

STATE OF MAINE



Department of Transportation

Standard Specifications Highways and Bridges

Revision of June, 1981

Re: Tld. Bk.: Pg. _____
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MAINE 1981

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Revision of June, 1981

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DIVISION 100 -- GENERAL PROVISIONS

SECTION 101 -- DEFINITIONS AND TERMS

Wherever in these specifications, on the plans or in other contract documents the following terms are used, the intent and meaning shall be interpreted as follows:

101.01 Abbreviations. The following abbreviations are to be construed the same as the respective expressions represented:

AAN	American Association of Nurserymen, Incorporated
AASHTO	American Association of State Highway and Transportation Officials
ANSI	American National Standards Institute
ARTRA	American Road & Transportation Builders Association
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWPA	American Wood-Preservers Association
AWS	American Welding Society
EIA	Electronic Industries Association
FHWA	Federal Highway Administration
FSS	Federal Specifications and Standards, General Services Administration
IES	Illuminating Engineering Society
IMSA	International Municipal Signal Association
IPCEA	Insulated Power Cable Engineers Association
ITE	Institute of Transportation Engineers
MUTCD	Manual On Uniform Traffic Control Devices
NBS	National Bureau of Standards
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NESC	National Electric Safety Code
SAE	Society of Automotive Engineers
SSPC	Steel Structures Painting Council
USDA	United States Department of Agriculture
UL	Underwriter's Laboratory

101.02 Acceptance Test. Test that determine the quality of the material at time of incorporation in the work and include control tests, certified tests and certificates of compliance.

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

101.04 Aggregate. Inert material such as sand, gravel, broken stone or crushed stone or a combination thereof.

101.05 Award. The acceptance by the Department of a bid.

101.06 Base Course. The layer or layers of specified or selected material of designated thickness placed on a subbase or a subgrade to support a surface course.

101.07 Bidder. An individual, firm or corporation submitting a bid for the advertised work.

101.08 Bridge. A structure having a clear span of 10 feet or more measured at the elevation of the bridge seats along the centerline of the road or in case of multiple spans when the combined clear spans equal or exceed 10 feet.

(a) Length. The length of a bridge structure is the overall length measured along the construction centerline 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.

(b) Roadway Width. The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or in case of multiple height of curbs, between the bottoms of the lower risers.

101.09 Calendar Day. Every day shown on the calendar, Sundays and Holidays included.

101.10 Change Order. A written order issued by the Engineer to the Contractor, covering changes in the plans or quantities or both, within the scope of the contract and establishing the basis of payment and time adjustments for the work affected by the changes.

101.11 Commissioner. The Commissioner of Transportation established by 23 MRSA § 4203(1).

101.12 Conduit. A pipe used for receiving and protecting wires or cable.

101.13 Construction Limit Line. A line outside of the established right-of-way indicating the limits within which the work will be performed and within which the Contractor may legally work.

101.14 Construction Easement (Right-of-Way). A right acquired by public authority to use or control property, outside of the established right-of-way limits for a designated highway purpose.

101.15 Contract. The written agreement between the Department and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to, the performance of the work, the furnishing of labor and materials and the basis of payment.

The contract includes the proposal, contract form and contract bonds, specifications, supplemental specifications, special provisions, general and detailed plans and notice to proceed, also any change orders and agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

A contract may include any part of a project or one or more projects.

101.16 Contract Bonds. The approved form of security, executed by the Contractor and his Surety or Sureties, guaranteeing complete execution of the contract and all its supplemental agreements and the payment of all legal debts pertaining to the construction of the project.

101.17 Contract Item (Pay Item). A specifically described unit of work for which a price is provided in the Contract.

101.18 Contract Payment Bond. The security furnished by the Contractor and his surety to guarantee payment of the debts covered by the bond.

101.19 Contract Performance Bond. A security furnished by the Contractor and his surety to guarantee performance of the work in accordance with the contract.

101.20 Contract Time. The number of working days or calendar days allowed for completion of the contract, including authorized time extensions.

In case a calendar date of completion is shown in the proposal instead of the number of working or calendar days, the contract shall be completed by that date.

101.21 Contractor. The individual, firm or corporation contracting with the Department for performance of prescribed work.

101.22 Vacant

101.23 Culvert. Any structure not classified as a bridge which provides a drainage opening under the roadway or approaches to the roadway.

101.24 Department. The Department of Transportation of the State of Maine, as established by 23 MRSA § 4202 et seq for the administration of highway, bridge and other public works; acting through the Commissioner of Transportation or through his duly authorized representative.

101.25 Vacant

101.26 Drainage. The system of pipes, drainage ways, ditches and structures by which surface or subsurface waters are collected and conducted from the highway area.

101.27 Engineer. The Chief Engineer of the Maine State Department of Transportation, acting directly or through his duly authorized representatives, who is responsible for engineering supervision of the construction.

101.28 Equipment. All machinery and equipment, together with the necessary supplies for upkeep and maintenance and also tools and apparatus necessary for the proper construction and acceptable completion of the work.

101.29 Extra Work. An item of work or labor and materials to be furnished by the Contractor not provided for in the contract as awarded but found essential to the satisfactory completion of the contract.

101.30 Extra Work Order. A change order concerning the performance of work or furnishing of materials involving extra work. Extra work may be performed at agreed prices or on a force account basis as provided elsewhere in these specifications.

101.31 Haul Road. A private way leading to a public way; used by the Contractor to provide materials to be incorporated in the work or to remove surplus material not required for the work.

101.32 Highway. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.33 Inspector. The Resident's authorized representative assigned to make detailed inspections of contract performance.

101.34 Vacant

101.35 Laboratory. The testing laboratory of the Department or any other testing laboratory which may be designated by the Engineer.

101.36 Lane. A strip of traveled way intended to accommodate the forward movement of a single line of vehicles.

101.37 Legal Holidays. Legal holidays shall include the following days: New Year's Day, Washington's Birthday, Patriot's Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day and Christmas Day. If any holiday listed above occurs on a Sunday the following Monday shall be considered a holiday.

101.38 Lines of Improvement. Irregular lines, left and right of the roadway centerline, within which construction will be performed.

101.39 Liquidated Damages. The charge assessed against the Contractor to cover additional costs incurred by the State because of failure of the Contractor to complete the contract within the contract time. Assessment of liquidated damages will be by deductions from payments otherwise due, of an amount at a specified rate per day for each day of overrun in contract time in accordance with the contract terms.

101.40 Supplemental Liquidated Damages. The charges assessed against the Contractor for his failure to complete specific work within a specified date or time. These charges are in addition to and separate and distinct from Liquidated Damages. Whenever Supplemental Liquidated Damages are applicable a Special Provision will set forth their terms. Assessment of damages will be the same as specified in Subsection 101.39.

101.41 Lump Sum. The single price bid by a Contractor as a single amount for a complete contract item as defined by the specifications.

101.42 Materials. Any substances specified for use in the construction of the project and its approaches.

101.43 Notice of Award. A written notice to the selected bidder, stating that his bid has been accepted and that, in accordance with the Notice to Contractors and the specifications, he is required to execute the Contract Agreement and furnish the satisfactory Contract Bonds.

101.44 Notice to Contractors. The official notice stating the time and place for the submission of bids.

101.45 Notice to Proceed. Written notice to the Contractor to proceed with the contract work including, when applicable, the date of beginning of contract time.

101.46 Owner. The legal or record owner of the building or premises on which the contract work is to be performed.

101.47 Pavement Structure. The combination of subbase, base course and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

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

101.49 Premises. Land of the owner on which the building or buildings now stand or to which they are to be moved.

101.50 Process Control Test. Test performed by the Engineer at the source of supply to determine the capability of the material prior to delivery.

101.51 Profile Grade. The trace of a vertical plane intersecting the top of the wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

101.52 Project. The specific section of the highway or bridge or both, together with all appurtenances and construction to be performed thereon under the contract.

101.53 Proposal. The offer of a bidder on a form prescribed by the Department, to perform the work and to furnish the labor and materials at the prices quoted.

101.54 Vacant

101.55 Proposal Guaranty. The security designated in the proposal and furnished with a bid to guarantee that the bidder will enter into the contract if his bid is accepted.

101.56 Questionnaire. The specified forms on which the Contractor shall furnish required information as to his ability to perform and finance the work.

101.57 Reference Stake. Stake, set beyond the line of improvement for use as control for the new construction.

101.58 Resident Engineer. A Registered Professional Engineer project representative of the Chief Engineer acting within the scope of the duties assigned to him or the authority given him.

101.59 Resident Inspector. A person, other than a Registered Professional Engineer, who is assigned as a project representative of the Chief Engineer in the same capacity and with the same duties and authority as a Resident Engineer.

101.60 Right-of-Way. A general term denoting land, property or interest therein, usually in a strip, acquired for or devoted to a highway.

101.61 Road. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.62 Roadbed. The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

101.63 Roadside. A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

101.64 Roadside Development. Those items necessary to the complete highway which provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching and the placing of other ground covers; such suitable planting and other improvements as may increase the effectiveness and enhance the appearance of the highway.

101.65 Roadway. The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways.

101.66 Schedule of Work. The approved work schedule, submitted by the Contractor, stating the dates within which he contemplates the start and completion of various work items within the contract time.

101.67 Section. (When referring to the Specifications). A numbered article or group of related articles forming a part of the specifications and applying to or controlling the procedure of an operation or regulation.

101.68 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.

101.69 Sidewalk. That portion of the roadway primarily constructed for the use of pedestrians.

101.70 Skew or Skew Angle. The acute angle formed by the intersection of the line normal to the centerline of the roadway or the working line of the superstructure with a line parallel to the face of the substructure or in the case of structural plate units and culverts, with the centerline of the structural plate units and culverts.

101.71 Specialty Items. Specialty Items shall be limited to work that requires highly specialized knowledge, craftsmanship or equipment not ordinarily available in contracting organizations qualified to bid on the contract as a whole and in general are to be limited to minor components of the overall contract.

101.72 Special Provisions. Additions and revisions to the standard and supplemental specifications covering conditions peculiar to an individual project.

101.73 Specified Completion Date. The date on which the contract work is specified to be complete.

101.74 Specifications. A general term applied to all directions, provisions and requirements pertaining to material and performances of the work.

101.75 State. The State of Maine acting through its authorized representatives.

101.76 Street. A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

101.77 Structures. Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, services pipes, underdrains, foundation drains and other features which may be encountered in the work and not otherwise classed herein.

101.78 Subbase Course. The layer or layers of specified or selected material of designated thickness placed on the subgrade to support a base course or a surface course.

101.79 Subcontractor. An individual, firm or corporation to whom the Contractor sublets parts of the contract.

101.80 Subgrade. The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

101.81 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, parapets and wing walls of abutments.

101.82 Superintendent. The Contractor's authorized representative in responsible charge of the work.

101.83 Superstructure. All that part of the structure above the bearings of simple and continuous spans, skewbacks of arches and top of footings of rigid frames; excluding backwalls, wingwalls and wing protection railing.

101.84 Supplemental Specifications. Additions and revisions to these standard specifications that are adopted subsequent to issuance of the printed book of Standard Specifications.

101.85 Supplementary Agreement. A written agreement executed by the Contractor and the Department covering the furnishing of materials, also for the performance of work not included in the original contract which is necessary for the proper completion of the work.

101.86 Surety. The corporation, company, partnership or individual, other than the Contractor, executing a bond furnished by the Contractor.

101.87 Surface Course. One or more layers of pavement designed to accommodate the traffic load. The top layer may be called the Wearing Course.

101.88 Titles (Or Headings). The titles or headings of the Sections and Subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

101.89 Town, City, Township, Plantation. A subdivision of the county used to designate or identify the location of the proposed work.

101.90 Traveled way. The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

101.91 Unit Price. The price bid by the Contractor for one unit of work, as defined by the specifications.

101.92 Utility. An organization serving the public by the transmission of services. For the purposes of this definition rail-ways are considered utilities unless otherwise clearly indicated by context.

101.93 Work. Work shall mean the furnishing of all labor, materials, equipment and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all the duties and obligations imposed by the contract.

101.94 Working days. A calendar day, exclusive of Saturdays, Sundays and State recognized legal holidays, as set forth in Subsection 101.37 Legal Holidays and the period November 15 to May 15 inclusive as set forth in Subsection 108.06, on which weather and other conditions not under the control of the Contractor will permit construction operation to proceed for 70 percent of the hours of the usual working day with the normal working force.

Saturday shall be considered one half of a working day if the Contractor works 2 or more hours during the forenoon. If the Contractor works after 12 o'clock noon, it shall be considered as one working day. If after approval, work is performed on a Sunday or a Legal Holiday, then the day shall be considered a working day. Necessary maintenance work or work necessary for the safety of the traveling public performed on Sundays or Legal Holidays will not be considered in working day computations.

Reference is made to Subsection 108.04 and Subsection 108.06.

101.95 Working Drawings. Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel or any other supplementary plans or similar data which the Contractor is required to submit for approval.

101.96 Work Order. A written order, signed by the Engineer, of a contractual status requiring performance by the Contractor without negotiations of any sort.

101.97 Intention of Terms. In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever anything is or is to be done, if, as, or, when or where contemplated, required, determined, directed, specified, authorized, ordered, given, designated, reserved, suspended, established, approval, approved, disapproved, acceptable, unaccep-

table, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected or condemned, it shall be understood as if the expression were followed by the words "by the Engineer" or "to the Engineer".

SECTION 102 - BIDDING REQUIREMENTS AND CONDITIONS

102.01 Qualification of Bidders. The form "Questionnaire and Financial Statement for Bidder", included with the proposal, shall be submitted only by bidders who have not been awarded a contract by the Department within the 5 years preceding the date of the opening of proposals or upon request of the Department at any time. The questionnaire statement shall include a complete report of the bidder's financial resources and liabilities, equipment, past record and personnel.

When a bidder who has not been awarded a contract by the Department within 5 years previous to the date of opening of proposals, wishes to submit proposals on more than one project on the same day, he may submit his "Questionnaire and Financial Statement for Bidders" under separate cover for consideration in conjunction with all of his proposals submitted on that day. The instructions on the form must be followed in detail. The proposal of any bidder not complying with the above requirement in regard to "Questionnaire and Financial Statement for Bidders" shall be considered informal and may be rejected.

102.02 Notice to Contractors. The Notice to Contractors will contain a description of the proposed work, instructions to the bidder regarding proposal forms, proposal guaranty, plans, specifications and the reservation of the right of the Department to reject any or all bids.

102.03 Method of Obtaining Plans, Specifications and Proposal Forms. Plans, specifications and proposal forms may be seen and obtained at the office of the Maine Department of Transportation, Augusta, Maine, upon payment as specified in the Notice to Contractors.

102.04 Contents of Proposal Forms. The proposal form will state the location and description of the contemplated construction and will show the estimate of the various quantities and kinds of work to be performed or materials to be furnished and will have a Schedule of Items for which unit or lump sum bid prices are invited. The proposal form will state the time in which the work must be completed, the amount of the proposal guaranty and the date, time and place of the opening of proposals. The proposal form will also include special provisions or requirements which vary from or are not contained in the Standard Specifications.

All papers bound with or attached to the proposal form are considered a part thereof and must not be detached or altered when the proposal is submitted.

The plans, specifications and other documents designated in the proposal form will be considered a part of the proposal whether attached or not.

The prospective bidder will be required to purchase from the Department each copy of the proposal form and each set of plans. The purchase price will be stated in the Notice to Contractors.

When there is more than one item for payment, specified under the same contract pay item, another digit or digits will be added to the end of the decimal of the pay item number to differentiate between the various pay items. The item number shown in these specifications for this particular case will not be used directly but will be altered as shown in the following illustration:

Item number shown in these specifications = 900.06

Pay item number for use in the proposal = 900.061,
900.062, -etc.

102.05 Issuance of Proposals. The Department reserves the right to disqualify or refuse to issue a proposal if the Commissioner determines that a bidder is in default for any of the following reasons:

- (a) Lack of competency, adequate machinery, plant and other equipment, as revealed by the Questionnaire and Financial Statement for Bidder and experience questions required under Subsection 102.01.
- (b) Uncompleted work which, in the judgment of the Commissioner, might hinder or prevent the prompt completion of additional work if awarded.
- (c) Failure to pay or satisfactorily settle bills due for labor and material on former contracts in force at the time of issuance of proposals.
- (d) Failure to comply with regulations of the Department.
- (e) Default under previous contracts.

102.06 Interpretation of Quantities in Bid Schedule. The quantities appearing in the Schedule of Items or on the plans are approximate and are prepared for the comparison of bids; they are not guaranteed to be accurate and are furnished without liability on the part of the Department. The Department reserves the right to increase or decrease the quantities shown or to omit items. Payment to the Contractor will be made only for the actual quantities of work performed and accepted or materials furnished in accordance with the contract.

102.07 Examination of Plans, Specifications, Special Provisions and Site of Work. The Department will prepare full, complete and accurate plans and specifications giving directions which will enable any competent mechanic or Contractor to carry them out. The bidder is expected to carefully examine the site of the proposed work, the proposal, plans, specifications, supplemental specifications, special provisions and contract forms before submitting a proposal. He is expected to fully inform himself as to the quantity and quality of materials and labor. The submission of a bid shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to the conditions to be encountered in performing the work and as to the requirements of the plans, specifications, supplemental specifications, special provisions and contract. The bidder will be held responsible for his failure or neglect to observe or comply with these instructions.

The bidder shall have access to and may examine, at the office of the Department, the record of all borings, tests excavations, other subsurface investigations and soil analysis, if any, made for design purposes prior to the construction of the project, the records of which may or may not be shown on the plans. The subsurface information furnished is based on the interpretation by the Department of investigations made at the specified locations indicated and no assurance is given that these conditions are necessarily typical or that they have remained unchanged since the field data was obtained. Such information is subject to inaccuracies inherent in drilling methods and to variations in the driller's classification and interpretation of soil layers. No assurance is given that the presence or absence of water in subsurface explorations at the time of these explorations will be representative of actual conditions at the time of construction. It is the obligation of the bidder to draw his own conclusions of subsurface conditions from his own investigations prior to submitting a proposal. The Contractor agrees, in signing his contract, that he will make no claim against the Department, if in carrying out the work he finds that the actual conditions encountered do not conform to those conditions shown by said borings, test excavations and subsurface investigations.

102.08 Preparation of Proposal. The bidder shall submit his proposal upon the forms furnished by the Department. The bidder shall specify a unit price or lump sum price, as required in the proposal, in words and figures, for each pay item for which a quantity is given and shall also show the products of the respective unit prices and quantities written in figures in the column provided for that purpose and the total amount of the proposal obtained by adding the amounts of the several items. All the words and figures shall be in ink. In case of a discrepancy between the prices written in words and those written in figures the prices written in words shall govern.

When an item in the proposal contains a choice to be made by the bidder, the bidder shall indicate his choice in accordance with the specifications for that particular item and thereafter no further choice will be permitted.

If a unit price or lump sum bid already entered by the bidder in the proposal is to be altered it shall be crossed out with ink, the new price entered above or below and initialed by the bidder, also with ink.

The bidder's proposal must be correctly signed with ink by the individual, by one or more members of the partnership, by one or more members or officers of each firm representing a joint venture or by one or more officers of a corporation or by an agent of the Contractor legally qualified and acceptable to the Department. If the proposal is made by 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 officials must be shown.

In addition, an affidavit executed and sworn to must accompany each proposal submitted by a corporation indicating the authority of the designated official to sign each document on behalf of the corporation.

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

- (a) 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.
- (b) If there are unauthorized additions, conditional or alternate bids or irregularities of any kind which tend to make the proposal incomplete, indefinite or ambiguous as to its meaning.
- (c) 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.
- (d) If the proposal does not contain a unit price for each pay item listed except in the case of authorized alternate pay items.
- (e) If any of the Bid Prices are obviously unbalanced, the Department will decide whether any Bid Prices are unbalanced above or below a reasonable cost analysis value determined by the Engineer.
- (f) If the proposal lacks any of the requirements of Subsection 102.08.

102.10 Proposal Guaranty. No proposal will be considered unless accompanied by a guaranty in an amount not less than the amount indicated in the proposal form and made payable to the Treasurer of the State of Maine. Acceptable forms of guaranty are an official bank check, a cashier's check, a certified check, a certificate of deposit or a United States Postal money order. A bidder using a certificate of deposit for a proposal guaranty must have the certificate form approved by the Commissioner of Transportation prior to the submission of the bid.

102.11 Delivery of Proposals. Each proposal shall be submitted in a sealed envelope. The envelope shall be correctly labeled to indicate its contents. When an envelope other than one furnished by the Department is used, it shall be of the same general size and shape and be similarly labeled to indicate its contents. Proposals shall be filed prior to the time and at the place specified in the Notice to Contractors. Proposals received after the time for opening of bids will be returned to the bidder.

102.12 Withdrawal or Revision of Proposals. A bidder may withdraw or revise a proposal after it has been deposited with the Department, provided the request for such withdrawal or revision is received by the Commissioner or Chief Engineer, in writing or in person, before the time set for opening proposals.

In addition to the above, any bidder who has submitted proposals on more than one project may, by a request in writing or in person, withdraw any or all of his additional proposals after the Department or its representative has announced that such bidder has submitted the apparent lowest proposal on the project for which bids have last been read. When this option is exercised, the proposal for any other project will be returned to the bidder unopened, provided the request for the withdrawal of the other proposal is made before the total amount of the first bid for any other project for which he has submitted a bid is read. No returned proposals will be considered after the bidder exercises his privilege to withdraw. Any bidder exercising the privilege to withdraw his bid or bids, waives all claims that may arise should it be found that his opened proposal is not in proper form or for any other reason is unacceptable to the Department.

102.13 Combination Proposals. Proposals may be issued for projects in combination 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. No combination bids, other than those specifically set up in the proposals by the Department will be considered.

102.14 Public Opening of Proposals. Proposals will be opened by the Department Representative in the order in which they are drawn and read publicly at the time and place indicated in the Notice to Contractors. Bidders, their authorized agents and other interested parties are invited to be present.

102.15 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 or proposals:

- (a) More than one proposal for the same work from an individual, firm or corporation under the same or different name.
- (b) Evidence of collusion among bidders. Participants in such collusion will receive no recognition as bidders for any future work of the Department until such participant shall have been reinstated as a qualified bidder.

Title 23, United States Code requires as a condition precedent to approval by the Secretary of Transportation of the contract for this work that there be filed a sworn statement executed by or on behalf of the person, firm, association or corporation to whom such contract is to be awarded, certifying that such person, firm, association or corporation has not, either directly or indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with such contract. This sworn statement shall be an affidavit executed and sworn to by the successful bidder before a person who is authorized to administer oaths. The original sworn statement shall be filed with the Department.

- (c) Lack of competency, as determined by the Commissioner after analysis of the Questionnaire and Financial Statement for Bidders.
- (d) Lack of responsibility as shown by past work judged by the Commissioner from the standpoint of workmanship and progress.
- (e) Incomplete work which, in the judgment of the Commissioner might hinder or prevent the prompt completion of additional work if awarded.
- (f) For being in arrears on existing or previous contracts, in litigation with the Department or having defaulted on a previous contract.

102.16 Material Guaranty. Before a contract is awarded, the successful bidder may be required to furnish a complete statement of the origin, composition and manufacture of any or all materials to be used in the construction of the work, together with samples which may be subjected to the tests herein provided to determine their quality and fitness for the contract.

102.17 Non-resident Contractors. The successful bidder, if a foreign corporation, shall file, with the Department at the time of the execution of the contract, notice of the name of its resident attorney, appointed as required by Statute.

The successful bidder, if a resident of another state and not a corporation, shall file with the Department at the time of the execution of the contract, a written appointment of a resident of this State, having an office or place of business herein, to be his true and lawful attorney upon whom all lawful processes in any actions or proceedings against him may be served. The appointment shall set forth the attorney's place of residence and shall agree that any lawful process against him which is served on said attorney shall be of the same legal force and validity as if served on him and that authority shall continue in force as long as any liability remains outstanding against him in this State. The appointment shall be filed in the office of the Secretary of State. Service of such process shall be made by leaving a copy of the process in the hands or in the office of the resident attorney and shall be sufficient service upon the successful bidder. The appointment shall continue in force until revoked by an instrument in writing, designating in a like manner some other person whom such process may be served which instrument shall be filed in the manner provided herein for the original appointment.

A Non-resident Contractor shall be deemed to be:

- (a) Any person who is not a resident of the State of Maine.
- (b) Any firm that has no member thereof resident of the State of Maine.
- (c) Any corporation established under laws other than those of the State of Maine.

