, any lot may be subdivided into two or more smaller lots. When such a subdivision is made, the specified sampling rate applies to each of the smaller lots.

Note 2 - An initial strength test result is defined as the average strength of two 6 x 12 inch compression test cylinders, cured for 28 days, and tested in the Department Laboratory except for Classes P, P-1 and P-2 cylinders which may be tested at the fabricator's plant under the supervision of the Engineer.

Note 3 - A retest result is defined as the strength of an individual test result obtained by coring or other suitable means.

Note 4 - The specified sampling rates shall apply except that no more than one test per truckload or batch of concrete will be required. At the option of the Engineer, lots consisting of fewer than three truckloads or batches, or containing 20 cubic yards or less, may be accepted without strength tests.

Note 5 - No lot shall include more than one class of concrete nor include concrete of the same class having different specified levels of slump or air entrainment.

Note 6 - For prestressed concrete, if more than one bed is used or if more than 80 cubic yards of concrete are used, the production shall be subdivided as equally as possible into 2 or more lots.

Table 914-5 Estimation of Lot Percent Defective

Variability-Known Procedure **Standard Deviation Method**

Sample Size
1

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	48.98	47.96	46.94	45.92	44.90	43.88	42.86	41.84	40.82
0.1	39.80	38.78	37.76	36.73	35.71	34.69	33.67	32.65	31.63	30.61
0.2	29.59	28.57	27.55	26.53	25.51	24.49	23.47	22.45	21.43	20.41
0.3	19.39	18.37	17.35	16.33	15.31	14.29	13.27	12.24	11.22	10.20
0.4	9.18	8.16	7.14	6.12	5.10	4.08	3.06	2.04	1.02	0.00

Note 1 - Numbers in the body of the table are estimates of lot percent defective corresponding to specific values of Q, the Quality Index. For values of Q greater than or equal to zero, the estimate of percent defective is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100.

Note 2 - This empirically derived table is suitable only for use with this specification.

Variability-Unknown Procedure **Standard Deviation Method**

Sample Size
2

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.66	49.33	48.99	48.66	48.32	47.99	47.65	47.32	46.98
0.1	46.64	46.31	45.97	45.64	45.30	44.97	44.63	44.30	43.96	43.62
0.2	43.29	42.95	42.62	42.28	41.95	41.61	41.28	40.94	40.60	40.27
0.3	39.93	39.60	39.26	38.93	38.59	38.26	37.92	37.58	37.25	36.91
0.4	36.58	36.24	35.91	35.57	35.23	34.90	34.56	34.23	33.89	33.56
0.5	33.22	32.89	32.55	32.21	31.88	31.54	31.21	30.87	30.54	30.20
0.6	29.87	29.53	29.19	28.86	28.52	28.19	27.85	27.52	27.18	26.85
0.7	26.51	26.17	25.84	25.50	25.17	24.83	24.50	24.16	23.83	23.49
0.8	23.15	22.82	22.48	22.15	21.81	21.48	21.14	20.81	20.47	20.13
0.9	19.80	19.46	19.13	18.79	18.46	18.12	17.79	17.45	17.11	16.78
1.0	16.44	16.11	15.77	15.44	15.10	14.77	14.43	14.09	13.76	13.42
1.1	13.09	12.75	12.42	12.08	11.75	11.41	11.07	10.74	10.40	10.07
1.2	9.73	9.40	9.06	8.72	8.39	8.05	7.72	7.38	7.05	6.71
1.3	6.38	6.04	5.70	5.37	5.03	4.70	4.36	4.03	3.69	3.36
1.4	3.02	2.68	2.35	2.01	1.68	1.34	1.01	0.67	0.34	0.00

Note 1 - Numbers in the body of the table are estimates of lot percent defective corresponding to specific values of Q, the Quality Index. For values of Q greater than or equal to zero, the estimate of percent defective is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100.

Note 2 - This empirically derived table is suitable only for use with this specification

Table 914-5 (Continued)

Variability-Unknown Procedure **Standard Deviation Method**

Sample Size
3

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.72	49.45	49.17	48.90	48.62	48.35	48.07	47.79	47.52
0.1	47.24	46.96	46.69	46.41	46.13	45.85	45.58	45.30	45.02	44.74
0.2	44.46	44.18	43.90	43.62	43.34	43.05	42.77	42.49	42.20	41.92
0.3	41.63	41.35	41.06	40.77	40.49	40.20	39.91	39.62	39.33	39.03
0.4	38.74	38.45	38.15	37.85	37.56	37.26	36.96	36.66	36.35	36.05
0.5	35.75	35.44	35.13	34.82	34.51	34.20	33.88	33.57	33.25	32.93
0.6	32.61	32.28	31.96	31.63	31.30	30.97	30.63	30.30	29.96	29.61
0.7	29.27	28.92	28.57	28.22	27.86	27.50	27.13	26.76	26.39	26.02
0.8	25.64	25.25	24.86	24.47	24.07	23.67	23.26	22.84	22.42	21.99
0.9	21.55	21.11	20.66	20.19	19.73	19.25	18.75	18.25	17.74	17.21
1.0	16.67	16.11	15.53	14.93	14.31	13.66	12.98	12.27	11.51	10.71
1.1	9.84	8.89	7.82	6.60	5.08	2.87	0.00	0.00	0.00	0.00

Note 1 - Numbers in the body of the table are estimates of lot percent defective corresponding to specific values of Q, the Quality Index. For values of Q greater than or equal to zero, the estimate of percent defective is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100.

Table 914-5 (Continued)

Variability-Unknown Procedure **Standard Deviation Method**

Sample Size
4

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.67	49.33	49.00	48.67	48.33	48.00	47.67	47.33	47.00
0.1	46.67	46.33	46.00	45.67	45.33	45.00	44.67	44.33	44.00	43.67
0.2	43.33	43.00	42.67	42.33	42.00	41.67	41.33	41.00	40.67	40.33
0.3	40.00	39.67	39.33	39.00	38.67	38.33	38.00	37.67	37.33	37.00
0.4	36.67	36.33	36.00	35.67	35.33	35.00	34.67	34.33	34.00	33.67
0.5	33.33	33.00	32.67	32.33	32.00	31.67	31.33	31.00	30.67	30.33
0.6	30.00	29.67	29.33	29.00	28.67	28.33	28.00	27.67	27.33	27.00
0.7	26.67	26.33	26.00	25.67	25.33	25.00	24.67	24.33	24.00	23.67
0.8	23.33	23.00	22.67	22.33	22.00	21.67	21.33	21.00	20.67	20.33
0.9	20.00	19.67	19.33	19.00	18.67	18.33	18.00	17.67	17.33	17.00
1.0	16.67	16.33	16.00	15.67	15.33	15.00	14.67	14.33	14.00	13.67
1.1	13.33	13.00	12.67	12.33	12.00	11.67	11.33	11.00	10.67	10.33
1.2	10.00	9.67	9.33	9.00	8.67	8.33	8.00	7.67	7.33	7.00
1.3	6.67	6.33	6.00	5.67	5.33	5.00	4.67	4.33	4.00	3.67
1.4	3.33	3.00	2.67	2.33	2.00	1.67	1.33	1.00	0.67	0.33
1.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note 1 - Numbers in the body of the table are estimates of lot percent defective corresponding to specific values of Q, the Quality Index. For values of Q greater than or equal to zero, the estimate of percent defective is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100.

Table 914-5 (Continued)

Variability-Unknown Procedure **Standard Deviation Method**

Sample Size
5

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.64	49.29	48.93	48.58	48.22	47.86	47.51	47.15	46.80
0.1	46.44	46.09	45.73	45.38	45.02	44.67	44.31	43.96	43.60	43.25
0.2	42.90	42.54	42.19	41.84	41.48	41.13	40.78	40.43	40.08	39.72
0.3	39.37	39.02	38.67	38.32	37.97	37.62	37.28	36.93	36.58	36.23
0.4	35.88	35.54	35.19	34.85	34.50	34.16	33.81	33.47	33.12	32.78
0.5	32.44	32.10	31.76	31.42	31.08	30.74	30.40	30.06	29.73	29.39
0.6	29.05	28.72	28.39	28.05	27.72	27.39	27.06	26.73	26.40	26.07
0.7	25.74	25.41	25.09	24.76	24.44	24.11	23.79	23.47	23.15	22.83
0.8	22.51	22.19	21.87	21.56	21.24	20.93	20.62	20.31	20.00	19.69
0.9	19.38	19.07	18.77	18.46	18.16	17.86	17.55	17.25	16.96	16.66
1.0	16.36	16.07	15.78	15.48	15.19	14.91	14.62	14.33	14.05	13.76
1.1	13.48	13.20	12.93	12.65	12.37	12.10	11.83	11.56	11.29	11.02
1.2	10.76	10.50	10.23	9.97	9.72	9.46	9.21	8.96	8.71	8.46
1.3	8.21	7.97	7.73	7.49	7.25	7.02	6.79	6.56	6.33	6.10
1.4	5.88	5.66	5.44	5.23	5.02	4.81	4.60	4.39	4.19	3.99
1.5	3.80	3.61	3.42	3.23	3.05	2.87	2.69	2.52	2.35	2.19
1.6	2.03	1.87	1.72	1.57	1.42	1.28	1.15	1.02	0.89	0.77
1.7	0.66	0.55	0.45	0.36	0.27	0.19	0.12	0.06	0.02	0.00

Note 1 - Numbers in the body of the table are estimates of lot percent defective corresponding to specific values of Q, the Quality index. For values of Q greater than or equal to zero, the estimate of percent defective is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100.

914.05

Table 914-5 (Continued)

Variability-Unknown Procedure **Standard Deviation Method**

Sample Size
6

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.63	49.27	48.90	48.53	48.16	47.80	47.43	47.06	46.70
0.1	46.33	45.96	45.60	45.23	44.86	44.50	44.13	43.77	43.40	43.04
0.2	42.68	42.31	41.95	41.59	41.22	40.86	40.50	40.14	39.78	39.42
0.3	39.06	38.70	38.34	37.98	37.62	37.27	36.91	36.55	36.20	35.84
0.4	35.49	35.14	34.79	34.43	34.08	33.73	33.38	33.04	32.69	32.34
0.5	32.00	31.65	31.31	30.96	30.62	30.28	29.94	29.60	29.26	28.93
0.6	28.59	28.25	27.92	27.59	27.26	26.92	26.60	26.27	25.94	25.61
0.7	25.29	24.96	24.64	24.32	24.00	23.68	23.37	23.05	22.74	22.42
0.8	22.11	21.80	21.49	21.18	20.88	20.57	20.27	19.97	19.67	19.37
0.9	19.07	18.78	18.49	18.19	17.90	17.61	17.33	17.04	16.76	16.48
1.0	16.20	15.92	15.64	15.37	15.09	14.82	14.55	14.29	14.02	13.76
1.1	13.50	13.24	12.98	12.72	12.47	12.22	11.97	11.72	11.47	11.23
1.2	10.99	10.75	10.51	10.28	10.04	9.81	9.58	9.36	9.13	8.91
1.3	8.69	8.48	8.26	8.05	7.84	7.63	7.42	7.22	7.02	6.82
1.4	6.63	6.43	6.24	6.05	5.87	5.68	5.50	5.33	5.15	4.98
1.5	4.81	4.64	4.47	4.31	4.15	4.00	3.84	3.69	3.54	3.40
1.6	3.25	3.11	2.97	2.84	2.71	2.58	2.45	2.33	2.21	2.09
1.7	1.98	1.87	1.76	1.66	1.55	1.45	1.36	1.27	1.18	1.09
1.8	1.01	0.93	0.85	0.78	0.71	0.64	0.57	0.51	0.46	0.40
1.9	0.35	0.30	0.26	0.22	0.18	0.15	0.12	0.09	0.07	0.05
2.0	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note 1 - Numbers in the body of the table are estimates of lot percent defective corresponding to specific values of Q, the Quality Index. For values of Q greater than or equal to zero, the estimate of percent defective is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100.

Table 914-5 (Continued)

Variability-Unknown Procedure **Standard Deviation Method**

Sample Size
7

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.63	49.25	48.88	48.50	48.13	47.75	47.38	47.01	46.63
0.1	46.26	45.89	45.51	45.14	44.77	44.40	44.03	43.65	43.28	42.91
0.2	42.54	42.17	41.80	41.44	41.07	40.70	40.33	39.97	39.60	39.23
0.3	38.87	38.50	38.14	37.78	37.42	37.05	36.69	36.33	35.98	35.62
0.4	35.26	34.90	34.55	34.19	33.84	33.49	33.13	32.78	32.43	32.08
0.5	31.74	31.39	31.04	30.70	30.36	30.01	29.67	29.33	28.99	28.66
0.6	28.32	27.98	27.65	27.32	26.99	26.66	26.33	26.00	25.68	25.35
0.7	25.03	24.71	24.39	24.07	23.75	23.44	23.12	22.81	22.50	22.19
0.8	21.88	21.58	21.27	20.97	20.67	20.37	20.07	19.78	19.48	19.19
0.9	18.90	18.61	18.33	18.04	17.76	17.48	17.20	16.92	16.65	16.37
1.0	16.10	15.83	15.56	15.30	15.03	14.77	14.51	14.26	14.00	13.75
1.1	13.49	13.25	13.00	12.75	12.51	12.27	12.03	11.79	11.56	11.33
1.2	11.10	10.87	10.65	10.42	10.20	9.98	9.77	9.55	9.34	9.13
1.3	8.93	8.72	8.52	8.32	8.12	7.92	7.73	7.54	7.35	7.17
1.4	6.98	6.80	6.62	6.45	6.27	6.10	5.93	5.77	5.60	5.44
1.5	5.28	5.13	4.97	4.82	4.67	4.52	4.38	4.24	4.10	3.96
1.6	3.83	3.69	3.57	3.44	3.31	3.19	3.07	2.95	2.84	2.73
1.7	2.62	2.51	2.41	2.30	2.20	2.11	2.01	1.92	1.83	1.74
1.8	1.65	1.57	1.49	1.41	1.34	1.26	1.19	1.12	1.06	0.99
1.9	0.93	0.87	0.81	0.76	0.70	0.65	0.60	0.56	0.51	0.47
2.0	0.43	0.39	0.36	0.32	0.29	0.26	0.23	0.21	0.18	0.16
2.1	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.02
2.2	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note 1 - Numbers in the body of the table are estimates of lot percent defective corresponding to specific values of Q, the Quality Index. For values of Q greater than or equal to zero, the estimate of percent defective is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100.

Table 914-5 (Continued)

Variability-Unknown Procedure **Standard Deviation Method**

Sample Size
8

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.62	49.24	48.86	48.49	48.11	47.73	47.35	46.97	46.59
0.1	46.22	45.84	45.46	45.08	44.71	44.33	43.96	43.58	43.21	42.83
0.2	42.46	42.08	41.71	41.34	40.97	40.59	40.22	39.85	39.48	39.11
0.3	38.75	38.38	38.01	37.65	37.28	36.92	36.55	36.19	35.83	35.47
0.4	35.11	34.75	34.39	34.04	33.68	33.33	32.97	32.62	32.27	31.92
0.5	31.57	31.22	30.87	30.53	30.18	29.84	29.50	29.16	28.82	28.48
0.6	28.15	27.81	27.48	27.15	26.82	26.49	26.16	25.83	25.51	25.19
0.7	24.86	24.54	24.23	23.91	23.59	23.28	22.97	22.66	22.35	22.04
0.8	21.74	21.44	21.14	20.84	20.54	20.24	19.95	19.66	19.37	19.08
0.9	18.79	18.51	18.23	17.95	17.67	17.39	17.12	16.85	16.57	16.31
1.0	16.04	15.78	15.51	15.25	15.00	14.74	14.49	14.24	13.99	13.74
1.1	13.49	13.25	13.01	12.77	12.54	12.30	12.07	11.84	11.61	11.39
1.2	11.17	10.94	10.73	10.51	10.30	10.09	9.88	9.67	9.47	9.26
1.3	9.06	8.87	8.67	8.48	8.29	8.10	7.91	7.73	7.55	7.37
1.4	7.19	7.02	6.85	6.68	6.51	6.35	6.19	6.03	5.87	5.71
1.5	5.56	5.41	5.26	5.12	4.97	4.83	4.69	4.56	4.42	4.29
1.6	4.16	4.03	3.91	3.79	3.67	3.55	3.43	3.32	3.21	3.10
1.7	2.99	2.89	2.79	2.69	2.59	2.49	2.40	2.31	2.22	2.13
1.8	2.04	1.96	1.88	1.80	1.72	1.65	1.58	1.51	1.44	1.37
1.9	1.31	1.24	1.18	1.12	1.07	1.01	0.96	0.91	0.86	0.81
2.0	0.76	0.72	0.67	0.63	0.59	0.55	0.52	0.48	0.45	0.42
2.1	0.39	0.36	0.33	0.30	0.28	0.26	0.23	0.21	0.19	0.17
2.2	0.16	0.14	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05
2.3	0.04	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.00

Note 1 - Numbers in the body of the table are estimates of lot percent defective corresponding to specific values of Q, the Quality Index. For values of Q greater than or equal to zero, the estimate of percent defective is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100.