SECTIONS 103 - AWARD AND EXECUTION OF CONTRACT

103.01 Consideration of Proposals. After the proposals are opened and read, they will be compared by the Department on the basis of the summation of the products of the approximate quantities shown in the Schedule of Items and the unit bid prices. The results of such comparisons will be available to the public. In the event of a discrepancy between unit bid prices and extensions, the unit bid price shall govern.

When unit bid prices indicate a credit to the State, the net result will be that result obtained by subtraction of the totals of the credit item or items from total of the plus item or items in the Schedule of Items. Double spaces will be provided in the Schedule of Items for those items which it is anticipated that a credit or minus unit price might be entered. This does not prohibit

credit or minus bidding on items for which no double spaces are provided in the schedule. However, care must be exercised to write the word "CREDIT" in conjunction with the written amount shown under the column headed Items and Unit Prices Bid, otherwise a plus unit price will prevail. The possibility of the withdrawal, by the Department, at some future date of a credit or minus item from the contract will not be a factor in the determination of the low bidder.

The right is reserved to reject any or all proposals, to waive technicalities or to advertise for new proposals, if in the judgment of the Commissioner the best interests of the Department will be promoted.

103.02 Award of Contract. The award of contract, if it be awarded, will be made within 30 calendar days after the opening of proposals, to the lowest responsible bidder whose proposal complies with all the requirements specified. The successful bidder will be notified by registered or certified letter mailed to the address shown on his proposal, that his bid has been accepted and that he has been awarded the contract.

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

103.04 Return of Proposal Guaranty. All proposal guaranties, except those of the 2 lowest bidders, will be returned within 3 days following the opening and checking of proposals. The proposal guaranty of the unsuccessful of the 2 lowest bidders will be held until the contract is executed by the successful bidder, at which time this proposal guaranty will be returned. The proposal guaranty of the successful bidder will be retained until after the contract has been executed, after which it will be returned.

If all proposals are rejected all guaranties will be returned within 3 days of the date of rejection. Unopened and informal proposals will be returned immediately.

103.05 Requirements of the Contract Bonds. The successful bidder must furnish the following bonds at the time of the execution of the contract:

- (a) A Contract Performance Bond for an amount equal to the full amount of the contract for the prompt and faithful performance and completion of the work to be done under the contract.
- (b) A Contract Payment Bond for an amount equal to the full amount of the contract for the payment in full for all labor and material used or required in connection with the work set forth by the contract.

The 2 bonds shall be payable to the Treasurer of the State of Maine or his successors in office. The forms of the bonds shall be those provided by the Department and the surety shall be acceptable to the Department. A bond shall be procured from insurance or bonding companies licensed to do surety bond business in the State of Maine and shall be executed or countersigned on the part of such company by a licensed resident agent in the State of Maine. The licensed resident agent, when executing or countersigning contract bonds, must indicate the name of the local bonding agency whom he represents or by whom he is employed, as well as the name of the surety company furnishing the bonds.

If surety company bonds are not provided, certified checks payable to the Treasurer of the State of Maine or other negotiable security acceptable to the Department shall be deposited with the Treasurer of the State of Maine in place of a surety company bond and shall be subject to all conditions of such bonds and to such agreements as may be required by the Department.

103.06 Execution and Approval of Contract. The contract shall be signed by the successful bidder and returned, together with the contract bonds, to the office of the Department at Augusta, Maine, within 15 calendar days after the date of the Notice of Award of contract, except if the 15th day falls on a holiday, a Saturday or a Sunday, then the conditions will be fulfilled if the contracts are received before 12 o'clock noon, on the day following the holiday or the Monday following the Saturday or Sunday. If the contract is not executed by the Department within 30 calendar days after the Notice of Award contract, the successful bidder shall have the right to withdraw his proposal without loss of his proposal guaranty. No contract shall be considered effective until it has been fully executed by all of the parties thereto. Three copies of the contract agreement shall be executed. One shall be kept by the Department, one shall be delivered by the Department to the State Controller and one returned to the Contractor.

103.07 Failure to Execute Contract. Failure of the successful bidder to execute the contract and file acceptable bonds within the time stated in the proposal shall be just cause for the cancellation of the award and the forfeiture of the proposal guaranty which shall become the property of the State. 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 Commissioner may decide. If the successful bidder refuses to accept an award, the Department may refuse to consider any proposal of the bidder for a period of not more than 3 years from the date of such refusal.

103.08 Insurance. Before work is started under the contract the Contractor will be required to file with the Department a Certificate of Insurance, executed by an insurance company or companies satisfactory to the Department and licensed by the State of Maine Department of Business Regulation, Bureau of Insurance to do business in the State of Maine, stating that the Contractor carries insurance in accordance with the following requirements and stipulations:

- (a) Workers' Compensation Insurance. With respect to all the operations the Contractor performs and all those performed for him by subcontractors, the Contractor or the subcontractor shall carry Workers' Compensation Insurance or shall qualify as a self-insurer with the State of Maine Workers' Compensation Commission, all in accordance with the requirements of the laws of the State of Maine.
- (b) Contractor's Public Liability and Property Damage Insurance. With respect to the operations he performs and also those performed for him by subcontractors, the Contractor shall carry regular Contractor's Public Liability Insurance and Contractor's Protective Public Liability Insurance, each covering bodily injury liability of not less than 300,000 dollars for damage arising out of bodily injuries to or death of one person and subject to that limit for each person, a total of 300,000 dollars damage arising out of bodily injuries to or death of two or more persons in any one accident or occurrence and covering property damage liability of not less than 300,000 dollars for all damages arising out of injury to or destruction of property in one accident.
- (c) Automobile Liability Insurance. The Contractor shall carry Automobile Liability Insurance covering the operation of all motor vehicles, including those hired or borrowed, used in connection with the contract, covering bodily injury liability of not less than 300,000 dollars for all damages arising out of bodily injuries to or death of one person and subject to that limit for each person, a total of 300,000 dollars for all damages arising out of bodily injuries to or death of two or more persons in any one accident or occurrence and covering property damage liability for a limit of not less than 300,000 dollars for all damages arising out of injury to or destruction of property in one accident or occurrence.
- (d) Contractual Liability Insurance. The Contractor shall carry Contractual Liability Insurance covering the liability he has assumed under the contract to indemnify and save harmless the Department, its officers and employees with respect to bodily injuries to or death of any person or persons or injury to or destruction of property. The limits for such insurance shall be not less than those specified for Contractor's Public Liability Insurance in paragraph (b) above.

- (e) **Blasting.** When explosives are to be used in the prosecution of the work, the insurance required under paragraphs (b), (c) and (d) above shall also contain provisions for protection, in the amounts stated, against damage claims due to such use of explosives.
- (f) Each policy shall be signed by the President and Secretary of the insurance company and shall be countersigned by a licensed resident agent in the State of Maine as an authorized representative of the company.
- (g) **Termination or Change of Insurance.** Each insurance policy shall be endorsed to provide that the insurance company shall notify the Department at least 30 days in advance of cancellation of or any change in the policy. No change shall be made without prior written approval of the Department.

The Contractor shall keep all the required insurances in continuous effect until 31 days after the date of final acceptance of the project or until such earlier time as may be established by the Department.
- (h) **Claims.** Each insurance policy shall state that the insurance company shall agree to investigate and defend the insured against all claims for damages, even if groundless.
- (i) **Compliance with the requirements of this Subsection** may be met by procurement of insurance covering all work under contract with the State or may be met by procurement of separate insurance for each individual contract. In either case a Certificate of Insurance must be filed for each contract to show evidence that all required insurance has been obtained.

SECTION 104 - SCOPE OF WORK

104.01 Intent of Contract. The intent of the contract is to provide for the construction and completion of the work described. The Contractor shall furnish all labor, materials, equipment, tools, transportation and supplies required to complete the work in accordance with the plans, specifications and terms of the contract.

104.02 Alteration of Plans or Character of Work. The Department reserves the right at any time during the progress of the work, to make increases or decreases in quantities and alterations in the details of construction, including alterations in the grade or alignment of the road or structure or both. Such increases or decreases and alterations shall not invalidate the contract nor release the surety and the Contractor agrees to accept the alterations the same as if they had been a part of the original contract.

Under no circumstances shall alterations of plans or of the nature of the work involve work beyond the termini of the proposed construction except as may be necessary to satisfactorily complete the project.

Unless such alterations and increases or decreases substantially change the character of the work to be performed or the cost thereof, the altered work will be paid for at the same unit prices as other parts of the work. If, however, the character of the work or the unit costs thereof are substantially changed, an allowance will be made as may have been agreed to in advance of the performance of the work or in case no agreement has been previously made, then an allowance shall be made, either for or against the Contractor, in an amount as the Engineer may determine to be fair and equitable.

No claim shall be made by the Contractor for loss of anticipated profits because of alterations or by reason of any variation between the approximate quantities and the final quantities of work done.

Payment for work changes or alterations will be made in accordance with the provisions set forth under Subsection 109.03. If the altered work increases the total cost of the work performed, an increase in contract time will be computed in accordance with the provisions of Subsection 108.06.

104.03 Extra Work. The Contractor shall perform unforeseen work, for which there is no price included in the contract whenever it is necessary or desirable in order to complete the work as contemplated. Before any extra work is started, a written supplemental agreement shall be entered into which, when executed, shall become a part of the original contract and the work paid for in the same manner as any other contract item. In place of such an agreement the Department may require the Contractor to do extra work on a force account basis. Such work shall be performed in accordance with the specifications and as directed and will be paid for as provided under Subsection 109.04.

104.04 Maintenance of Traffic. The roadway, while under construction, shall be kept open to traffic unless otherwise provided.

The Contractor shall keep the portion of the project being used for public travel, whether it be used by through or local traffic and whether it is on new or old locations of the road between project termini, in a condition that traffic will travel over a satisfactory surface at all times with a minimum of delay. Portions of the project open to public traffic shall have a minimum width as specified in Section 652 -- Maintenance of Traffic.

The Engineer may authorize the use of and pay for, granular materials to maintain the traffic lane widths providing the locations have been prepared by eliminating objectionable material and providing adequate temporary drainage has been installed before the granular material is placed. Quantities of granular materials will

be determined by the most appropriate method of measurement at the time the material is placed in accordance with the specifications for the particular type of granular material authorized for use. Payment for the granular material will be made when it is placed on the project and payment as Common Excavation will be made when the temporary lane is removed.

The Contractor shall also provide and maintain in a safe condition temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages and farms. The Contractor shall bear all expenses in maintaining traffic over the section of road under construction whether it is on new or old location between project termini and of constructing and maintaining approaches, crossings, intersections and other features necessary, without direct compensation, except as authorized above or provided in Section 652 -- Maintenance of Traffic.

104.041 Special Detours. When the proposal contains the item, Special Detours, the payment of such item shall cover all costs for constructing, repairing, maintaining and removing the detour or detours, including all temporary bridges and accessory features and obliteration of the detour road. Right-of-way for temporary detours or bridges or both called for under this paragraph, will be furnished by the Department unless otherwise indicated on the plans or stated in the Special Provisions.

104.042 Vacant

104.043 Vacant

104.044 Maintenance During Suspension of Work. Prior to suspension the Contractor shall make passable and shall open to traffic the portions of the project, under improvement, agreed upon by the Contractor and the Engineer for the temporary accommodation of traffic for the anticipated period of suspension. All portions of the project to be used by traffic during periods of suspension shall have a minimum width specified in Section 652 -- Maintenance of Traffic. To provide space for snow removal, this width shall be a minimum of 36 feet in cuts.

Those portions of the existing highway to be used by traffic, between the termini of the project, on which the existing pavement has not been disturbed and on which the Contractor does not work, exclusive of cross culvert installations, clearing and cutting trees and on which the Contractor does not haul excavation or other materials, may be approved for suspension if requested in writing by the Contractor. The pavement on these suspended portions will be maintained by the State until the Contractor commences or resumes work on them.

The portions of the roadway to be used by traffic during periods of winter suspension which have not been surfaced, shall be shaped to a cross section slope of at least $\frac{3}{8}$ of an inch per foot but not greater than $\frac{3}{4}$ of an inch per foot and graded smooth. All costs of grading and regrading upon resumption of work including addition or removal of materials placed by the Contractor or placed by others for ice control, shall be considered incidental to the contract and no separate payment will be made. This shall be done regardless of the designated cross sectional slope required for final completion of the pavement structure.

During periods of approved suspension of work, the Contractor will not be responsible for plowing snow, sanding ice, maintaining the road, patching or retreating the surface, repairing or replacing damaged guard rail, barricades, curbs, poles, signs, catch basins and other permanently installed items of the project. The Contractor will be responsible for the correction of settlement.

Upon resuming work, following winter suspension, the Contractor shall clean up all evidence of snow and ice control including removing excess sand and debris from the roadway. No payment will be made for such work as it will be considered included in the work of the contract.

104.045 Maintenance During Winter Construction. When the Contractor's operations are being carried out during periods subject to winter weather conditions, the Contractor shall be responsible for plowing snow from the traffic lanes of portions of the project, including bridges and the sidewalks of bridges, on which the Contractor is actually carrying on operations. Plowing duties may be assigned to others; however, the responsibility shall remain with the Contractor. This responsibility for plowing shall extend over 24 hours each day, 7 days a week. Sanding of such portions will be done by the agency responsible for the regular winter maintenance operation.

On portions of a project carrying traffic, including bridges, where no construction operations have taken place and on portions of a project where the Contractor has completed his operations leaving the roadway in a suitable condition to carry traffic, the State or other agency responsible for the winter maintenance will plow snow and sand.

104.05 Rights in and Use of Materials Found on the Work. The Contractor, with approval, may use on the project such stone, gravel, sand or other material found in the excavation and will be paid both for the excavation of such materials at the corresponding contract unit price and for the pay item for which the excavated material is used. Except for stone used for riprap, stone ditch protection and loam, the Contractor shall replace with other acceptable material at his own expense, that portion of the excavated material so removed and used which was needed for use in embankment, backfill, approaches and otherwise. Stones and loam found

in the excavation which are used for riprap, loam or loam stockpiled will not be required to be replaced with other material. No charge for any of the foregoing materials so used will be made against the Contractor. The Contractor shall not excavate nor remove any material from within the right-of-way which is not within the limits of improvement, without authorization.

104.06 Repair of Roads Damaged by Contractor. Damage to any road or structure caused by equipment, including trucks, used in the prosecution of this work, shall be repaired by the Contractor to the satisfaction of the Engineer and the municipality affected. Except as otherwise provided, payments for such work shall be considered included in the several items of the contract. An exception shall be when such damage has been done by trucks carrying legal loads and operating in full accordance with the laws of the State on roads having a surface width of 20 feet and over maintained by the Department and structures maintained by the Department, the Contractor shall not then be held liable for the damage caused. On such roads, having a bituminous surface width of less than 20 feet and providing an alternate route is available for the return trip, the Contractor may haul in one direction only. If no alternate route is available the Contractor shall be responsible for maintaining the surface in an acceptable manner, for a minimum width equal to the original pavement width.

In the event it is necessary for the Contractor to transport gravel, borrow or other construction material in legally registered vehicles carrying legal loads over town ways, a Contractor's Bond of not more than 5,000 dollars per mile of traveled length may be required by the town or other agency, the exact amount of the bond to be determined prior to use of any town way. The town may also require the Contractor to control dust. The Contractor will not be paid directly for any necessary bond, maintenance or dust control on town ways. Such costs shall be incidental to the contract.

Should the Contractor's operations create a dust nuisance on haul roads to private property, the Department will be responsible for the abatement of the dust nuisance. The Contractor will be compensated for dust control in accordance with contract items but other maintenance of such roads will be the responsibility of the Contractor; cost of which will not be paid directly but shall be considered included in the work of the contract.

104.07 Removal and Disposal of Structures and Obstruction. Unless otherwise provided, guard rail, drainage pipe, culverts, curbing, bridges or other manufactured highway material, except utility property, traffic control devices, lights and their supporting structures, found within the limits of the work, shall become the property of the Contractor. The material shall be removed as indicated by the excavation limits and disposed of by the Contractor at no additional expense to the State except as hereafter provided.

Removal and disposal of highway material found above ground, such as guard rail, curbing and bridge steel, shall, unless otherwise provided, be considered included in the work of the contract and no separate payment will be made.

104.08 Final Cleaning up. Before final acceptance, the highway, bridges, streams, structures, lawns, property adjacent to the project and grounds occupied by the Contractor in connection with the work shall be cleaned of all rubbish, excess material, temporary structures and equipment and the ground graded to match the surrounding terrain and seeded and mulched if required. All parts of the work shall be left in an acceptable condition.

SECTION 105 -- CONTROL OF WORK

105.01 Authority of the Engineer. The Engineer will decide all questions which relate to the quality and acceptability of materials furnished and work performed and to the rate of progress of the work, as well as questions on the interpretation of the plans and specifications and on the acceptable fulfillment of the Contract.

The Engineer will have the authority to suspend the work wholly or in part in accordance with Subsection 108.07.

105.02 Plans and Working Drawings. Plans showing details of the construction contemplated, will be furnished by the Department. Roadway plans will show alignment, profile grade, typical cross sections of improvements, right-of-way and general cross sections. Structure plans will, in general, show dimensions of the work contemplated. When the structure plans do not show all dimensions in detail, they will show general features and details of the structures. The Contractor shall keep one complete set of plans available on the work site at all times.

The Contractor shall furnish, on the size sheets required, working and detail drawings, not furnished by the Department, as required for any part of the finished construction.

Working drawings for structures shall consist of shop detail, erection and other working plans showing details, dimensions, material, sizes and types of material and other information necessary for the complete fabrication and erection of the work which are not included in the plans furnished by the Department. These may include plans for falsework, bracing, centering, form work, steel reinforcement and masonry lay-out diagrams.

The Contractor shall submit for approval 2 sets of any preliminary working drawings. These drawings shall be submitted in time to allow discussion and correction prior to beginning the work they cover. Prior to the approval of the drawings, work done or materials ordered for the structures involved shall be at the Contractor's risk. One set of these drawings will be returned to the Contractor approved or marked with corrections to be made; the other set will be retained. After approval has been given, the Contractor shall supply the Engineer with 3 sets of the corrected working drawings.

Approval of the Contractor's working drawings relates to the requirements for strength and detail and such approval will not relieve the Contractor from responsibility for errors in dimensions, for successful completion of the project or for responsibility for damage claims as defined in Subsection 107.15.

The Contractor shall furnish the Department with copies of working drawings as may be required for approval and construction purposes. All final tracings on plastic sheets or equivalent shall be filed with the Department.

The contract price shall include the cost of furnishing all working drawings and final tracings and the Contractor will be allowed no extra compensation for such drawings.

105.03 Conformity with Plans and Specifications. All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross sections, dimensions and material requirements, including tolerances, shown on the plans or indicated in the specifications.

In the event the Engineer finds the materials or the finished product in which the materials are used not within reasonably close conformity with the plans and specifications but that reasonably acceptable work has been produced, he will then make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification which may provide for an appropriate adjustment in the contract price for such work or materials necessary to conform to his determination based on engineering judgement.

In the event the materials or the finished product in which the materials are used or the work performed are found not to be in reasonably close conformity with the plans and specifications and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

105.04 Coordination of Plans, Specifications, Supplemental Specifications and Special Provisions. These Specifications, the Supplemental Specification, the Plans, Special Provisions and other supplementary documents are 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 pro-

vide for the complete work. In case of discrepancy, calculated dimensions shall govern over scaled dimensions; plans shall govern over specifications; supplemental specifications shall govern over specifications; special provisions shall govern over both specifications and plans. When the plans provide that new work is to connect with existing structures the Contractor must verify all dimensions before proceeding with the work.

The Contractor shall take no advantage of any apparent error or omission in the plans or specifications. In the event the Contractor discovers such an error or omission, he shall immediately notify the Engineer. The Engineer will then make corrections and interpretations as may be necessary to fulfill the intent of the plans and specifications.

105.05 Cooperation by Contractor. The Contractor will be supplied with a maximum of 4 sets of plans and contract assemblies, including supplemental specifications and special provisions, free of charge; one set of which the Contractor shall keep available on the work site.

The Contractor shall give the work the constant attention necessary to maintain the progress and shall cooperate with the Engineer and his Inspectors, with utilities and with other Contractors in every way possible.

The Contractor shall have on the work at all times, a competent English speaking Superintendent capable of reading and understanding the plans and specifications and experienced in the type of work being performed, who shall receive instructions from the Engineer or his authorized representatives. The Superintendent 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. Such superintendence shall be furnished regardless of the amount of work sublet.

The Contractor shall furnish the Engineer with a list of names, addresses and telephone numbers of contractor personnel who may be reached in case of emergency during hours when no work is being performed. On weekends and during storms the Contractor shall alert certain of his personnel to stand by and shall inform the Engineer of arrangements so made.

105.051 Preconstruction Conference. After the contract has been executed and before the start of construction, the Engineer may schedule a preconstruction conference which the Contractor's Superintendent will be required to attend. In order that proper coordination may be obtained between the work of the Contractor and the work of the various utilities, a representative of each affected utility may also attend the preconstruction conference. A report of the preconstruction conference will be prepared by the Engineer.

The Contractor shall submit an acceptable Schedule of Work not later than 10 days after the preconstruction conference. In preparing the Schedule of Work, consideration shall be given to the complexity of the work to be done by utilities. The Schedule of Work shall include a detailed schedule of the priorities of all operations involving the utilities. The agreement reached with utilities at the preconstruction conference shall be incorporated into the Schedule of Work.

The Schedule of Work shall be submitted, on forms furnished by the Department, indicating the order in which the Contractor proposes to do the work, including the date he will start and complete work on the various items. Submissions of the first progress estimate will be contingent on acceptance of the Schedule of Work by the Department.

Revisions in the Contractor's Schedule of Work shall be set forth in a letter of notification and if such changes affect the operations of a utility, a minimum of 10 days notice shall be given for such revisions unless previous arrangements have been made with the utility company involved.

105.06 Cooperation with Utilities. Pipe lines, gas lines, wire and cable lines, sewer lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals, manholes and all other utility fixtures and appurtenances within the limits of the proposed construction will be relocated or adjusted by the owners without expense to the Contractor except as otherwise provided.

In order that proper coordination may be obtained between the work of the Contractor and the work of various utilities a preconstruction utility meeting will be required when called for in the Special Provisions. A representative of each affected utility, the Contractor or his representative authorized to make decisions for him in regard to the scheduling of the proposed work, will be required to attend the meeting. A report of the preconstruction utility meeting will be prepared by the Engineer.

When the preconstruction utility meeting is called the Contractor shall submit an acceptable Schedule of Work not later than 10 days after the meeting. In preparing the Schedule of Work, consideration shall be given to the complexity of the work to be done by the utilities. The Schedule of Work shall include a detailed schedule of the priorities of all operations involving the utilities. The agreements reached at the utility meeting shall be incorporated into the Schedule of Work. If a preconstruction utility meeting is not required, the Contractor shall submit the Schedule of Work to the Department within 10 days after the preconstruction meeting.

The Department will notify utility companies and other parties affected and will try to have all necessary adjustments of the public or private utility fixtures and appurtenances within the limits of construction made as soon as practicable. Adjustments will include relocations, temporary or permanent, which are required to permit reasonably convenient and safe construction of the project and will also include unforeseen conditions if they are clearly the responsibility of the Department as provided above.

Where adjustments have not been completed and are not provided for in the Special Provisions nor noted on the plans they may be agreed upon at the preconstruction utility meeting or at a special meeting called for this purpose. Adjustments due to unforeseen conditions may be made by order of the Engineer or may be agreed upon at a special meeting. The decision in ordering adjustments by utilities at their expense or at the expense of the Department shall be final.

For his convenience, the Contractor may request temporary changes of location of utility fixtures and appurtenances, which are not the responsibility of the Department. He shall satisfy the Department that the proposed temporary changes do not interfere with his or other Contractor's operations or the requirements of the work and do not cause obstructions or a hazard to traffic. The Contractor shall make his own request to the utility or other party affected by such temporary changes. The temporary changes shall be made solely at the Contractor's expense.

Any work done upon or within the right-of-way of a railroad shall be under the supervision and control of the Chief Engineer of the railroad or other designated officer of the railroad to the extent necessary, in the judgement of the Chief Engineer of the railroad or other designated officer, to insure safe and uninterrupted operation of its trains and the convenient conduct of its business. Any additional conditions or requirements for doing work within the railroad right-of-way will be set forth in the Special Provisions.

It shall be understood and agreed that the Contractor has considered in his bid all of the permanent and temporary utility fixtures and appurtenances in their present or relocated positions as prescribed in the Special Provisions or shown on the plans and that no additional compensation will be allowed for delays, inconvenience or damage sustained by him due to interference from utility fixtures and appurtenances or the operation of adjusting them.

105.07 Cooperation Between Contractors. The Department reserves the right to contract for and perform other additional work on or near the work covered by the contract.