Table 914-5 (Continued)

Variability-Unknown Procedure **Standard Deviation Method**

Sample Size
9

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.62	49.24	48.85	48.47	48.09	47.71	47.33	46.95	46.57
0.1	46.18	45.80	45.42	45.04	44.66	44.29	43.91	43.53	43.15	42.77
0.2	42.40	42.02	41.64	41.27	40.89	40.52	40.15	39.77	39.40	39.03
0.3	38.66	38.29	37.92	37.55	37.19	36.82	36.46	36.09	35.73	35.37
0.4	35.00	34.64	34.29	33.93	33.57	33.21	32.86	32.51	32.15	31.80
0.5	31.45	31.10	30.76	30.41	30.07	29.72	29.38	29.04	28.70	28.36
0.6	28.03	27.69	27.36	27.03	26.70	26.37	26.04	25.72	25.39	25.07
0.7	24.75	24.43	24.11	23.80	23.49	23.17	22.86	22.56	22.25	21.94
0.8	21.64	21.34	21.04	20.75	20.45	20.16	19.87	19.58	19.29	19.00
0.9	18.72	18.44	18.16	17.88	17.61	17.33	17.06	16.79	16.53	16.26
1.0	16.00	15.74	15.48	15.23	14.97	14.72	14.47	14.22	13.98	13.73
1.1	13.49	13.26	13.02	12.79	12.55	12.32	12.10	11.87	11.65	11.43
1.2	11.21	10.99	10.78	10.57	10.36	10.15	9.95	9.75	9.55	9.35
1.3	9.16	8.96	8.77	8.59	8.40	8.22	8.04	7.86	7.68	7.51
1.4	7.33	7.17	7.00	6.83	6.67	6.51	6.35	6.20	6.04	5.89
1.5	5.74	5.60	5.45	5.31	5.17	5.03	4.90	4.77	4.64	4.51
1.6	4.38	4.26	4.14	4.02	3.90	3.78	3.67	3.56	3.45	3.34
1.7	3.24	3.14	3.03	2.94	2.84	2.75	2.65	2.56	2.47	2.39
1.8	2.30	2.22	2.14	2.06	1.98	1.91	1.84	1.76	1.70	1.63
1.9	1.56	1.50	1.44	1.37	1.32	1.26	1.20	1.15	1.10	1.05
2.0	1.00	0.95	0.90	0.86	0.82	0.77	0.73	0.70	0.66	0.62
2.1	0.59	0.55	0.52	0.49	0.46	0.43	0.41	0.38	0.36	0.33
2.2	0.31	0.29	0.27	0.25	0.23	0.21	0.20	0.18	0.17	0.15
2.3	0.14	0.13	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.05
2.4	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01
2.5	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note 1 - Numbers in the body of the table are estimates of lot percent defective corresponding to specific values of Q, the Quality Index. For values of Q greater than or equal to zero, the estimate of percent defective is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100.

Table 914-5 (Continued)

Variability-Unknown Procedure **Standard Deviation Method**

Sample Size
10

Q	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	50.00	49.62	49.23	48.85	48.46	48.08	47.70	47.31	46.93	46.54
0.1	46.16	45.78	45.40	45.01	44.63	44.25	43.87	43.49	43.11	42.73
0.2	42.35	41.97	41.60	41.22	40.84	40.47	40.09	39.72	39.34	38.97
0.3	38.60	38.23	37.86	37.49	37.12	36.75	36.38	36.02	35.65	35.29
0.4	34.93	34.57	34.21	33.85	33.49	33.13	32.78	32.42	32.07	31.72
0.5	31.37	31.02	30.67	30.32	29.98	29.64	29.29	28.95	28.61	28.28
0.6	27.94	27.60	27.27	26.94	26.61	26.28	25.96	25.63	25.31	24.99
0.7	24.67	24.35	24.03	23.72	23.41	23.10	22.79	22.48	22.18	21.87
0.8	21.57	21.27	20.98	20.68	20.39	20.10	19.81	19.52	19.23	18.95
0.9	18.67	18.39	18.11	17.84	17.56	17.29	17.03	16.76	16.49	16.23
1.0	15.97	15.72	15.46	15.21	14.96	14.71	14.46	14.22	13.97	13.73
1.1	13.50	13.26	13.03	12.80	12.57	12.34	12.12	11.90	11.68	11.46
1.2	11.24	11.03	10.82	10.61	10.41	10.21	10.00	9.81	9.61	9.42
1.3	9.22	9.03	8.85	8.66	8.48	8.30	8.12	7.95	7.77	7.60
1.4	7.44	7.27	7.10	6.94	6.78	6.63	6.47	6.32	6.17	6.02
1.5	5.87	5.73	5.59	5.45	5.31	5.18	5.05	4.92	4.79	4.66
1.6	4.54	4.41	4.30	4.18	4.06	3.95	3.84	3.73	3.62	3.52
1.7	3.41	3.31	3.21	3.11	3.02	2.93	2.83	2.74	2.66	2.57
1.8	2.49	2.40	2.32	2.25	2.17	2.09	2.02	1.95	1.88	1.81
1.9	1.75	1.68	1.62	1.56	1.50	1.44	1.38	1.33	1.27	1.22
2.0	1.17	1.12	1.07	1.03	0.98	0.94	0.90	0.86	0.82	0.78
2.1	0.74	0.71	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46
2.2	0.44	0.41	0.39	0.37	0.34	0.32	0.30	0.29	0.27	0.25
2.3	0.23	0.22	0.20	0.19	0.18	0.16	0.15	0.14	0.13	0.12
2.4	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.05
2.5	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01
2.6	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00

Note 1 - Numbers in the body of the table are estimates of lot percent defective corresponding to specific values of Q, the Quality Index. For values of Q greater than or equal to zero, the estimate of percent defective is read directly from the table. For values of Q less than zero, the table value must be subtracted from 100.

915.01

SECTION 915 - REINFORCEMENT STEEL

915.01 Reinforcement Steel for Structures.

(a) Deformed Bars. Reinforcement steel shall be deformed bars conforming to AASHTO M 31. All bars shall have the tensile requirements of Grade 60. Detailing dimensions for hooks and bends shall be in accordance with the Manual of Standard Practice for Detailing Reinforced Concrete Structures (ACI 315) for Grade 60. Production bending of Grade 60 bars shall be by the cold method with motive power machines in the shop and with portable motive power machines in the field.

Grade 40 reinforcement may be substituted for Grade 60. If Grade 40 is used, working drawings shall be furnished in accordance with Subsection 105.04. The drawings shall show revised bar sizes, numbers and spacing. Design and quantity calculations shall also be furnished. Calculations shall be based on the Service Load Design Method of the AASHTO Standard Specifications for Highway Bridges.

(b) Deformed Bars, Zinc-Coated (Galvanized). Reinforcement steel shall be deformed bars conforming to Subpart *(a)* above. Galvanizing shall conform to ASTM A 767. Coating Class I shall be furnished. Fabrication shall be before galvanizing.

(c) Deformed Bars, Epoxy Coated. Reinforcement steel shall be deformed bars conforming to Subpart *(a)* above. Epoxy coating shall conform to AASHTO M 284 except that the thickness of the cured coating shall be 7 plus or minus 2 mils.

(d) Spiral Reinforcement. Spiral reinforcement shall be plain, round, hot-rolled steel bars conforming to AASHTO M 31, Grade 60.

(e) Structural Shapes, Plates and Bars. Structural shapes, plates and bars used for reinforcement or other miscellaneous embedded metal work shall conform to the requirements for structural steel specified in Subsection 917.10 and shall be galvanized in accordance with AASHTO M 111.

(f) Welded Steel Wire and Welded Deformed Steel Wire Fabric Reinforcement. Welded steel wire fabric shall conform to AASHTO M 55 and shall be hot-dipped galvanized after fabrication to produce a Class 2 coating equal to that specified in ASTM A 641, Table 1.

Welded deformed steel wire fabric reinforcement shall conform to AASHTO M 221 and shall be hot-dipped galvanized after fabrication to produce a Class 2 coating equal to that specified in ASTM A 641, Table 1.

(g) Tolerances. Fabricating tolerances for deformed reinforced steel bars shall be in accordance with Figures 3 and 4 of the CRSI Manual of Standard Practices unless otherwise specified.

(h) Weight. The weight of steel bar reinforcement, as applicable to Subparts *(a), (b), (c)* and *(d)* above, will be computed from the cutting lists in accoroance with the following:

Designation	Pounds per Foot
3	0.376
4	0.668
5	1.043
6	1.502
7	2.044
8	2.670

9	3.400
10	4.303
11	5.313

915.02 Prestressing Reinforcement.

(a) High-Tensile Strength Steel Wire, Seven-Wire Strand and Alloy Bars. Prestressing reinforcement shall be high-tensile-strength steel wire, high-tensile-strength seven-wire strand or high-tensile-strength alloy bars.

High-tensile-strength steel wire shall conform to AASHTO M 204.

High-tensile-strength seven-wire strand shall conform to AASHTO M 203, Grade 270.

High-tensile-strength alloy bars shall conform to ASTM A 722. Bars with greater minimum ultimate strength but otherwise produced and tested in accordance with ASTM A 722 may be used provided they have no properties which make them less satisfactory than the specified material.

(b) Testing Prestressing Reinforcement. All wire, strand or bars to be shipped to the site shall be assigned a lot number and tagged for identification purposes. Anchorage assemblies to be shipped shall be identified in the same manner. All samples submitted shall be representative of the lot to be furnished and, in the case of wire or strand, shall be taken from the same master roll. The manufacturer shall furnish samples selected from each lot. If ordered, the selection of samples shall be made at the manufacturer's plant.

915.03 Reinforcement Steel for Concrete Base and Concrete Surface Courses. Reinforcement steel may be either deformed steel bars or cold-drawn steel wire.

(a) Tolerances. Fabricating tolerances for deformed reinforcement steel bars shall be in accordance with Figures 3 and 4 of the CRSI Manual of Standard Practices unless otherwise specified.

(b) Bar Mats. Bar mats shall be rolled cold-drawn steel wire or deformed steel bars from new billet steel conforming to AASHTO M 31. The bars shall be Size No. 3. All bars shall have the tensile requirement of Grade 40 or Grade 60. The bar mats shall be fabricated in accordance with ASTM A 184.

Deformed bar mats shall be assembled by clipping the bars.

(c) Welded Steel Wire Fabric. Welded steel wire fabric shall conform to AASHTO M 55.

Wire fabric shall be not less than 5 feet in width and shall be shipped in sheets and not in rolls. Fabric for slope protection, gutters and miscellaneous items may be shipped in rolls. Sheets shall be bent in the shop.

(d) Joint Tie Bolt Assembly. The bar used shall conform to Subsection 915.01, Subpart *(a)* and shall be of the plain type. The tensile strength of the assembly shall be not less than 15,000 pounds. The tie bolt assemblies shall be equipped with an approved fastener for installation of the assembly in the steel pavement form. The fastener shall hold the assembly in the designated position during the placing and finishing of the concrete and subsequent removal of the forms without damage to the concrete or the tie bolt assembly.

(e) Dowels. Dowels for transverse joints shall be carbon steel dowels, part of the length of which shall be encased in stainless steel or monel metal tubing, or infused with chromium, or shall be solid stainless steel dowels. The carbon steel dowels may be of any grade of carbon steel.

Dowel bars shall be plain round bars. The bars shall be free from burring or other deformation restricting slippage in the concrete. Dowel bars shall be coated with asphaltic oil.

The sleeve-type end caps for dowel bars shall be metal of approved design covering 4 inches of the dowel, with a closed end containing a cork plug to hold the end of the sleeve at least 1 inch from the end of the dowel bar.

(f) Tie Bars. Tie bars shall conform to Subsection 915.01, Subpart *(b)*.

915.04 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Plain and deformed bars	Four 30-inch pieces from each heat
Post-tensioning:	
Bars (threaded)	One 6-foot piece (between threads) from each lot
Cable with fittings	One 6-foot piece (between fittings) from each reel
Pretensioning:	
Bars	One 6-foot piece from each lot
Cable	One 6-foot piece from each reel
Welded wire fabric	One 2 square feet piece from each source
Anchorages	Two assemblies (complete with plates) of each size or type

915.05 Certification of Compliance. Certifications are required for reinforcement bars, pretensioning bars, welded wire fabric and galvanizing and shall be submitted in accordance with Subsection 106.04.

SECTION 916 - SIGN MATERIALS

916.01 Aluminum. Flat sheets (signs) and plates shall conform to ASTM B 209, Alloy 6061-T6. Thicknesses for the various sizes and shapes shall be as follows:

Regulatory, Warning and Guide Signs

Square and Diamond Shaped Signs:	
30" x 30" or less	0.080"
More then 30" x 30"	0.125"
Rectangular Signs:	
30" or less (horizontal dimension)	0.080"
More than 30" (horizontal dimension)	0.125"
Other Shaped Signs:	
30" or less (longest horizontal dimension)	0.080"
More than 30" (longest horizontal dimension)	0.125"

Distance and Destination Signs

All sizes	0.100"
Signs Mounted on Breakaway Barricades:	
All sizes	0.024"

Weld filler wire shall be AWS classification ER5356 or ER5556.

Other aluminum items shall conform to the following:

Aluminum Items	ASTM	ASTM Alloy and Temper
Bars and Rods	B 221	6063-T6
Delineator sheets	B 209	6061-T6
Washers, Alclad	B 209	2024-T4
Flange splicing material	B 209	6061-T6
Shims	B 209	1100-O
Letters, Numerals, Symbols	B 209	6061-T6
Posts, Truss Chords, Truss Bracing Members	B 221	6061-T6
Post and Chord Caps	B 26	356-T6
Post Clips	B 308	6061-T6
Structural shapes	B 308	6061-T6
Nuts, 5/16 inch and larger	B 211	6262-T9
Tamperproof type, 1/4 inch and under	B 211	2024-T4
Rivets (shall be of the size and length recommended by the manufacturer)	B 316	6053-T61
Bolts (finished bolts shall have at least 0.002 chromated sealed anodic coating)	B 211	2024-T4

916.02 Aluminum Extruded Sign Panels. Sign panels shall be made of extruded aluminum sections conforming to ASTM B 221, Alloy 6063-T6. The sections shall be 12 inches wide, bolted together with a minimum section modulus of 0.605 inches cubed per foot for 2-inch thick panels.

Sign panel sections shall be joined to each other through flanges with 3/8 inch bolts and the maximum span between vertical supports shall be 18 feet. Sign panels shall be joined to the supporting structure.

Trim moldings shall be of the same color and material as the sign face.

916.03 Paints. Transparent screen process paints and necessary thinners for application to signs utilizing white or silver reflective backgrounds shall be recommended by the manufacturer of the reflective sheeting. Color shall be visually determined according to ASTM D 1535 by comparison with the Federal Highway Administration Interstate Highway Color Charts using the Munsell notation.

916.04 Reflective Sheeting.

(a) *Type I Sheeting.* Type I sheeting shall consist of spherical lens elements adhered to a synthetic resin and enclosed by a flexible, transparent sheeting having a smooth flat outer surface. Type I sheeting shall conform to the reflectance requirements of Table 916-1 and to Subpart *(c)*.

(b) *Type II Sheeting.* Type II sheeting shall consist of spherical lens elements adhered to a synthetic resin and encapsulated by a flexible transparent sheeting having a smooth flat outer surface. Type II sheeting shall conform to the reflectance requirements of Table 916-2 and to Subpart *(c)*.

(c) *General Requirements.*

(1) *Reflectance.* The reflective sheeting shall have the minimum brightness values in Tables 916-1 and 916-2 for the observation angles expressed as average candle-power per foot-candle per square foot of material. Measurements shall be conducted in accordance with Federal Specification LS-300C or with a reflex photometer bench model which has been calibrated with reflective standards provided by the manufacturer.

916.04

(2) *Rainfall Performance.* The brightness of the reflective sheeting totally wet by rain, shall be not less than 90 percent of the values in Tables 916-1 and 916-2. Wet performance measurements shall be conducted in conformance with Federal Specifications LS-300C.

(3) *Colors.* The colors of the sheeting to be furnished shall be designated. The colors shall conform to the AASHTO Manual for Signing and Pavement Marking of the National System of Interstate and Defense Highways. Color shall be visually determined according to ASTM D 1535 by comparing with Federal Highway Administration Interstate Highway Color Charts using the Munsell notation. Color charts are on file in the Department Laboratory. In addition, the colors shall be the same in daylight and at night under artificial headlight lumination. Noticeable deviation from the shades that would affect the required performance shall be cause for rejection of any sheeting or completed sign at any time before Acceptance.

(4) *Adhesive.* The reflective sheeting shall be precoated with a pressure sensitive adhesive or a tack-free, heat-activated adhesive, either of which shall be applied to properly prepared flat surfaces without the necessity of additional adhesive coats on the reflective sheeting or application surface.

The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solvents and shall be easily removed after accelerated storage for 4 hours at 150 degrees F under weight of 2.5 pounds per square inch.

The adhesive coated sheeting, when applied at 72 degrees F and conditioned for 24 hours at this temperature, shall form a durable bond to clean, smooth, corrosion and weather resistant substrates when exposed to temperatures from -30 degrees F to 200 degrees F. Sheeting applied to 6 by 6 inch, cleaned and etched panels of 0.040 inch, 6061-T6 aluminum, conditioned for 24 hours at 72 degrees F and 50 percent relative humidity and further conditioned for 18 hours at -10 degrees F, shall show no separation from the substrate or cracking at -10 degrees F, when subjected to a 10 inch-pound impact of a 2-inch steel ball (1.19 pounds), dropped from a height of 8 1/2 inches through a 2 1/8 inch tube. The test panel shall be centered and supported by its edges over a 4 by 4 inch open area and the impact point shall be in the center of the open area.

The sheeting shall resist peeling from application surface when a 5 pound per inch width force is applied in accordance with ASTM D 903.

The precoated adhesive shall have no staining effect on the reflective sheeting and must be mildew resistant.

(5) *Flexibility.* The reflective sheeting shall have sufficient strength and flexibility so that it can be handled, processed and applied according to the recommendations of the sheeting manufacturer without appreciable stretching, tearing or other damage.

When tested in accordance with Federal Test Method 141/6224 and 141/6115, the Type I reflective sheeting, with the liner removed, shall have a tensile strength of not less than 5 pounds per inch of width. Elongation shall not be less than 10 percent. The machine speed shall be 12 inches per minute.

Following liner removal, the reflective sheeting shall not shrink more than 1/32 inch in 10 minutes or more than 1/8 inch in 24 hours at 72 degrees F and 50 percent relative humidity and shall be sufficiently flexible to show no cracking when slowly bent in one second's time around a 1/8 inch mandrel with adhesive contacting the mandrel.

The reflective sheeting for cones, drums and delineator guide posts shall conform to the above except that after being conditioned for 24 hours at 10 degrees F, the sheeting shall be sufficiently flexible to show no cracking when slowly bent in one second's time around a 1/8-inch mandrel with adhesive contacting the mandrel.

(6) *Surface.* The sheeting surface shall be smooth and flat to facilitate cleaning and wet performance. Type I sheeting shall exhibit an 85 degree glossmeter rating of not less than 40 and Type II sheeting shall exhibit an 85 degree glossmeter rating of not less than 50 in accordance with ASTM D 523. The sheeting surface shall be readily processed and compatible with recommended transparent and opaque process inks and show no loss of the color coat with normal handling, cutting and application.

Following accelerated exposure as outlined hereinafter, no process inks shall be removed when tested by scratching through the ink surface, applying cellophane tape over the scratched area, and removing the tape with one quick motion.