The Contractor shall arrange his work and shall place and dispose of the material being used so as not to interfere with the operations of other Contractors within the limits of the same project. He shall join his work with that of the others in an acceptable manner and in proper sequence to that of the others. In case of dispute the Engineer shall be the referee and his decision shall be final and binding.

Each Contractor involved shall assume all liability, financial and otherwise, in connection with his contract and shall protect and save harmless the State from any and all damages or claims 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 the same project. He shall assume all responsibility for his own work not completed or accepted because of the presence and operation of the other Contractors.

105.08 Construction Stakes, Lines and Grades. The Engineer, unless otherwise specified by special provisions, will set reference stakes establishing lines, slopes, profile grade on road work, centerline and bench marks for bridge work, culvert work, protective and accessory structures and appurtenances as he may deem 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 from which the Contractor shall establish other necessary controls and perform the work.

The Contractor shall be responsible for the preservation of all stakes and marks and if any of the construction stakes or marks have been carelessly destroyed or disturbed by the Contractor, the cost of replacing them by the State will be charged against the Contractor and will be deducted from money due the Contractor at a rate of 50.00 dollars per hour for each State survey crew, 2 to 4 men, used to replace the stakes or marks.

The Department, unless other provisions are made, will be responsible for the accuracy of lines, grades and other engineering work set forth under this section.

105.09 Authority and Duties of Resident Engineer or Resident Inspector. The Resident Engineer or the Resident Inspector has immediate charge of each construction project. He is responsible for the administration and satisfactory completion of the project and has been assigned commensurate authority. The Resident Engineer or the Resident Inspector has the authority to reject defective material and to suspend work that is being improperly performed.

105.10 Duties of the Inspector. Inspectors employed by the Department will be authorized to inspect work done and materials furnished. The inspection may extend to any part of the work and to the preparation, fabrication or manufacture of the materials to be used. The inspector will not be authorized to alter or waive the provisions of the contract. The inspector is not authorized to issue instructions contrary to the plans and specifications nor will he act as foreman for the Contractor.

105.11 Inspection of Work. All materials and every detail of the work will be subject to inspection by the Engineer. The Engineer shall be allowed access to all parts of the work and shall be furnished with information and assistance by the Contractor required to make a completed and detailed inspection.

If the Engineer requests, the Contractor, at any time before acceptance of the work, shall remove or uncover portions of the finished work. After examination, the Contractor shall restore the work to the standards required by the specifications. Should the work exposed or examined prove to be 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. Should the work so exposed or examined prove to be unacceptable, the uncovering or removing and the replacing of the covering or making good of the parts removed, will be at the Contractor's expense.

Any work done or materials used without supervision or inspection by an authorized Department representative may be ordered removed and replaced at the Contractor's expense unless the Department representative failed to inspect after having been given reasonable notice that the work was to be performed.

When any unit of government or political subdivision or any railroad is to pay a portion of the cost of the work covered by this contract, its respective representative shall have the right to inspect the work. Such inspection shall in no sense make any unit of government or political subdivision or any railroad a party to this contract and shall in no way interfere with the rights of either party hereunder.

105.12 Removal of Unacceptable and Unauthorized Work. Except as provided in subsection 105.03 all work which does not conform to the requirements of the contract will be considered unacceptable.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness or any other cause, found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner at the Contractor's expense.

No work shall be done without lines and grades having been given unless otherwise authorized. Work done contrary to the instructions of the Engineer, work done before preliminary measurements are made, work done without proper inspection, work done beyond the lines shown on the plans or as given, except as herein specified or any extra work done without authority and a prior agreement in writing, will be considered unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the Contractor's expense.

When material is fabricated or treated with another material or where any combination of materials is assembled to form a finished product, any or all of which are covered by specifications, the failure of any of the components of the product to comply with the designated specifications may be sufficient cause for the rejection of the whole.

Materials shipped from approved deposits or sources of supply which are found to be defective upon arrival at destination shall not be used.

105.13 Load Restrictions. The Contractor shall comply with legal load restrictions against hauling of material on public roads beyond the limits of the project. A special permit will not relieve the Contractor of liability for damage which may result from moving of equipment.

Hauling materials over the base courses or surface course under construction shall be limited to legal loads. 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. In no case shall legal load limits be exceeded unless permitted in writing, with the exception of equipment used in grading operations, which operation includes the preparation of the subgrade prior to placing the subbase course. The Contractor shall be responsible and shall pay for all repairs for damage done by his hauling equipment.

105.14 Approaches and Access. Approaches, accesses or cross-overs other than public ways contemplated by the Contractor shall be approved prior to their construction. Approaches, accesses or crossovers shall be removed, the ground restored to its original contour and the area loamed, seeded and mulched. This work will not be paid for directly but shall be considered included in the work of the contract.

105.15 Maintenance During Construction. The Contractor shall maintain the work during construction and until the project is accepted. This maintenance shall be day by day, continuous and effective with adequate equipment and forces to keep the roadway and structures in satisfactory condition.

The Contractor shall provide a sufficient number of watchmen and take all precautions for the protection of the work and the safety of the public for all work not provided for in Section 630 -- Traffic Officers. This work will not be paid for directly but will be considered included in the work of the contract.

When a contract is for placing a course upon a course or upon subgrade previously constructed, the Contractor shall maintain the previously constructed course or subgrade during all construction operations.

Costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various work items. Such work will not be paid for directly but shall be considered included in the work of the contract.

105.16 Failure to Maintain Roadway or Structure. If the Contractor fails to comply with the provisions of Subsection 105.15, the Engineer will notify the Contractor of such failure. If the Contractor fails to provide satisfactory maintenance immediately after receipt of the notice, the Engineer may proceed to maintain the project and the entire cost of this maintenance will be deducted from monies due or to become due the Contractor.

105.17 Acceptance.

- (a) Partial Acceptance. If at any time during the progress of the work 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 completed in compliance with the contract, he may accept that unit and the Contractor may be relieved of further responsibility for that unit. Such partial acceptance shall in no way void or alter any of the terms of the contract.
- (b) Final Acceptance. Upon notice from the Contractor of completion of the entire project, the Engineer will make an inspection. If all construction provided for and contemplated by the contract is found completed to his satisfaction, that inspection shall constitute the final inspection and the Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of the final inspection.

If the inspection discloses any work, in whole or in part, as being unsatisfactory, the Engineer will give the Contractor the necessary instructions for correction and the Contractor shall immediately comply with and execute such instructions. Upon correction of the work, another inspection will be made which will constitute the final inspection provided the work has been satisfactorily completed. In such event, the Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of final inspection.

105.18 Claims for Adjustments and Disputes. If the Contractor claims additional compensation is due him for work or material not clearly specified in the contract or not ordered as extra work as specified under Subsection 101.29, the Contractor shall notify the Engineer in writing of his intention to make a claim for additional compensation before he begins the work on which he bases the claim. If notification is not given and the Engineer is not given an opportunity to keep account of actual costs, the Contractor hereby agrees to waive any claim for such additional compensation. Notice by the Contractor and the fact that the Engineer has kept account of the cost shall not be construed as substantiating the validity of the claim. If the claim is found to be just it will be paid as extra work as provided for force account work. Nothing in this Subsection shall be construed as establishing any claim contrary to the terms of Subsection 104.02.

105.19 Access to Contractor's Records. The Contractor and his subcontractors shall make foreman's daily time reports, records of force account work, employment records, payrolls and other documents substantiating payment, available for inspection by authorized representatives of the Department and shall permit such representatives to interview employees during working hours. These records shall be retained for a period of at least 3 years after acceptance of the project.

105.20 Cost Reduction Incentive. The Contractor may submit proposals, in writing, for modifying the plans, specifications or other requirements of this contract for the sole purpose of reducing the total cost of construction. The cost reduction proposal shall not impair in any manner the essential functions or characteristics of the project, including but not limited to service life economy of operation, ease of maintenance, desired appearance or design and safety standards.

The proposals shall be identified as Cost Reduction Incentive proposals and shall contain the following information:

- (a) A description of both the existing contract requirements for performing the work and the proposed changes.
- (b) An itemization of the contract requirements that must be changed if the proposal is adopted.
- (c) A detailed estimate of the cost of performing the work under the existing contract and under the proposed change.
- (d) A statement of the time within which the Engineer must make a decision thereon.
- (e) The contract items of work affected by the proposed changes, including any quantity variation attributable thereto.

The provisions of this Subsection shall not be construed to require the Engineer to consider any cost reduction proposal which may be submitted, nor shall it be construed to require the Contractor to follow these procedures for all contractor requested changes which might result in a savings to the contract. Proposed changes in basic design of a bridge or of a pavement type will not be considered as an acceptable cost reduction proposal. The Department will not be liable to the Contractor for failure to accept or act upon any cost reduction proposal submitted pursuant to this section nor for any delays to the work attributable to any such proposal. If a cost reduction proposal is similar to a change in the plans or specifications for a project under consideration by the Department at the time the proposal is submitted or if a proposal is based upon or similar to, Standard Specifications, Special Provi-

sions or Standard Plans adopted by the Department after the advertisement for the contract, the Engineer will not accept the proposal and the Department reserves the right to make such changes without compensation to the Contractor.

The Contractor shall continue to perform the work in accordance with the requirements of the contract until an executed change order incorporating the cost reduction proposal has been issued. If an executed change order has not been issued by the date upon which the Contractor's cost reduction proposal specifies that a decision thereon should be made or such other date as the Contractor may subsequently have specified in writing, such cost reduction proposal shall be deemed rejected.

The Engineer shall be the sole judge of the acceptability of a cost reduction proposal and of the estimated net savings from the adoption of all or any part of such proposal. In determining the estimated net savings the right is reserved to disregard the contract bid prices if, in the judgment of the Engineer, such prices do not represent a fair measure of the value of work to be performed or to be deleted.

The Department reserves the right, where appropriate, to require the Contractor to share in the Department's costs of investigating a cost reduction proposal submitted by the Contractor as a condition of considering such proposal. Where a condition is imposed, the Contractor shall indicate his acceptance thereof in writing and the acceptance shall constitute full authority for the Department to deduct amounts payable to the Department from any monies due or that may become due to the Contractor under the contract.

If the Contractor's cost reduction proposal is accepted in whole or in part, the acceptance will be by a contract change order which shall specifically state that it is executed pursuant to this Subsection. The change order shall incorporate the changes in the plans and specifications which are necessary to permit the cost reduction proposal or that part of it which has been accepted and shall include any conditions upon which the Department's approval thereof is based if the approval of the Department is conditional. The change order shall also set forth the estimated net savings in the cost of performing the work attributable to the cost reduction proposal. All reasonably incurred costs of developing the cost reduction proposal and of implementing the changes will be deducted from the total estimated decrease in the Contractor's cost of performance to arrive at the net savings amount. The contract change order shall further provide that the Contractor be paid 50 percent of the net savings amount.

The amount specified to be paid to the Contractor in the change order for a cost reduction proposal shall constitute full compensation to the Contractor for the cost reduction proposal and the performance of the work thereof.

Acceptance of the cost reduction proposal and performance of the work shall not extend the time of completion of the contract unless specifically provided for in the change order authorizing the use of the cost reduction proposal.

The Department reserves the right to adopt a cost reduction proposal for general use on contracts administered by the Department when it determines that the proposal is suitable for application to other contracts. When an accepted cost reduction proposal is adopted for general use, only the Contractor who first submitted such proposal will be eligible for compensation pursuant to this section and in that case, only as to those contracts awarded to him prior to submission of the accepted cost reduction proposal. Cost reduction proposals identical or similar to previously submitted proposals will be eligible for consideration and compensation under the provisions of this Subsection if the identical or similar previously submitted proposals were not adopted for general application to other contracts administered by the Department. Subject to these provisions, the State or any other public agency shall have the right to use all or any part of any submitted cost reduction proposal without obligation or compensation of any kind to the Contractor.

SECTION 106 - CONTROL OF MATERIAL

106.01 Source of Supply and Quality Requirements. The materials used on the work shall meet the quality requirements of the contract at the time they are incorporated into the work. To expedite inspection and testing of materials, the Contractor shall notify the Engineer of his proposed sources of materials sufficiently prior to delivery to allow time for testing. Representative samples of materials may be taken at the source of supply by the Engineer before delivery is started. If after trial, it is found that sources of supply for previously approved materials do not produce specified products, the Contractor shall furnish materials from other sources. All material will be tested and accepted as specified elsewhere in these specifications or as otherwise specified in the contract.

Samples of materials for tests, upon which the acceptance or rejection is to be based, shall be taken by the Engineer either prior to shipment or after being received at the place of construction. Sampling, inspection and testing shall be done in accordance with the methods hereafter specified. The Contractor shall provide facilities, as the Engineer may require, for conducting field tests and for collecting and forwarding samples. All liquid and cement bituminous material bulk delivery and distributors shall be equipped with an acceptable sampling valve.

The Contractor shall not use or incorporate into the work any materials represented by preliminary samples until tests have been made and the material found to be acceptable unless otherwise authorized. Only materials which have been approved shall be incorporated in the work. It is the Contractor's responsibility to perform the work and supply materials using methods and equipment that will not cause the materials to change to the extent that they might be outside of the specification for the particular material during or after placing on the roadway. Any material which, after prior approval has been obtained, has for any reason become unfit for use or outside of its specification limit, shall not be incorporated in the work.

106.02 Local Material Sources.

- (a) Designated Sources. Possible sources of local materials may be designated on the plans and described in the special provisions. The quality of material in such source may be acceptable but the Contractor shall determine for himself the amount of equipment and work required to produce material meeting the specifications. It shall be understood that it is not possible to determine from samples, the limits for an entire source. 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 designate 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 and described under special provisions, together with the right to use such property as may be specified.

- (b) Contractor Furnished Sources. If the Contractor elects to use material from sources other than those designated, he shall acquire the necessary rights to take material from those sources and he 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 sources shall be borne by the Contractor. Before the removal of any material from the source for use on the project the source must have the approval in writing. In addition to providing acceptable material, a condition of approval will be the acceptability of the arrangements for rehabilitation of the site. These arrangements shall be incorporated into an agreement between the land owner and the Contractor. The Engineer shall be furnished a copy of the agreement. The Contractor shall also certify in writing that the existence of the pit and his operation complies with local ordinances.

106.021 Pit Rehabilitation. Unless pit owners and the Contractor agree to pit rehabilitation including loam fields, under which-ever condition specified below applies, use of the source will not be authorized.

- (a) Newly opened pits and loam fields from which any material has been removed for the project shall be completely rehabilitated.
- (b) Areas of extensions of existing pits from which common borrow, granular borrow, gravel borrow, rock borrow or loam have been removed for the project shall be completely rehabilitated.
- (c) Areas of extensions of existing pits which have become depleted by the removal of other gravel, sand, aggregate items or loam for the project shall be completely rehabilitated.
- (d) Areas of extensions of pits which have not become depleted by the removal of other gravel, sand, aggregate items or loam shall be rehabilitated to the extent of grading the slopes to 1 horizontal to 1 vertical or flatter.

Depleted shall be interpreted to mean when the only remaining material is within 10 feet of a property line on a 1 horizontal to a 1 vertical slope or when the character of the material so radically changes that it can not longer be used as originally anticipated.

Completely rehabilitated shall be interpreted to mean grading of all areas disturbed as a result of the project and treating of the ground surface in accordance with Section 657, Rehabilitation of Pits.

Surface material stripped from the pit shall be placed in such a manner that it can be used advantageously for restoration of the pit; however, it is not intended that stripping be placed on top of areas of anticipated future operations.

At no time shall the Contractor excavate from pit faces which are vertical or have an over-hang. The Contractor must stop excavating within a 1 horizontal to 1 vertical slope 10 feet inside of a property line of a deposit, even though the material within pit will remain at a steeper angle of repose. The exception may be when an additional agreement is reached with an adjacent property owner which will allow the extension of a pit onto the adjacent property owner's land. The Contractor must insure that hazards such as steep pit faces and ponds are protected by flattening slopes or by the erection of suitable fencing.

106.03 Samples, Test, Cited Specifications. Materials will be inspected, tested and accepted as specified in Subsection 106.01. Work in which untested and unaccepted material is used without approval or written permission will be at the Contractor's risk and the work may be considered unacceptable and unauthorized and may not be paid for. When specifications, materials, procedures, designs or testing methods are designated to conform to AASHTO, ASTM, MUTCD or other cited organization, the designation shall mean the most recent cited standard or interim specification procedures or methods current on the date of advertisement for bids. Samples for testing will be taken by qualified representatives of the Department and shall be furnished by the Contractor at no cost to the State.

Unless otherwise designated, tests will be made at the expense of the Department. Materials being used are subject to inspection, testing or rejection at any time prior to incorporation into the work. Copies of test reports will be furnished to the Contractor's representative upon request.

106.04 Plant Inspection. The Engineer may inspect the materials at the plant and the following conditions shall be met:

- (a) The Engineer shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has arranged for materials.
- (b) The Engineer shall have full access at all times to the parts of the plant which concern the manufacture and production of the materials being furnished.
- (c) If required, the Contractor shall arrange for an approved testing laboratory building for the use of the Inspector. The building shall be located near the plant and conform to the requirements of Section 639 -- Engineering Facilities.
- (d) Adequate safety measures shall be provided and maintained.

The Department reserves the right to retest material, after the material has been accepted at the source, delivered to the project and before the material is incorporated into the work and to reject all retested materials which does not meet the requirements of the specifications.

106.05 Vacant

106.06 Storage of Materials. Materials shall be stored to assure the preservation of their quality and fitness for the work. The method of storage shall be subject to approval. Stored materials even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located

to facilitate their prompt inspection. Portions of the right-of-way may be approved for storage purposes and for the placing of the Contractor's plant and equipment, but any additional space required shall 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 the written permission shall be furnished upon request. All storage sites, either on the right-of-way or on private property, shall be restored to original condition by the Contractor at his expense at the completion of the project. The provisions of this subsection shall not apply to the stripping and storing of topsoil or to other materials salvaged from the work.

106.07 Handling Materials. All materials shall be handled in such manner to preserve their quality and fitness for the work. Aggregates shall be transported from the storage site to the work in tight vehicles to avoid loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities and quality of materials intended for incorporation in the work and the quantities and quality of such material actually received at the construction site.

106.08 Unacceptable Materials. Materials not conforming to the requirements of the specifications, at the time they are used, shall be unacceptable and all such materials will be rejected and shall be removed immediately from the work site unless otherwise instructed. No rejected material, the defects of which have been corrected, shall be used until approval has been given.

106.09 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 to the Contractor at the points specified in the special provisions. All cost of handling and placing materials after they are delivered shall be considered as included in the contract price for the item under which they are used.

The Contractor will be held responsible for all Department furnished material delivered to him and deductions will be made from any monies due to make good all shortage and deficiencies, from any cause whatsoever and for any damage which may occur after such delivery and for any demurrage charges.

SECTION 107 -- LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.01 Laws to be Observed. The Contractor shall keep fully informed of all Federal and State Laws, 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. He shall at all times observe and comply

with all laws, ordinances, regulations 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, his employees or his subcontractors.

107.02 Permits, Licenses and Taxes. The Contractor shall procure all permits and licenses, pay all charges, fees and taxes and give all notices necessary and incidental to the due and lawful prosecution of the work.

107.03 Patented Devices, Materials and Processes. If the Contractor employs any design, device, material or process covered by letters of patent or copyright, he shall provide suitable legal agreement with the patentee or owner. The Contractor and the surety shall indemnify and save harmless the State and 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 obligated to pay by reason of any infringement at any time during the prosecution or after the completion of the work.

107.04 Restoration of Surfaces Opened by Permit. The right to construct or reconstruct any utility service in the highway or street or to grant permits to construct or reconstruct is, at any time during construction, hereby expressly reserved by the Department and the Contractor shall not be entitled to any damages whether for digging up the street or for any delay occasioned thereby.

Any individual firm or corporation wishing to make an opening in the highway must secure a permit from the Department. The Contractor shall allow parties bearing such permits and only those parties, to make openings in the highway. When ordered, the Contractor shall make all necessary repairs due to such openings and such necessary work will be paid for as extra work or as provided for in the special provisions and will be subject to the same contract conditions as the original work performed.

107.05 Federal Aid Provisions. When the United States Government pays all or any portion of the cost of a project, the Federal laws and the rules and regulations made pursuant to such laws must be observed by the Contractor. The reports and the records enumerated in Subsection 105.19 and the work shall be subject to the inspection by the appropriate Federal agency.

Such inspection shall not make the Federal Government a party to this contract and will not interfere with the rights of either party of this contract.

107.06 Sanitary Provisions. The Contractor shall provide and maintain in a neat sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements of the State and Local Boards of Health or of other bodies or agencies having jurisdiction. There shall be no source of inconvenience, complaint or nuisance to the public or to residents or others in the vicinity of the work.

107.07 Public Convenience and Safety. The Contractor shall at all times conduct his work 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 Subsection 105.15.

Fire hydrants on or adjacent to the highway shall be kept accessible to fire apparatus at all times. Footways, gutters, sewers, inlets and portions of the highway, adjacent to the work under construction, shall not be obstructed more than is necessary.

107.08 Railway-Highway Provisions. If the plans require materials to be hauled across the tracks of any railroad, the Department will make preliminary arrangements with the railroad to permit crossings required or to permit the use of any existing private crossings. The Contractor shall negotiate and enter any necessary agreements with the railroad pertaining to construction, maintenance and protection of the crossing and shall pay, as an expense incidental to the contract, all costs applicable thereto. If the Contractor elects to use crossings other than those shown on the plans described in the special provisions he shall make his own arrangements for the use of such crossings.

Work to be performed by the Contractor in construction on a railroad right-of-way shall be performed at a time and in a manner not to unnecessarily interfere with the movement of trains or traffic of the railway company. The Contractor shall use precautions to avoid accidents, damage or unnecessary delay or interference with the railway company's trains or other property. Work on a railroad right-of-way shall conform to provisions of Subsection 105.06.

107.09 Bridges Over Navigable Waters. Work on navigable waters shall not interfere with free navigation of the waterways and shall not impair navigable depths and widths except as allowed by permit issued by the US Coast Guard and other applicable regulatory agencies.

107.10 Water Traffic and Stream Discharge. The Contractor shall provide for water traffic to pass under or through the bridge. Whenever a movable span is included in the work he shall provide a clear and unobstructed opening having a width conforming to the lesser dimensions secured by either the old or the new structure and shall provide and maintain such sights, signals and other warnings as may be required for public safety and convenience or to conform with Federal regulations.

Expenses connected with the maintenance of water traffic and losses arising from unforeseen obstruction or difficulty encountered in connection therewith or from delay or hindrance from any cause resulting therefrom shall be borne by the Contractor and shall not constitute a claim for extra compensation or for an extension of time for the completion of the contract.

During construction and until completion of the work the Contractor shall provide a waterway ample and efficient for stream discharge. All debris dropped into the streambed, as the result of the Contractors operations, shall be removed by the Contractor who will be responsible for all damage which may result from such water backing up or flowing over, through, from or along any part of the work or which any of the Contractors operations may cause to flow elsewhere. Furthermore the Contractor will be held responsible for all damage caused by or resulting from lowering the elevation of the water in the stream by reason of his operations.

107.11 Vacant

107.12 Use of Explosives. When explosives are necessary the Contractor shall use 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.

All explosives shall be stored in a secure manner in compliance with the latest rules and regulations for the keeping of explosives as set forth by the State Insurance Department and local laws and ordinances. All explosive storage places shall be clearly marked.

The Contractor shall notify each utility, having structures close to the work, of his intention to use explosives. The notice shall be given sufficiently in advance to enable the utilities to protect their property from injury. Such notice shall not relieve the Contractor of responsibility for any damage resulting from his blasting operations.

Any site where there are electric blasting caps or where explosive charges are being placed or have been placed shall be designated as a Blasting Zone. A Blasting Zone shall be marked by approved signs in accordance with the MUTCD.

The signs shall be conspicuously placed at each end of the Blasting Zone and shall remain in place only while blasting conditions are in effect and shall be removed after the blast and after all caps have been removed from the area.

All persons and adjacent property within the danger zone of blasting operations shall be warned by the Contractor and no blasting shall be done until the zone is cleared. Sufficient flagmen, furnished by the Contractor, shall be stationed outside the danger zone to stop all approaching traffic during blasting operations.

Before blasting the Contractor shall have adequate equipment available, to remove debris from the traveled way to restore normal traffic flow with a minimum of delay.

Watchmen shall be provided by the Contractor during the loading period and until the charges have been exploded.

107.13 Protection and Restoration of Property and Landscape. The Contractor shall be responsible for the preservation of all public and private property and shall carefully protect from disturbance or damage all land monuments and property marks until the Engineer has witnessed or referenced their location and shall not move them until directed.