The sheeting shall permit cutting and color processing at temperatures of 60 to 100 degrees F and relative humidities of 20 to 80 percent. The sheeting shall be heat resistant and permit force curing without staining of unapplied sheeting at temperatures up to 150 degrees F. The sheeting surface shall be solvent resistant and shall withstand cleaning with VM & P naphtha, mineral spirits and turpentine.

(7) *Weathering and Durability.* When processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and, following cleaning, shall show no appreciable discoloration, cracking, crazing, blistering or dimensional change. The sheeting shall be certified by the manufacturer to retain not less than 50 percent of the specified minimum brightness values when exposed to Atlas twin arc weathering, ASTM G 23, Type D for 1200 hours for Type I sheeting or for 2200 hours for Type II sheeting in accordance with ASTM D 822.

(8) *Storage.* The reflective sheeting, as supplied, shall be capable of withstanding storage at temperatures up to 100 degrees F for periods up to 1 year without damage.

(9) *Colorfastness.* One of the specimens prepared and subjected to accelerated weathering specified above shall be used to test for colorfastness. The specimen shall be wetted with a mild detergent and water solution and compared with a similarly treated unexposed specimen under natural (North sky) daylight or artifical daylight having a color temperature of 7500 K. The colorfastness shall be evaluated as follows:

Excellent - No appreciable change in color
Good - Perceptible but no appreciable change in color
Fair - Appreciable change in color

Appreciable change in color means a change that is immediately noticeable in comparing the exposed specimen with the original comparison specimen. If closer inspection or a change of angle of light is required to make apparent a slight change in color, the change is not appreciable. The colorfastness of the reflective material shall show a rating of Good or better.

916.05 Legends, Borders and Accessories. The legend for each sign shall consist of letter, numerals, shields and other symbols. The border on each sign shall be of the same type and manufacture as the system used for the legend. Border widths shall be as stated.

All letters and numerals shall meet the requirements established by the Federal Highway Administration in the Standard Alphabets for Highway Signs and the Standard Lower-Case Alphabets for Highways.

(a) Type A Demountable.

(1) General. The demountable sign letters, digits, arrows, borders and alphabet accessories shall be reflectorized and shall consist of acrylic plastic prismatic reflectors supported by embossed aluminum frames.

Letter design shall be the Federal Standard Alphabet Series D modified to accommodate the required reflectors.

(2) Component Requirements. The reflector shall consist of a clear and transparent plastic face, herein referred to as the lens, and the opaque plastic back of identical material fused to the lens under heat and pressure around the entire perimeter to form a homogeneous unit permanently sealed against dust, water and water vapor. The reflector shall be crystal, amber, red or green.

The lens shall consist of a smooth front surface free from projections or indentations other than for identification and a rear surface bearing a prismatic configuration that is able to effect total internal reflection of light. The manufacturer's trademark shall be molded legibly into the face of the lens.

The specific brightness of each reflex reflector intended for use in cut-out letters, symbols and accessories shall be equal to or exceed the following minimum values with measurements made with reflectors spinning. Failure to meet the specific brightness minimum shall constitute failure of the reflector being tested. Failure of more than two reflectors out of fifty subjected to test shall constitute failure of the lot.

Observation Angle Degrees	Entrance Angle Degrees	Specific Brightness Candlepower/Square Inch/Foot-Candle
0.1	0	14.0
0.1	20	5.6

For amber reflectors, the specific brightness minimum shall be 60 percent of the value shown for crystal. For red or green reflectors the specific brightness minimum shall be 25 percent of the value shown for crystal.

Optical measurements shall be conducted in accordance with Federal Specification LS300 or with a reflex photometer, bench model.

Failure of more than 2 percent of the reflectors being tested for the seal test or failure of any of the reflectors being tested for the heat resistance test as specified in AASHTO M 290 shall constitute failure of the lot.

The assembled cut-out letter, symbol or accessory shall withstand the combined corrosion test set forth in ASTM B 117.

(3) *Design and Fabrication of Frames.* Letter designs shall be the Federal Standard Alphabet Series D modified to accommodate the required reflectors.

All items shall be fabricated from 0.040 inch sheet aluminum stock conforming to ASTM B 209, Alloy 6061-T6.

Mounting holes shall be provided within the frames to permit the use of screws, rivets or other common fasteners.

The size and spacing of reflector holes shall be such as to afford maximum night legibility and visibility to the finished cutout figure.

After metal fabrication has been completed, the finishing process shall be as follows:

- Aluminum frames shall be prepared in accordance with Subsection 916.10.
- Frames shall be finished in white or other colors as specified, using baked enamel. Baked enamel shall be Dupont epoxy white baking enamel G-922-Y-99642 or equal and shall be applied in accordance with the manufacturer's recommendations.

(b) *Type B Direct and Permanently Applied Reflective Sheeting Copy.* The reflective sheeting for cut-out letters, numerals, symbols, borders and route markers shall conform to Subsection 916.04, pressure sensitive or heat activated, silver-white.

Permanently applied legend and border, complying with the above, of the designated sizes shall be used exclusively for those signs for which any of the following letter sizes are specified:

- Upper case letters and digits when used in conjunction with lower case letters 6 inches or less in height.
- All letters and digits 6 inches in height.
- When the background is nonreflectorized, either Type I or Type II sheeting may be used for copy.
- When the background is Type I sheeting, Type I sheeting shall be used for copy.
- When the background is Type II sheeting, Type II sheeting shall be used for copy.

916.06 Steel. Steel structural shapes and plates, posts, chord and bracing members shall all conform to ASTM A 36. Post and chord caps shall conform to ASTM A 27. Steel posts and U-shaped rail shall conform to ASTM A 499 with length of post and minimum pounds per foot as specified.

All steel components shall be galvanized in accordance with ASTM A 123 or, for posts, chord and bracing members, ASTM A 53, Grade B pipe.

Bolts, nuts and washers shall conform to ASTM A 307 and shall be galvanized by the hot-dip process according to ASTM A 153.

916.07 Stainless Steel. Stainless steel nuts shall conform to ASTM A 194, Grade 8F, except that the nuts shall be lock nuts with semifinished hex nuts equivalent to American Standard Heavy Series.

Stainless steel bolts, washers and screws shall conform to ASTM A 193, austenitic steel.

916.08 Fabrication. The name of the fabricators of the signs and supports shall be furnished before fabrication is started and, if requested, information shall be furnished as to the fabricator's qualifications and experience.

(a) Shop Drawings. Shop drawings shall be submitted in accordance with Subsection 105.04.

(b) Flat Sheet Signs. Flat sheet signs shall be fabricated of a single piece of sheet aluminum without joints and without supporting frame.

(c) Multiple Panel Signs. Multiple panel signs shall be made of extruded sections as specified in Subsection 916.02.

All panels shall be flat and straight within commercial tolerances established by the aluminum industry.

(d) Cutting Metals. Materials 1/2 inch thick or less may be sheared, blanked, sawed or milled. Materials over 1/2 inch thick shall be sawed or milled. Cut edges shall be true and smooth and free from excessive burrs or ragged breaks.

Re-entrant cuts shall be filleted by drilling prior to cutting.

Flame cutting will not be permitted for aluminum.

(e) Bolt Holes in Metals. Bolt holes either shall be drilled to finished size or may be blanked to finish size provided the diameter of the blanked hole is at least twice the thickness of the metal being blanked.

Bolt holes for one-post signs shall be 3/8 inch diameter and shall be located as shown in the Federal Highway Administration Manual of Standard Highway Signs.

Bolt holes for two-post signs shall be located as shown on the drawings.

(f) Welding. Welding shall conform to Section 509.

(g) Sign Surface Preparation. All fabrication including cutting and punching of holes, excluding mounting holes for demountable letters, numerals, symbols, and borders, shall be completed prior to surface preparation. Prior to painting or application of reflective sheeting to the aluminum, the sheets shall be treated in strict accordance with the following procedures:

(1) Degreasing. Preliminary cleaning shall be done by using either of the following degreasing methods:

- Vapor Degreasing. Sheets shall be totally immersed in a saturated vapor of trichlorethylene or perchlorethylene. Trademark printing shall be removed with lacquer thinner or by a controlled alkaline cleaning system.
- Alkaline Degreasing. Sheets shall be totally immersed in a tank containing a controlled alkaline solution. The instructions of the solution's manufacturer concerning time, temperature and concentration shall be followed. Immersion time depends upon the amount of dirt and the solution strength. All evidence of the trademark printing shall be removed. Sheets shall be thoroughly rinsed by a high pressure spray of clear cold water and allowed to dry completely.

(2) *Etching.* Preliminary cleaning shall be followed by a surface etch using either of the following etching methods:

- Acid Etching. Sheets shall be totally immersed in a 6 to 8 percent phosphoric acid solution of 100 degrees F or an approved commercially available acid etching solution. The sheets shall be thoroughly rinsed using a high pressure spray of cold water and allowed to dry completely.
- Alkaline Etching. Sheets shall be totally immersed in a controlled alkaline solution. The instructions of the manufacturer concerning time, temperature and concentration shall be followed. Smut shall be removed with an acidic chromium compound, such as a chromic acid solution and rinsed thoroughly. Sheets shall be allowed to dry completely.

(3) *Chromate Conversion Coating.* The chromate conversion coating shall be applied to the sheets according to the manufacturer's instructions. The coating shall conform to ASTM B 449 Class 2 and shall range in color from silvery iridescent to pale yellow. The coating should be 10 to 35 milligrams per square foot with a median of 25 milligrams per square foot as the optimum coating weight. The coating shall be within the prescribed weight limits, tightly adhered to the sheet, coherent within itself and show no dusting of the coated surface.

(4) *Handling.* Aluminum sheets shall not be handled except by a clean device or clean canvas gloves between all cleaning, etching, and coating operations and the application of paint and/or reflective sheeting. There shall be no opportunity for the sheets to come in contact with grease, oil or other contaminants after the surface preparation processes and the application of paint or reflective sheeting.

(h) *Shop Painting and Reflectorization.* All legends, borders and background shall be of the color and shall be placed on the sign as designated.

(1) *Application.* Reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified by the manufacturer. Heat activated adhesive coated sheeting shall be preperforated.

Signs faces comprising two or more pieces or panels of reflective sheeting shall be carefully matched for color at the time of sign fabrication to provide uniform appearance and brilliance, both day and night.

At splices, pressure sensitive adhesive coated sheeting shall be overlapped not more than 3/16 inch or butted. When butted, the gaps shall not exceed 1/32 inch. Only butt splices will be permitted on signs screen processed with transparent color. Sheeting applied to extruded sections shall extend over top edges and down side legs a minimum of 1/16 inch.

After aging 48 hours at 75 degrees F, adhesion of reflective sheeting to sign surface shall be strong enough to resist stripping from the panel when tested with a stiff putty knife and shall meet other requirements as specified for reflective sheeting in Subsection 916.04.

916.08

(2) *Green Enamel Paint for Traffic Sign Exterior.* Green enamel paint to be used for traffic sign background on exterior surfaces shall be a medium oil air-drying alkyd type. The enamel shall have been prequalified as an acceptable coating. The enamel shall be suitable for spray application to aluminum treated in accordance with Subsection 916.03 or primed plywood and shall dry to a smooth uniform film, free from defects.

The enamel shall meet the following physical requirements:

	Minimum	Maximum
Gloss, specular - 60 degrees after 48 hours dry, %	80	
Drying Time		
Set to touch, hours		1
Dry to handle, hours		4
Dry hard, hours		18[1]
Fineness of grind (Hegman)	7	
Consistency, Stormer KU	60	70

Color of the dried enamel shall match the color chip which is available from the Department's sign shop. The backs of aluminum signs shall not be painted.

(3) *Screen Process Printing.* All legends and borders on signs except demountable or cut-out legends and border, shall be applied by screen process printing after the sheeting is attached to the sign base material. All screening shall be done as recommended by the manufacturer of the reflective sheeting. Transparent screen process paint, after application to the reflective sheeting and thoroughly dry shall conform to ASTM D 1535 and shall match the Federal Highway Administration Interstate Highway Color Charts using Munsell notation when compared in natural daylight. Any noticeable deviation from the shades shall be cause for rejection of the sign.

The application of a finishing clear or clear coat shall be applied after screen printing, if required by the manufacturer. Application of the coating shall be according to the sheeting manufacturer's recommendation.

Black legend and border may be applied, other than by screen printing, to those signs requiring this color. The materials and application technique shall be as recommended by the reflective manufacturer or approved.

(i) *Packaging, Storage and Shipping.* Packaging, storage and shipping of signs produced using either Type I or Type II sheeting shall be according to the sheeting manufacturer's recommendations. All other signs shall be packaged in such manner that they are protected during shipment and storage. The packaging shall be adequate to prevent damage to any part of the sign, including any demountable legends or borders. Before packaging, all signs shall be free of moisture and all paints shall be thoroughly dry. Adhesive tapes shall not be applied to any sign surfaces. All packaged signs shall be kept entirely dry.

All assembled or partially assembled signs, other than flat sheet signs, shall have sufficient braces securely attached to prevent buckling or warping from the time of assembling to attaching on permanent supports.

916.09 Breakaway Sign Supports. Aluminum alloy shall conform to ASTM B 209, ASTM B 210, ASTM B 221 or ASTM B 308.

Nuts and bolts of aluminum alloy shall conform to ASTM B 316.

Posts for mounting signs shall be fabricated of one piece seamless aluminum tubing of uniform wall thickness. Posts shall be tire-wrapped to protect the finish during shipment and handling.

Spring pins shall conform to ASTM A 276, Type 304 or 420 with a minimum strength of 5000 pounds in double shear.

Hex studs and nuts used in the breakaway coupling assembly shall conform to ASTM A 320, Grade l7, with a minimum yield strength of 105,000 psi. Hex nuts in the assembly shall conform to ASTM A 194, Grade 2H.

Load concentrating washers shall conform to ASTM A 564, Type 630, Condition H 1025, with a minimum yield strength of 145,000 psi.

Washer retainers shall conform to ASTM A 570, Grade 40 or ASTM A 569.

Anchor bolts shall conform to ASTM A 307. Galvanizing of anchor bolts (top 6 inches), nuts, washers and leveling plates shall conform to ASTM A 123.

Breakaway shock absorber cable shall have a plain button on one end. Stainless steel wire rope shall conform to Military Specification MIL-W-5693C. The wire rope shall be 1/4 inch in diameter with a minimum breaking strength of 4700 pounds and shall be 1 x 19 construction.

Cutting pins shall conform to ASTM A 564, Type 630, Condition H 1025 with a minimum yield strength of 145,000 psi.

Hex studs with nuts and washer retainer shall have a zinc coating electrodeposited in accordance with ASTM A 164, after which a chromate dip shall be applied. The coating shall be Type GS which shall have a minimum thickness of 0.0010 inches with a maximum plus tolerance of 0.0005 inches. The maximum tolerance can be exceeded provided all attaching parts can be freely assembled.

Mechanical testing of the shock absorber assemblies shall conform to AASHTO T 244.

The shock absorber assembly shall be tested in tension. The tube shall not fail through its cross section separating the tube from the cable. The cutting pins shall begin and progress to slice through the walls of the tube before a maximum load of 4500 pounds is applied.

Equivalent material may be accepted in place of specified material. Approval is based on written submission of reasons for the material substitution, accompanied by test data supplied by a testing agency indicating the chemical analysis of the equivalent material and its conformance to the mechanical specifications of the specified material.

916.10 Bendaway Sign Supports.

(a) *Steel U Posts.* Steel U posts shall be fabricated from hot-rolled steel conforming to ASTM A 499 or ASTM A 663, Grade 80 with a minimum of 0.20 percent copper.

Minor variations will be permitted in the shape of the posts to conform to a manufacturer's standard if such variations do not in any way reduce the minimum requirements herein specified. All posts members shall have flat ribs on the side of the post farthest from the flanges. All post members shall be of no smaller size than that indicated for each sign size or type designated and shall meet the corresponding minimum requirements stated below. The weight per foot shall be that of each individual member comprising the post or post assembly. The term post shall also be construed to mean post member.

Post Requirements

Weight, Lbs/Ft	Face Width, Inches	Depth, Inches	Area, Square Inches	Section Modulus Axis Parallel to Sign Face Single Post, Inches Cubed
2.00	3 1/16	1 15/32	0.590	0.175
2.25	3 1/16	1 1/2	0.677	0.203
3.00	3 1/2	1 7/8	0.907	0.484
4.00	3 5/8	2	1.190	0.644

All posts exceeding the above requirements shall be suitably proportioned to present a pleasing appearance when supporting their respective signs, as judged by the Engineer. Each post shall be provided with not less than fifty-eight 3/8 inch diameter holes spaced on 1 inch centers, beginning 1 inch from the top. All posts shall be of adequate length to meet the requirements for erection. All posts shall be entirely galvanized after fabrication, including punching and drilling of holes in conformance with ASTM A 123.

Signs shall be secured to the post by means of 18-8 stainless steel 5/16 inch 18 UNC hexagonal head bolts conforming to ASTM A 320, Grade B8, Class I. Sign mounting bolts shall extend beyond the end of each nut not more than 3/4 inch when fully tight.

(b) *Aluminum U Posts.* Aluminum U posts for bendaway sign supports shall be extruded from ASTM B 221, Alloy 6061-T6.

Sign panels shall be affixed to the posts by means of a 5/16 inch NC18-2A hex head machine bolt of Aluminum Alloy 2024-T4 using hex nuts of Aluminum Alloy 6061-T6. Sign mounting bolts shall extend beyond the end of each nut not more than 3/4 inch when fully tight.

Resilient asbestos or fiber washers 5/16 inches inside diameter shall be used between the bolt head and the sign face.

(c) *Two Piece Steel U Posts.* Two piece steel U posts shall be fabricated from hot-rolled steel conforming to ASTM A 499, Grade 60 and to the following:

Tensile strength, minimum ..... 90,000 psi
Yield point, minimum ..... 60,000 psi

Carbon steel rails used for the manufacture of the U posts shall conform to ASTM A 1.

Charpy V-Notch Type A specimens of the steel U posts shall be submitted for testing. The specimens shall conform to AASHTO T 266 and shall be machined and ready for testing. Charpy fracture energy shall not exceed 1600 inch-pounds per square inch when tested at 150 degrees F in accordance with AASHTO T 266.