The Contractor shall not enter private property without first obtaining permission.

The Contractor shall be responsible for all damage or injury to property of any kind, during the prosecution of the work, resulting from any act, omission, neglect or misconduct in his manner or method of executing the work or at any time due to defective work or materials and said responsibility will not be released until the project has been completed and accepted.

When or where there is any direct or indirect damage or injury to public or private property by or on account of any act, omission, neglect or misconduct in the execution of the work or in consequence of the nonexecution thereof by the Contractor, he shall restore, at his own expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding or otherwise restoring as may be directed or he shall make good such damage or injury in an acceptable manner.

In case of failure on the part of the Contractor to restore damaged property or make good such damage or injury, the Engineer may, upon 48 hours notice, excluding Holidays and Sundays, proceed to repair, rebuild or otherwise restore damaged property as necessary and the cost thereof will be deducted from monies due or which may become due the Contractor under the contract.

107.14 Forest Protection. In carrying out work within or adjacent to State or National Forests, the Contractor shall comply with all regulations of the State Fire Marshals Office, Forestry Department 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 forests. He shall keep the forests 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 forest supervisor.

The Contractor shall take all reasonable precautions to prevent and suppress fires. He shall require his employees and subcontractors, to notify a forest official at the earliest moment of the location and extent of any fire seen by them and to do everything reasonable within their power to prevent and suppress and to assist in preventing and suppressing fires.

107.15 Responsibility for Damage Claims. The Contractor shall indemnify and save harmless the Department, its officers and employees, from all suits, actions or claims of any character brought because of any injuries or damage received or sustained by any person, persons or property on account of the operations of the Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any omission, neglect or misconduct of the Contractor; or because of any claims or amounts recovered from infringements of patent, trademark or copyright; or from claims or amounts arising or recovered under the "Workmen's Compensation Act" or other law, ordinance, order or decree; and so much of the money due the said Contractor under and by virtue of his contract as may be considered necessary by the Department for such purpose may be retained for the use of the State; or in case no money is due, his surety may be held until suit or suits, action or actions, claim or claims for injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished the Department.

The Contractor shall promptly pay all bills for labor, materials, machinery, water, tools, equipment, trucks, automobiles, freight, fuel, light and power and for all other things contracted for or used by him on account of the work. If at any time during the progress of the work or before final payment of any money due the Contractor under the terms of this contract, any claim for labor, materials, water, tools, equipment, trucks, automobiles, freight, fuel, light and power or for any other things specified as aforesaid or for damages by reason of any acts, omissions or neglect of the Contractor in the prosecution of the work, shall be presented to the Department, the Department may retain monies due the Contractor under this contract as would be necessary to discharge all claims whether for labor or materials or for damages when the validity of such claims shall be established and finally determined, all such claims may be paid from the amount so retained if it be sufficient for that purpose. If such claims are invalid and groundless, any amount so retained shall be paid to said Contractor or in case of default of contract to the Contractor's surety. Neither the Department nor any member thereof shall be liable to any individual, firm or corporation making such claims for failure or refusal to hold and retain any money due under this contract for the purpose of payment of such claim. If the monies so retained under this contract are insufficient to pay all such claims presented to the Department and adjudged by any court of competent jurisdiction to be valid obligations of said Contractor, the Department may at its discretion pay the claim and the Contractor shall repay the Department all sums so paid. The Department, at

its option, may also on the written consent of the Contractor use any monies due or to become due under this contract for the purpose of paying any claims presented to said Department. Should the Contractor neglect to pay any undisputed claim made in writing to the Department within 30 days after the date of final acceptance as specified in Subsection 109.10 but continuing unsatisfied for a period of 90 days, the Department may pay such claim and deduct the amount thereof from the balance due the Contractor.

If the Contractor neglects to discharge any claim made in writing to the Department within 30 days after the date of final acceptance of the project and continuing unsettled for a period of 6 months after the date of final acceptance, the Department may, after due notification to the surety, make the final payment.

107.16 Third Party Beneficiary. It is not intended by the provisions of any part of the contract to create the public or any member thereof a third party beneficiary hereunder or to authorize anyone not a party to this contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of this contract. The duties, obligations and responsibilities of the parties to this contract, with respect to third parties, shall be and remain as imposed by the laws of Maine.

107.17 Opening Sections of Project to Traffic. At the option of the Engineer, sections of the work may be opened for traffic. Opening shall not constitute acceptance of the work or any part thereof or a waiver of any provisions of the contract; provided, however, that on such portions of the project completed and accepted, the Contractor will not be required to assume the expense of maintaining the roadway for traffic. Such expense will be borne by the Department as provided in Subsection 104.03.

Any damage to the highway not attributable to traffic which occurs on uncompleted sections, except slides, shall be repaired by the Contractor at his expense. The removal of slides shall be done by the Contractor on a basis agreed to prior to the removal of the slides.

If the Contractor is dilatory in completing shoulders, drainage structures or other features of the work, the Engineer may order all or a portion of the project open to traffic and the Contractor will not be relieved of his liability and responsibility during the period the work is so opened prior to final acceptance. The Contractor shall conduct the remainder of his construction operations to cause the least obstruction to traffic and in accordance with Section 652 -- Maintenance of Traffic.

107.18 Contractor's Responsibility for Work. Until final written acceptance of the project, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements or from the nonexecution of the work. The Contractor shall rebuild, repair, restore and make good all injuries or damages to the work caused by

any of the above before final acceptance and he shall bear the expense thereof. Damage to the work due to unforeseeable causes beyond the control of the Contractor, including but not restricted to acts of God, of the public enemy or governmental authorities shall be repaired by the Contractor with the approval and under the direction of the Engineer and paid for at the respective contract unit prices for the quantities and items of work involved. In a contract for the placing of a base course or surface course or courses upon previously constructed and completed work, the Contractor will be required to maintain the previously constructed work concurrently with his own operations for the entire project.

In case of suspension of work from any cause whatsoever, the Contractor will be responsible for the project and shall take precautions as may be necessary to prevent damage to the project, provide for normal drainage and shall erect any necessary temporary structures, signs or other facilities at his expense. During such period of suspension of work, the Contractor shall continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings and soddings furnished under his contract and shall take precautions to protect new tree growth and other important vegetation growth against injury.

107.19 Contractor's Responsibility for Utility Property and Services. When the Contractor's operations are adjacent to properties of railway, telegraph, telephone and power companies or are adjacent to other property where damage might result in considerable expense, loss or inconvenience, work shall not be commenced until all arrangements for their protection have been made.

The Contractor shall cooperate with the owners of underground and overhead utility lines in their removal and rearrangement operations that these operations may progress in a reasonable manner, that duplication of work may be reduced to a minimum and that services will not be unnecessarily interrupted.

The Contractor shall use suitable precaution to prevent damage to pipes, conduits and other underground structures; to poles, wires, cables and other overhead structures, whether or not shown on the plans. Arrangements for special protection of utility plant, when needed, shall be made by the Contractor with the utility in advance of construction operations.

If utility services are interrupted as a result of accidental breakage or as a result of utility plant being exposed or unsupported, the Contractor shall promptly notify the proper utility and shall cooperate in the restoration of service. If service is interrupted, repair work will be continuous until the service is restored. No work shall be undertaken around fire hydrants until provisions for continued services have been approved by the local fire authority.

Telephone cable plastic components have a softening point of 176°F and a melting point of 230°F. The Contractor shall not build fires near cable lines which produce temperatures around the cable in excess of 150°F and fires will not be allowed when the wind direction is from the fire towards the cable line. Protection of the cable line from damage shall be the responsibility of the Contractor.

107.20 Furnishing Right-of-Way. The Department will be responsible for securing necessary right-of-way in advance of construction. Any exceptions will be indicated in the contract.

107.21 Personal Liability of Public Officials. In carrying out the provisions of these specifications and in exercising the power or authority granted to them by or within the scope of the contract, there shall be no liability upon the Department, the Engineer and 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.

107.22 No Waiver of Legal Rights. The Department shall not be precluded or estopped by any measurement, estimate or certificate made either before or after the completion and acceptance of the work and payment therefore from showing the true amount and character of the work performed and materials furnished by the Contractor, nor from showing that any such measurement, estimate or certificate is untrue or is incorrectly made, nor that the work or materials do not in fact conform to the contract. The Department shall not be precluded or estopped, notwithstanding any such measurement, estimate or certificate and payment in accordance therewith from recovering from the Contractor or the Contractor's sureties or both, such damage as it may sustain by reason of his failure to comply with the terms of the contract. Neither the acceptance by the Department or any representative of the Department, nor any payment for or acceptance of the whole or any part of the work, nor any extension of time, nor any possession taken by the Department, shall operate as a waiver of any portion of the contract or of any power herein reserved or of any right to damages. A waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

107.23 Minimum Wages. The wages for an hour's work paid to employees in the various classifications, as designated in the proposal, shall not be less than the wage rates set forth in the contract. This provision, pertaining to wages, shall apply to all work performed on the contract by the Contractor with his own organization and to all work performed by a subcontractor.

107.24 Safety and Accident Prevention. The Contractor shall fully comply with all applicable Federal, State and local laws governing safety, health and sanitation. The Contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions, on his own responsibility or as the

Engineer may determine, reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

107.25 Historical Deposits. Activities that would cause a disturbance to any object of archaeological, paleontological or other historical interest shall immediately cease and shall not be resumed until an investigation of the deposit has been completed and the removal of articles of interest has been accomplished. Should such a deposit be uncovered the Contractor or the Engineer shall notify the Department immediately.

The first indication of archaeological deposits may be the burial grounds or campsites of Indians, revealing the bones of the dead and their implements. The first indications of paleontological deposits may be the exposure of marine fossils or shells found mainly in clay deposits. Indications of deposits of more recent historical interest may be the exposure of dumps in landfill areas, abandoned campfire sites and building foundations.

Delay of the Contractor's operations in the event of the above shall not be compensated for directly and shall be considered incidental to general items in the contract but may be justification for adjustment of working days or calendar days if a delay involves one or more working days or calendar days.

The Contractor's attention is directed to Chapter 398 of MRS Title 27 §371, which places the ownership with the State of Maine of artifacts, specimens and material which are public property by virtue of having been found on, in or beneath State controlled lands.

107.26 Soil Erosion and Water Pollution Control. Measures shall be taken during the life of the contract to control soil erosion and water pollution using provisions contained herein, coordinated with the permanent erosion control features specified elsewhere in the contract to assure effective and continuous erosion control throughout the construction and post-construction period. The erosion control measures shall be continued until the permanent facilities have been constructed and until the grass on seeded slopes is sufficiently established to be an effective erosion deterrent. The erosion control features shall be acceptably maintained by the Contractor.

Any work within or adjacent to any State or National Forest, park or other public or private lands, shall comply with all regulations of the appropriate authorities having jurisdiction over such forest, park or land. The areas of construction operations shall be kept in an orderly condition and all refuse and discarded materials disposed of.

In case of repeated failures by the Contractor to control erosion, pollution and/or siltation, the Engineer reserves the right to use State forces to provide the necessary corrective measures. Such incurred direct costs plus project engineering costs will be charged to the Contractor and appropriate deductions made from the Contractor's progress payment estimate.

Temporary pollution control may include construction work outside the right-of-way where work is necessary as a result of roadway construction such as borrow pit operations, haul roads and equipment storage sites.

In the event of conflict between these requirements and erosion and pollution control laws, rules or regulations of other Federal or State or local agencies, the more restrictive laws, rules or regulations shall apply.

These protective requirements will also apply to aggregate preparation, borrow pit, mixing plant, waste disposal and hauling operations. The Contractor shall provide all necessary ditches, sedimentation ponds, dikes or other devices deemed necessary. Pits plant sites, waste areas and haul roads which are to be developed in areas where no such activities existed prior to this contract, whether in sight of the road or not shall be graded smooth, loamed, seeded and mulched where future use of the area is not anticipated. This policy shall also apply to the expansion of existing sites but only to that area affected by the expansion.

- (a) Preconstruction Conference. At the preconstruction conference or prior to the start of construction, not including clearing and/or tree removal, the Contractor shall submit his Schedule of Work which shall include provisions for immediate temporary and permanent erosion control work applicable to clearing and grubbing; grading for bridges and other structures at water courses; earthwork; and paving. He shall also submit his proposed method of erosion control on haul roads and borrow pits and his plan for disposal of waste materials. No work, other than clearing and tree removal, shall be started until the erosion control schedules and methods of operations have been accepted and approved. Clearing and tree removal, prior to receipt of the Contractor's Schedule of Work will only be allowed providing the Contractor's method of operation does not establish a source of water pollution or cause the soil to erode.
- (b) Erosion Control. The Engineer shall have the authority to limit the surface area of erodible earth material exposed by clearing and grubbing and the surface area of erodible earth material exposed by excavation, borrow and fill operations and to direct the Contractor to immediately provide permanent or temporary erosion control measures such as seeding, sodding, mulching and placing erosion control mesh. Such

work may also include the construction of temporary berms, dikes, dams, sediment basins, slope drains and use of temporary mulches, mats, seeding or other control devices or methods as necessary to control erosion.

Cut slopes shall be fine graded, loamed if required and mulched as the excavation proceeds. Berm ditches shall be constructed prior to excavating for the cut. Between the dates of August 15th and May 1st, loam or seed will not be required but during periods of above freezing temperatures the slopes shall be fine graded and protected with mulch until such time as the final treatment can be applied. If construction continues during freezing weather, the slopes shall be continuously graded before freezing and the surface temporarily protected from erosion by the application of mulch. Cut slopes shall not be left exposed over the winter or any other extended time of work suspension unless treated in the above manner.

Uncompleted fill slopes shall be kept in a smooth condition and the surface temporarily protected with mulch. Fill slopes shall not be left unprotected over the winter or during other periods of extended suspension.

Until such time as weather conditions allow ditches to be finished with the permanent surface treatment, erosion shall be controlled by the installation of bales of hay in accordance with the standard detail for temporary ditch protection or by other approved measures.

The Contractor shall incorporate permanent erosion control features into the project at the earliest practicable time as shown in the Schedule of Work. Temporary erosion control measures shall be used to correct conditions that develop during construction prior to installation of permanent erosion control features or that are needed temporarily to control erosion during normal construction practices but not associated with permanent control features on the project.

Where erosion is likely, clearing and grubbing operations shall be schedule and performed so that grading operations and permanent erosion control features can follow immediately thereafter; otherwise, temporary erosion control measures may be required between successive construction stages. The surface area of erodible earth material exposed at one time by clearing and grubbing shall not exceed 750,000 square feet without approval. The Contractor shall limit the area of excavation, borrow and embankment operations commensurate with his capability and progress in keeping the finish grading, mulching,

seeding and other such permanent erosion control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination impractical, temporary erosion control measures shall be provided immediately.

The area of erodible earth material exposed at one time by excavation, borrow or fill shall not exceed 750,000 square feet without prior written approval. The Engineer may increase or decrease the area of erodible earth material to be exposed at one time by clearing and grubbing, excavation, borrow and fill operations as determined by his analysis of project conditions.

- (c) Water Pollution. The Contractor shall exercise every reasonable precaution throughout the life of the contract to prevent pollution of rivers, streams, estuaries, coves, bays, lakes, ponds or other impoundments as well as tidal marshlands. Pollutants such as chemicals, fuels, lubricants, bitumens, raw sewage, wood chips and other harmful waste shall not be discharged into or alongside of rivers, streams, estuaries, coves, bays, lakes, ponds or other impoundments as well as tidal marshlands or into natural or man-made channels leading thereto. The Contractor shall also comply with the applicable regulations of the State Department of Inland Fisheries and Wildlife and other statutes relating to prevention and abatement of pollution.

Such operations as removing borrow, washing aggregates, constructing embankments under water, disposing of waste or surplus material, disposing of oil, bitumens, wood chips or chemicals may result in violation of the water pollution laws.

Unless otherwise approved in writing, construction operations in rivers, streams, estuaries, coves, bays, lakes, ponds or other impoundments, as well as tidal marshlands, shall be restricted to those areas where channel changes are shown on the plans and to those areas which must be entered for the construction of temporary or permanent structures.

Upon completion of the work; rivers, streams, estuaries, coves, bays, lakes, ponds or other impoundments, as well as tidal marshlands, shall be promptly cleared of all falsework, piling, debris or other obstructions caused by the construction operations.

Excavated material shall not be deposited in or so near to rivers, streams, estuaries, coves, bays, lakes, ponds or other impoundments as well as tidal marshlands and flood plains, that it will be washed away by high water or runoff.

Frequent fording of streams with construction equipment will not be permitted. Temporary bridges or other structures shall be used wherever stream crossings are necessary. Unless otherwise approved in writing, mechanized equipment shall not be operated in streams except as may be required to construct channel changes and temporary or permanent structures.

- (d) Method of Measurement and Basis of Payment. In the event that temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness or failure to install permanent controls as a part of the work as scheduled and are ordered, such work shall be performed by the Contractor at his own expense and all costs shall be considered the contract and no additional payment will be made. Temporary erosion and pollution control work required, which is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls, shall be performed as ordered.

Where the work to be performed is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls and falls within the specifications for a work item that has a contract price, the units of work shall be paid for under the appropriate contract item. Necessary grading, unless performed under some other item, will be paid for under Section 631, Equipment Rental. Should the work not be comparable to the project work under the applicable contract items, the Contractor shall perform the work on a force account basis or by agreed unit prices in accordance with Subsection 109.04.

SECTION 108 -- PROSECUTION AND PROGRESS

108.01 Subletting of Contract. The Contractor shall not sublet, sell, transfer, assign or otherwise dispose of the contract or contracts or any portion thereof or of his right, title or interest therein, without written request to and written consent of the Department.

Requests for permission to sublet, assign or otherwise dispose of any portion of the contract shall be in writing and if requested, accompanied by an assurance that the organization which will perform the work is experienced and equipped to do the work. The Contractor shall give assurance that the minimum wage for labor, as stated in his proposal, shall apply to labor performed on all work sublet, assigned or otherwise disposed of in any way. If consent is given, the Contractor will be permitted to sublet a portion thereof, but shall perform with his own organization, work amounting to not less than 50 percent of the total contract cost,

except that any items designated in the contract by the Department as Specialty Items may be performed by subcontract and the cost of any such Specialty Items so performed by subcontract may be deducted from the total cost before computing the amount of work required to be performed by the Contractor with his own organization.

Upon receipt of suitable evidence that the subcontractor is not performing in a satisfactory manner the Department may by a letter to the Contractor, withdraw its approval of a subcontractor. The Contractor upon receipt of such letter shall discharge the subcontractor from all further work on the contract, as a subcontractor. It is agreed between the parties to the contract that such action shall not constitute a breach of contract.

The Contractor shall file with the Department copies of all sublet assignments and shall, if requested by the Department, furnish copies of sublet agreements. No subcontracts, nor transfer of contract, shall in any case relieve the Contractor of his liability under the contract and bonds.

In addition to the above it is agreed and understood that all subcontracts will contain, by inclusion or reference, all the pertinent provisions of the contract and will be subject to requirements thereof.

The Contractor may, for purposes of this requirement, omit, remove or obscure the prices shown in the copy of the subcontract submitted to the Department.

A subcontracting arrangement shall be considered to exist when a person or firm assumes obligation for performing part of the contract work, using their own equipment and workmen; procuring their own materials and supplies exclusive of contract pay items such as Structural Steel Delivered and furnishing their own supervision with only general overall supervision being exercised by the prime Contractor or approved subcontractor or lower tier subcontractor before performing work on any contract item.

108.02 Notice to Commence Work. The notice to commence work will give the date on which it is expected the Contractor will begin construction and from which date contract time will be charged. Commencement of work by the Contractor may be deemed as a waiver on his part of this notice. The Contractor shall not begin work prior to the date of signing the contract agreement by the Commissioner.

108.03 Prosecution of Work. The Contractor shall begin work as set forth in the Schedule of Work, specified in Subsection 105.05. The Department reserves the right to request a revised Schedule of Work at any time.

If, during the construction of the project satisfactory progress is not being made to enable completion of the project within the time specified in the contract, the Engineer shall order the Contractor, in writing, to increase his forces, machinery and equipment or otherwise increase his effort. The Contractor shall comply with this order or he shall reply, in writing, why it would not be necessary for him to do so in order to complete the project within the time specified. The failure of the Engineer to make such demand shall not relieve the Contractor of his obligation to complete the work within the time specified. The Contractor shall not suspend the work without a written order. Should the work for any reason be discontinued by the Contractor, with the written consent or order, he shall notify the Engineer at least 24 hours before again resuming operations. The Engineer may require the Contractor to resume operations by giving a written 24-hour notice.

108.04 Limitation of Operations. The Contractor shall conduct the work at all times in a manner and sequence to assure the least interference with traffic. He shall have due regard to the location of detours and to the provisions for handling traffic. He shall not open up work to the prejudice or detriment of work already started. 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 finishing such section is essential to public convenience.

Unless otherwise specified, the Contractor shall not carry on construction operations on Sundays or Legal Holidays, unless of an emergency nature. The Contractor may work on Washington's Birthday, Patriots Day and Columbus Day without first obtaining permission of the Chief Engineer. Permission to work on Sundays and other Legal Holidays must be obtained prior to the Sunday or Legal Holiday. In addition, if so directed, the Contractor shall suspend all work, other than maintaining the roadway for traffic, on all portions of the project open to traffic, at such other times as he deems necessary. When such suspensions are ordered, working days or calendar days will not be charged against the Contractor during the suspension period.

108.05 Character of Workmen, Methods and Equipment. The Contractor shall at all times employ sufficient superintendents, foremen, labor and equipment for prosecuting the work in the manner and time required by the contract.

All workmen shall have sufficient skill and experience to properly perform the work assigned them.

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 be removed immediately by the Contractor or subcontractor employing such person and the employee shall not be employed again 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 such orders are complied with.

All equipment which is used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work to produce satisfactory quality work and meet all safety requirements. Equipment used on the project shall not cause injury to the roadway, adjacent property or other highways.

When the methods and equipment to be used by the Contractor are not prescribed in the contract, the Contractor is free to use any methods or equipment that will accomplish the contract work according with the requirements of the contract.

When the contract specifies that the construction be performed by certain methods and equipment, those methods and the equipment shall be used unless others are authorized. If the Contractor wishes to use a method or equipment other than those specified, he may request permission to do so. The request shall be in writing and include a full description of the methods and equipment to be used, an explanation of the reasons for making the change and an estimate of savings or added cost, if any, to the Department. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with contract requirements. If, after trial use the Engineer determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining construction with the specified methods and equipment. The Contractor shall at his own expense remove the deficient work and replace it with work of specified quality or take such other corrective action as may directed. No change will be made in the basis of payment for construction items involved nor in contract time as a result of authorizing a change in methods or equipment under these provisions.

108.06 Determination and Extension of Contract Time. The number of working days or calendar days allowed for completion of the work will be stated in the proposal and the contract and will be known as the contract time.

When the contract time is on a working day basis, the Engineer will furnish the Contractor a written weekly report showing the number of working days charged to the contract for the preceding week, the number of working days specified for completion of the contract and the number of working days remaining to complete the contract. The Contractor will be allowed one week in which to file a written protest setting forth in what respects said weekly statement is incorrect, otherwise the statement shall be deemed to have been accepted by the Contractor as correct.

When the contract time is on a calendar days basis it shall consist of the number of calendar days stated in the contract counting from the effective date of the Engineer's order to proceed, including all Sundays, holidays and non-work days.

All calendar days elapsed between the effective dates of any orders to suspend work and to resume work for suspensions not the fault of the Contractor shall be excluded.

The Number of working days or calendar days, allowed to complete the contract, is based on the original contract amount. If satisfactory fulfillment of the contract, with extensions and increases authorized under Subsection 104.02, require the performance of work in greater quantities than those set forth in the proposal, the contract time will be increased in the ratio of the total cost of the work actually performed to the total cost in the proposal. The increase in contract time shall be computed to the nearest one-half day.

When the contract is on a working day basis, the time charge shall start on whichever of the following dates occur first; the date any work is performed on a pay item or the date specified in the Notice to Commence Work as described in Subsection 108.02. When the time charge is on a calendar day basis the computations for time shall start when any work is performed on a pay item, but no later than the date specified in the proposal.

Unless otherwise specified, the period from November 15th to May 15th, inclusive, all days not defined as working days in Subsection 101.94, all State of Maine holidays as specified in Subsection 101.37 and all authorized suspension shall be excluded from the number of working days.

When the contract is on a working day basis and work has been suspended during the winter months the time charge will resume on the first working day after May 15th. If because of ground or weather conditions the Contractor is unable to work, a working day will not be charged.

If the Contractor finds it impossible for reasons beyond his control to complete the work within the contract time, he may make a written request to the Department for an extension of time, setting forth the reasons which he believes will justify the granting of his request. If the Department finds that the work was delayed because of conditions beyond the control and without the fault of the Contractor, it may extend the time for completion in an amount as the conditions justify. The extended time for completion shall then be in full force and effect the same as though it was the original time for completion.

When the Engineer has made final acceptance of the work as prescribed in Subsection 105.17 the daily time charge will cease.

108.07 Temporary Suspension of Work. The Engineer shall have the authority to suspend work wholly or in part by written order, for a period as he may deem necessary due to unsuitable weather, to conditions considered unfavorable for the prosecution of the work,

to failure on the part of the Contractor to correct conditions unsafe for workmen or the general public or to carry out written orders given or to perform any provisions of the contract or for any other reasons or conditions in the public interest.

If it should become necessary to suspend work for an indefinite period, the Contractor shall store all materials so they will not obstruct or impede the traveling public, nor become damaged in any way. He shall take all precautions to prevent damage or deterioration of the work already performed, provide suitable drainage of the roadway by opening ditches, shoulder drains and erect temporary structures where necessary.

108.08 Failure to Complete on Time. For each work day or calendar day that any work remains uncompleted after the contract time specified for the completion of the work, the amount per working day or calendar day, specified in the contract shall be deducted from any money due the Contractor, not as a penalty but as liquidated damages; provided, however, that due account shall be taken of any adjustment of the contract time for completion of the work granted under the provisions of Subsection 108.06. If such charges exceed the sum which would have been payable under the contract the Contractor and the Surety shall be liable and shall pay the Department the amount of such excess.

108.09 Schedule of Liquidated Damages. The specific rates for liquidated damages shall be set forth in the following schedule:

Original Contract Amount		Amount of Liquidated	
From	To and	Damages Per Day	
More Than	Including	Calendar	Working
		Day	Day
\$ 0	\$ 25,000	\$ 45	\$ 63
25,000	50,000	75	105
50,000	100,000	110	154
100,000	500,000	150	210
500,000	1,000,000	225	315
1,000,000	2,000,000	300	420
2,000,000	5,000,000	450	630
5,000,000	10,000,000	600	840
10,000,000	and more	700	980

108.10 Default of Contract. If the Contractor:

- (a) Fails to begin the work under contract within the time specified in the Notice to Proceed or
- (b) Fails to perform the work with sufficient workmen and equipment or with sufficient materials to assure the prompt completion of said work or
- (c) Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable or

- (d) Discontinues the prosecution of the work or
- (e) Fails to resume work which has been discontinued within a reasonable time after notice to do so, or
- (f) Becomes insolvent or is declared bankrupt or commits any act of bankruptcy or insolvency or
- (g) Allows any final judgment to stand against him unsatisfied for a period of 10 days or
- (h) Makes an assignment for the benefit of creditors without authorization by the Department or
- (i) For any other cause whatsoever, fails to carry on the work in acceptable manner, the Engineer will give notice in writing to the Contractor and his Surety of such delay, neglect or default.

If the Contractor or Surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Commissioner will, upon written notification of the fact of such delay, neglect or default and the Contractor's failure to comply with such notice, have full power and authority without violating the contract, to take prosecution of the work away from the Contractor. The Department may use any or all materials and equipment as may be suitable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof or use such other methods as in the opinion of the Engineer will be required for the completion of the contract in an acceptable manner.

All costs and charges incurred by the Department, together with the cost of completing the work done under the contract, will be deducted from monies due or which may become due the Contractor. If such expense exceeds the sum which would have been payable under the contract, the Contractor and the Surety shall be liable and shall pay to the Department the amount of such excess.

108.11 Termination of Contract. The Department may, by written order, terminate the contract or any portion thereof after determining that for reasons beyond either Department or Contractor control he is prevented from proceeding with or completing the work as originally contracted for and the termination would therefore be in the public interest. Such reasons for termination may include, but need not be necessarily limited to executive orders of the President of the United States relating to prosecution of war or national defense, national emergency which relates a serious shortage of materials, orders from duly constituted authorities relating to energy conservation and restraining orders or injunctions obtained by third-party citizen action resulting from national or local environmental protection laws or where the issuance of such order or injunction is primarily caused by acts or omissions of persons or agencies other than the Contractor.

When the Department orders termination of a contract effective on a certain date, 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 elsewhere in these Specifications. Items which are eliminated in their entirety by such termination shall be paid for as provided in Subsection 109.05.

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

After receipt of Notice of Termination from the Department, the Contractor shall submit, within 60 days of the effective termination date, his claim for additional damages or costs not covered above or elsewhere in these Specifications. Such claim may include such cost items as idle equipment time, bidding and project investigative costs, overhead expenses attributable to the project terminated, legal and accounting charges involved in claim preparation, subcontractor costs not otherwise paid for, idle labor cost if work is stopped in advance of termination date, guaranteed payments for private land usage as part of original contract and any other cost or damage item for which the Contractor feels reimbursement should be made. The intent of negotiating this claim would be that an equitable settlement figure be reached with the Contractor. In no event, however, will loss of anticipated profits be considered as part of any settlement.

The Contractor agrees to make his cost records available to the extent necessary to determine the validity and amount of each item claimed.

Termination of a contract or portion thereof shall not relieve the Contractor of his contractual responsibilities for the work completed, nor shall it relieve the Surety of its obligation for and concerning any just claim arising out of the work performed.

SECTION 109 -- MEASUREMENT AND PAYMENT

109.01 Measurement of Quantities. All work acceptably completed under the contract will be measured according to United States customary units.

For all items, other than those to be paid for by lump sum, after the work is completed and before final payment is made, the Engineer shall determine the quantities of various items of work accepted as the basis for final payment. In case of unit price items, the Contractor, will be paid the amount for the quantity of work accepted and for the materials placed. The quantities of work performed shall be computed in accordance with the methods of measurements described under the item involved.

The distance between stations when used as a definition or term of measurement will be 100 linear feet measured horizontally.

The method of measurement and computations to be used in determination of quantities of materials furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice.

Unless otherwise specified, longitudinal measurement for surface area computations will be made horizontally and no deduction will be made for individual fixtures having a surface area of 9 square feet or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or as ordered.

Structures will be measured according to neat line as shown on the plans or as altered for field conditions in accordance with the method of measurement stated in the specifications.

All items which are measured by the linear foot will be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the plans or in the special provisions.

In computing volumes of excavation the average end area method or other acceptable methods will be used.

The term "gage", when used in connection with the measurement of plates, will mean the US Standard Gage.

Except for electrical application, the term "gage" referring to the measurement of wire shall mean the wire size number specified in AASHTO M 32. When used in electrical applications the term "gage" will mean the American Wire Gage (AWG).

The term "Ton" will mean 2,000 pounds avoirdupois.

The term "barrel" will mean 376 pounds of cement.

Timber will be measured by the thousand feet board measure (MFBM) actually incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.

The term "lump sum" when used as an item of payment will mean complete payment for the work described in the contract.

When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories unless otherwise specified.

When standard manufactured items such as fence, wire, plates, rolled shapes, pipe conduit or others are identified by gage, unit weight or section dimensions, such identification will be 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.

All materials which are measured or proportioned by weight shall be weighed on accurate approved scales. When a delivery slip is required for payment of materials measured by weight, weighing, except for automatic ticket printer systems, shall be performed by a Licensed Public Weighmaster furnished by the Contractor, on approved platform truck scales in accordance with the following requirements.

- (a) Licensed Public Weighmaster. A Licensed Public Weighmaster shall be any person satisfying the requirements of the State Sealer of Weights and Measures and granted a license as a Public Weighmaster. Each Licensed Public Weighmaster shall provide himself with an impression seal as required by the State Sealer and shall impress this seal upon delivery slips issued by him. When completed by a Licensed Public Weighmaster, delivery slips shall be considered as the Weight Certificates required by the Maine Weights and Measures Law, MRSA Title 10. The Weighmaster shall perform all duties required of him by law and the specifications.
- (b) Weighing Trucks. Tare weights of trucks hauling stone, bituminous mixes and similar items shall be determined twice daily, once during the forenoon and once during the afternoon. The tare weight thus found shall be used to determine the net load until the next tare weighing of the empty truck. Tare weights of trucks hauling liquid and bituminous cement materials or other items not generally on a repeat basis shall be determined immediately before being loaded and the weight thus found shall be used for that load only. The tare weight of a truck shall be defined as the weight of the empty vehicle including the driver, but with no passengers.
- (c) Platform Truck Scales. An approved platform truck scale meeting the following requirements shall be provided, installed and maintained by the Contractor or be available to him at an approved nearby location:
 - 1. The scale shall conform to the specifications, tolerances and regulations for commercial weighing devices of the National Bureau of Standards and shall be accurate within maximum tolerances of plus or minus 2 pounds per 1,000 pounds of load.

2. No auxiliary indicators, in combination with the beams or dial of the scale shall be used to increase the scale capacity above the manufacturer's rated capacity, which capacity shall be at least 10 percent in excess of the maximum gross load weighed.
 3. The platform of the scale shall be of sufficient size to accommodate the entire vehicle or combination of vehicles. If a combination of vehicles must be divided into separate units in order to be weighed, each unit shall be entirely disconnected before weighing and a separate weight certificate, delivery slip or ticket shall be issued for each separate unit.
 4. The value of the minimum graduation on the indicator of the scale shall not be greater than 20 pounds. All weighing shall be read and recorded to the nearest 20 pounds or one-hundredth ton.
 5. The scale shall be set on concrete or other approved foundation. The recording mechanism of the scale shall be suitably housed or protected from weather.
 6. The Contractor shall have the scale inspected and approved by the State Sealer of Weights and Measures within a period of 12 months preceding the date of any weighing and after each change of location.
- (d) Check Weighing. Check weighing shall be made on the weights and on the weighing-in scales during production in the following manner:
1. At least once each day, in the presence of a State Inspector a loaded truck which has been weighed and the weight slip issued, shall be turned and a new weighing made of the truck and load with the truck heading in reverse direction and at the opposite end of the scale platform from the first weighing. The new weight will be recorded. If the variation from the first weight is 0.2 of 1 percent or less, the fact will be so noted in the project records. However, if the variation exceeds 0.2 of 1 percent the scales may not be used until rechecked and resealed by the State Sealer of Weights and Measures.
 2. At least once each day, a loaded truck which has moved off the scales will be intercepted, directed back to the scales and reweighed under the supervisions of a State Inspector.

3. At least once each day, in the presence of a State inspector, a truck which has been emptied will be directed to the scales before being loaded at a time other than the normal tare weighing and weighed again for a check on the tare weight.
 4. Check weighing will be on a plant basis and although a plant may produce material for more than one project or contract, check weighing will not be required for each project or contract.
 5. Although a minimum of one check weighing a day is specified, additional checks will be made occasionally at the discretion of the Engineer. Claims by the Contractor for delays or inconvenience due to check weighing will not be considered.
- (e) Reciprocal Agreements. Weighing of materials on scales located outside the State of Maine will be permitted for materials produced or stored outside the State, when requested by the Contractor and approved. Out of State weighing, in order to be approved, must be performed by a Licensed Public Weighmaster or a person of equal authority in the State concerned, on scales accepted in the State concerned and meeting the requirements given in subparagraph 109.01(c).
- (f) Delivery Slips. Serially pre-numbered delivery slips of acceptable size and format for stating the following minimum information shall be furnished by the Contractor, in as many copies as may be necessary. One copy shall be signed and retained by the Engineer or his inspector upon accepting delivery of the material.

Vehicle Identification

Date

Project

Identification of material

Quantity information as necessary:

Gross, Tare and Net Weights, Volume of Load if not material requiring weighing, Net Gallons at 60°F If Bituminous Liquids

Signatures (legible initials acceptable) of:
Weighmaster (if weight measured material) Contractor's representative (if volume measured material), State representative

Materials included in the quantity shown on the delivery slips and not used in the work or subsequently rejected, shall be deducted from the amount being measured for payment.

All quantities of materials delivered, shall be reconciled between the Contractor and the Engineer before the end of the following working day.

If materials are shipped by rail, the car weight may be accepted provided that only the actual weight of material is paid for. However, car weights will not be acceptable for materials to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty, daily, at such times as directed. Each truck shall bear a legible identification mark.

Rail shipments of bituminous liquid shall be measured directly by volume. Correction shall be made when liquid bituminous material has been lost from the car, wasted or otherwise not incorporated in the work. Other shipments of bituminous liquids will be measured by the gallon or ton. Volumes will be measured at 60°F or will be corrected to the volume at 60°F using the tables in ASTM D 1250.

When bituminous liquids are shipped by truck or transport, net certified weights or volume subject to correction for loss or foaming, may be used for computing quantities. Net certified weight shall be determined upon loading for all bituminous liquids when shipped by truck or transport. The net weight of each load shall be converted to net gallons at 60°F by a conversion factor expressed in pounds per gallon.

109.011 Determination of Conversion Factor. The supplier or producer of the bituminous liquids shall determine the specific gravity of each lot of each type and grade of liquid furnished according to the most recent AASHTO method, corrected to 60°F. The conversion factor shall be determined by multiplying the specific gravity by 8.328; the weight in pounds of 1 gallon of water at 60°F to the nearest one-hundredth pound per gallon. The conversion factor in pounds per gallon shall be entered upon all loading invoices for each bituminous liquid.

Upon delivery, the net gallons measured when loaded shall be subject to correction when bituminous liquid has been lost from the vehicle, wasted or otherwise not incorporated in the work. Correction when required at a location other than the point of loading and weighing, will be determined by volume measurement, using a calibrated tank gauge, measuring stick or other acceptable measurement. Measurement shall be reconciled with the Contractor when performed and shall be final.

109.012 Automatic Ticket Printer System on Automatic Bituminous Mixing Plant. If an approved automatic ticket printer system is used with an approved automatic bituminous mixing plants, the requirements for delivery slips for payment of materials measured by weight, as given in the following Subsections, shall be waived: 109.01(a), 109.01(b), 109.01(c), 109.01(d). The automatic printed ticket will be considered as the Weight Certificate.

The requirements of 109.01(f) shall be met by the weigh slip or ticket, printed by the automatic system, which accompanies each truck load, except for the following changes:

- (a) The quantity information required shall be individual weights of each batch or total net weight of each truck load.
- (b) Signatures (legible initials acceptable) of Weighmaster (required only in the event of a malfunction below), State representative.

Automatic bituminous mixing plants shall have the scales sealed by the State Sealer of Weights and Measures within a period of 12 months preceding the date of any weighing and after each change of location. The Contractor shall make checks on the accuracy and sensitivity of the aggregate and asphalt plant scales as specified in Subsection 401.082(e), in the presence of a representative of the State, at intervals not exceeding 60 days.

Daily checks will be made to see that the weigh hoppers are discharging completely and that the balances return to zero. Also, daily sensitivity checks will be made on all scales.

At least twice during each 5 days of production either of the following checks will be performed:

- (c) A loaded truck may be intercepted and weighed on a platform scale that has been sealed by the State Sealer of Weights and Measures within the past 12 months. Whenever the discrepancy in net weights is greater than 1 percent, but does not exceed 2 percent, the plant inspector will notify the producer to take corrective action; payment will still be governed by the printed ticket. If the discrepancy exceeds 2 percent, the plant will be required to be run manually and payment will be determined by truck platform scale net weight until effective corrective measures have been taken.
- (d) Where platform scales are not readily available, a check will be made to verify the accuracy and sensitivity of each scale within the normal weighing range and to assure that the interlocking devices and automatic printer system are functioning properly.

- (e) In the event of a malfunction of the automatic printer system, production may be continued without the use of platform truck scales for a period not to exceed the next 2 working days, providing total weights of each batch are recorded on weight tickets and certified by a Licensed Public Weighmaster.

109.02 Scope of Payment. Payments to the Contractor shall be full compensation for furnishing all materials and for performing all work under the contract in a complete and acceptable manner and for all risk, loss, damage or expense of whatever character arising out of the nature of the work or the prosecution thereof, subject to the provisions of Subsection 107.22.

If the Basis of Payment clause in the specifications relating to any unit price in the bid schedule requires that the unit price cover and be considered compensation for certain work or material essential to the item, this same work or material will not be measured or paid for under any other pay item which may appear elsewhere in the specifications.

109.03 Compensation for Altered Quantities. When the accepted quantities of work vary from the quantities in the bid schedule, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices for the accepted quantities of work, unless an appeal has been filed under the dispute clause of Subsection 105.18. No allowance, except as provided in Subsection 104.02, will be made for any increased expense, loss of expected reimbursement or loss of anticipated profits suffered or claimed by the Contractor resulting either directly from such alterations or indirectly from unbalanced allocation among the contract items of overhead expense on the part of the bidder and subsequent loss of expected reimbursement or from any other cause.

109.04 Extra and Force Account Work. Extra work performed in accordance with the requirements and provisions of Subsection 104.03 will be paid for at the unit prices or lump sum stated in the order authorizing the work or the Commission may require the Contractor to do such work on a force account basis to be compensated in the following manner:

- (a) Labor. When an item "Hand Labor" is not called for in the proposal the following shall apply. For all labor and foremen in direct charge of the specific operations, the Contractor shall receive the rate of wage agreed upon by the Engineer before beginning work, for each hour that labor and foremen are actually engaged in the work. To the labor costs shall be added an amount equal to 40 percent of the sum thereof; which added amount shall constitute payment for all

bond and insurance premiums and taxes paid by the Contractor for property damage, liability and workmen's compensation, insurance premiums, unemployment insurance contributions, social security taxes and other overhead and profit on the force account work.

When the item "Hand Labor" is called for in the proposal, labor shall be paid for at the contract unit price per hour to which no percentage will be added. Specialized skilled labor will be provided on an agreed price in accordance with the preceding paragraph. The Engineer reserves the right to determine the number and type of laborers employed under this Subsection.

- (b) Materials. For all materials used and incorporated in the permanent work, the Contractor shall receive the actual cost of such materials and freight and delivery charges, as shown by the original receipted bills, plus 15 percent of such costs not including State sales tax. For all materials not incorporated in the permanent work, the Contractor shall receive actual value of such material at the time of its use less the fair salvage value of material when released. Upon the sum thus determined an allowance of 15 percent will be made to the Contractor.
- (c) Equipment. When the item "Equipment Rental" is not called for in the proposal the following shall apply; For any power operated machines or other equipment, including trucks, the use of which has been authorized, the Contractor shall receive the rental rates approved for the actual time that such equipment is in operation on the work, to which rental sum no percentage shall be added.

When the item "Equipment Rental": is called for in the proposal the items shall be used in accordance with that specification.

- (d) Superintendence. No part of the salary or expense of anyone connected with the Contractor's forces above the grade of foreman and having general supervision of the work, will be included in the labor items as specified above, except when the Contractor's organization is entirely occupied with force account work. In this case, the salaries of the superintendent and the timekeeper may be included in the labor item specified above when the nature of the work is such that, their services are required. The allowable rate of pay of such employees shall be as agreed upon before starting the work.

(e) Compensation. The compensation as set forth above shall be received by the Contractor as payment in full for extra work done on a force account basis.

(f) Statements. All statements shall be accompanied and supported by receipted invoices for all materials used and transportation charges. If materials used on the force account work are not specifically purchased for such work but are taken from the Contractor's stock, then instead of invoices, the statements shall contain or be accompanied by an affidavit of the Contractor certifying that such materials were taken from his stock, that the quantity claimed was actually used and that the price and transportation claimed represent the actual cost to the Contractor. No payment will be made for work performed on a force account basis until the Contractor has furnished duplicate itemized statements of the cost of such force account work detailed to the following:

Name, classification, date, daily hours, total hours, rate and amount for each foreman and laborer.

Designation, dates, daily hours, total hours, rental rate and amount for each unit of equipment.

Quantities of materials, prices and amounts.

Transportation charges on materials.

(g) Specialty Work. When specialty work is considered necessary for the satisfactory completion of the project for which there is no contract price and the type of work involved requires specially trained men and special equipment, the Contractor may engage an approved concern or personnel to do this work.

Payment for acceptably completed specialty work will be made on the basis of the total cost of the work, supported by an invoice in duplicate, made out to the Contractor from the Concern actually performing the work.

Total cost of the work shall mean the cost of all labor, materials, equipment, tools, insurances, taxes and any other authorized costs necessary to complete the work. To the sum thus determined an amount of 15 percent will be allowed the Contractor.

109.05 Eliminated Items. Should any items contained in the proposal be found unnecessary for the completion of the work, the Engineer may, upon written notification to the Contractor, eliminate such items from the contract and such action shall not invalidate the contract. No allowance will be made for anticipated profits for items eliminated in making final payment to the Contractor. When a Contractor is notified of the elimination of items, he will be reimbursed for actual work done and costs incurred in partial performance of the eliminated items, as shown on bills submitted by the Contractor, including mobilization of materials prior to notification.

109.06 Adjustments for Changes in Common Carrier Rates. It is understood and agreed that the accepted proposal for this project is based on common carrier rates on file with the Interstate Commerce Commission or with a corresponding intra-state commission or body and in effect on the day of opening bids. Payments to the Contractor will be adjusted to compensate for increases and decreases in cost due to changes in common carrier rates becoming effective after the date of opening bids and before the date specified for completion of the work, as adjusted because of authorized extensions of time.

The adjustments shall be the product of the net increases or decreases in the said common carrier rates, multiplied by the net quantity material shipped at the new rates to the work and incorporated in the work, all as shown by the receipted common carrier bills.

109.07 Partial Payments. Partial payments will be made at least once each month as the work progresses. Estimates may be paid twice each month if in the judgment of the Engineer the amount of work performed is sufficient to warrant such payment. Payment will be based upon estimates, prepared by the Engineer, of the value of the work and materials complete in place and accepted in accordance with the contract and in accordance with Subsections 109.08 and 109.09, for materials delivered. All materials estimates and payments shall be subject to correction in subsequent partial estimates and payments and on the final estimate and payment. No such estimate or payment shall be made when, in the judgment of the Engineer, the work is not proceeding in accordance with the provisions of the contract or when the total value of the work done since the last estimate amounts to less than 5,000.00 dollars.

Except as provided in Subsection 107.15, the amount for payment shown on each progress estimate will be paid in full until 50 percent of the contract amount has been paid, after which 5 percent of each subsequent progress payment will be deducted and withheld until completion of the work.

Upon completion of the work under this contract, the Engineer may release 60 percent of the amount then retained. The balance of the amount retained will be held until all reports required of the Contractor are received and final payment is authorized by the Commissioner. The Commissioner, at his option, may retain temporarily or permanently, from time to time, such portion of the amount retained as he deems equitable.

109.08 Payment for Material Delivered on the Project. At the discretion of the Engineer, acting upon a request from the Contractor and accompanied by receipted bills, payment may be made for all or part of the value of acceptable, non-perishable materials which are to be incorporated in the work; such as stone masonry, curbing, timber and lumber, metal culverts, stone and sand, gravel and other materials delivered on the work or in the vicinity of the work at acceptable storage places and not used at the time. Materials, paid for by the Department shall become the property of the Department and in the event of default on the part of the Contractor, the Department may use or cause to be used, these materials in the construction of the work provided for in the contract. The Contractor shall be responsible for any damage to or loss of these materials.

The payment for certain materials shall be determined as follows:

- (a) Borrow and unprocessed aggregates: 50 percent of the unit price.
- (b) Processed aggregates, except stone; stockpiled in the pit, 30 percent of the unit price; when stockpiled on the project, 60 percent of the unit price.
- (c) Processed stone; stockpiled in the quarry, 45 percent of the unit price; when stockpiled on the project, 55 percent of the unit price.
- (d) Loam stockpiled; 25 percent of the unit price.
- (e) Payment for all other materials shall be made as previously specified.

The amount thus paid by the Department shall go to reduce estimated amounts due the Contractor as the material is used in the work.

Partial payments for materials stockpiled will not constitute acceptance and any faulty material will be rejected even though previous payment may have been made.

No allowance for partial payment shall be made upon fuels, supplies, form lumber, falsework or other materials or on temporary structures of any kind which are not in the contract as a pay item or covered by the provisions of Subsection 109.04.

No payment will be made on living or perishable plant materials unless acceptably planted in their final locations.

109.09 Payment for Materials Not Delivered on the Project. At the discretion of the Engineer, acting upon a request from the Contractor, an estimate, accompanied by the receipted bills, may be made for payment for all or part of the value of acceptable non-perishable material not delivered on the project but stored in acceptable storage and not used at the time of such estimate. Payment for such materials shall be in accordance with Subsection 109.08. In addition, the Contractor shall provide a material bond in the amount of payment contemplated. The form of bond shall be that provided by the Department and the surety shall be one which is acceptable to the Department. A certified and duly executed copy of the bond shall be filed with and approved by the Department before payment is made. Payment will be in the amount indicated by receipted bills filed with the Department. Total payments made to the Contractor shall not exceed the amount specified in the bond.