Minor variations will be permitted in the posts and spacer straps to conform to a manufacturer's standard. The retainer spacer strap shall be fabricated from steel conforming to AISI Grade 1020. Posts and retainer spacer straps shall be galvanized after fabrication, including punching and drilling holes, in conformance with ASTM A 123.

Signs mounted on a single post shall be fastened to the post by means of 18-8 stainless steel 5/16-18 UNC hexagon headed bolts and nuts conforming to ASTM A 320, Grade B8, Class 1.

Signs mounted on more than one post shall be secured to the posts by means of Aluminum Alloy 2024-T4 5/16-NC18-2A hexagon headed machine bolts, and by means of Aluminum Alloy 6061-T6 5/16-NC18-2B hexagon nuts.

Sign mounting bolts shall extend beyond the end of each nut but not more than 3/4 inch when fully tightened.

Connector bolts and retainer bolts shall be 3/8-16 UNC-2 inches long hex head, integral flange and shall conform to ASTM A 354, Grade BD.

Lock nuts shall be 3/8-16 UNC hex head, integral flange and shall conform to ASTM A 563, Grade DH.

Lock washers shall be 3/8 inch extra duty, helical spring.

Connector bolts and retainer bolts, lock nuts and lock washers shall be mechanically galvanized in accordance with ASTM B 454, Class 25.

The posts shall be straight and have a smooth finish, free of burrs.

916.11 Non-Breakaway Sign Supports. Material requirements shall conform to that specified above for breakaway sign supports and to the following:

- Stainless steel hardware shall conform to ASTM A 320 (AISI Type 304).
- The underside of the post bases shall be coated with an aluminum-pigmented alkaline-resistant paint coating conforming to Subsection 912.02.
- The castings for post caps may be permanent mold casting conforming to ASTM B 26, ASTM Alloy 356-T6. Each casting shall be 100 percent visually inspected for surface defects and irregularities. The castings shall be of uniform quality and conditions, free from cracks and shall not contain any other defects such as blowholes, porous places, hard spots and shrinkage defects which due to their nature, degree or extent, detrimentally affect the suitability of the castings for their intended use. Castings exhibiting these surface discontinuities are subject to rejection as a result of visual inspection.
- Galvanizing of anchor bolts (top 8 inches), nuts, washers and leveling plates shall conform to ASTM A 123.

916.12 Overhead Sign Supports. Overhead sign supports shall be fabricated in accordance with Section 509.

Brackets shall be provided for mounting signs (including future signs) of the type to be supported by the structures. They shall be adjustable to permit mounting the sign faces at any angle between a truly vertical position and 3 degrees from vertical. This angle shall be obtained by rotating the front lower edge of the sign forward of the top edge. All brackets shall be of lengths equal to the heights of the signs being supported.

All steel fabricated components other than stainless steel parts, including clamps and brackets, shall be galvanized in accordance with Subsection 917.12.

916.13 Timber Sign Supports. Timber posts shall conform to Subsection 918.01.

916.14 Delineators. Delineators shall consist of one or more mounted reflector units of any one of the following types:

(a) Type A - Prismatic Center Mount. The reflector units shall consist of a hermetically sealed acrylic plastic prismatic reflex reflectors housed in embossed aluminum and provided with a single grommeted mounting hole.

The reflector shall consist of a clear and transparent plastic face with at least 7 square inches of reflective area, herein referred to as the lens, with a heat-sealable, plastic-coated metallic foil back, fused to the lens under heat and pressure around the entire perimeter of the lens and central mounting hole to form a unit permanently sealed against dust, water and water vapor.

Component requirements of Subsection 916.05 shall apply except that the reflectors shall be crystal or amber and the minimum specific intensity values shall be as follows:

Observation Angle Degree	Entrance Angle Degrees	Specific Intensity Candlepower Per Foot-Candle Crystal	Amber
0.1	0	119	71
0.1	20	47	28

The housing shall be 0.020 inch aluminum formed to approximately 3 1/4 inches in diameter and sufficient in depth to retain the acrylic reflector. It shall have embossed circular reinforcement ribs or other suitable conformation to provide rigidity of the housing and shall be marked with the name and part number of the manufacturer.

An aluminum grommet with a 3/16 inch inside diameter shall be expanded within the reflector mounting hole.

(b) *Type B - Prismatic Center Mount.* The reflector unit shall consist of a sealed optical system having a plastic face with a prismatic molded rear surface fused to a plastic back at central and peripheral edges. The complete reflector unit shall be provided with a metal grommeted central hole for mounting which can accommodate 3/16 inch metal fasteners. The reflector shall be approximately 3 1/4 inches in diameter.

In addition to the above requirements, the reflector units shall conform to the applicable component requirements for Type A reflector units described in this Subsection except that the reflector shall be either crystal or amber and the minimum specific intensity values shall be as prescribed for the Type A reflector in this Subsection.

(c) *Type C - Type II Sheeting.* The reflectors shall consist of adhesive coated Type II reflective sheeting permanently adhered to an aluminum backing sheet. The reflective sheeting shall be silver or yellow and shall conform to Subsection 916.04.

The silver or yellow reflectors shall be 5 by 5 inch squares with 3/4 inch radius corners and two 1/4 inch diameter mounting holes, 3 inches on center.

The silver reflectors shall be 5 by 10 inch rectangular shapes with 3/4 inch radius corners and two 1/4 inch diameter mounting holes, 8 inches on center.

The reflective sheeting shall be mechanically applied with the equipment and in a manner prescribed by the sheeting manufacturer.

The aluminum backing sheet shall conform to ASTM B 209, Alloy 6061-T6, 0.080 inch thick, properly degreased and etched or treated with a light, tight, amorphous chromate type coating.

916.15 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Aluminum alloys	In accordance with Subsection 911.04
Letters, demountable	3 units from each source
Paint	In accordance with Subsection 912.36
Reflective sheeting	Two 12 x 12 inch sheets for each type and color
Steel	In accordance with Subsection 917.13
Stainless steel	In accordance with ASTM A 193
Shock absorber	1 unit from each source

916.16 Certification of Compliance. Mill certifications shall be furnished for the chemical and physical properties of all metals and shall be submitted in accordance with Subsection 106.04.

916.17 Tables. Tables referenced in the Specifications are as follows:

Table 916-1 Type I Sheeting Reflectance Requirements

Observation Angle Degrees	Silver White	Yellow	Orange	Green	Red	Blue	Brown
	0.2-0.5	0.2-0.5	0.2-0.5	0.2-0.5	0.2-0.5	0.2-0.5	0.2-0.5
Entrance Angle							
-4 deg.	70-30	50-25	25-13.5	9.0-4.5	14.5-7.5	4.0-2.0	1.0-0.35
15 deg.	45-22	35-18	14-8.0	6.0-3.2	9.5-5.0	2.8-1.3	0.6-0.25
30 deg.	30-15	22-13	5.0-4.0	3.5-2.2	6.0-3.0	1.7-0.8	0.3-0.2
45 deg.	7.5-5.0	7.5-4.0	1.0-0.8	1.0-1.0	2.0-1.0	0.5-0.2	0.2-0.1

Table 916-2 Type II Sheeting Reflectance Requirements

Observation Angle Degrees	Silver	Yellow	Orange	Green	Red
	0.2-0.5	0.2-0.5	0.2-0.5	0.2-0.5	0.2-0.5
Entrance Angle					
-4 deg.	250-95	170-62	100-30	45-15	45-15
30 deg.	150-65	100-45	60-25	25-10	25-10
50 deg.	35-22	23-15	14-9	6-1.5	6-4

SECTION 917 - STRUCTURAL STEEL AND OTHER FERROUS METALS

917.01 Bolts and Bolting Material. Steel bolts, nuts and washers shall conform to ASTM A 307. Galvanizing, when specified, shall be in accordance with AASHTO M 232.

Corrosion-resistant steel bolts and anchor cramps shall be of an alloy steel, containing approximately 18 percent chromium and 8 percent nickel, conforming to ASTM A 276, Type 302.

High-strength steel bolts, including suitable nuts and plain hardened washers, shall conform to AASHTO M 164 or AASHTO M 253. When AASHTO M 164, Type 3 bolts are specified, they, along with suitable nuts and washers, shall have an atmospheric corrosion resistance approximately two times that of carbon steel with copper.

Anchor bolts and rock anchors and hardware shall conform to AASHTO M 183 and shall be galvanized after fabrication, including threading, in accordance with AASHTO M 232.

Welded stud shear connectors shall conform to Division II, Section 10, AASHTO Standard Specifications for Highway Bridges.

917.02 Flooring. Steel for grid flooring shall conform to AASHTO M 183 and shall be galvanized in accordance with AASHTO M 111. Formed steel flooring shall conform to ASTM A 570, Grade 30.

917.03 Castings for Drainage Structures. Metal shall conform to the following:

- Gray iron castings shall conform to AASHTO M 105, Class 30 and shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blowholes and other defects in composition affecting their strength and value for the service intended. The castings shall be sandblasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean and uniform surface.
- Carbon-steel castings shall conform to AASHTO M 103. Grade shall be optional.
- Ductile iron castings shall conform to ASTM A 536, Grade 65-45-12.
- Structural steel shall conform to AASHTO M 183.

Galvanizing, where specified for these units, shall conform to AASHTO M 111.

917.04 Permanent Steel Bridge Deck Forms. Metal deck forms to remain in place shall be fabricated from steel conforming to ASTM A 446, Grade C or E and shall be galvanized with a minimum of 2 ounces per square foot (total coating, both sides), based on a triple spot when tested in accordance with AASHTO T 65. All supports for reinforcement steel in contact with the forms shall also be galvanized.

917.05 Rivets. Structural rivet steel shall conform to ASTM A 502, Grade 1. High-strength structural rivet steel shall conform to ASTM A 502, Grade 2.

917.06 Steel Bearings. Bearing pins shall be either annealed carbon steel forging conforming to AASHTO M 102, Class C or cold-finished carbon steel shafting conforming to AASHTO M 169, Grades 1016 to 1030 inclusive. Structural steel bearings for prestressed concrete beams shall be hot-dip galvanized in accordance with Subsection 917.12 except that bearing areas of pins and surfaces upon which pins bear shall be excluded from this requirement.

917.07 Steel Castings. Medium-strength carbon steel castings shall conform to AASHTO M 103, Grade 65-35. High-strength steel castings shall conform to ASTM A 148.

917.08 Steel Forgings. Steel forgings shall conform to AASHTO M 102, Class C. The forgings shall be thoroughly annealed before being machined.

917.09 Steel Piling.

H-piles shall conform to AASHTO M 183.

Steel piling shall conform to AASHTO M 202 or AASHTO M 223.

Steel shells for cast-in-place piles shall conform to ASTM A 252, Grade 2. If the thickness is not prescribed, the shells shall be of such thickness and shall be reinforced so that they show no sign of distortion when driven. They shall be watertight and shall withstand collapsing forces until filled with concrete.

Certified copies of mill test results shall be furnished. Joints shall be butt jointed and arc welded. All shells shall be equipped with heavy steel points having a diameter not less than the outside diameter of the pile tip. The design of the metal shells shall be submitted and approved before the shells are driven.

Closure plate for steel pipe piling shall be 1/2 inch greater than the pile diameter and shall be 3/4 inch minimum thickness. The plate shall be welded all around.

Splices for steel pipe piling shall be of the internal type and full penetration butt welds shall be made all around.

917.10 Structural Steel. Carbon structural steel shall conform to AASHTO M 183. Supplementary Requirement S3 is mandatory for materials designated (T) as main

load carrying member components subject to tensile stress. Zone 2 of Table S1 shall govern the toughness requirements.

High-strength low-alloy structural manganese vanadium steel shall conform to ASTM A 441. Supplementary Requirement S3 of AASHTO M 183 is mandatory for materials designated (T) as main load carrying member components subject to tensile stress. Zone 2 of Table S1. AASHTO M 183 shall govern the toughness requirements.

High-strength low-alloy structural steel shall conform to AASHTO M 161. Supplementary Requirement S1 is mandatory for materials designated (T) as main load carrying member components subject to tensile strength. Zone 2 of Table S1 shall govern the toughness requirements.

High-strength low-alloy structural steel with 50,000 psi minimum yield point for thickness 4 inches and under shall conform to AASHTO M 222. Supplementary Requirement S1 is mandatory for materials designated (T) as main load carrying member components subject to tensile stress. Zone 2 of Table S1 shall govern the toughness requirements.

High-strength low-alloy columbium-vanadium steel of structural quality shall conform to AASHTO M 223. Supplementary Requirement S2 is mandatory for materials designated (T) as main load carrying member components subject to tensile stresses. Zone 2 of Table S1 shall govern the toughness requirements.

High-yield-strength, quenched and tempered alloy steel plate, suitable for welding shall conform to AASHTO M 244. Supplementary Requirement S3 is mandatory for materials designated (T) as main load carrying member components subject to tensile stress. Zone 2 of Table S1 shall govern the toughness requirements.

917.11 Transverse Tie Rods. Transverse tie rods shall be high-tensile-strength steel bars conforming to ASTM A 722, Type I bar.

Transverse tie rods shall be blast cleaned (SSPC-SP-6) and coated with a two-component, self-priming, chemically cured, catalyzed coal tar epoxy coating conforming to Subsection 912.22.

Nuts and washers shall conform to Subsection 917.01 and shall be galvanized.

917.12 Zinc Coating on Steel. Zinc coating (hot-dip galvanizing), applied on iron and steel products, shall conform to AASHTO M 111.

Zinc coating (hot-dip galvanizing), applied on iron and steel hardware, shall conform to AASHTO M 232.

917.13 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Bolts, nuts, washers, and miscellaneous hardware	Subject to inspection and testing prior to shipment
Castings:	
Carbon	Subject to inspection and testing prior to shipment
Gray iron	2 bars for each 100 tons
Steel for flooring, deck forms, rivets, bearings, castings, forgings, piling and structures	Subject to inspection prior to shipment
Steel, structural	Subject to inspection and testing at point of fabrication

917.14 Certification of Compliance. Mill certifications are required, except for castings, and shall be submitted in accordance with Subsection 106.04.

SECTION 918 - TIMBER AND TIMBER PRESERVATIVES

918.01 Timber Posts. Timber posts shall be of timber with a stress grade of 1200 pounds per square inch or more as tested in accordance with West Coast Lumber Inspection Bureau, Southern Pine Inspection Bureau or other appropriate timber association.

The post may be rough sawn or dressed and shall be treated with preservatives in accordance with Subsection 918.06.

918.02 Timber Bearing Piles. Timber bearing piles shall conform to AASHTO M 168, except that untreated foundation piles having smooth, tight bark need not be peeled.

Treated timber piles shall be treated with creosote by the full-cell process to a retention of not less than 20 pounds of preservative per cubic foot of timber in accordance with AWPA Standard No. C3.

918.03 Timber Sheet Piles. Timber sheet piles shall conform to Subsection 918.05 and shall be dressed on four sides and shall be tongue and grooved or grooved for splines.

Treated timber sheet piles shall be treated with creosote by the full-cell process to a retention of not less than 20 pounds of preservative per cubic foot of timber in accordance with AWPA Standards No. C2 and C3.

918.04 Timber Connectors and Hardware. Timber connectors shall conform to Division II , Section 20, AASHTO Standard Specifications for Highway Bridges.

Hardware for timber structures shall be of the design, size and materials conforming to Division II , Section 20, AASHTO Standard Specifications for Highway Bridges.

918.05 Timber for Structures. Timber for structures shall conform to AASHTO M 168 with the following modifications:

- Timber shall be southern pine of structural grade. The timber shall be stress graded, conforming to Standard Grading Rules of the Southern Pine Inspection Bureau. Materials shall be designated and graded as No. 2 Dense if 4 inches thick and as No. 2 Dense SR if 5 inches or thicker.
- Timber for decking shall be graded as Dense Select Decking.

Treated timber structures shall be treated with creosote by the full-cell process to a retention of not less than 20 pounds of preservative per cubic foot of timber in accordance with AWPA Standard No. C2.

Timber for mudsills shall be heart cedar, heart cypress, redwood or other durable timber and shall be untreated.

918.06 Timber Preservatives. Timber preservatives and the preservative treatment process shall conform to AASHTO M 133 with the following minimum retention properties:

Preservative	Minimum Retention Lbs/Cu Ft of Timber
Creosote	6.0
Pentachlorophenol	0.45
Chromated copper arsenate	0.60

918.07 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Timber posts, piles and connectors	Subject to inspection prior to shipment
Timber for structures	Subject to inspection and testing prior to shipment
Timber preservatives	In accordance with AASHTO M 133

SECTION 919 - MISCELLANEOUS

919.01 Bags. Bags for concrete bag slope protection shall be cloth, 7 ounce, thread count 40 by 26 or equal. The bags shall measure approximately 18 by 29 1/2 inches when closed and tied, and shall be capable of holding 1 cubic foot of concrete without ripping, tearing, bursting or loss of concrete during handling and placing on the slope.

919.02 Bearing Pads.

(a) Elastomeric Bearing Pads. Elastomeric bearing pads for bridge beams shall conform to Division II, Section 25, AASHTO Standard Specifications for Highway Bridges. Grade 60 shall be used.

Elastomeric bearing pads for bridge railing posts shall conform to Division II, Section 25, AASHTO Standard Specifications for Highway Bridges. Grade 70 shall be used.

The manufacturer shall provide certified reports on the lot from which each shipment is made, based on tests made in his own laboratory or by a testing agency.

(b) Preformed Fabric Pads. Preformed fabric pads shall be composed of multiple layers of 8-ounce duck impregnated and bound with high quality natural rubber or of equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plies shall be such as to produce a thickness of 1/8 inch after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 10,000 pounds per square inch without detrimental reduction in thickness or extension.

919.03 Calcium Chloride. Calcium chloride shall conform to ASTM D 98 or AASHTO M 144 except that the alkali and impurity requirements need not apply.

919.04 Caulking Compound. Aluminum-impregnated caulking compound shall conform to Federal Specification TT-C-598, consistency Grade I.

919.05 Waterproofing.

Asphalt seal coat shall conform to AASHTO M 115, Type I for use below ground level and to AASHTO M 115, Type II or III for use above ground level. Primer shall conform to AASHTO M 116.

Bituminized cotton fabric shall conform to AASHTO M 117.