109.10 Acceptance and Final Payments. When the project has been accepted as provided in Subsection 105.17 the Engineer will prepare a final quantity estimate of the various classes of work performed. After approval of the final quantity estimate by the Contractor and after all supporting information necessary to substantiate pay quantities, including statements itemizing force account work, have been furnished by the Contractor, payment will be made in the amount of the work done after deducting all previous payments and all remaining amounts to be retained or deducted under the provisions of the contract.

Upon submission by the Contractor of all required reports, completed forms and certificates and a written statement that all bills for labor, equipment and material used under this contract have been paid, the payment of final estimate for the remaining amount retained may be paid. A written request for payment of the final estimate should accompany this statement but the failure of the Contractor to make a request for payment of the final estimate shall not prohibit making the final payment. The acceptance by the Contractor of the final payment shall constitute a release to the Department from all claims and liability under the contract. Upon termination of work and acceptance of the payment by the Contractor, the Contractor will then be released from further obligation, except as set forth in the contract bond.

All prior partial estimates and payment shall be subject to correction in the final estimate and payment.

DIVISION 200 -- EARTHWORK

SECTION 201 -- CLEARING RIGHT-OF-WAY

201.01 Description. This work shall consist of clear cutting, selective clearing and thinning, removing single trees, including dead, blown down or uprooted trees, removing and disposing of all stumps and debris within the limits of the right-of-way and easement areas except such objects as are designated to remain or are to be removed in accordance with other sections of these specifications. This work shall also include the preservation from injury to or defacement of all vegetation and objects designated to remain and the treatment of stumps with herbicides.

- (a) Clearing shall consist of cutting and disposing of all trees, down timber, stubs, brush, bushes and debris within designated limits.
 - (b) Selective Clearing and Thinning shall consist of cutting and disposing of designated trees, down timber, stubs, brush, bushes and debris within designated limits. This work also includes application of approved herbicides.
 - (c) Removing trees shall consist of cutting and disposing of single trees, stumps and roots, located outside the limits of clearing or selective clearing and thinning limits, as indicated on the plans or as authorized.
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- 1. A single tree is defined as any tree or remains of a tree, still standing, 12 inches or more in its largest cross-sectional dimensions measured as specified in Subsection 201.09 and taller than 5 feet measured from the ground at the base of the tree.
 - 2. A stump is defined as the remains of a single tree 12 inches or more at its largest cross-sectional dimension from which the toppings have been removed and which is an average of 5 feet or less in height measured from the ground at the base of the stump.

MATERIALS

201.02 Materials. Materials shall conform to the requirements specified in the following Subsections of Division 700 -- Materials Details:

Herbicide	717.07
Tree Paint	708.04

CONSTRUCTION REQUIREMENTS

201.03 General. The Engineer will establish clearing and selective clearing limit lines and will designate all things that are to be preserved and to remain.

Alignment stakes, grade stakes, witness stakes, boundary markers, bench marks and tie points shall be preserved until permission for their destruction is given.

201.04 Clearing. In areas indicated on the plans, all trees, down timber, stubs, brush, bushes, shrubs, plants and debris not designated to remain shall be removed and disposed of.

In areas where the proposed embankment is not designated to be grubbed, as provided in subsection 203.09, all stumps shall be cut off as close to the ground as is practicable. When stumps are to remain in the backslope rounding of cut sections, they shall be cut flush with the final slope line.

All wood in the clearing area, except trees designated to remain, shall become the property of the Contractor, unless otherwise provided.

Unsound or unsightly branches of trees and shrubs designated to remain, and not specified to be removed under another item, shall be removed as directed. Branches of trees extending over the road-bed shall be trimmed to provide a clear height of 20 feet above the road and shoulder surface. Trimming shall be done by skilled workmen and in accordance with good tree surgery practices. All removing and trimming, painting with tree paint and disposing of debris, shall be a part of and included in clearing, selective thinning or tree removal items.

The Contractor shall take special care to completely dispose of all elm trees removed, by burning or by burying under soil in approved areas.

All live hardwood stumps, 1 inch or more in diameter located between the lines of improvement and the outermost clearing or selective clearing lines shall be treated with herbicides, unless specifically exempted.

In areas where stumps and shrubs are to remain, the surface of the ground shall not be unduly disturbed or compacted. Existing ground cover shall be preserved insofar as possible and the area shall be left neat and clean and in a condition which is reasonably consistent with the surroundings.

201.05 Selective Clearing and Thinning. In order that trees may be properly marked, the Contractor shall give the Engineer at least 2 weeks notice prior to starting work. Only those trees or bushes designated to be removed shall be cut. In no event shall selective clearing and thinning operations begin until approval is given.

All dead or diseased trees or shrubs, junk, trash, litter or foreign matter of any kind shall be removed from the areas to be enhanced. This shall include uprooted stumps and all branches, tops, trunks and dead wood, resulting from woodcutting operations or from any other causes.

Trees and shrubs to be preserved shall be carefully pruned to remove all dead, diseased and injured wood. In addition, in certain areas, the Engineer may require the branches of designated trees to be removed to a height above ground as directed. Complete clearing may be required in certain areas. Such clearing shall be included under this Subsection. Storing logs and pulpwood in thinned areas shall be avoided.

The Contractor shall avoid disturbing or compacting the existing ground surfaces as well as avoiding damage to plant growth. Use of heavy equipment, operating anywhere within the area to be selectively thinned, will not be allowed unless authorized.

Any injury to trees and shrubs which are to be preserved shall be carefully repaired. Disturbed ground surface shall be restored as nearly as possible to natural conditions.

Pruning and repairs to live trees and shrubs shall be done by skilled workmen or tree surgeons according to approved arboricultural practice. All stumps, new or old, shall be cut off as close to the ground as is practicable.

Trees falling outside the specified limits of the thinning areas shall be removed and disposed of in a satisfactory manner. Undesirable trees leaning or falling over the highway right-of-way from outside shall be cut at the property line.

201.06 Herbicides. With the exception of coniferous (softwood) trees, stumps over 1 inch in diameter resulting from cutting live hardwood trees and shrubs shall be treated with approved herbicide spray mixture. The spray mixture may be applied at any time until regrowth from the stumps has reached a height of approximately 24 inches except that it shall not be applied when the stumps are wet or frozen. The herbicide spray mixture shall be sprayed or brushed on all exposed surfaces of stumps, stubs, and the stems only, of regrowth, until there is complete saturation and run-off. Particular attention shall be given to the bark and all exposed roots.

All stumps and stubs shall receive at least one treatment with the herbicide spray mixture. At the time of final acceptance, live regrowth or hardwood tree seedlings shall have been substantially eliminated.

Particular care must be taken that the spray does not land on or too near live trees and shrubs that are to be preserved. Unless otherwise directed the spray mixture shall not be applied closer than 2 feet from the trunk of a tree that is to remain.

When directed live stumps in specified areas shall be exempted from spraying with herbicides.

The Contractor shall be responsible for maintaining the treated area until final acceptance of the work. Any damage or die-back shall be repaired at the Contractor's expense as directed. At the time of final acceptance the area shall be free of all dead, dying or damaged trees and shrubs and litter of any kind as well as free from regrowth.

201.07 Disposal. All brush, timber, logs and other woody debris shall be disposed of by methods approved. The Contractor shall make every effort to provide useful disposition of woody material which may be marketable. If the Contractor can demonstrate that a reasonably suitable market for the material is not available, other disposal methods may be approved.

Acceptable methods of disposal may include chipping, burning or burying.

- (a) Chipping. Wood chippers shall reduce woody material to chips, not over 1/4 inch thick by not over 8 inches long, and the chips shall be spread uniformly over the ground or as directed.
- (b) Burning. A Special Provision will state when burning is not allowed. Logs, brush and other refuse produced as a result of clearing may be disposed of by burning, provided pollutent type material is not used to start or maintain the fire. All fires shall be started with natural material and the fire maintained in such a manner that minimum of visible smoke is produced.

Special attention shall be paid to wind direction to assure no nuisance results from smoke.

Burning shall be done in accordance with applicable laws and ordinances and under the direction of competent watchmen. Extreme care shall be taken to control the fires. Fires will not be allowed where there is any possibility of burning, scorching, overheating or otherwise jeopardizing trees, shrubs, surrounding forest cover, adjacent property or buildings nor where there is a possibility of damaging overhead wires and cables. Fires will not be allowed where undisturbed ground is to remain exposed nor on areas which have been seeded to grass or other plants.

The Contractor will be held responsible for any damage caused by fires built in the construction of the project. Such responsibilities shall include removing and disposing of burned material, replacing trees, shrubs, fences or any other material or object which has been designated to remain and seeding, fertilizing and mulching the burned areas. At the option of the Engineer, a cash settlement, instead of replacing damaged trees and plants, may be accessed or a combination of replacement and cash settlement. When directed, the Contractor may be required to perform such work beyond the right-of-way lines.

- (c) Burying. Brush and logs may be disposed of by burying in approved waste dumps or by placing in the portion of the embankments outside a slope 1 1/2 horizontal to 1 vertical extending from the edge of the shoulder to the existing ground and covering with a minimum of 2 feet of earth. Excavation or borrow used to cover the brush and logs in the slopes may be placed in layers at least 2 feet thick and compacted only to the extent that the stability of the slope is assured.

201.08 Removing Single Trees and Stumps. When called for on the plans or designated, complete removal and disposal of single trees and stumps shall be required and shall include the backfilling of stump holes.

Trees which have been uprooted shall be removed by cutting the tree and removing the stump from the ground or where approved the stumps may be placed back in the hole to present a natural appearance. The area shall be graded to conform to the surrounding terrain.

201.09 Method of Measurement. Clearing, and selective clearing and thinning will be measured by the acre, determined from horizontal dimensions, acceptably and actually cleared or thinned within the limits shown on the plans or additional areas flagged by the Engineer. Areas not shown on the plans or not flagged for clearing or thinning will not be measured for payment.

Single trees and stumps will be measured by each unit. The size of the tree shall be the average horizontal cross sectional dimension determined by circumferential measurement at a height of 4 1/2 feet above the ground. When trees are removed under this contract and the removal of the stump is also required, the stump size shall be the same size as that determined for the tree. The size of all other stumps shall be the greatest horizontal cross sectional dimension determined at the top of the stump. Trees or stumps which have multiple trunks protruding from a single base trunk shall be measured for payment as a single tree or stump.

Individual trunks of multiple trunk trees or stumps having a diameter of less than 12 inches will not be included to determine the size of a tree or stump.

201.10 Basis of Payment. The accepted quantities of clearing, selective clearing and thinning, will be paid for at the contract unit price per acre.

The accepted quantity of single trees and stumps removed will be paid for at the contract unit price each. Payment for trees shall include removal and disposal of the entire tree except stumps. Payment for removing stumps shall include removal and disposal of the stump and roots. Stumps removed from grubbing areas and excavation areas which are also within clearing areas will not be paid for directly but their removal shall be considered incidental to the various contract bid items. Stumps removed from within grubbing areas and excavation areas located outside of clearing areas will not be paid for directly unless they result from the removal of the single tree tops, under this contract, or unless they are shown on the plans as single trees. All other stumps designated to be removed will be paid for at the contract unit bid price each.

The accepted quantity of removal of dead, blown down or uprooted trees over 6 inches in diameter will be paid for at the contract unit price each. No reduction in payment will be made for removal of such tree trunks when the stump is left in place. Trees which are less than 6 inches in diameter will not be paid for but shall be removed as directed and the costs considered included in the various bid items.

When the bid schedule does not contain an estimated quantity for clearing, the work will not be paid for directly but shall be considered included in the other contract items.

When the use of herbicide or tree paint is required to complete the work outlined under this section it will not be paid for directly, but will be considered as included in the other contract items.

Grubbing, when required, will be measured and paid for as provided in Section 203 -- Excavation and Embankment.

Payment for removal of trees and stumps not classified as pay items under this Section, shall be considered included in the various contract items and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
201.11 Clearing	Acre
201.12 Selective Clearing and Thinning	Acre
201.22 Removing Dead, Blown Down or Uprooted Tree over 6 inches	Each
201.23 Removing Single Tree Top Only	Each
201.24 Removing Stump	Each

SECTION 202 -- REMOVING STRUCTURES AND OBSTRUCTIONS

202.01 Description. This work shall consist of removing wholly or in part, and satisfactory disposing of all designated buildings, structures, old pavement, and other obstructions which are required to be removed, except for the obstructions to be removed and disposed of under other contract items. It shall also include the salvaging of designated materials.

CONSTRUCTION REQUIREMENTS

202.02 Removing Buildings. The Contractor shall remove and dispose of all buildings and foundations indicated.

Cavities remaining as a result of foundation or structure removal shall be filled to the level of the surrounding ground and, if within the limits of embankment or below the subgrade in excavation areas, shall be compacted in accordance with applicable embankment construction requirements.

Details of the ownership of the building and all the equipment, fixtures and materials therein, except equipment belonging to a public utility or equipment or fixtures specifically excepted and details relative to the date of availability of the property, will be stated in the Special Provision.

Written notice will be given the Contractor when any building becomes available prior to the date specified. On the above specified date, or upon notice of availability, ownership of the buildings shall transfer from the State to the Contractor who then shall proceed with the work required under this section. The buildings shall not be used or occupied for any purpose while in the right-of-way and the buildings shall be removed as soon as possible after date available, unless otherwise authorized.

If, during the negotiations between the Department and the owners of the building specified under this section, agreements are made with the owners to move, remove or raze the buildings, the Department reserves the right to remove any or all items from the contract upon written notice to the Contractor and no payment will be made for the items. Removal of debris, when necessary under such conditions, will be accomplished under Section 629 -- Hand Labor and Section 631 -- Equipment Rental.

All debris and unusable materials shall be removed to an approved dump or waste area and buried. No material shall be disposed of by burning.

202.03 Removing Existing Superstructure, Structural Concrete, Railings and Bridges. Removing existing superstructures shall consist of removing and disposing of existing superstructure including fill, pavement, railing and all other material on or over the superstructure unless otherwise specified. Removing existing structural concrete shall be to the limits designated on the plans and shall be accomplished without damage to the portion of the structure to remain.

Removing existing bridge shall be to the limits shown on the plans.

When the material from an existing structure is to be retained by the Department, it shall be carefully dismantled by the Contractor and all materials except those which may be specified to be reused in the new structure, shall be loaded on trucks supplied by the Department or carefully stored within the right-of-way. The use of any portion of the salvaged material in connection with new or temporary construction shall not be anticipated by the Contractor. The dismantling of metal structures or railings shall, when especially provided, include the removal of all bolts and rivets necessary to disconnect the members and the match-marking of these members for future reassembling.

When the material from an existing structure is designated to become the property of the Contractor, it shall be entirely removed and disposed of out of sight of the highway and beyond the limits of the right-of-way. Such material shall not be deposited in rivers, streams or other bodies of water. If the material is to be wasted then it shall be disposed of at an approved dump or other approved location.

When practical, any suitable material removed shall be used in backfilling or for the formation of embankments and no additional allowances for payment will be made. Unsuitable or surplus material shall be disposed of in an approved waste area.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which might damage new construction, shall be completed prior to placing the new work. If this is not feasible, the work shall be done only when approved and entirely at the Contractor's risk.

202.04 Removing Pavement. All portland cement concrete pavement and portland cement concrete base course designated for removal shall be broken into pieces suitable for use in construction of embankment or disposed of as directed. When used in the construction of embankments, the maximum size of any fragment shall not exceed the thickness of the layer being placed. The Contractor may, at his option and with approval, dispose of material in approved waste areas and replace with an equivalent volume of granular borrow at no cost to the State.

202.05 Method of Measurement. Removing buildings and removing existing superstructures and removing existing bridges will each be measured by the lump sum. Removing pavement will be measured by the square yard with no deductions made for areas occupied by existing catch basins and manholes. Removing existing structural concrete will be measured either by the cubic yard in place before work starts on the particular portion of the structure to be removed or by the unit as specified. Removing existing railings will be measured by the linear foot in place along the grade and line of the railing from outside to outside of end posts or rail projections, whichever is greater.

202.06 Basis of Payment. The accepted quantity of removing building, removing existing superstructure and removing existing bridge will be paid for at the contract lump sum price which price shall be full compensation for removing and disposing of the obstructions and building foundations down to an elevation matching the surrounding ground as directed. Removing pavement will be paid for at the contract unit price per square yard which price will be full compensation for removing and disposing of pavement and pavement reinforcement. Material for backfilling holes resulting from removal of obstructions will be measured and paid for as provided in Section 203 -- Excavation and Embankments. The quantity of structural concrete removed will be paid for, either at the contract unit price per cubic yard or at the contract lump sum price, which price shall include disposal of the concrete. The quantity of railing removed will be paid for at the respective contract unit price per linear foot of railing removed and disposed of.

When the payment item calls for material to be retained by the Department, payment shall include the salvage of these materials, custody, preservation and storage on the right-of-way and disposal as provided herein. When the proposal does not include pay items for removal of structures and obstructions as provided in this Section, such work shall be considered incidental to the various contract items and no direct payment will be made except that removal of foundations will be paid as provided in Section 203 -- Excavation and Embankment.

Payment will be made under:

Pay Item	Pay Unit
202.08 Removing Building No. _____	Lump Sum
202.09 Removing Existing Superstructure (Retained by Department)	Lump Sum
202.10 Removing Existing Superstructure (Property of Contractor)	Lump Sum
202.11 Removing Portland Cement Concrete Pavement	Square Yard
202.12 Removing Existing Structural Concrete	Cubic Yard
202.121 Removing Existing Concrete	Lump Sum
202.13 Removing Existing Railings (Retained by Department)	Linear Foot
202.14 Removing Existing Railings (Property of Contractor)	Linear Foot
202.19 Removing Existing Bridge	Lump Sum

SECTION 203 -- EXCAVATION AND EMBANKMENT

203.01 Description. This work shall consist of the removal, haul, disposal and compaction if required, of all material not being removed under some other item, encountered for the construction of the project in accordance with the specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established. Excavation, except structural excavation, will be classified as common excavation, rock excavation, unclassified excavation, as hereafter described. Material not classified as excavation which is required to construct embankments, backfill trenches and holes shall be classified as borrow.

- (a) Common Excavation shall consist of the removal of all material encountered in grading the project within the limits of construction and in driveways which is not otherwise classified and paid for. Common excavation shall include the removal and disposal of boulders, solid mortared stone masonry, and concrete masonry when each is less than 2 cubic yards in volume and all soft and disintegrated rock which can be removed with ordinary excavating machinery. It shall include grubbing which consists of the removal and disposal of all stumps, roots, bushes, grass, turf or other objectionable material it shall include berm ditches and cut slope downspouts.

Common Excavation shall include muck removal which shall consist of the excavation and disposal of saturated or unsaturated mixtures of soils and organic matter not suitable for embankment foundation material regardless of moisture content.

Common Excavation shall include the removal and disposal of all material encountered in excavating for stream channel diversion, channel widening or straightening, when designated on the plans, outside the limits of structural excavation of other classifications.

- (b) Rock Excavation shall consist of the removal of hard igneous, metamorphic and sedimentary rock which cannot be excavated without blasting and all boulders, solid mortared stone masonry, concrete masonry, each having a volume of 2 cubic yards or more.
- (c) Unclassified Excavation shall consist of the removal of common excavation and rock excavation as classified above and not measured separately.

When identical unit prices are bid for Common Excavation and for Rock Excavation, such bids shall be considered as a bid for Unclassified Excavation of the combined items and shall be so classified.

MATERIALS

203.02 Materials. Borrow shall consist of approved material required for the construction of embankments or for other portions of the work as designated and shall be obtained from beyond the limits of the required cut slopes. Unless otherwise designated in the contract, the Contractor shall make his own arrangements for obtaining borrow and shall pay all costs involved. No material shall be removed from an approved borrow pit except for use under this contract.

Material shall meet the requirements of the following Subsections of Division 700 -- Materials:

Common Borrow	703.18
Granular Borrow	703.19
Gravel Borrow	703.20
Rock Borrow	703.21
Tree Paint	708.04

Slope blanket backfill material shall meet the requirements of aggregate for base or aggregate for subbase, Type D specified in Subsection 703.06 as directed.

203.03 Unauthorized Use of Materials. No common excavation, rock excavation, unclassified excavation or borrow which is designated for use in embankments or backfill may be diverted for the Contractor's own use. Any unauthorized use of such material will be adjusted by deducting quantities, measured by the most appropriate method as determined and 115 percent of the quantity deducted from the total amount.

CONSTRUCTION REQUIREMENTS

203.04 General. Prior to beginning of excavation, grading, and embankment operations in any area, all necessary clearing in that area shall have been performed in accordance with Section 201 -- Clearing Right of Way.

Unsuitable material shall be disposed of as directed and no material shall be wasted without permission. Excavating operations shall be conducted so that material outside of the limits of slopes will not be disturbed.

The Engineer may designate as unsuitable those soils that cannot be properly compacted in embankments and all such unsuitable material shall be disposed of in approved waste storage areas or waste areas as directed.

Suitable material taken from excavation shall be used in the formation of embankment, subgrade, and for backfilling as indicated on the plans, or as directed, except that if the volume of suitable excavated material exceeds that required to construct the embankments to the grades indicated, the excess shall be used to grade the areas of ultimate development, or wasted as directed.

The Contractor shall give the Engineer sufficient time before beginning excavation to take necessary cross section elevations and measurements. The Contractor shall not excavate beyond the dimensions, slopes and elevations established, and no material shall be removed prior to the staking out and cross-sectioning of the site. Unless otherwise authorized, borrow material shall not be placed until after all suitable excavation has been placed in the embankment unless the use of granular borrow is called for on the plans or required for use under embankments or in conjunction with the use of excavated material or for the maintenance of traffic. If the Contractor places more borrow than is required and thereby causes a waste of suitable excavation material, the amount of such waste will be measured by the method deemed most appropriate and 115 percent of the amount deducted from the borrow volume.

When different unit prices are bid for Common Excavation and Rock Excavation, the Contractor will be required to strip earth from the ledge to provide an opportunity for the Engineer to take the necessary measurements. When identical prices are bid for Common Excavation and Rock Excavation, the Contractor will not be required to strip the earth from the ledge.

When it is necessary to temporarily remove fencing designated to remain, the fencing shall be replaced by the Contractor at his expense in as good a condition as it was originally. The Contractor shall be responsible for the confinement of livestock when a portion of the fence is removed. When new fencing for confinement of livestock is required, it shall be erected before existing fencing is disturbed. Where the new fencing cannot be erected in its final location, any temporary fencing shall be at the Contractor's expense.

Excavation for obliteration of old roadways or salvaging material from old roadways shall include all grading operations necessary to incorporate the old roadway into the new roadway and surroundings or placing salvaged material in a stockpile as directed.

The degree of finish for grading ditches and slopes, both fill slopes and cut slopes, shall be that obtainable from machine operations. Ditches shall be constructed to within 6 inches above or below the grade called for on the cross sections or as otherwise modified but in no case shall the ditch be finished in a condition that will not allow the flow of water. Ditches shall be graded to the extent that puddles will not form. All provisions for measurement and payment limits shall remain in force and no payment will be made for unauthorized work done beyond authorized pay limits.

Unstable slopes subject to sliding and slumping, shall be excavated to the lines and grades shown or as directed. Immediately after each location is excavated, approved granular slope blanket backfill material shall be placed and shaped to match the adjacent slopes.

203.05 Roadway Excavation. The roadway excavation shall be maintained in such condition that the excavation will be well drained. Temporary drains, drainage ditches and culverts shall be constructed to intercept and divert water which may adversely affect the condition of the excavation and the prosecution of the work.

Excavation shall, in general, proceed in a direction upgrade. Subgrades shall be promptly graded and rolled to minimize absorption of water. Adjacent ditches shall be graded to the extent that puddles will not form. Grubbing areas which cannot be drained shall be promptly filled with approved excavation or borrow to such an elevation that surface drainage will be effective. If, due to unusual circumstances, drainage by gravity cannot be accomplished, the Engineer may require the Contractor to provide adequate means of pumping the area. Pumping may be required on a 24 hour a day continuous basis and no direct compensation for cost of pumping will be made.

Muck shall be removed in such a manner to insure its complete removal with no areas remaining or trapped below the embankment. Excavated muck shall be deposited in designated waste storage areas as shown on the plans or as otherwise directed. When muck is encountered that was not contemplated on the plans, it shall be disposed of as indicated above.

Excavation adjacent to the roots of trees or shrubs which are to remain shall be removed by hand. Live roots to be removed shall be cut cleanly and approved tree paint applied within 24 hours to the cut surfaces remaining.

When excavating results in a subgrade of unsuitable soil, the Engineer may require the Contractor to remove unsuitable material and backfill with approved material. The Contractor shall conduct his operations in such a way that the Engineer can take the necessary measurements before the backfill is placed.

Material classified as rock, whether paid for as rock excavation or unclassified excavation, shall be excavated to the required depth. Care shall be taken that undrained pockets will not be left in the surface of the rock remaining. The space between the rock remaining and the normal subgrade shown on the plans shall be backfilled with the designated aggregate subbase or aggregate base, pulverized rock or other approved material. The Contractor should conduct his excavating and hauling work in a manner that will cause as little contamination as possible. Fine grading at the normal subgrade line will be required unless aggregate subbase or aggregate base material is used.

Ditches in rock cuts shall be constructed with no protrusions of rock above the designated rock cut pay lines. The space between the rock remaining and the finished surface of the ditch shall be backfilled with broken rock.

For earth and rock backslopes designated to be constructed on a 2 to 1 slope or flatter, the slope shall be uniformly finished to within 6 inches above or 6 inches below the lines designated, but in no case shall projections of rock extend over 6 inches above the actual finished surface of the slope as constructed. Rock backslopes designated to be constructed on a 1/4 to 1 slope shall be excavated at least to a vertical plane.

Materials which have been displaced or loosened beyond the finished work as shown on the plans shall be removed and disposed of by the Contractor. The Engineer shall determine if the displacement of such material was unavoidable and his decision shall be final. In all cuts, loose rocks on the backslopes shall be removed to the finished grade of the slope.

Buried structures and obstructions, as specified in Subsection 104.07, located within the designated limits of the work, shall be removed as part of the applicable excavation item for type of work being performed. Buried structures and obstructions located below or outside the required excavation, whose removal is ordered, shall be removed and such removal paid for as Common Excavation, Rock Excavation or Unclassified Excavation, whichever is applicable.

203.06 Waste Areas. The location of all waste areas shall be approved. When the area is beyond the right-of-way line, the written permission of the property owners shall be obtained by the Contractor, including permission to grade, loam, seed and mulch the waste area, if so directed. A copy of the permit shall be supplied before any use is made of the waste area.

When so directed, waste areas shall be uniformly graded to drain, covered with loam or other earthy material that will support growth, and the area seeded and mulched in accordance with Section 618, Seeding, Method Number 2. Unless otherwise specifically provided in Contracts with Common Excavation, Rock Excavation or Unclassified Excavation, grading, furnishing and placing loam, seed and mulch in waste areas shall be considered incidental to the Contract and no separate payments will be made.

In Contracts that do not contain Common Excavation or Unclassified Excavation items, grading, furnishing and placing loam, seed and mulch in waste areas will be paid for under applicable pay items of the contract.

Entrances to waste areas located within wooded areas shall not be established at intervals less than 800 feet. These entrances shall be angled away from view of oncoming traffic.

When waste areas are located within wooded areas, a screen of trees at least 100 feet wide shall be maintained between the nearest edge of the waste area and the right-of-way line or the constructions limit line.

The entrances to waste areas shall be treated in the same manner as the waste area except that, if entrances in wooded areas exceed 16 feet in width, the ground shall also be replanted with trees compatible with the type growth in adjacent area. These plantings shall extend for a length of 100 feet along the entrance road or as otherwise directed.

All trees which are damaged, uprooted or otherwise moved as a result of the waste material and trees which have had waste material placed around them to the extent that they may die, shall be cut and removed at the expense of the Contractor.

Waste areas may be established by the Department. When such waste areas are established, the location and other conditions relating to them will be described in the Special Provisions or on the plans.

203.07 Haul Roads. In wooded areas, haul roads shall be kept to a minimum width and placed at approximately right angles to the road or angled away from view of oncoming traffic.

203.08 Borrow. The location of all borrow pits and rock borrow quarries shall be approved in accordance with Subsection 106.021 and Section 657, Rehabilitation of Pits. Prior to the completion of the project all borrow pits and haul roads shall be graded to blend with adjacent ground, loamed if necessary, seeded and mulched.

The Contractor shall notify the Engineer sufficiently in advance of opening any borrow areas so that cross section elevations and measurements of the ground surface after stripping may be taken and the borrow material can be tested before being used. Existing pits shall, when directed, be graded and shaped by the Contractor prior to being cross sectioned for original measurements.

Borrow pits shall be excavated to neat lines and all slopes shall be dressed uniformly and left in a neat condition. When practicable, the bottom of all pits shall be graded to drain the pit.

203.09 Preparation of the Embankment Area. When the depth of the embankment measured vertically below subgrade does not exceed 5 feet, the area on which the embankment is to be placed shall be grubbed as defined in Subsection 203.01 (a). When the embankment is more than 5 feet, as measured above, all vegetation in the embankment area shall be cut as specified in Section 201 -- Clearing Right-of-Way.

When embankment is to be placed and compacted on hillsides or where new embankment is to be compacted against existing embankment, slopes steeper than 2 to 1 shall be continuously benched by excavating steps into the existing material of sufficient width to permit operations of placing and compacting the additional material. Material removed shall be placed and compacted along with the new embankment material. When such benching is required, it shall be indicated on the plans, called for in the special provisions or as directed.

203.10 Embankment Construction-General. Layers shall start at the deepest portion of the fill and as placement progresses, layers shall be constructed approximately horizontal. Except for the first layer over swampy ground and cleared areas, roadway embankment of earth material shall be placed in layers not exceeding 8 inches, loose measure unless otherwise approved and shall be compacted as specified before the next layer is placed.

When it is impractical to construct layers over the full width of the cross section, partial width layers may be authorized.

Effective spreading equipment shall be used on each layer to obtain uniform thickness. Each layer shall be crowned and maintained free of ruts and ridges to provide direct drainage of water from the embankment. As the compaction of each layer progresses, grading and manipulating will be required to assure uniform density. Construction equipment shall be routed uniformly over the entire surface of each layer.

Embankments within 50 feet of a bridge abutment, structural plate or box culvert type structure shall be compacted by the moisture and density control method as specified in Subsection 203.12 except that rock embankments may be constructed over culverts as specified in Subsection 203.15.

Water shall be added or removed, if necessary, in order to obtain required compaction. Aeration of excavated roadway materials to reduce the moisture content to within specified limits shall be as specified under Subsection 631.04.

When placing layers of specified thickness is not feasible, such as filling in water or over swampy ground, the initial layer of embankment may be constructed in one layer to an elevation where bridging will be accomplished. In embankment areas where no grubbing is required, the material placed in the first layer shall be of sufficient depth to cover all stumps.

When the excavation or borrow consists predominantly of fragments of such size that the material cannot be placed in embankments in layers of thickness prescribed without breaking down the pieces, such material may be placed in layers in thicknesses not exceeding the approximate average size of the larger rocks but in no case shall exceed 2 feet. Rocks exceeding this thickness shall be separated and collectively placed in accordance with the requirements for rock embankments. Each layer shall be leveled and smoothed with suitable leveling equipment and by even distribution of rock spalls and finer rock fragments or earth. The Engineer may test any or all layers by moisture and density control as specified in Subsection 203.12 which are constructed in depth exceeding 8 inches. The layers so constructed shall not be placed above an elevation 2 feet below the finish subgrade. The remainder of the embankment shall be composed of suitable material smoothed and placed in layers not exceeding 8 inches loose thickness and compacted as specified for earth embankments.

Where guard rail is to be installed, rock shall not be placed in the embankment under the location of the guard rail to a depth of 4 feet below the finished grade of the shoulder. Rocks, broken concrete or other solid materials shall not be placed in any portions of embankments where piling is to be placed or driven or where utility conduits are to be placed.

Excess or unsuitable excavated material, including rock and boulders, which cannot be used in embankments shall be placed in the nearest available waste storage areas. When it is impossible to dispose of all material in the manner described, the remainder shall be disposed of in approved waste areas.

When material obtained from roadway excavation is unsatisfactory for use in the formation of embankments due to excessive moisture content and when it can be rendered satisfactory for such use by combining with granular material, granular borrow or granular excavation shall be used in combination with such unsatisfactory material for embankment formation when and only as directed.

If the embankment is required to be deposited on only one side of abutments, wing walls, piers or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structure. When embankment is to be placed on both sides of a concrete wall, structural plate or box type structure, operations shall be so conducted that the embankment is always at approximately the same elevation on both sides of the structure.

At the close of each day's work, the embankment surface shall be graded, crowned, smoothed, rolled and sealed against infiltration of water.

The portion of the embankment and subbase outside a 1 1/2 to 1 slope extending from the edge of the finished shoulder to the existing ground as shown on the standard detail entitled "Disposal of Waste Materials" will be required to be compacted only to the extent that stability of the slope is assured. As construction of the embankment progresses, material placed in the portion of the embankment outside the 1 1/2 to 1 slope shall not be placed above the elevation of the surface of the main embankment unless provisions are made to allow drainage of surface water from the embankment. The surface of the slopes shall be finished to present a uniform neat appearance.

The portion of the embankment inside the aforementioned 1 1/2 to 1 slope lines shall be compacted in accordance with the designated embankment compaction requirements specified for the project.

203.11 Construction of Embankment-Layer Method. The layer method will be required unless otherwise specified. Unless otherwise approved the material shall be deposited and spread in full width layers not more than 8 inches in depth, loose measure, upon compacted material. Clay or loam soils shall be compacted by use of sheepfoot or tamping-type roller having a minimum weight on each tamper, under working conditions, of 250 pounds per square inch of cross sectional bearing area. Sand or gravel soils shall be compacted by vibratory type compaction equipment or by pneumatic tired equipment and, if necessary, by the addition of water. A combination of the above or other methods capable of producing equivalent results may be used. The compacting operations shall be continued until each layer is compacted to its full depth and width.

The Contractor will be required to demonstrate that the compaction equipment and methods are obtaining satisfactory compaction.

With approval, the Contractor may place layers in excess of 8 inches and less than 24 inches, loose measure, providing the specified compaction requirements are obtained and the Contractor agrees to make necessary excavations in the layer for the Engineer to determine density.

Satisfactory compaction for the purpose of the demonstration is defined as not less than 90 percent of the maximum density. The maximum density shall be determined in accordance with AASHTO T 180, Method C or D, corrected by the Soils Laboratory Adjustment Chart, available at the Soils Laboratory, Bangor, Maine. Field density tests will be made in accordance with AASHTO T 191 or AASHTO T 205 adjusted to include only the material passing a 3/4 inch sieve or by an approved method using a calibrated nuclear device.

203.12 Construction of Embankment with Moisture and Density Control. The contract will designate the areas to be constructed with moisture and density control, and the distance below subgrade to which such methods shall be applied. The moisture content at the time of compaction shall be suitable to obtain the required density. The maximum density shall be determined in accordance with

AASHTO T 180, Method C or D, corrected by the Soils Laboratory Adjustment Chart available at the Soils Laboratory, Bangor, Maine. Field density tests will be made in accordance with AASHTO T 191 or AASHTO T 205 adjusted to include only the material passing a 3/4 inch sieve or by an approved method using a calibrated nuclear device.

All material in embankments above the elevation designated on the plans for moisture density control shall be placed at a moisture content suitable to obtain the required density. Each layer placed with controlled moisture shall be compacted to not less than 90 percent of the maximum density.

Density requirements will not apply to the portions of embankments constructed of material which cannot be tested in accordance with AASHTO T 191 or when the material contains more than 30 percent material retained on a 2 inch square mesh sieve.

203.13 Preparation of Foundation and Construction of Embankments in the Abutment and Pier Areas. Prior to placing the embankment, the foundation areas under the Abutments and Piers as indicated on the plans shall be prepared by removing the top soil, sod and all existing unsuitable material including surface boulders larger than 12 inches. The entire area from which the top soil has been removed shall be rolled until the underlying soils to a depth of eight inches shall be compacted to 95 percent of the maximum density in accordance with the first paragraph of Subsection 203.12.

Granular Borrow placed below the elevation of the bottom of the abutments and piers shall conform to the gradation for Aggregate Subbase Course -- Gravel, Subsection 703.06(b).

Placing and compacting of Granular Borrow at abutments and piers, from foundation area up to the elevation of the bottom of the concrete shall be as follows:

The material shall be placed in uniform layers not exceeding 8 inches in thickness, loose measure. Each layer shall be compacted by means of suitable compaction equipment to a density of 98 percent of the maximum density as determined under the requirements of Subsection 203.12. No successive layers shall be placed until the layer under construction has been brought to the required density and approved.

The Engineer will make known upon request, both the maximum density and the optimum water content for the various materials to be used in the embankment construction. It shall be the responsibility of the Contractor to notify the Engineer not less than 48 hours in advance as to which material he proposes to use.

The remainder of the embankment shall be compacted as indicated on the plans or as stated in the specifications.

203.14 Vacant

203.15 Construction of Embankments-Rock. The material for rock embankment shall be placed in compacted layers not exceeding 3 feet in depth. Depositing the rock directly over the end of the fill from the hauling equipment will not be permitted; it shall be deposited on the fill and pushed into place. The top of the rock embankment shall be so choked that there will be no infiltration of the earth embankment placed on the surface of the rock embankment.

The method shall be used only in fills in excess of 4 feet in depth. In no case shall the rock embankment be placed within 1 foot of subgrade unless authorized.

When structures are located under rock embankment, they shall be covered with not less than 2 feet of earth excavation or borrow before the rock embankment is placed over the structures.

203.16 Winter Construction of Embankments. Frozen material shall not be placed in the core embankment. The construction of embankments may continue during cold weather only when all frozen material in the top of the core embankment or the existing ground is moved to the waste storage area before placing additional material. When this procedure results in additional borrow quantity, the additional borrow will not be paid for directly.

Compaction shall be in accordance with the specified method of embankment construction. When the prevailing temperatures are below 30°F, all material used in embankment construction shall have a moisture content at the time of compaction equal to or less than the optimum moisture content.

The embankment shall not be constructed upon frozen material except that such construction of embankments may be allowed providing the total depth of the added fill, including gravel bases, plus the depth of the frozen material beneath does not exceed 5 feet. Frozen material may be left in the embankment only if it has been compacted as specified prior to freezing. The Contractor shall not resume construction of any embankments built in this manner until all frozen material has thawed. If test holes are required to make this determination they shall be dug and backfilled with satisfactory compaction at the Contractor's expense. Before additional material is added, uncompacted material on the surface of such embankments shall be either recompactd in accordance with the specified method of embankment construction or removed.

203.17 Preparation and Protection of the Subgrade. Unless otherwise provided, the subgrade shall be brought to a condition of uniform stability and compaction for the full width of the roadway by grading and rolling operation and shall be maintained to a tolerance of 1 inch above or 3 inches below the required grade and cross section. The surface shall be compacted to uniform density and stability and graded to the extent that puddles of water will not form. Any additional material required as a result of low subgrade shall be furnished and placed at the expense of the Contractor.

The required compaction shall be the same as specified for embankments. When the subgrade occurs in cuts, the required compaction shall apply to a depth of 6 inches below subgrade unless otherwise specified.

The Contractor shall protect the subgrade from damage. Ditches and drains along the roadway shall be maintained to effectively drain the subgrade. In no case shall vehicles be allowed to travel in a single track and form ruts. No material shall be deposited on a subgrade until the subgrade has been approved.

203.18 Method of Measurement. Excavation and borrow will be measured by the number of cubic yards measured in its original position by cross sectioning the area excavated. Measurements will include slides in common excavation and unclassified excavation, not attributable to carelessness of the Contractor, and authorized excavation of earth, rock, shale, muck or other unsuitable material. Volumes will be computed by the average end area method or by other methods generally recognized as conforming to good engineering practice.

Muck excavation, to be measured for payment as common excavation will be the number of cubic yards of material acceptably excavated from areas shown on the plans, or other authorized areas not shown on the plans, placed in waste storage areas or hauled to an approved waste area. Muck excavation shall be measured in its original position by cross sectional elevations and the volume computed by the average end area method. If muck is stored in excess of the maximum slope requirements of any waste storage area, the amount requiring reloading, hauling and disposing of in other waste storage areas or approved waste areas will not again be measured for payment.

When it is impractical to measure excavation by the cross-sectional method due to the erratic location of isolated deposits, acceptable methods involving three-dimensional measurements may be used. When small quantities of borrow are involved and it is impractical to measure in its original position, a quantity not exceeding 2,000 cubic yards per item for a single project may be measured in vehicles at the point of delivery, and a quantity not exceeding 5,000 cubic yards per item for a single project may be measured in place. When measured in vehicles, the quantity for payment shall be 90 percent of the quantity determined for earth and 75 percent of the quantity determined for rock, as shown on delivery slips. When measured in place, the amount for payment shall be 115 percent of the quantity so measured for earth material and 75 percent of the quantity so measured for rock.

Unless authorized, measurement allowance for earth excavation will not exceed the designated cut slope lines indicated on the plans and no allowance will be made for any material removed from beyond the designated slope lines.

Unless authorized, rock slopes designated to be constructed on a 1/4 to 1 slope or on a 2 to 1 slope or flatter, no allowance will be made for material removed beyond the designated slope lines.

Unless authorized, material placed in embankments outside a surface parallel to and 6 inches beyond the neat line of embankment slope or 12 inches beyond the neat line of the waste storage area in which waste has been placed, will not be included in the quantity for payment and will be deducted from the borrow at 100 percent of the material so measured in place.

The elevations for final cross sections for excavation shall be determined at the surface of the finished ground with no additional allowance for thickness of loam, sod, riprap, erosion control mesh, hay mulch or other type ground surface except that excavation for slope gravel blanket will be measured by the cubic yard.

Measurements will be made for unsuitable materials actually excavated and removed to obtain proper compaction in cut sections and in foundations for fill sections.

Aeration of excavated materials to reduce moisture content to specified limits will be measured as specified under Section 631 -- Equipment Rental.

203.19 Basis of Payment. The accepted quantity of excavation and borrow will be paid for at the contract unit price per cubic yard for each of the pay items included in the schedule of items. Payment shall be full compensation for obtaining borrow when required and for excavating, loading, hauling, placing, grading and compacting all material necessary for the formation of embankments. It shall also include full compensation for disposal of unsuitable and surplus material when necessary. It shall also include excavation in embankments for determining density.

Haul, connected with the disposal of waste and/or surplus material shall be limited to a maximum distance of 2,000 feet beyond the limits of the project for disposal in flattening slopes or other roadway work. If no disposal areas are designated, the haul shall be made to an approved waste area supplied by the Contractor.

Payment for removal of unstable material below subgrade in cuts will be paid at the contract unit price per cubic yard for Common Excavation or Unclassified Excavation, whichever is appropriate.

Payment for placing and compacting any backfill, except Special Backfill, placed in accordance with Section 206 -- Structural Excavation, will not be paid for separately but will be included in the payment for any one of the related excavation items, provided however, there is suitable excavation material available in its original position at the time of backfilling. When there is no suitable material available for backfilling, the material authorized will be paid for under the contract item for the class of material used.

When rock is encountered and no item is included in the contract for its removal, the excavation of the rock will be paid for at 6 times the contract unit price for common excavation.

The furnishing and placing of backfill material between the rock remaining and the normal subgrade line of rock cuts will be considered to be included under the payment for material authorized; granular type excavation or granular borrow. The quantity of Aggregate Subbase or Aggregate Base for payment in rock cuts shall include only the material placed above the normal subgrade line.

Earth material from beyond the designated slope lines on earth cut slopes, as specified in Subsection 203.18, when authorized, may be paid for when used to construct embankments at the contract unit bid price for excavation or borrow, whichever is less. Costs for furnishing and placing material necessary to backfill and to grade rock cut slopes designated to be constructed on a slope of 2 horizontal to 1 vertical or flatter, will be considered to be included under the payment for the material used; excavation or borrow.

When muck is encountered the excavation of the muck will be paid for at the contract unit price bid for Common Excavation or Unclassified Excavation.

Excavation which requires more than one handling prior to final placement in the embankments including material placed as backfill and loamy top soil to be stockpiled and reserved for later use on the slopes, will be paid for at the contract unit price for Common Excavation, Unclassified Excavation or Rock Excavation, as the case may be, for each handling approved. It may be paid for under another contract item for the second handling when so authorized. Each handling shall be considered to include the operations of excavating loading, transporting, unloading and disposing of earth or rock material.

Excavation for slope blanket backfill, as specified in Subsection 203.04, will be paid for at twice the contract unit price bid for common excavation. Backfill material will be paid for as specified in Subsection 304.07.

Excavation for benching to receive embankments will not be paid for directly but shall be considered included in the other contract items.

Water added to embankment material to aid in compaction will not be paid for directly but shall be considered included in the contract items.

Payment for compacting the soils in the Abutment and Pier areas, after the top soil has been removed will not be made directly but shall be considered included in the other contract items. Excavation and compaction, as specified in Subsection 203.13 will be paid for at the contract unit price for common excavation.

Machine aerating, for aerating excavated material only, will be paid for as specified under Section 631 -- Equipment Rental.

Removal of portland cement concrete pavement and portland cement concrete base course, when not included in the contract as a separate pay item, will be paid for under Pay Item 203.21. Excavation done for roadway obliteration will be paid for under the appropriate excavation item. Scarifying for obliteration of roadways, when no excavation is required, will be paid for under the appropriate pay item of Section 631 -- Equipment Rental. Payment for excavation or filling and compacting material in building or other foundation holes, whether existing or created by the removal of structures and obstructions, will be made under the appropriate pay item for excavation or borrow and no additional allowances will be made.

All work and materials required to grade, loam, seed, and hay mulch waste areas and haul roads to and from waste areas to eliminate unsightly conditions and control erosion, will not be paid for directly but will be considered included in the work of the various classifications of excavation all as specified in Subsection 203.06.

Whenever the use of tree paint is required to complete the work outlines under this section, it will not be paid for directly but will be considered included in the other contract items.

Stripping pits to obtain necessary borrow will not be paid for separately but will be considered included in the other contract items.

When common excavation and rock excavation are reclassified as unclassified excavation, because of identical unit bid prices, payment will be made for the reclassified items under Pay Item 203.22, Unclassified Excavation at the identical unit bid price.

Payment will be made under:

Pay Item	Pay Unit
203.20 Common Excavation	Cubic Yard
203.21 Rock Excavation	Cubic Yard
203.22 Unclassified Excavation	Cubic Yard
203.24 Common Borrow	Cubic Yard
203.25 Granular Borrow	Cubic Yard
203.26 Gravel Borrow	Cubic Yard
203.27 Rock Borrow	Cubic Yard

SECTION 204 -- VACANT

SECTION 205 -- VACANT

SECTION 206 -- STRUCTURAL EXCAVATION

206.01 Description. This work shall consist of the excavation, haul and backfill or disposal of all material excavated for the construction of bridges, masonry retaining walls, box culverts, pipe culverts, storm drain culverts, underdrain culverts and other structures in accordance with these specifications and in reasonably close conformity with the lines, grades and typical cross sections shown on the plans or established. Ditches at inlets and outlets of culverts, special ditches and outlet ditches therefrom, all as shown on the plans, shall be constructed and paid for under Section 203 -- Excavation and Embankments. Excavation for structure below designed excavation limits as specified or shown on the plans will be included under this section. Material which is required to be excavated under another item shall not be included under this item. Rock shall be as defined in paragraph 203.01 (b).

- (a) Structural Earth and Structural Rock Excavation for Drainage and Minor Structures shall include the excavation and disposal of all material encountered in excavating for pipe culverts, structural plate culverts, box culverts, underdrains, culvert end walls, concrete steps and other minor structures.
- (b) Structural Earth and Structural Rock Excavation for Abutments and Retaining Walls and Piers shall include the excavation and disposal of all material, including existing wood or masonry piers or abutments, encountered in preparing foundation pits for abutments and masonry retaining walls and piers. When called for on the plans, existing approach fills, abutments or piers (not included within the limits specified above) shall be removed and disposed of under this classification.
- (c) Special Backfill shall consist of obtaining, hauling and placing selected material suitable for the location where it is to be used. Special backfill as a contract item will be called for on the plans or in the proposal.

CONSTRUCTION REQUIREMENTS

206.02 Construction Methods. The Contractor shall notify the Engineer a sufficient length of time in advance of the beginning of structural excavation so that necessary elevations and measurements may be taken of the undisturbed ground. When ledge rock is encountered which is to be removed, the Contractor shall uncover the ledge and provide ample opportunity for the Engineer to take the necessary measurements of the undisturbed rock.

When the foundation material is soft or otherwise unsatisfactory, the excavation shall be carried to a depth designated and the material removed below the elevation shown on the plan shall be replaced with approved granular material, thoroughly compacted or a lower elevation for the bottom of the structure shall be established.