Tar seal coat shall conform to AASHTO M 118, Type II. Primer shall conform to AASHTO M 121.

919.06 Geotextiles. Fibers used in the manufacture of geotextiles and threads used in sewing geotextiles shall be long-chain, polymeric filaments or yarns consisting of at least 85 percent, by weight, polyolefins, polyesters or polyamides. The fibers shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvages.

Geotextile rolls shall be furnished with wrapping and, prior to placement, shall be stored for protection against moisture and extended ultraviolet ray exposure. Each roll shall be labeled to provide product identification.

Test methods and requirements for the uses of geotextiles shall conform to the following:

Physical Property	Uses and Requirements		Test Methods
	Underdrains	Roadway Stabilization Rip-Rap Filter Retaining Structure Filter	
Grab Strength (lbs)	80 min	200 min	ASTM D 4632
Puncture Strength (lbs)	25 min	80 min	ASTM D 3787
Burst Strength (psi)	130 min	320 min	ASTM D 3786
Trapezoidal Tear (lbs)	25 min	50 min	ASTM D 4533
Seam Strength (lbs)	70 min	180 min	ASTM D 4632
Ultraviolet Degradation, Retained Strength	70% at 150 hours	70% at 150 hours	ASTM D 4355
Apparent Opening Size U.S. Standard Sieve	0.297 mm max (No. 50)	0.6 mm max (No. 30)	ASTM D 4715
Permeability	1×10^{-2} cm/sec minimum	1×10^{-3} cm/sec minimum	ASTM D 4491

919.07 Fly Ash. Fly ash for portland cement concrete shall conform to ASTM C 618, Class C or Class F except that the loss on ignition shall be not more than 3 percent. When Class C fly ash is used, the magnesium oxide shall not exceed 2.5 percent. Before each source of fly ash is approved, certified results of tests conducted by a testing agency shall be submitted to and verified by the Department. Accompanying the certification shall be a statement from the supplier listing the source and type of coal, the methods used to burn, collect and store the fly ash, and the quality control measures employed.

Conformance to the requirements for loss on ignition and fineness shall be determined by the supplier for each truck load of fly ash delivered to the mixing site. The test values determined shall be included on the delivery ticket. The Engineer may require that the fly ash not be used until the Department has performed tests for loss on ignition and fineness.

Fly ash for other uses shall conform to ASTM C 593 except that the loss on ignition shall be not more than 10 percent and the combined content of silica and aluminum oxide shall be a minimum of 50 percent.

919.08 Gaskets. Hemp or oakum gaskets shall be closely twisted and shall be of the size and type required for the pipe. Gaskets shall be in one piece of sufficient length to pass around the pipe and lap.

When used for watertight flexible joints, rubber gaskets and flexible plastic gaskets shall conform to AASHTO M 198.

919.09 Hydrated Lime. Hydrated lime shall conform to ASTM C 207, Type N.

919.10 Latex Emulsion Admixture. Latex emulsion admixture shall be a nonhazardous, film-forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture. It shall be homogeneous and uniform in composition.

The latex shall be a styrene-butadiene polymeric emulsion stabilized with anionic, nonionic, and polyorgano-siloxane fluid surfactant in which the anionic surfactant is a sodium alkyl sulfate.

Latex modifiers shall be prequalified by a testing agency and shall conform to the requirements listed in the prequalification test program for styrene-butadiene latex emulsions of the FHWA Report No. FHWA-RD-79-35. A certified copy of the test properties shall be furnished in accordance with Subsection 106.04.

Prior to submitting a mix design in accordance with Subsection 518.06 Subpart *(b)*, a sample of the latex emulsion admixture shall be submitted to the Department Laboratory and tested for conformity to the following requirements:

Polymer (solids) %	46-50
Butadiene % of polymer	32-36
Styrene % of polymer	64-68
pH	9.5-11.5

The percent of solids will be determined in accordance with Section 990, NJDOT M-2. Other properties will be determined in accordance with the procedure in the above referenced FHWA Report.

919.11 Portland Cement. Portland cement shall conform to the following:

Masonry Cement	ASTM C 91
Portland Cement, Type II and Type III (See Note 1)	ASTM C 150
White Portland Cement, Type I and III (See Note 2)	ASTM C 150

Note 1 - For Type II, the autoclave expansion shall not exceed 0.5 percent. Type III may be used only for prestressed or precast items.

Note 2 - Shall not contain more than 0.55% by weight of ferric oxide (Fe_2O_3).

Portland cement, Type II , which has been pre-blended with a maximum of 15 percent fly ash, by weight, and conforming to ASTM C 595 may be used. When blended portland cement is used, no additional fly ash shall be added.

Different brands of cement, the same brand of cement from different mills or different types of cement shall not be mixed.

Suitable means shall be provided for storing and protecting the cement against dampness. Cement which for any reason has become partially set or which contains lumps of caked cement will be rejected. The temperature of the cement at the time of delivery to the mixer shall not exceed 160 degrees F.

919.12 Quick-Setting Patch Materials. The material shall be packaged and ready for mixing just prior to use in accordance with the manufacturer's instructions. It shall be concrete gray in color and contain no calcium chloride or admixture containing calcium chloride, or other ingredient in sufficient quantity to cause corrosion to steel reinforcement. It shall be quick-setting for use as a concrete patching compound where fast setting, rapid strength gain, nonshrink and high bond strength characteristics are needed.

The material shall be classified into the following types:

Type I - Suitable for use above water.

Type IA - Suitable for use above water. As much as 15 pounds of No. 8 coarse aggregate may be added to increase yield without adversely affecting the properties.

Type II - Suitable for use underwater.

Type III - Suitable for use above water at air temperatures below 32 degrees F.

Type IV - Suitable for use above water and for use in hot weather (95 degrees F plus or minus 5 degrees).

The material shall be packaged in quantities so that one complete packaging unit shall produce a net yield, in place, after final set, of between 5 and 6 square feet of patch, 1 inch thick. For Type IA, this yield excludes the added aggregate. Should liquid activator, other additives, adhesive or bonding agents be integral to the performance of the patch material, they shall be provided so that one package of additive, activator, adhesive or bonding agent is required for one package of patch material.

The material when tested in accordance with Section 990, NJDOT M-3 shall meet the following requirements:

Bond strength.

1 day	1000 psi min
7 day	2000 psi min

Expansion/Shrinkage.

Cured in Water	+0.20% max
Cured in Air	-0.20% max
Difference	0.30% max

Durability. Patching material must retain 90 percent of the 28-day compressive strength after 50 freeze-thaw cycles.

Permeability. The chloride content of the patching material must not exceed 2.5 pounds per cubic yard at or below the 2 inch level.

Compressive strength (psi). Patching material is classified as follows:

	2 hrs	*1 day*	*7 days*	*28 days*
Type I and IA	1000	3000	4000	4500
Type II	--	2000	4000	4500
Type III	1000	3000	4000	4500
Type IV	1000	3000	4000	4500

Time of Set:	*Not Less Than*	*Not More Than*
Type I and IA	5 minutes	--
Type II	5 minutes	20 minutes
Type III	5 minutes	--
Type IV	5 minutes	--

919.13 Hay and Straw.

Salt hay shall be of salt meadow grasses. Hay shall be timothy, red top or native grasses. Straw shall be stalks of oats, wheat, rye, or barley relatively free from seeds, noxious weeds and other foreign matter, free from decayed matter and from organic matter soluble in water.

919.14 Sodium Chloride (Rock Salt). Sodium chloride shall conform to ASTM D 632, Type I with the following exceptions:

- Sodium chloride shall be in the form of rock salt containing, at the time of delivery, not more than 1.0 percent moisture as determined by drying at 230 plus or minus 9 degrees F (110 plus or minus 5 degrees C) to constant weight.
- Evaporated solar or other salt shall not be furnished in lieu of rock salt.

919.15 Water. Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water will be tested in accordance with and shall meet the requirements of AASHTO T 26. Water known to be of potable quality may be used without test. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass or other foreign materials.

919.16 Waterstops. Metallic waterstops shall be sheet copper conforming to Subsection 911.03.

Nonmetallic waterstops shall be synthetic rubber or polyvinyl chloride conforming to Division II, Section 4, AASHTO Standard Specifications for Highway Bridges.

919.17 Epoxy Bedding and Bonding Compound. Epoxy bedding and bonding compound shall be a two-part, non-sag gel, rapid-setting epoxy adhesive, contained in a plastic mixing and dispensing device, such as Riser Gel as manufactured by Preco Industries, or equal, conforming to the requirements of Appendix D, NJDOT Research Report No. 86-013-7778. Copies of the report may be obtained from Bureau of Transportation Structures Research. The epoxy shall be used at the ambient temperature range of 40 to 100 degrees F.

919.18 Sampling and Testing Methods. Sampling and testing will be performed in accordance with the following:

Bearing Pads	1 square foot from each lot.
Chlorides:	
Calcium	1 quart from each lot.
Sodium	1 quart for chemical analysis from each lot and 1 large bag for gradation.
Latex Emulsion	In accordance with Subsection 919.10.
Masonry Cement	In accordance with ASTM C 91.
Portland Cement	In accordance with ASTM C 150.
Water	1 gallon from each source.

919.19 Certification of Compliance. Manufacturer's certifications are required for bearing pads and portland cement and shall be submitted in accordance with Subsection 106.04.

SECTION 990 - METHODS OF TESTS

This Section consists of the following NJDOT Methods of Tests which have been adopted and are used by the Department.

A-1 MORTAR-MAKING PROPERTIES OF FINE AGGREGATE

1. **Scope.** This method of test is used to determine the mortar-making properties of fine aggregate by tensile strength at the age of 7 days when compared to Standard Ottawa mortar.

Note: Subsequent samples of fine aggregate which fail to meet the minimum strength for 7 days will be tested for both 7 and 28 days.

2. **Procedure.** The Standard Ottawa mortar will be prepared in accordance with AASHTO T 162 and tested in accordance with AASHTO T 132.

The fine aggregate sample mortar will be prepared and tested in accordance with the paragraph above by replacing the Standard Ottawa sand with the same weight of fine aggregate sample and using sufficient mixing water to produce the same consistency as obtained with the Standard Ottawa mortar.

3. **Report.** The strength of the fine aggregate sample will be reported as a percentage of the Standard Ottawa mortar at age of 7 days.

A-2 DETERMINATION OF REFLECTANCE VALUE OF AGGREGATES

1. **Scope.** This method of test is used to determine the daylight 45 degree - 0 degree, luminous directional reflectance of fine and coarse aggregate.

2. **Apparatus.** The apparatus will conform to ASTM E 97 and to the following:

- The receptacle for testing fine aggregate will be a flat-bottomed dish with a diameter of 3 to 4 inches and a minimum depth of 1/2 inch.
- The receptacle for testing the coarse aggregate will be of sufficient size to hold several pounds of aggregate and will be at least 5 inches deep.

3. **Procedure.**

(a) Fine Aggregate. Fill flat-bottomed dish to overflowing with representative sample. Strike off excess material until the fine aggregate is even with the top edge of the receptacle. Place a flat, clean, 1/8 inch glass plate, approximately 4 inches square, on the reflectance standard and standardize the reflectometer. Select the standard that is closest to the sample being tested. Place glass plate and reflectometer on sample and take a reading. Repeat this procedure two times, using a different area selected from the total sample.

(b) Coarse Aggregate. Fill flat-bottomed pan to a depth of about 4 inches with sample to be tested. Level material with a metal scoop. Standardize the reflectometer on reflectance standard as described above. Select the standard that is closest to sample being tested. Place glass plate and reflectometer on prepared sample and determine reflectance. Take two additional readings at different locations on the surface of the material.

4. **Report.** Reflectance value will be an average of three readings reported to the nearest 1 percent.

A-3

A-3 SOUNDNESS OF AGGREGATES BY USE OF SODIUM SULFATE

1. **Scope.** This method of test is used to determine the resistance of aggregates to disintegration by a saturated solution of sodium sulfate.

2. **Apparatus.** The apparatus will consist of the following:

- Square opening sieves conforming to ASTM E 11:
  Fine Series: Nos. 4, 8, 16, 30, 50 and 100.
  Coarse Series: 2 1/2, 2, 1 1/2, 1, 3/4, 1/2 and 3/8 inches.
- Containers for immersing the aggregate samples in the sulfate solution as described in this method will be perforated. The perforations will allow free access and drainage of the solution without loss of the aggregates. The containers for fine aggregate will be No. 120 mesh sieves of sufficient size to hold a minimum of 100 grams, and allow proper solution cover. The volume of the solution will be such that a minimum of 1/2 inch of solution rises above the top surfaces of the aggregates.
- Balances for fine aggregates will have a minimum capacity of 500 grams, sensitive to 0.1 gram or less. Balances for coarse aggregates will have a minimum capacity of 5000 grams, sensitive to 1 gram or less.
- Drying oven will be capable of maintaining a constant temperature of 230 plus or minus 9 degrees F (110 plus or minus 5 degrees C) with a minimum evaporation rate of 25 grams per hour.
- Saturated solution of sodium sulfate using USP (US Pharmaceutical) or equal grade of the salt will be used. The temperature of the solution will be 70 plus or minus 2 degrees F and will have a specific gravity range of 1.151 to 1.174 at 70 plus or minus 2 degrees F. Contaminated solutions will be discarded.

3. **Samples.** Fine aggregate will be passed through a No. 4 sieve. The sample will be of sufficient size to provide not less than 100 grams of the following sizes. Each of the following sizes will be used for testing the fine aggregate:

Passing	Retained on
No. 4	No. 8
No. 8	No. 16
No. 16	No. 30
No. 30	No. 50
No. 50	No. 100

Coarse aggregate will be considered that which is larger than retained on a No. 4 sieve.

The sample will be of sufficient size to provide the following amounts of the various sizes:

Sieve Size	Weight
2" to 1 1/2"	2000 grams
1 1/2" to 1"	1500 grams
1" to 3/4"	1000 grams
3/4" to 1/2"	750 grams
1/2" to 3/8"	500 grams
3/8" to No. 4	300 grams

If the samples contain less than 5 percent of any of the sizes specified for fine and coarse aggregate above, that size will not be tested, but will be considered to have the same loss as the average of the next smaller and the next larger size, or the same loss as the next smaller or the next larger size, whichever is applicable. Each sieve size tested will be shaken to refusal prior to cycling.

For testing coarse aggregates, three consecutive sieve sizes will be tested to determine the amount of loss. The sizes are to be determined by the gradation of the sample.

The preparation of the sample and procedure for testing will conform to ASTM C 88 except that any referral to a previous section of the test will be interpreted as referring to the same section of this test method.

The process of alternate immersion and drying will be repeated for 5 cycles.

4. **Quantitative Examination.** The quantitative examination will be made as follows:

After completion of the final cycle, and after the sample has cooled, the sample will be washed until free of sodium sulfate solution, as determined by the reaction of the wash water with barium chloride.

After the removal of the sodium sulfate solution, each fraction of the sample will be dried to constant weight at 230 plus or minus 9 degrees F (110 plus or minus 5 degrees C), weighed, and, except in the case of ledge rock, sieved over the same size sieve on which it was retained before the cycling procedure. The amount retained on this sieve, after the sample is shaken to refusal, will be weighed and the weight recorded.

In the case of ledge rock, the loss in weight will be determined by subtracting the final weight of all fragments which have not split into three or more pieces from the original weight of the test sample.

Note: A piece of aggregate is defined as any fragment that weighs at least 10 percent of the oven dry weight of the fragment from which it was broken.

5. **Report.** The report will show the total weighted average loss calculated from the percentage loss for each sieve fraction based on the original grading of the sample.

In the case of ledge rock, the loss will be determined as outlined above.

A-4 DETERMINATION OF PERCENTAGE OF MICA IN FINE AGGREGATE

1. **Scope.** This method of test is used to determine the mica content of fine aggregate.

2. **Apparatus.** The apparatus will consist of the following:

- Square opening No. 10 and No. 200 sieves conforming to ASTM E 11.
- Balances for fine aggregate having a minimum capacity of 500 grams, sensitive to 0.1 gram or less. The analytical balances used in the mica determination will have a capacity of not more than 200 grams, sensitive to 0.1 milligram.
- Ionizing brush, 3 inch length, equipped with a polonium ionizer built in the ferrule of the brush which is an alpha emitter and immediately neutralizes any surface in close proximity freeing it of static electricity.
- Microscope, wide field, low power magnification 20X, working distance 71 mm (2.795 inches), field area 12.6 mm (0.496 inches).
- Rubber-edged scraping blade with metal stem rubber edge approximately 4 inches in length.
- Roundometer as described in ASTM D 1155.

3. **Selection of Sample.** Sample as received in the Laboratory will be taken from representative sample of field stockpile. Fine aggregate will be graded in conformance with current standard gradation specifications for the fine aggregate under test. A representative air-dried sample will be split to approximately 25 grams. The sample

will be representative of material passed through a 10 mesh sieve and retained on a 200 mesh sieve. The 25 gram sample will then be kept in a friction top can until ready for test. This sample will be further reduced to two representative 1 gram samples, both of which will be tested for mica content.

4. **Procedure.** Weigh two 1 gram samples from the 25 gram sample on an analytical balance. Brush surface of vibrating glass panel with ionizing brush (see Note). Adjust the height of slope of the glass panel to 1 3/4 inches. Set the vibrator amplitude control at such a position that flat particles on the upper half of the panel will move slowly up the slope, while the fine aggregate rolls down. Pour the sample slowly onto the vibrating glass panel at such a rate that no bunching occurs. While the flat particles are moving toward the upper end of the panel, scrape mica particles into suitable receiver. Repeat this procedure until microscopic examination of each separation shows that 95 percent or more of the mica has been removed. Weigh the collected mica. Both 1 gram samples are to be tested.

Note: If mica adheres to the glass panel during the test, indicating static electricity, clean the panel and brush with the ionizing brush.

5. **Calculation.**

$$\text{Percent of Mica} = \frac{\text{Weight of Mica in Grams} \times 100}{\text{Weight of Sample}}$$

6. **Report.** Report results of the test to the nearest 0.1 percent. The average of the results of the two samples tested will be reported.

A-5 DETERMINATION OF PERCENTAGE OF CARBONATES IN CRUSHED GRAVEL BY PETROGRAPHIC ANALYSIS

1. **Scope.** This method of test is used for the visual determination of rock types and deleterious material in coarse aggregates.

2. **Apparatus.** The apparatus will be as follows:

- Binocular microscope.
- Dilute hydrochloric acid.
- Scale accurate to plus or minus 0.1 gram
- Geology or mason hammer, or other cracking implement, and a steel striking plate.
- Penknife, screwdriver, or similar scratching device.

3. **Petrographer.** The examiner will have a degree in geology or will be a trained technician with a general background in geology and a specific background in petrology.

4. **Sample Preparation.** A sample of approximately 35 pounds will be split and screened to produce a representative sample of 300 grams of plus 4 material for aggregate sizes 3 through 5, 1000 grams of plus 4 material for aggregate sizes 56 through 68, and 500 grams of plus 8 material for aggregate sizes 7 through 9. The samples will then be washed to remove any coating which would make particle examination difficult.

5. **Procedure.** The prepared sample will be divided into rock types as defined in ASTM C 294. This will be done by visual examination with the aid of the binocular microscope, dilute HCl, and cracking and scratching implements. The resulting groups will be weighed to the nearest gram and calculated as a percent of the whole.

Deleterious material samples will be examined for weathered and leached, porous, friable, fractured, altered, or otherwise unsound particles. Pieces affected by such conditions to the degree that their performance may be impaired will be sorted out, weighed, and calculated as a percent of the whole.

Since this is a subjective determination, the following guidelines will be used in determining if particles are weathered and unsound:

- Can be broken into several pieces by a light hammer tap.
- Show more than superficial oxidation or alteration of feldspars.
- Are visibly porous.
- Show numerous microfractures or cleavage planes.
- Are of abnormal coloration.

Particles which are as outlined above should be considered worthy of close examination.

6. Report. Report will contain the percentage by weight of individual rock types, as defined in ASTM C 294, and percentage by weight of deleterious material which will be reported as weathered and unsound.

A-6 DETERMINATION OF PERCENTAGE OF ADHERENT FINES PRESENT IN COARSE AGGREGATE

1. Scope. This method of test is used to determine the percentage of adherent fines present in coarse aggregates.

2. Apparatus. The apparatus will be in accordance with AASHTO T 11.

3. Sample. The sample for the test will conform to AASHTO T 11.

4. Procedure. The test sample will be dried to constant mass at a temperature of 230 plus or minus 9 degrees F (110 plus or minus 5 degrees C) and weighed to the nearest 0.1 percent. The sample will be sieved, for a period not to exceed 1 minute, over a No. 16 sieve. The material passing the No. 16 sieve will be considered nonadherent fines. The remaining material will then be tested in accordance with AASHTO T 11 and that material determined to be finer than the No. 200 sieve will be considered adherent fines.

5. Report. The report will include the amount of nonadherent fines computed as a percentage of the total mass of the sample and the amount of adherent fines computed as a percentage of the total mass of the sample.

A-7 SHALE, SCHIST, SLATE, AND SOFT AND DECOMPOSED PARTICLES IN SOIL AGGREGATE

1. Scope. This method of test is used to determine the percentage of shale, schist, slate, and soft and decomposed particles in soil aggregate.

2. Apparatus. The apparatus will be in accordance with AASHTO T 27 and the following:

- The drying oven will be of the forced convection type capable of maintaining a temperature of 230 plus or minus 9 degrees F (110 plus or minus 5 degrees C).
- The brass rod will be in accordance with AASHTO T 189.
- The reading glass will be 4X, mounted on a suitable stand.

3. **Sample.** Sample for test will weigh, after drying, not less than 2500 grams nor more than 3500 grams obtained by use of a sample splitter or the quartering method.

4. **Procedure.**
   (a) *Gradation.* The sample will be separated by use of 2-inch, 3/4-inch, 3/8-inch and No. 200 sieves and the particle size distribution determined in accordance with AASHTO T 27.
   (b) *Determination of shale, schist, slate, and soft and decomposed particles.* The portions of the sample passing the 2-inch sieve and retained on the 3/4-inch sieve, and passing the 3/4-inch sieve and retained on the 3/8-inch sieve will be examined for shale, schist, slate, and soft and decomposed particles by:
   - The scratch hardness test in accordance with AASHTO T 189.
   - Lithological examination.
   - Combination of scratch hardness test and lithological examination.

   (c) *Separation and Weighing.* Particles determined to be shale, schist, slate, and soft and decomposed particles in accordance with (b) above will be separated from their respective sample fractions and weighed.

5. **Calculation and Report.** The report will include the following:
   - The percent of particle distribution as determined in 4(a) above for the entire sample.
   - Percentage of shale, schist, slate, and soft and decomposed particles for each size larger than 3/8-inch sieve as determined by the above procedure.
   - Total weighted percent of shale, schist, slate, and soft and decomposed particles for the entire sample. For the purpose of calculating the test results, the material finer than 3/8 inch sieve will be considered to contain the same percentage of shale, schist, slate, and soft and decomposed particles as the next larger size.

A-8 RAPIDLY DETERMINING THE BREAKDOWN IN SIZES OF SOIL AGGREGATE

1. **Scope.** This method of test is used to determine rapidly the approximate amount of soil aggregate which may be expected to break down to finer sizes under field compaction and exposure to weathering.

2. **Apparatus.**
   a. The apparatus for determining moisture density relationship and aggregate breakdown will conform to AASHTO T 99, Method C.
   b. The apparatus for performing the mechanical analysis will conform to AASHTO T 27.

3. **Preparation of Sample.**
   a. A sample of approximately 150 pounds will be air dried and thoroughly mixed.
   b. A mechanical analysis will be run on two samples of approximately 12 pounds each, obtained from the above sample by quartering. These two gradations will be averaged and the average reported as the original gradation of the material.
   c. A sample will be prepared to have the same gradation as the original determined in 3 b above.

d. The maximum density at optimum moisture content will be determined from a representative portion of the prepared sample by using AASHTO T 99, Method C including the replacement option, for material retained on the 3/4-inch sieve.

4. **Procedure.**
   a. Another sample will be compacted from the remaining material at the optimum moisture content determined in 3 d above.
   b. A mechanical analysis will be performed on the prepared sample after compaction.

5. **Report.** The report will include the following:
   - Average of two gradations determined in 3 b above.
   - Gradation of the prepared sample after compaction in 4 b above.
   - Specified gradation for the material.
   - Maximum density at optimum moisture of the prepared sample determined in 3 d above.

A-9 SCRATCH HARDNESS TEST FOR COARSE AGGREGATE PARTICLES

1. **Scope.** This method of test is used to determine the quantity of soft particles in coarse aggregates on the basis of scratch hardness. It is intended to be used to identify materials that are soft including those which are so poorly bonded that the separate particles in the piece are easily detached from the mass. The test is not intended to identify other types of deleterious materials which may be designated separately in the Specifications.

The scratch hardness test should be made on a freshly broken surface of the aggregate particle. If the particle contains more than one type of rock and is partly hard and partly soft, it should be classified as soft only if the soft portion is 1/3 or more the volume of the particle.

The scratch hardness test may be made on the exposed surface of a particle provided consideration is given to softening of the surface due to weathering. A particle with a thin, soft, and weathered surface and a hard core should normally be classified as "soft".

2. **Apparatus.** Apparatus will be a brass rod, 1/16 inch (1.6 millimeters) in diameter, with a rounded point, mounted in a device so that a load of 2 plus or minus 0.1 pound (8.9 plus or minus 0.4 N) is applied to the specimen tested. The brass rod will be of suitable hardness so that when filed to a sharp point, it will scratch a copper penny (US Lincoln design), but fail to scratch a nickel (US Jefferson design). For use in the field, the brass rod of the specified size and hardness may be mounted into the wooden shaft of an ordinary lead pencil. A suitable design for the scratch hardness apparatus is on file in the Department Laboratory.

3. **Preparation of Sample.** Coarse aggregate for the test will consist of material from which the sizes finer than the 3/8 inch (9.5 millimeter) sieve have been removed. The sample tested will be of such size that it will yield not less than the amounts of the different sizes prescribed in Table 1 below which will be available in amounts of 10 percent or more.

Table 1 - Minimum Size of Sample to be Tested (Square Opening Sieves)

Sieve Size		Sample
Millimeters	**Inches**	**Mass Grams**
9.5 to 12.5	3/8 to 1/2	200
12.5 to 19.0	1/2 to 3/4	600
19.0 to 25.0	3/4 to 1	1500
25.0 to 37.5	1 to 1 1/2	4500
37.5 to 50.0	1 1/2 to 2	12000

Should the sample contain less than 10 percent of any of the sizes prescribed in Table 1 above, that size will not be tested but, for the purpose of calculating test results, it will be considered as containing the same percentage of soft particles as the average of the next larger and the next smaller size or, if one of these sizes is absent, it will be considered to have the same loss as the next larger or next smaller size, whichever is present.

The above requirements cover aggregates composed of a mixture of different types of rock. When the aggregate is composed of only one type of rock, the weight of the sample tested may be reduced to an amount considered appropriate by the Engineer.

4. Procedure. Subject each particle of aggregate under test to a scratching motion of the brass rod, using a pressure of 2 pounds (8.9 N). Particles are considered to be soft if, during the scratching process, a groove is made in them without deposition of metal from the brass rod, or if separate particles are detached from the rock mass.

5. Calculation and Report. The report will include the following:

a. Mass and number of particles of each size of each sample tested with the brass rod.
b. Mass and number of particles of each size of each sample classified as soft in the test.
c. Percentage of test sample classified as soft by mass and by number of particles, and
d. Weighted average percentage of soft particles calculated from percentages in c above and based on the grading of the sample of aggregate received for examination or, preferably, the average grading of the material from that portion of the supply of which the sample is representative. In these calculations, sizes finer than the 3/8 inch (9.5 millimeter) sieve will not be included.

B-1 DETERMINATION OF ASPHALT CONTENT OF INVERTED EMULSIFIED ASPHALT

1. Scope. This method of test is used to determine the asphalt content of inverted emulsified asphalt.

The inverted emulsified asphalt first will be dehydrated and then distilled in accordance with AASHTO T 78.

2. Apparatus. The apparatus will consist of a 1-liter glass beaker and distillation apparatus in accordance with AASHTO T 78.

3. Procedure. Weigh 200 grams of the material into the tared 1-liter glass beaker. Heat, with constant stirring, to a temperature of 350 degrees F. This temperature will be attained within 20 to 30 minutes. Weigh the residue.

Weigh 150 grams of the dehydrated material into a tared flask and distill in accordance with the method prescribed above. Weigh the residue in the 8-ounce tin box and also the emptied distillation flask. When the dehydration does not yield sufficient residue for 150 gram distillation charge, or when the residue foams excessively in the flask on distillation, an approximate charge of 125 grams may be used.

The asphalt content, percent by weight, will be calculated according to the following formula:

$$\text{Percent Asphalt Content} = \frac{A\,(B + C)}{2D}$$

Where A = Weight in grams of residue in beaker after open evaporation to 350 degrees F.
B = Weight in grams of residue in 8-ounce tin box.
C = Weight in grams of residue in distillation flask.
D = Weight in grams of residue from open evaporation taken for distillation test. This weight is normally 150 grams as specified above.

B-2 MAXIMUM SPECIFIC GRAVITY OF BITUMINOUS MIXTURES BY SOLVENT IMMERSION

1. **Scope.** This method consists of placing a bituminous mixture in a large pycnometer and introducing a solvent that dissolves the asphalt, thereby liberating the air voids in the mass. From the weights of the sample and the solvent used, the specific gravity of the voidless bituminous mixture can be determined by calculation.

2. **Apparatus.** The apparatus will be as follows:
   - Constant temperature water bath thermostatically controlled at 25 plus or minus 0.2 degrees C.
   - Balance of approximately 3 kilogram capacity accurate to plus or minus 0.1 gram.
   - Specific gravity bottle as approved. Lower portion will be a 1000 millimeter Erlenmeyer flask with a 45/50 ground glass neck. The upper portion will be specially made with dimensions as approved and have a ground glass 45/50 connection to fit into the flask portion. The top will be fitted with a ground glass stopper.
   - Solvent (trichloroethylene or 1,1,1,-trichloroethane, industrial pure grade or better).

3. **Procedure.** The specific gravity bottle will be calibrated as follows:
   - Weigh the empty flask unit and record its weight under A.
   - Weigh the flask unit filled to mark with solvent brought to a temperature of 25 degrees C and record weight under B.

The specific gravity of the solvent will be determined by hydrometer or pycnometer, to three decimal places at 25/25 degrees C and recorded under C.

The sample of bituminous mix will be broken up and heated sufficiently to pass through the large neck of the flask. The sample will be placed in the flask and weighed and recorded under D. Approximately 500 millimeters of solvent will be added and the flask allowed to stand until all bitumen in sample is dissolved. The contents will be carefully agitated to help break uo the specimen and to release air voids.

When all bitumen is in solution and no more air bubbles rise, the flask will be filled to mark with solvent and placed in the constant temperature bath for 2 hours. The solvent which has previously been brought to a temperature of 25 degrees C will be added to flask as required. The flask containing bituminous mix and solvent will be weighed at 25 degrees C and recorded under E. Maximum specific gravity of bituminous mixture sample will be calculated as follows:

$$\text{Maximum Specific Gravity} = \frac{(D - A) \times C}{(B + D) - (E + A)}$$

Where A = Weight of flask unit, grams
B = Weight of flask filled to mark with solvent at 25 degrees C, grams
C = Specific gravity of solvent
D = Weight of flask plus sample, grams
E = Weight of flask plus sample, plus solvent at 25 degrees C, grams.

4. Report. The maximum specific gravity will be reported to the nearest 0.001 together with a calculation and other sample information.

B-3 METHOD OF SAMPLING BITUMINOUS MIXTURES

1. Scope. This method is used to at the plant to sample bituminous mixtures for Marshall stability tests and acceptance extraction tests.

2. Apparatus. The apparatus will be as follows:

- Table of random numbers.
- Scoop to make furrow and to dig material from the furrow in the pile of bituminous mixture.

3. Procedure.

The samples for extraction and stability testing will be taken from trucks, at the plant, by the Department's plant inspector.

The rates of sampling will be applied to the plant's production for all Department Projects rather than for individual Projects.

The plant's production will be divided into successive parts or lots of the size specified for the mixture being sampled. Five samples to be tested for stability and five samples to be used for extraction testing will be taken from each lot.

The Department's plant inspector will assign consecutive lot numbers for each type of mix at the plant. The producer will include the assigned lot identification number on each weigh ticket.

A table of random numbers will be used by the Department to make random selection as to which ton of mix and thus from which truckload each sample will be taken.

The following method will be used to obtain samples from the designated truckloads of material:

- From one of the conical piles of mixture within the truck, a furrow 3 to 6 inches in depth will be dug extending from the top to the bottom of the pile. The furrow will be prepared within either the front or the rear half of the truck. A coin will be flipped to determine which half of the truck is to be used:
  HEADS - front half, **TAILS** - rear half.

The furrow will follow the slope of the pile and be formed as near to its center as possible. Sampling in areas between piles will be avoided because of possible segregation.

Scoops of approximately equal volumes of material will be dug from the furrow, representing the top third, center third and bottom third of the pile. The sample will be a minimum of 28 pounds in weight.

The sample removed from the truck will be reduced as follows:

- Marshall Specimen. From the container of material, the Department's representative will take a sample to be molded into one specimen for the Marshall stability test, taking care to ensure that the temperature of the mixture does not fall below that specified for molding.

  During the production of the first lot of each mix supplied and for each succeeding fourth lot (1, 5, 9, etc.), the Department's representative will mold three Marshall specimens in addition to those molded for stability tests. The specimens will be submitted to the Department Laboratory for verification of the mix properties.

- Extraction Sample. Following the removal of material for the Marshall specimen the remaining material will be remixed. The Department's representative will then take a 1000 plus gram sample from the remixed material for the acceptance test. From the remaining material, a comparison sample of approximately 5 pounds will be wrapped, sealed and labeled.

In the event of a situation whereby the test results will not be valid because of human or mechanical failure, the comparison sample will be tested and used in place of the initial acceptance sample.

The comparison sample is to be stored at the plant so it will be available for selection by Department personnel if required.

Prior to and after each remixing and quartering, all tools will be cleaned to prevent build-up of asphalt and fines. The cleaning during the remixing and quartering operations will be accomplished without solvents.

All samples forwarded for comparison testing must be identified as to their lot number and position in the lot's sampling sequence. For this purpose, an identification code, consisting of a number followed by a letter, will be used with each sample. The number portion of the code will be the number of the lot from which the sample was taken. The letter portion will indicate where the sample fits into the lot's sampling sequence. The letter A will be used to indicate the first sample of the lot, the letter B for the second sample, the letter C for the third, and so forth. When several samples (extractions and/or stability) come from the same truckload of mix, each of these samples will have the same identification code (number and letter).

B-4 LABORATORY ANALYSIS OF BITUMINOUS CONCRETE

Quantitative Extraction of Bitumen

1. **Scope.** This method of test is used for the quantitative determination of bitumen in paving mixtures and pavement samples. The bitumen content is calculated by difference from the weight of the extracted aggregate, moisture content and weight of ash in extract. As an alternate, AASHTO T 164, Method A, may be used except that the moisture content will be determined in accordance with Subsection 903.02 as

required, and the use of a steam bath for the ash determination is not required. A balance conforming to AASHTO M 231, Class C may be used to determine the weight of the ash.

2. **Apparatus.** The apparatus will consist of the following:
   - Oven, capable of maintaining temperature at 280 plus or minus 5 degrees F.
   - Pan, 12 inch diameter.
   - Balance, capable of weighing 2000 grams to an accuracy of 0.2 gram.
   - Hot plate, electric, 3600 watt, low, medium, and high setting.
   - Small mouth graduate, 1000 millimeter capacity.
   - Test tube, 100 millimeter capacity.
   - Desiccator.
   - Analytical balance.
   - Centrifugal extraction apparatus, consisting of a bowl (minimum capacity 1300 grams) and an apparatus in which the bowl may be revolved up to a speed of 3600 rpm. The apparatus will be provided with a container for catching the solvent thrown from the bowl and a drain for removing the solvent. The apparatus will be provided with explosion-proof features installed in a hood to provide ventilation.
   - Filter rings, to fit the rim of the bowl.
   - Reagent, inhibited solvent 1,1,1, trichloroethane.
   - Centrifuge, capable of rotating 100 millimeter test tubes at 1500 rpm.
   - Torque wrench calibrated in inch-pounds with a minimum capacity of 110 inch-pounds.

3. **Procedure.** Random weight samples of 1000 grams plus are to be used for extraction. If the sample has cooled to ambient temperature, it will be heated at 280 degrees F for a minimum of 30 minutes. Samples taken at the batch plant which are still hot may be processed immediately.

The sample will be weighed to the nearest 0.1 gram and transferred into the bowl.

The sample will be covered in the bowl with solvent and sufficient time allowed for the solvent to disintegrate the sample (not over 1 hour). The bowl containing the sample and the solvent will be placed in the extraction apparatus. The filter ring will be dried, weighed, and fitted around the edge of the bowl. The cover will be clamped on the bowl tightly with a torque wrench to 110 inch-pounds. A beaker will be placed under the drain to collect the extract.

The centrifuge will be revolved until the solvent ceases to flow from the drain. The machine will be allowed to stop, 200 to 250 milliliters of solvent will be added, and this procedure repeated twice more. The extract and the washings will be collected in a suitable graduate. Sufficient solvent additions will be used, as required, to produce an extract that is clear and not darker than a light straw color.

The filter ring will be removed from the bowl and dried. As much as possible of the mineral matter adhering to the ring will be removed and added to the aggregate. The ring and contents of the bowl will be dried to constant weight in an oven at 280 degrees F.

The volume of the total extract in the graduate will be recorded. The extract will be agitated thoroughly and 75 milliliters immediately measured out and poured into a previously weighed test tube. The test tube will be placed in a centrifuge and revolved at 1500 rpm for 60 minutes. The extract will be decanted and approximately 25 milliliters of clean solvent added to the test tube. The residue will be dislodged and stirred with a spatula. The test tube will be filled with solvent, cleaning the spatula, and

placed back in the centrifuge for 30 minutes. The rinsing process will be repeated a second time and the test tube placed back in the centrifuge for 30 minutes. The test tube will be decanted and placed in an oven until dry, then cooled in a desiccator and weighed. A minimum of one determination of fines in the extract will be done on each lot of material.

Centrifuge fines in the extract will be calculated as follows:

$$\text{Weight of fines in extract} = \frac{AB}{75}$$

Where A = Total amount of extract
B = Amount of material in tube

Covert to ash as follows:

$$Y = 1.0338X + 1.0488$$

Where Y = Weight of ash in extract
X = Weight of centrifuge fines in extract

Calculate percentage of bitumen in the sample as follows:

$$\text{Percent asphalt cement} = \frac{(W1 + W2) - (W3 + W4 + W5)}{W1} \times 100$$

Where W1 = Weight of sample
W2 = Weight of ring
W3 = Weight of aggregate
W4 = Weight of ring after centrifuging
W5 = Weight of fines in extract

A minimum of one sample per lot but not less than two samples per day will be tested for moisture. The amount of moisture in the mixture can be compensated for by using the equation listed in AASHTO T 164, Method A, or by mathematically calculating the sample dry weight by dividing the wet weight by 1 plus moisture content. The most recent moisture content for each mix will be used. Samples for moisture determination will be obtained.

The percentage of bitumen will be determined to the nearest 0.01 of a percent. This will be rounded to the nearest 0.05 percent. The rounding procedure will be in accordance with ASTM E 29.

Mechanical Analysis of Extracted Aggregate

1. **Scope.** This method is used to determine the particle size distribution of fine and coarse aggregates extracted from bituminous mixtures, using sieves with square openings. As an alternate, AASHTO T 30 may be used.

2. **Apparatus.** The apparatus will be as follows:
   - Balance or scale sensitive to within 0.2 gram.
   - Sieves with square openings, mounted on substantial frames constructed in a manner that will prevent loss of material during sieving. Suitable sieve sizes will be selected to furnish the information required by the specifications covering the material to be tested. The woven wire cloth sieves will conform to the specifications for sieves for testing purposes in AASHTO M 92.

3. **Sample.** The sample will consist of the entire amount of mineral aggregate from which the bituminous material has been extracted.

4. **Procedure.** The test sample will be dried to a constant weight and weighed. The weight of mineral matter contained in the extracted bitumen will be determined and this weight added to the weight of the sample under test.

The test sample after being dried and weighed will be placed over proper sieves decreasing in size down to the No. 10 or No. 8 with a catch pan under them. The sieving operation will be conducted by means of lateral and vertical motion of the sieve, accompanied by jarring action so as to keep the sample moving continuously over the surface of the sieve. In no case will fragments in the sample be turned or manipulated through the sieve by hand. Sieving will be continued until not more than 1 percent by weight of the residue passes any sieve during 1 minute.

The fine aggregate in the catch pan will be weighed and recorded. The aggregate will then be placed in a large pan and covered with water which contains a wetting agent (Joy, Calgon or other suitable product) and agitated vigorously and the wash water immediately poured over a nest of two sieves consisting of a 2.00 or 1.18 millimeter sieve superimposed over a No. 200 sieve.

The agitation will be sufficiently vigorous to result in a complete separation from the coarse particles of all particles finer than the No. 200 sieve, and bring them into suspension in order that they may be removed by decantation of the wash water. Care will be taken to avoid decantation of the coarse particles. The operation will be repeated until the wash water is clear.

All materials retained on the nested sieves will be returned to the container. The washed aggregate will be dried to constant weight at a temperature 230 plus or minus 9 degrees F (110 plus or minus 5 degrees C) and weighed to the nearest 0.1 percent.

If the amount of material passing the No. 200 sieve fails to meet the minimum requirement for the sample under test, the coarse aggregate of the sample must also be washed over a No. 200 sieve. The minute amount of fines washed from the coarse aggregate will then be added to the passing No. 200 material washed from the fine aggregate portion of the sample.

The dried material will then be placed over a set of proper sieves including the No. 200 sieve. It will be agitated mechanically for 10 minutes.

The weight of material passing each sieve and retained on the next and the amount passing the No. 200 sieve will be recorded. The weight of dry material passing the No. 200 sieve by dry sieving will be added to the weight of mineral matter in the extract in the ring, and the weight removed by washing in order to obtain the total passing the No. 200 sieve.

5. **Report.** The results of the sieve analysis will be reported as follows:

The total percentage passing each sieve will be determined to the nearest 0.1 percent when reported on the work sheet and daily inspection report. When recorded on the lot data report, results for the No. 8 sieve will be rounded to the nearest 0.5 percent. The No. 200 sieve will be reported to the nearest 0.1 percent and all other sieves will be reported to the nearest whole percent.

The rounding procedure will be in accordance with ASTM E 29.

B-5 MEASURING THICKNESS OF BITUMINOUS CONCRETE FROM CORES

1. **Scope.** The method consists of placing the drilled bituminous concrete core in a measuring device and recording the individual lift thickness of the specified courses.

2. **Apparatus.** The apparatus will consist of a calipering device that will measure the axial lengths of individual lifts before separation. A drawing of this device is on file at the Department Laboratory.

The apparatus is so designed that the specimens will be held with its axis in a horizontal position by two metal roller bearings sufficiently rigid and stable to maintain alignment without distortion or deflection.

The apparatus will provide for the accommodation of specimens of different nominal lengths over a range of at least 1/2 to 12 inches.

A suitable gauge will be provided to calibrate and check the zero reference point of the apparatus.

3. **Procedure.** The specimens will be placed in the measuring apparatus with the smooth end of the core, that is, the end that represents the upper surface of a pavement core, firmly against the hardened-steel reference pin.

Four equidistant measurements, approximately 90 degrees apart, will be taken around the periphery of the specimens using the sliding index attached to the scale to indicate to each reading the division of the various lifts. Each of these four measurements for each lift will be read directly to 0.001 of an inch. The four measurements will be averaged and recorded to the nearest 0.01 of an inch.

If, during the course of the measuring operation, it is discovered that one or more of the measuring points is not representative of the plane of the core because of a small projection or depression, the specimen will be rotated slightly about its axis and the measurement taken at the nearest discernible point.

4. **Report.** The first (top) lift average thickness will be reported, to the nearest 0.01 of an inch, as the difference between the zero reference point and the demarcation point of the first lift.

The second lift average thickness will be reported to the nearest 0.01 of an inch, as the difference between the zero reference point and the demarcation point of the second lift minus the measurement of the first lift.

Additional lift thicknesses will be reported as the difference between the zero reference point and the demarcation point of the subsequent lifts minus the total measurement of all previous lifts.

B-6 DETERMINING CONFORMANCE OF BITUMINOUS CONCRETE MIXTURE FOR FULLY AUTOMATED PLANTS USING HOT BIN SAMPLES AND BATCH WEIGHT PRINTOUTS

1. **Scope.** This method is used to determine the gradation and asphalt content of a bituminous concrete mixture by use of bin samples and printout ticket.

2. **Apparatus.** Apparatus for coarse and fine aggregate will conform to AASHTO T 27 and apparatus for mineral filler will conform to AASHTO T 37.

3. **Procedure.** Under the supervision of the Engineer, random samples of not less than 25 pounds shall be taken by the producer from each hot bin for each 600 tons batched. (The bin samples shall be taken during the loading of the truck from which the Marshall samples are selected). When mineral filler is used, a minimum of one filler sample shall be taken per lot.

The minimum sample weight for testing shall be 25 pounds for bins No. 5 and No. 4, 10 pounds for bin No. 3, and 2 pounds for bin No. 2. Minimum test sample weight for bin No. 1 shall be 500 grams, and for mineral filler 100 grams.

Test samples from bins No. 2, 3, 4 and 5, after being weighed, will be placed over proper sieves decreasing in size down to the No. 8 with a catch pan underneath. The sieving operation will be conducted by means of a mechanical sieve shaker. The material passing the No. 8 sieve will be washed and graded using the procedure hereinafter described for bin No. 1.

The bin No. 1 material will be weighed and recorded, then washed through a No. 200 mesh sieve. The sample will be carefully agitated during this washing operation resulting in the minus 200 material being removed by the washing medium.

The washed material will be thoroughly dried and weighed, then placed over the proper sieves, decreasing in size down to the No. 200 with a catch pan underneath. It will be agitated mechanically for 5 minutes.

The amount of material passing each sieve and retained on the next and the amount passing the No. 200 sieve will be recorded. The weight of dry material passing the No. 200 and the weight removed by washing will be added together in order to obtain the total passing the No. 200.

The mineral filler sample is to be washed over a No. 200 sieve using inhibited solvent 1,1,1, trichloroethane or in accordance with AASHTO T 37.

4. **Report.** The percent of material from each bin will be determined by dividing the recorded delivery ticket weights for each bin by the total aggregate weight of the load.

The mix gradation will be determined by computing the percentage of material passing each sieve for each bin, and multiplying the percentage by each bin percentage determined above and then summing the products.

The asphalt content will be determined by dividing the recorded delivery ticket asphalt cement weight for the load by the total load weight. Percentages will be reported to the nearest 0.01 percent on the work sheet and the daily inspection report and rounded to the nearest 0.05 percent when reported on the lot data report.

Bin percentages and bin gradations will be determined to the nearest 0.1 percent when reported on the work sheet and daily inspection report. When recorded on the lot data report, results for the No. 8 sieve will be rounded to the nearest 0.5 percent. Results for the No. 200 sieve will be reported to the nearest 0.1 percent and all other sieves will be reported to the nearest whole percent.

The rounding procedure will be in accordance with ASTM E 29.

B-7 DETERMINATION OF PERCENT OF AIR VOIDS IN OPEN-GRADED MIX

1. **Scope.** The method is used to determine the percent of air voids in open-graded bituminous concrete mix design specimens.

2. **Apparatus.** Apparatus will be in accordance with AASHTO T 167 for molding, weighing and curing specimens, and in accordance with AASHTO T209 for determining maximum specific gravity. Apparatus will include a device to measure the specimens to 0.001 of an inch.

3. **Procedure.** Mold six specimens using the materials and formula for the particular mix being evaluated.

The specimens will be molded at 255 degrees F using a pressure of 2000 pounds per square inch.

After removal from the mold, specimens will be oven cured for 24 hours at 140 degrees F and, thereafter, brought to test temperature of 77 degrees F by storing in the air bath at this temperature for not less than 5 hours before testing.

Weigh each specimen in air. Report to the nearest 0.1 gram.

Measure the height and diameter of each specimen at four approximately equidistant locations and average respectively. Report to the nearest 0.001 inch.

Calculate the volume of each specimen based on the average height and diameter and convert to cubic centimeters.

Calculate the bulk specific gravity of the specimens using the formula:

$$\text{Bulk Specific Gravity} = \frac{\text{Density}}{0.99707\ \text{g/cm}^3}$$

Where Density = mass divided by volume and 0.99707 g/cm^3 is the density of water at 77 degrees F (25 degrees C).

Determine the maximum specific gravity of the specimens according to AASHTO T 209.

Calculate the percent of air voids using the formula:

$$\text{Percent Air Voids} = \frac{\text{Maximum Specific Gravity} - \text{Bulk Specific Gravity}}{\text{Maximum Specific Gravity}} \times 100$$

4. **Report.** Report the average air voids of the specimens to the nearest 0.1 percent.

B-8 COATING OF BITUMINOUS CONCRETE PATCH

1. **Scope.** This method of test is used to determine the retention of a bituminous film on aggregates used in bituminous concrete patch in the presence of water.

2. **Apparatus.** A glass container with a tight cover of sufficient size to hold a 200 gram test sample of bituminous concrete patch material.

3. **Procedure.** A sample of approximately 200 grams of bituminous concrete patch will be placed in the glass container, completely covered with distilled water and allowed to stand for 24 hours at room temperature. After the 24 hour period, the container will be shaken vigorously by hand for 5 minutes. The water will then be poured from the container and the sample will be removed and placed on a flat surface. The sample will be allowed to air dry before a visual examination is made to estimate the coated areas. (See Note)

4. **Report.** Report the estimated coated area as above 90 percent or below 90 percent.

Note - Any thin, brownish, translucent areas are to be considered fully coated.

B-9 BULK SPECIFIC GRAVITY OF COMPACTED BITUMINOUS MIXTURES

1. **Scope.** This method of test is used to determine the bulk specific gravity of specimens of compacted bituminous mixtures as defined in AASHTO M 132. The bulk specific gravity of the compacted bituminous mixtures may be used in calculating the unit weight of the mixture.

2. **Test Specimens.** Test specimens may be taken either from laboratory-molded bituminous mixtures or from field samples of bituminous mixtures.

The recommended thickness of specimens should be at least one and one-half times the maximum size of the aggregate.

Field samples will be taken with a core drill, diamond or carborundum saw, or by other suitable means. Care will be taken to avoid distortion, bending, or cracking of specimens during and after removal. Specimens will be stored in a safe, cool place.

Specimens may be separated from other pavement layers by sawing or other suitable means.

Specimens will be free of foreign materials such as tack coat, foundation material, soil, paper, or foil.

3. **Apparatus.** Apparatus will be as follows:
   - Balance will conform to AASHTO M 231 for the class of balance required for the weight of the principal sample being tested. The balance will be equipped with suitable suspension apparatus and holder to permit weighing the specimen while suspended from the center of scale pan of balance. The holder should be immersed to a depth sufficient to cover it and the test sample during weighing. Wire suspending the holder should be the smallest practical size to minimize any possible effects of a variable immersed length.
   - Water bath for immersing the specimen in water while suspended under the balance will be equipped with an overflow outlet for maintaining a constant water level.

4. **Procedure.** Dry the specimen by allowing it to remain undisturbed at room temperature, 77 plus or minus 10 degrees F (25 plus or minus 5.5 degrees C), for at least 12 hours. A fan may be used to aid drying if needed. After the specimen is dry or cooled to room temperature, record the dry mass (A). Immerse each specimen in water at 77 plus or minus 10 degrees F (25 plus or minus 5.5 degrees C) until all visible bubbling has ceased and record the immersed mass (C). Remove the specimen from the water, surface dry by blotting with a damp towel, and determine the surface-dry mass (B). If desired, the sequence of testing operations may be changed to expedite the test results. For example, first the weight of the immersed mass (C) can be determined, then the surface-dry mass (B) and finally the dry mass (A).

5. **Calculation.** Calculate the bulk specific gravity of the specimen as follows:

$$\text{Bulk specific gravity} = \frac{A}{B - C}$$

Where: A = Mass in grams of sample in air
B = Mass in grams of surface-dry specimen in air
C = Mass in grams of sample in water

6. **Report.** The bulk specific gravity will be reported to the nearest 0.001.

C-1 DETERMINATION OF YIELD OF CONCRETE PRODUCED BY CONTINUOUS-MIXING-TYPE TRUCK MIXERS

1. **Scope.** This method is used to determine the yield of concrete which is proportioned volumetrically in a continuous-mixing-type truck mixer.

2. **Apparatus.** The apparatus will consist of 1/4 cubic yard container having dimensions of 36 by 36 by 9 inches. The container will be constructed of materials that do not become deformed when filled with concrete.

3. **Procedure.** Set all controls of the mixer unit at the settings approved for the mix design being checked. Activate the mixer and discharge sufficient material to fill the mixing auger assembly and discharge chute. Then deactivate the mixing unit. Reset cement meter to zero and reactivate the mixer and discharge material into the 1/4 cubic yard container until it is level-struck full, making provision for the material settling into all corners. Record the count as shown on the cement meter.

4. **Calculation.** Calculate the cement count that is equivalent to the amount of cement specified in the mix design for 1/4 cubic yard. Calculate the yield by dividing the actual cement count by the specified count and multiplying by 100. The result will be 100 plus or minus 2 percent.

J-1

J-1 BRITTLENESS OF LIQUID JOINT FILLER

1. **Scope.** This method of test is used to determine the brittleness of liquid joint filler.

2. **Apparatus.** The apparatus will be as follows:
   - The apparatus used to form the specimen required is shown in Figure 1 below. This forms a 1 1/2 by 2 1/2 inch specimen of the material for test on 26 gauge black iron.
   - A 1 inch mandrel.

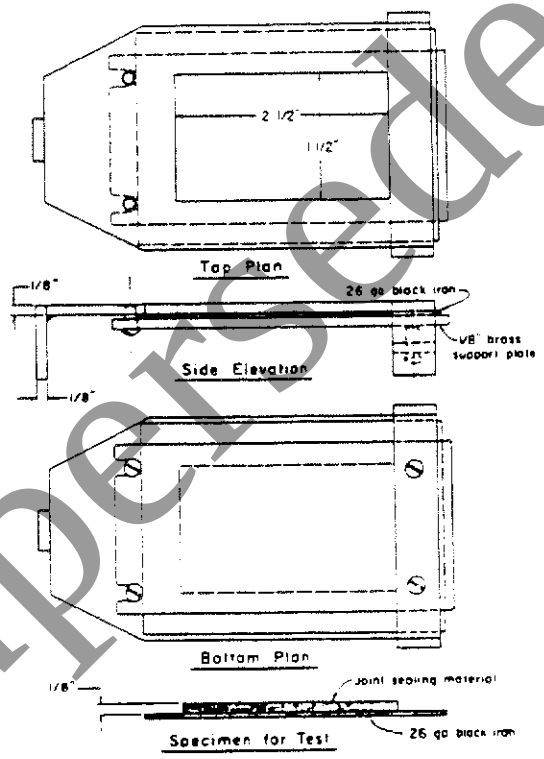

Figure 1

3. **Preparation of Sample.** The sample of material to be tested will be heated on a hot plate to 300 degrees F and maintained at this temperature while being uniformly and homogeneously mixed by stirring.

4. **Procedure.** After being heated and mixed as specified above, the material will be poured into the opening shown in Figure 1 until the opening is slightly more than filled. After being poured, the material will be allowed to cool for a period of 30 minutes after which excess material will be cut off with a broad putty knife until the surface of the

material is flush with the top of the mold. After being cut off, the material on the iron sheet will be removed from the mold without disturbing the specimen in any way. The specimen on the iron sheet and the mandrel will then be placed in a suitable container which will be maintained at a temperature of 8 plus or minus 1 degree F for a period of 2 hours. The specimen on the iron sheet will then be bent over the mandrel in 3 seconds. When making the bend, the black iron sheet with the specimen resting upon it will be placed and centered on the mandrel along the 1 1/2 inch dimension. During the bending, the specimen will be maintained at the temperature specified above.

5. Report. Five specimens will be poured for each sample tested. If the material shows any sign of a crack, it will be considered as not complying with the requirements of the Specifications.

J-2 ELASTOMERIC JOINT SEALERS
High Temperature Recovery Test

1. Scope. This method of test is used to indicate the preformed elastomeric compression sealer's potential long-term resiliency at high temperatures in actual field application.

2. Apparatus. The compression set clamp assembly described in ASTM D 395, Method B, will be used with the exceptions specified herein.

If a dial gauge is used, it will have a 1/4-inch diameter foot and will be mounted on a platform. If a dial caliper is used, it will be graduated in thousandths of an inch, made of stainless steel, hardened throughout and carefully calibrated.

3. Preparation of Sample. A 6-inch length of the preformed elastomeric compression sealer specimen will be cut from the actual extruded sealer. In this test the internal surfaces will remain as received from production while the outside surfaces only may be dusted off with talc to prevent them from sticking to the steel compression plates.

4. Procedure. A new specimen will be used for each test. Each specimen will be deflected between parallel plates to Z percent of the nominal width. Each width measurement will be taken in the center of 6-inch length. The width measurements will be made at both the top and bottom longitudinal edges of the specimen. For this purpose each edge will be placed at the center of the foot of the gauge or at the measuring tips of caliper jaws. The position of the foot or jaw will be carefully marked on the specimen before the first reading is made.

Prior to compression, the specimen will be placed in such a horizontal position that the plane through both edges of the top surface of the sealer is perpendicular to the compression plates. As the specimen is being compressed, the top surface of the joint sealer will fold inward toward the center of the specimen. The compressed width will be measured on the centers of all 4 sides of the clamp assembly with a carefully calibrated internal dial caliper.

The clamp assembly with the compressed specimen will be exposed for 70 hours in an oven maintained at 212 plus or minus 2 degrees F. The clamp assembly will not be preheated. When the aging period in the oven is completed, the clamp assembly will be removed and the test specimen immediately unclamped. The test specimen is to be cooled at room temperature (73 plus or minus 4 degrees F) on a wooden surface for 1 hour before measuring the heat-aged recovery width. This measurement is to be made at the same location as the original width. The recovery is to be calculated as described herein.

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5. Calculations. Recovery, expressed as a percentage of the original width and in relation to the corresponding recovered width, will be calculated separately for the top and the bottom measurements. For the determination of physical requirements, the smaller of the two recovery percentages will be used. Recovery is to be calculated as follows:

$$\text{Percent Recovery} = \frac{\text{Recovered Width}}{\text{Original Width}} \times 100$$

Low Temperature Recovery Test

1. Scope. This method of test is used to determine the preformed elastomeric compression sealer's potential long-term resiliency at low temperatures in actual field application.

2. Apparatus. Compression set clamp assembly described in ASTM D 395, Method B, will be used with the exceptions specified further herein.

If a dial gauge is used, it will have a 1/4 inch diameter foot and will be mounted on a platform. If a dial caliper is used, it will be graduated in thousandths of an inch, made of stainless steel hardened throughout, and carefully calibrated.

3. Preparation of Sample. A 6-inch length of performed elastomeric compression sealer specimen will be cut from the actual extruded sealer. In this test the internal and the outside surfaces may be dusted with talc to prevent adhesion.

4. Procedure. A new specimen will be used for each test. Each specimen will be deflected between parallel plates to 50 percent of the nominal width. Each width measurement will be taken in the center of a 6-inch length. The width measurements will be made at both the top and bottom longitudinal edges of the specimen. For this purpose each edge will be placed at the center of the foot of the gauge or at the measuring tips of caliper jaws. The position of the foot or jaw will be carefully marked on the specimen before the first reading is made.

Prior to compression, the specimen will be placed in a horizontal position so that the plane through both edges of the top surface of the sealer is perpendicular to the compression plates. As the specimen is being compressed, the top surface of the joint sealer will fold inward toward the center of the specimen. The compressed width will be measured on the center of all 4 sides of the clamp assembly.

The clamp assembly with compressed specimen will be exposed in a frost-free refrigerated box for the time and at the temperature specified in Subsection 908.03, Table 908-2. To achieve the frost-free condition, a sufficient amount of a desiccant such as calcium chloride will be placed in the box. When the cold aging period is completed, the test specimen will be unclamped at the test temperature and allowed to recover for 2 hours in a free state at the test temperature. The recovery width will then be measured with the specimen still at the test temperature. The recovery is to be calculated as described further herein. The measurements will be made at the locations at which the original widths were determined.

5. Calculations. Recovery expressed as a percentage of the original width and in relation to the corresponding recovered width will be calculated separately for the top and the bottom measurements. For the determination of physical requirements, the smaller of the two recovery percentages will be used. Recovery is to be calculated as follows:

$$\text{Percent Recovery} = \frac{\text{Recovered Width}}{\text{Original Width}} \times 100$$

Pressure Deflection Test

1. **Scope.** This method of test is used to determine the performance limits of the preformed elastomeric compression sealer, its pressure-deflection curb, and possible minimal unit contact pressure at 80 percent of sealer's nominal width.

2. **Preparation of Sample.** A 6-inch length of the preformed elastomeric compression sealer specimen will be cut from the extruded sealer.

The internal and outside surfaces of the specimens may be dusted with talc to prevent adhesion.

3. **Procedure.** The pressure deflection test will be performed in accordance with ASTM D 575, Method A. The sealer will be deflected in this test at a rate of approximately 0.2 inch per minute. The test will be performed in a reasonably dust-free enclosure at the constant room temperature (73 plus or minus 4 degrees F).

A new specimen will be used for each test. The specimen will be placed between the platens of the testing machine in the horizontal position in such a way that a plane through both edges of the top surface of the sealer will be perpendicular to the platens, which must be larger than the specimen.

The test specimen will be at zero percent deflection. It will then be deflected at the prescribed rate until the limit of safe compressibility is established as described in Section 908. The specimen will then be immediately released at the same rate back to the initial zero percent deflection. The pressure-deflection cycle or test run will be successfully repeated two additional times (total three times) as stated above and up to the limits of deflection established in the first run.

The zero percent deflection is at zero pounds of pressure. The pressure exerted by the sample, its deflection, the time schedule at the beginning and the end of the test run and the rate of speed will be read and recorded continuously from the beginning to the end of the test.

Bend Test

1. **Scope.** This method of test is used to determine adequacy of the preformed elastomeric compression sealer's splices exposed to actual field conditions.

2. **Procedure.** The sealer splice will be bent on all four sides perpendicular to vertical and horizontal axis around a round-shaped object having a diameter equal to 2 to 3 times the nominal width of the sealer and held in such position at least 2 minutes. The test will be conducted at room temperature. No splice separation will be detectable.

M-1 DETERMINING pH OF PEAT

1. **Scope.** This method of test is used to determine the pH (hydrogen-ion concentration) of peat by means of a pH meter and the moisture content and organic content of peat by the Ignition Loss method.

2. **Determination of pH (Hydrogen-ion Concentration).** Weigh 20 grams of peat into a 250 milliliter beaker. Add sufficient distilled water to make a slurry and stir the suspension several times at regular intervals for about 1 hour.

Using a pH meter, measure the pH of the peat suspension by immersing both the glass electrode and calomel electrode attachments deep into the thoroughly stirred suspension and reading the meter needle on the dial.

3. **Determination of Moisture Content.** Weigh 200 grams of peat in a tared dish and dry in the oven to constant weight at 230 plus or minus 9 degrees F (105 plus or minus 5 degrees C).

$$\text{Percent Moisture} = \frac{\text{Loss of Weight of Sample}}{200} \times 100$$

4. **Determination of Organic Content.** Weigh 1 gram of the oven-dried peat into a porcelain crucible and ignite to constant weight.

$$\text{Percent Organic Content} = \text{Loss of Weight of Sample} \times 100$$

M-2 PERCENT SOLIDS IN LATEX EMULSION ADMIXTURE

1. **Scope.** This method of test is used to determine the percentage of solids in a latex emulsion admixture used in latex modified concrete.

2. **Procedure.** All samples to be tested must be at room temperature. Weigh three aluminum cups and record the weight of each. Mix each sample by inverting the container five to ten times. Weigh approximately 1 gram of latex to the nearest milligram into each preweighed aluminum cup. Place all three samples in the oven to dry for 120 minutes at 285 plus or minus 2 degrees F. Remove the samples from the oven and place immediately in a desiccator until cool. Reweigh each sample out of the desiccator to the nearest milligram and record.

Note: Every sample must be tested in triplicate.

3. **Calculation.**

$$\text{Total Solids in Percent} = \frac{C\text{-}A}{B\text{-}A} \times 100$$

Where A = Weight of empty aluminum cup.
B = Weight of aluminum cup and wet sample.
C = Weight of aluminum cup and dried sample.

4. **Report.** If the results for the three samples are within 2 percent, average the three results to obtain the percent solids.

If the results for the three samples are not within 2 percent, but two results are within 1 percent, the average of the two results within 1 percent is reported as the percent solids and the third determination is discarded.

If the results for the three samples are not within 2 percent and no two results are within 1 percent, all the values will be discarded and the test procedure will be repeated.

M-3 QUICK-SETTING PATCH MATERIALS

1. **Preparation of Samples.** All samples are to be prepared in accordance with manufacturer's recommendations. If several design mixes are given, the material will be tested in the worst condition (having the most water), which would be consistent with its intended use as a patching material.

2. **Tests.** Materials will be tested according to the following:

Time of Set. Run Proctor according to ASTM C 403 except cardboard molds may be used.

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Strength Development. Two cubes per test in accordance with ASTM C 109 except, in the case of magnesium phosphate materials, the specimens will be air cured.

Bond Strength - Arizona Shear Method. Prepare four 4 by 8 inch composite cylinders consisting of a base cylinder of hardened conventional concrete and an upper portion of patching material.

The base concrete will be made from 4 by 8 inch cylinders having a minimum compressive strength of 5000 psi. These cylinders will be cut into equal halves along a 30 degree angle with the vertical axis. After being cut, the base cylinders will be etched with a 50 percent solution of hydrochloric acid and placed in 4 by 8 inch cylinder molds with cut face up.

When preparing the composite cylinders, brush a small amount of the patching material into the saw-cut surface of the base cylinder and fill the remaining half of the cylinder mold with patching material using the standard consolidation procedures defined in AASHTO T 126. Remove the cylinders from the mold after 24 hours. Test two specimens at 1 day and two specimens at 7 days in accordance with the procedure listed in AASHTO T 22.

Expansion-Shrinkage. Change in volume and length will be monitored from batching until the materials have reached equilibrium. Prepare four 2 by 2 by 10 inch autoclave bars according to ASTM C 157. Cure in room at 70.4 to 76.4 degrees F and 50 percent relative humidity for 24 hours. Record initial reading for 24 hours, then place two bars in water bath in moisture room, leave the other bars in the initial curing conditions and take a reading on each bar every 24 hours until stability has been attained.

Durability. Prepare four 4 by 8 inch cylinders for each material. Test two cylinders according to ASTM C 192 for 28 day compressive strength. The remaining two cylinders will be tested as follows:

- Cure for 24 hours in room at 70.4 to 76.4 degrees F and 50 percent relative humidity, followed by 6 day cure in a lime water solution.
- Following the 7 day cure period, begin 50 cycle freeze-thaw test. Each cycle will consist of 16 hours freeze (air) and 8 hours thaw (solution). The solution will be proportioned by weight of 96 percent water, 3.2 percent sodium chloride, and 0.8 percent calcium chloride.
- At the end of the 50 cycles, perform compressive test and report the results as a percentage of the 28-day compressive strength result.

  Note - After every tenth cycle, cylinders will be examined visually and their condition recorded in accordance with ASTM C 672.

Permeability.

- Prepare one 4 by 8 inch cylinder and cure 24 hours at 70.4 to 76.4 degrees F and 50 percent relative humidity. Saw cut the cylinder into two 4 by 4 inch cylinders.
- Seal all sides and the bottom with hot paraffin leaving the saw-cut surface exposed.
- Place cylinders in durability solution for 7 days.
- Measure the amount of chlorides at the 1-inch, 2-inch and 3-inch levels, from the top surface, in accordance with AASHTO T 260.

  Note - If the material is to be used at temperatures lower than 70 degrees F, the Engineer may test the time of set and compressive strength at the lower temperatures.

P-1 DETERMINING WATER RESISTANCE OF TRAFFIC PAINT

1. **Scope.** This method of test is used to determine the water resistance of traffic paint.

2. **Apparatus.** The apparatus will consist of 4 by 8 inch glass panels and suitable solvent.

3. **Procedure.** The glass panels used in this test will be thoroughly cleaned with a suitable solvent to remove the presence of any grease, then with hot soapy water, rinsed with clear warm water, and allowed to dry before the paint is applied.

The paint will be applied to the panels in a wet film thickness of 0.015 inch. Allow the paint film to dry in a horizontal position at room temperature (75 plus or minus 5 degrees F) for 2 hours, protecting it against accumulation of dust, then immerse the glass panel in distilled water at room temperature for 18 hours. Allow to air dry for 2 hours and then examine.

The paint will show no softening or blistering.

P-2 GLASS BEADS

1. **Scope.** These methods of tests are used to determine the suitability of glass beads for reflectorizing traffic paint.

2. **Sampling.** Bags selected at random are split by a sample splitter to about 3 pounds (1 quart). The number of bags selected will be the nearest cube root of the number of bags in the lot or shipment. Each sample will again be split to such a size that a combined sample of approximately 1 quart will be obtained for the tests. For determining the percent spheres, grading, and daylight 45 degrees - 0 degree reflectance, the combined sample is split to such amounts as required for the particular tests.

3. **Spherical Particles.** The percentage of spherical particles will be determined in accordance with ASTM D 1155, Procedure B.

4. **Index of Refraction.**

(a) *General.* When immersed in liquids, all transparent or translucent objects yield images under a microscope which are bounded by dark shadow outlines or halos. As the index of refraction of the solid nears that of the liquid, the dark shadow outlines decrease in prominence and disappear when both object and liquid have the same refractive index.

(b) *Procedure.* Liquid Immersion Method at 25 Degrees C.

The crushed particles of glass beads are placed on a clean glass slide and covered with a small fragment of cover glass. (Small pieces of cover glass are advantageous because less sample and liquid are required and the crystals are more easily found.) A drop of liquid of known refractive index is introduced and the specimen examined under the microscope.

When the solid possesses a higher index than that of the liquid, the contours are usually dark and well defined with a halo or band of light within the back bands. As the microscope tube is raised, this band of light will appear to move inward, i.e., toward the center of the solid. If, on the other hand, the solid possesses a lower index of refraction, the black contours are relatively weak, with the bright halo outside the black bands, and upon raising the objectives, the band of light or bright halo apoears to move outward or away from the center.

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If a solid of unknown index is immersed in a series of liquids of known refractive index, one after another, until the black contours bounding the image just disappear when the solid is immersed in one of the liquids, the index of that particular liquid is the index sought of the solid.

5. Grading. Approximately 100 grams of glass beads are separated by mechanical sieving into a series of US standard sieves and the following determinations are made:

- Percent passing Nos. 16, 20, 30, 50 and 100 mesh sieves.
- Percent retained on Nos. 16, 20, 30, 50 and 100 mesh sieves.

6. Chemical Stability. Samples of beads will show no tendency toward decomposition or surface etching when subjected to each of the following tests:

- Resistance to Hot Water Attack. Twenty-five grams of beads are run with 250 milliliters of distilled water and subjected to 90 hours continuous running in a Soxhlet Extraction Apparatus.
- Resistance to Attack Comparable to that of Normal Soil Acidity (pH 5 to pH 6). Twenty-five grams of beads are soaked for 90 hours in 500 milliliters of buffered solution (pH 5 to pH 6) at room temperature. The solution is then decanted and the beads rinsed with 100 milliliters of distilled water.
- Resistance of Lime Water Attack (encountered on portland cement concrete highways). Twenty-five grams of beads are boiled for 2 hours in 1000 milliliters of saturated lime water solution. Solution is then decanted and beads are rinsed with 100 milliliters of distilled water.
- Resistance to Attack by Salt Solution (encountered in winter with treated sands, etc). Twenty-five grams of beads are boiled for 3 hours in 500 milliliters of a 1.0 normal solution of calcium chloride. Solution is then decanted and beads are rinsed with 100 milliliters of distilled water.

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