Any suitable material removed from the excavation area including that material removed from beyond the specified excavation pay limits shall be used for backfilling or for the formation of embankments and no additional allowances for payment will be made. Unsuitable or surplus material shall be disposed of as directed.

When the foundation is to be placed on solid rock, the rock shall be excavated to a firm surface, either level stepped or serrated. In trenches for pipe culverts, underdrains, structural plate pipes and structural plate pipe arches, when solid or disintegrated rock or boulders are encountered, the rock shall be excavated to designated depth below the bottom of the proposed pipe. Except for installations of underdrain, the material so removed shall be replaced with selected fine compressible material such as silty clay or sand and uniformly compacted and shaped in accordance with Subsection 603.04.

When the structure is to rest on an excavated surface, other than rock, special care shall be taken not to disturb the bottom of the excavation. Final removal of the material to grade shall not be made until immediately preceding the placing of the culvert pipe, concrete or masonry.

After each excavation is completed, the Contractor shall notify the Engineer and no culverts or masonry shall be placed, foundation piles driven or other installations made, until the depth of the excavation and the character of the foundation material has been approved.

Before drainage or underdrainage pipe is installed in cut areas where common excavation, unclassified excavation or muck excavation is removed below the subgrade elevation shown on the plans, the undercut roadbed shall be filled with approved granular material to a depth sufficient to support construction equipment. All fill material shall be compacted as required.

206.03 Backfilling. Backfilling shall consist of placing suitable material in all spaces excavated and not occupied by drainage structures, bridge structures and other permanent structures up to the elevation of the existing ground or other elevations shown on the plans or designated. Backfill material shall be fine readily compressible soil or granular material, at or near optimum moisture content, and shall not contain stones larger than 3 inches, frozen lumps, chunks of clay, mineral matter or any other objectionable material. The material shall be uniformly distributed in layers of not more than 8 inches, loose measure and each layer thoroughly compacted by use of approved compactors before successive layers are placed. When backfill is being placed around

a pipe or structure, operations shall be so conducted that the fill is always at approximately the same elevation on both sides of the structure. Water shall be added when necessary to increase the moisture content of the backfill material to obtain compaction. Puddling or jetting of backfill will not be allowed unless specifically provided in the contract.

Backfill shall not be placed against gravity sections of masonry abutments, wing walls, box culverts or other structures requiring forms, until the masonry has been placed at least 7 days. For reinforced sections, no backfill shall be placed until the masonry has been in place at least 14 days. Backfilling around pipes, catch basins and manholes, the joints of which are made with portland cement mortar, shall not be done until the mortar has been in place at least 12 hours unless methods approved by the Engineer are used to protect the mortar from being disturbed.

Unless otherwise indicated on the plans or directed, all sheeting and bracing used during structural excavation shall be removed by the Contractor following the completion of the work, and all voids resulting from use of the sheeting and bracing backfilled where necessary.

206.04 Method of Measurement. Structural excavation will be measured by the number of cubic yards of material removed, measured in its original position acceptably excavated in conformity with the plans or as directed.

When structures are to be installed where roadway excavation is to be removed, only the excavation beyond and below the roadway excavation limits will be classified as structural excavation.

- (a) Pipe culverts, underdrains, catch basins, structural concrete steps and other minor structures. For these structures there will be no measurement for structural earth excavation except that excavation required below a plane parallel with and 12 inches below the bottom of the aforementioned structures, as shown on the plans, hereafter called Structural Earth Excavation, Below Grade. When measured for payment, the quantity of Structural Earth Excavation, Below Grade, will be the amount actually excavated, provided the maximum allowable horizontal dimensions do not exceed those bounded by vertical surfaces 15 inches from the structure, except 18 inches outside the lines of the base of catch basins, and to the vertical neat lines of underdrain trenches, as shown on the plans.

When rock is required to be excavated for installation of these structures, the depth for measurement will be the actual depth required in accordance with the specifications or as otherwise designated. The quantity of rock will be the number of cubic yards actually removed provided the maximum allowable hori-

zontal dimensions do not exceed those bounded by vertical surfaces specified in the preceding paragraph. Any removal of hard rock for the purpose of leveling, stepping or serrating, as shown on the plans or determined, shall be measured within the aforementioned limits.

- (b) Abutments, masonry retaining walls, piers, box culverts, structural plate pipes, structural plate pipe arches and substructure units of structural plate arches. For these structures, the quantity to be measured for payment will be the amount actually excavated to the required elevation, provided, however, that the maximum allowable horizontal dimensions do not exceed those bounded by vertical surfaces 18 inches outside the neat lines of the base as shown on the plans. For structural plate pipes and structural plate pipe arches, the maximum allowable dimensions shall be those bounded by vertical planes 18 inches outside the span as shown on the plans. For structures constructed on grillages, the maximum allowable dimensions shall be those bounded by vertical planes 6 inches outside the grillage and the depth to the required elevation.

When the outermost limit of French Drains exceeds the vertical planes stated above, then the limit to be measured for payment will be extended upward from the bottom of the French Drain to a vertical plane bounded by the outermost limit of the French Drain.

When rock is required to be excavated for the construction of these structures to: (1) definite elevations as shown on the plans, or (2) elevations designated by the Engineer after the rock has been exposed, the maximum depth of measurement for payment will be to a horizontal plane or planes located 12 inches below the elevation shown or designated. Any removal of hard rock, for the purpose of leveling, stepping or serrating, as shown on the plans or determined, shall be measured within the aforementioned limits and paid for as structural rock excavation. When earth is required to be removed to uncover existing rock, it will mean to excavate to undisturbed hard rock and will be so measured for payment.

- (c) Special Backfill. The quantity of Special Backfill to be measured for payment as a contract item will be the number of cubic yard of material acceptably placed and measured in place, but will not include replacement of material excavated beyond the specified pay limits for structural excavation.

206.05 Basis of Payment. The accepted quantities of structural excavation, when specified to be paid for separately, will be paid for at the contract unit price per cubic yard. The work, whether paid for separately or incidental to the structure, shall include the placing and compacting of all backfill, the formation of any embankments made with material from structural excavation and the disposal of all surplus or unsuitable material, unless otherwise specified.

Earth excavation for installation of pipe culverts, under-drains, catch basins, structural concrete steps and structural concrete culvert headwalls and other minor structures will not be paid for and all costs for such excavation and disposal of materials will be considered incidental to the contract unit price per item for the structure being installed or constructed. Rock excavation for the installation of these structures will be paid for at the contract unit price for Pay Item 206.07, Structural Rock Excavation -- Drainage and Minor Structures.

The accepted quantity of Structural Earth Excavation - Drainage and Minor Structures, Below Grade and of Structural Rock Excavation - Drainage and Minor Structures, will be paid for at the contract unit price per cubic yard.

When rock is encountered and no Structural Rock Excavation-Drainage and Minor Structures item is included in the contract, the excavation of the rock will be paid for at 6 times the contract unit price per cubic yard for Structural Earth Excavation-Drainage and Minor Structures, Below Grade.

When rock is encountered and no structural rock excavation item is included in the contract, the excavation of the rock will be paid for at 6 times the contract unit price for structural earth excavation of the corresponding classification.

When it is necessary to excavate for abutments, masonry retaining walls, structural plate pipes, structural plate pipe arches or substructure units for structural plate arches, piers or box culverts below the elevation shown on the plans, payment for such excavation will be made at 1 1/2 times the contract unit price for the item classification applying where the extra depth is required.

Material from structural excavation which cannot be placed in its final position in one operation and must be stockpiled for future use will, when rehandled and placed as backfill or embankment, be measured and paid for as "common borrow" or "common excavation", whichever is less. The work will be considered performed in one operation if at the time the excavation is made there exists, within the limits of the work, a location where fill material can be placed in its final position.

When no bid item appears in the contract for clearing drainage ways, maintenance of traffic, special detours or cofferdams, any necessary work of this type will not be paid for directly but will be considered incidental to the work. Unless otherwise specified, payment under the pertinent contract items shall include costs of all pumping, bailing, drainage, sheeting, bracing and incidentals required for proper execution of the work.

Any backfill or bedding materials, except for material used to backfill underdrain, whose source is other than structural excavation, will be paid for under the class of material used. Material used to backfill underdrain will not be paid for but shall be considered incidental to the cost of the underdrain.

Excavation for channels, berm ditches and cut slope downspouts will be paid for under Section 203 -- Excavation and Embankment.

Special backfill will be paid for at the contract unit price per cubic yard.

Payment will be made under:

Pay Item	Pay Unit
206.061 Structural Earth Excavation-Drainage and Minor Structures, Below Grade	Cubic Yard
206.07 Structural Rock Excavation-Drainage and Minor Structures	Cubic Yard
206.081 Structural Earth Excavation-Abutments, Retaining Walls, Box Culverts and Structural Plate Units	Cubic Yard
206.091 Structural Rock Excavation-Abutments, Retaining Walls, Box Culverts and Structural Plate Units	Cubic Yard
206.10 Structural Earth Excavation-Piers	Cubic Yard
206.11 Structural Rock Excavation-Piers	Cubic Yard
206.14 Special Backfill	Cubic Yard

SECTION 207 -- BRUSH MATTING

207.01 Description. This work shall consist of furnishing and placing a mat of brush over areas of soft subsoil in accordance with these specifications at locations shown on plans or designated.

MATERIALS

207.02 Materials. Brush shall consist of trunks, stems and limbs of trees or bushes and shall not exceed 4 inches in diameter. This brush may be comprised of either hardwood or softwood species

and shall be live at the time of cutting. Brush matting material may be obtained from matter accumulated by clearing the area for brush mat installation, other clearing areas on the project and other areas off the project.

CONSTRUCTION REQUIREMENTS

207.03 General. Stumps and stubble within the mat area shall be cut close to the ground to permit the brush matting to come in close contact with the ground surface. The brush shall be placed in alternate transverse and longitudinal directions in even numbers of layers of approximately equal thickness. Soft wood bows may be used but must be distributed so that they will not be concentrated at any one location. The completed matting shall have a thickness between 24 and 36 inches before compression and shall be of such density that ground surface is not visible through it except adjacent to large stumps.

After the brush matting is in place, the matting shall be compressed by placing Granular Borrow over it. The granular material must fill the voids within the brush mat as well as providing compression of the brush. A two foot layer of granular borrow shall be placed above the brush matting before embankment construction is started in the normal manner.

207.04 Method of Measurement. Brush matting will be measured by the square yard, complete in place, not to exceed dimensions shown on the plans or authorized. Measurements will be taken parallel to the slope of the ground.

207.05 Basis of Payment. The accepted quantity of brush matting will be paid for at the contract unit price per square yard complete in place. Granular borrow will be paid for under Pay Item 203.25.

Payment will be made under:

Pay Item	Pay Unit
207.06 Brush Matting	Square Yard

SECTION 208 -- SAND DRAINS

Reserved

DIVISION 300 -- BASES

SECTION 301 -- PLANT MIX BITUMINOUS BASE COURSE

301.01 Description. This work shall consist of placing one or more courses of bituminous mixture constructed on an approved base or subbase in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established.

MATERIALS

301.02 Composition of Mixture. The bituminous base shall be composed of a mixture of aggregate, filler, if required and bituminous material, combined as required in Subsection 401.02.

301.03 Materials. Aggregates shall meet the applicable requirements of Section 703 -- Aggregates.

Bituminous material shall be of the type and grade specified in the contract. The bituminous material shall meet the applicable requirements of Section 702 -- Bituminous Material, and may be conditionally accepted at the source.

CONSTRUCTION REQUIREMENTS

301.04 General. The construction requirements shall be as specified in Subsections 401.07 through 401.19 inclusive.

301.05 Surface Tolerance. The surface of the base course will be tested with a 10 foot straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between two contacts with the surface shall at no point exceed 1/4 inch. All humps or depressions exceeding the specified tolerances shall be corrected.

301.06 Method of Measurement. Plant mix bituminous base course will be measured as specified in Subsection 401.21.

301.07 Basis of Payment. The accepted quantities of plant mix bituminous base course will be paid for at the contract unit price per ton for the bituminous mixtures including bituminous material, when specified, complete and in place.

Payment will be made under:

Pay Item	Pay Unit
301.08 Plant Mix Bituminous Base Course, Grading A	Ton
301.09 Plant Mix Bituminous Base Course, Grading B	Ton
301.10 (Vacant)	
301.11 (Vacant)	

SECTION 302 -- ROAD MIX BITUMINOUS BASE COURSE

302.01 Description. This work shall consist of placing aggregate and bituminous material and mixing in place on an approved base or subbase in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established.

MATERIALS

302.02 Bituminous Material. The bituminous material furnished shall meet the applicable requirements of Section 702 -- Bituminous Materials. The type and grade of bituminous materials will be specified in the contract documents.

Bituminous material may be conditionally accepted at the source.

302.03 Aggregate. Aggregates shall meet the requirements of Subsection 703.04 immediately preceding addition of bituminous material to the mix. This acceptance will be based on tests of samples of the stockpiles after all aggregates have been blended.

CONSTRUCTION REQUIREMENTS

302.04 Construction Requirements. The construction of road mix bituminous base shall meet the requirements of Subsections 405.04 through 405.10 inclusive.

302.05 Surface Requirements. The surface will be tested using a 10 foot straightedge at selected locations. The variation of the surface from the testing edge between any 2 contacts with the surface shall at no point exceed 1/4 inch. All humps or depressions exceeding the specified tolerance shall be corrected.

302.06 Method of Measurement. Aggregate for road mix bituminous base will be measured by the cubic yard complete in place. Bituminous material will be measured by the gallon in accordance with Section 109 -- Measurement and Payment.

302.07 Basis of Payment. The accepted quantities of road mix bituminous base course will be paid for at the contract unit price per cubic yard for the aggregates and per gallon for the bituminous material for road mix bituminous base of the type specified complete in place.

Payment will be made under:

Pay Item	Pay Unit
302.08 Aggregate for Road Mix Bituminous Base	Cubic Yard
302.09 Bituminous Material for Road Mix Bituminous Base	Gallon

SECTION 303 -- VACANT

SECTION 304 -- AGGREGATE BASE AND SUBBASE COURSE

304.01 Description. This work shall consist of furnishing and placing one or more courses of aggregates on a prepared surface in accordance with the specifications in reasonably close conformity with the lines, grades, thicknesses and typical cross sections, as shown on the plans or established.

MATERIAL

304.02 Aggregate. Aggregates shall conform to the requirements specified in the following Subsections of Division 700 -- Materials:

Aggregate Base	703.06(a)
Aggregate Subbase	703.06(b)

Aggregate for subbase or base courses shall be material meeting the aggregate type requirements specified in the following table.

Material	Aggregate Type (Subsection 703.06)
Aggregate Subbase Course, Gravel, Top 9 inches	D
Aggregate Subbase Course, Gravel, Below 9 inches	1D or E
Aggregate Subbase Course, Granular	G
Aggregate Subbase Course, Sand	F
Aggregate Base, Course, Crushed	2A or B
Aggregate Base, Course, Screened	2B or C

1. Contractor's option
2. Will be designated on the plans

Material for the various classes of aggregate base and aggregate subbase, at the time it is deposited on the roadbed shall conform to the gradation requirements of the contract. Oversized stones shall be removed from the aggregate before depositing on the roadway.

CONSTRUCTION REQUIREMENTS

304.03 Placing. The maximum compacted thickness of any subbase or base layer shall not exceed 12 inches unless the Contractor demonstrates by a test section that the required compaction can be obtained. If compacted layers more than 12 inches are allowed, the Contractor shall agree to make the necessary excavations and backfilling in the course for the Engineer to determine the density.

When layers are of differently graded aggregate, fine grading of the lower layer will not be required.

Each layer of aggregate shall be placed over the full width of the section except when existing traffic or other conditions restrict operations over the full width, the Engineer may authorize the Contractor to place less than full width layers. When the Contractor places material to complete the full width, the exposed edge of the previously placed aggregate shall be cleaned of all contamination before additional base or subbase aggregate is placed adjacent thereto.

Aggregate base and subbase courses may be placed upon frozen surfaces when such surfaces have been properly constructed.

The material as spread shall be well mixed with no pockets of either fine or coarse material. Segregation of large or fine particles will not be allowed.

304.04 Shaping, Compacting and Stabilizing. Compaction of each layer shall continue until a density of not less than 95 percent of the maximum density has been achieved for the full width and depth of the layer. The maximum density shall be determined in accordance with AASHTO T 180, Method C or D, corrected by the Soils Laboratory Adjustment Chart available at the Soils Laboratory Bangor, Maine. Field density tests will be made by the Department. The surface and compaction and stability shall be satisfactorily maintained until the pavement course has been placed. If required, additional water and fine material shall be applied to prevent checking, raveling or rutting.

Fine material added to the base shall be uniformly blended into the top 9 inches of the course being stabilized. The blended material shall meet the requirements of Subsection 304.02.

If the top of any layer becomes contaminated by degradation of the aggregate or addition of foreign material, the contaminated material shall be removed and replaced with the specified material.

All layers of Aggregate Subbase Course shall be compacted to the required density immediately after placing. As soon as the compaction of any layer has been completed, the next layer shall be placed unless otherwise authorized.

The Contractor shall bear full responsibility for and make all necessary repairs to the subbase course and the subgrade until the full depth of the subbase course is placed and compacted. Repairs shall be considered incidental to other contract items.

The top of any Aggregate Base or Subbase Course layer shall be scarified and loosened for a minimum depth of 1 inch immediately prior to the placing of the next layer of Aggregate Base or Subbase. This scarifying shall be considered incidental to placing the course, and no separate payment will be made.

The surface of each layer shall be maintained during compaction operations in such a manner that a uniform texture is produced and the aggregate firmly keyed. The moisture content of the material shall be maintained at the proper percent to attain the required compaction and stability.

If voids remain on the surface after the subbase course has been constructed to grade, compacted, checked and approved, sand levelling material shall be dumped and spread as directed. The quantity of sand levelling material shall be limited to the amount necessary to fill the voids and the minor low areas on the subbase surface. After the sand levelling material has been spread, it shall be completely rolled by a rubber tired roller with water applied, if necessary. The surface of this material shall be maintained in its compacted and graded condition until the bituminous pavement has been placed. The furnishing, spreading, compacting and maintaining of sand levelling material will be considered included in the measurement and payment of the subbase course and no separate payment will be made.

304.05 Surface Tolerance. The completed surface of the subbase or base course shall be shaped and maintained to a tolerance, above or below the required cross sectional shape, of 3/8 inch.

304.06 Method of Measurement. Aggregate base course and aggregate subbase to subbase course will be measured by the cubic yard in place unless designated by pay item to be measured by truck measure. When measured in place, the width and thickness for measurement will be the width and thickness of aggregate base or subbase as shown on the plans or as modified. The length will be along the centerline unless modified by other methods generally recognized as conforming to good engineering practice. All measurements will be in accordance with Section 109 -- Measurement and Payment. When designated by pay item to be measured by truck measure, the measurement will be in vehicles at the point of delivery as shown on delivery slips in accordance with Subsection 109.01(f).

Aggregate base course and aggregate subbase course designated by pay item to be measured in place and used for driveways and other locations difficult to accurately measure in place, may be measured in vehicles at 80 percent of the number of cubic yards accepted and used, at the point of delivery as shown by "Delivery Slips" in accordance with Subsection 109.01(f). The quantity so measured shall not exceed 1,000 cubic yards per contract, after shrinkage.

304.07 Basis of Payment. The accepted quantities of aggregate base course and aggregate subbase course of the type specified will be paid for at the respective contract unit price per cubic yard.

When aggregate is required for slope blanket backfill, bedding under drainage structures and other foundations, it shall be paid for at twice the contract unit price for the respective aggregate base or subbase course item used.

Payment for aggregate base and subbase courses shall include, purchasing material, stripping, pits, excavating, crushing, screening, hauling, placing, compacting and other necessary processes which are required to furnish acceptable material under this item.

Water and/or fines added to material to aid compaction and stabilization to prevent raveling and rutting shall be incidental to the work.

Removal and replacement of contaminated material shall be incidental to the work.

Materials which do not meet the gradation requirements for Aggregate Base or Aggregate Subbase at the time of placing will not be paid for under Aggregate Base of Aggregate Subbase Pay Item.

The quantity of aggregate subbase or aggregate base placed on rock subgrade shall include only that material placed above the normal subgrade line. Furnishing and placing aggregate subbase or aggregate base backfill material between the ledge and the normal subgrade line will not be paid for directly but shall be considered incidental to the work.

Payment will be made under:

Pay Item	Pay Unit
304.08 Aggregate Base Course-Screened	Cubic Yard
304.083 Aggregate Base Course-Screened, Truck Measure	Cubic Yard
304.09 Aggregate Base Course-Crushed	Cubic Yard
304.093 Aggregate Base Course-Crushed, Truck Measure	Cubic Yard
304.10 Aggregate Subbase Course-Gravel	Cubic Yard
304.103 Aggregate Subbase Course-Gravel, Truck Measure	Cubic Yard
304.11 Aggregate Subbase Course-Granular	Cubic Yard
304.113 Aggregate Subbase Course-Granular, Truck Measure	Cubic Yard
304.12 Aggregate Subbase Course-Sand	Cubic Yard
304.123 Aggregate Subbase Course-Sand, Truck Measure	Cubic Yard

SECTION 305 -- PRE-MIXED BITUMINOUS BASE

305.01 Description. This work shall consist of furnishing and placing pre-mixed aggregate and bituminous material mixed either by the road mix method on an approved base or by a mixing plant. The bituminous mixture shall then be placed on an approved base or sub-base in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established.

MATERIALS

305.02 Bituminous Material. The type and grade of bituminous material will be specified in the contract documents. The bituminous material furnished shall meet the applicable requirements of Section 702 -- Bituminous Materials or as otherwise specified. Bituminous material may be conditionally accepted at the source.

305.03 Aggregate. Aggregates shall meet the requirements of Subsection 703.04 and the gradations specified in Subsection 703.11, Gradation A immediately preceding addition of bituminous material to the mix. This acceptance will be based on tests of samples of the stockpiles after all aggregates have been blended.

CONSTRUCTION REQUIREMENTS

305.041 Weather Limitations. No material shall be mixed between September 15 and May 1, unless the aggregate is heated and dried, as directed during the mixing process. The heated mixture may be used directly from the plant without stockpiling, but if stockpiled, shall be protected from moisture. When placing mix after September 15th, the mix required shall be pre-mixed and stockpiled prior to September 15th. Necessary changes in the bituminous material to permit prolonged stockpiling shall be provided so that the mixture may be readily handled and placed during fall weather. Mixture placed after September 15th may be placed upon frozen base when the base has been properly constructed. Mixture may be placed after September 15 only if the air temperature is above 30°F.

305.042 Equipment. The equipment used by the Contractor shall include mixing, spreading, finishing and compacting equipment, a bituminous distributor and equipment for heating bituminous material.

The distributor shall be designed, equipped, maintained and operated so that bituminous material at constant temperature may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallon per square yard. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall also be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

All liquid and cement bituminous material bulk delivery vehicles and distributors shall be equipped with an acceptable sampling valve. On bulk delivery vehicles the valve shall be located in an accessible area in the lower half of the front or rear bulk head. The valve shall be similarly located on distributors, except that it may be installed in a circulating line having a rising flow. Instead of road-mixing equipment, stationary mixing plants or other methods of proven performance may be used by the Contractor.

The mixing plant shall include an aggregate charging bin capable of volumetric proportioning the aggregate. The plant shall be equipped with an asphalt pump and metering system. The plant shall be capable of producing a uniform mixture with a minimum of segregation.

Rollers shall be self-propelled steel wheel tandem or 3 wheel rollers weighing not less than 8 tons each, and pneumatic tire rollers having a total compacting width of not less than 60 inches and the gross weight adjustable within the range of 200 to 350 pounds per inch of compaction width. The operating weight shall be as directed. Tire pressure or contact pressure may be specified for pneumatic tire rollers.

305.043 Mixing. The materials shall be pre-mixed and stockpiled, in an approved manner at approved locations. A stockpile sufficient to cover the area required for at least 2 days construction shall be maintained.

Mixed material to be used after September 15 shall be mixed prior to that date and shall be protected from moisture. The Contractor may elect to use a mixing plant, the road mix method on an approved surface, or other approved methods and equipment that will produce the specified results.

When the pre-mixed bituminous base is mixed by the road-mix method on an approved base the procedures used shall conform to Subsections 405.07, 405.08 and the first four paragraphs of 405.09, except the surface moisture of the aggregate shall in no case exceed 2 percent of the dry weight of the aggregate during mixing.

When pre-mixed bituminous base is mixed in a mixing plant the surface moisture of the aggregate shall in no case exceed 2 percent of the dry weight of the aggregate during mixing.

At the Contractor's option, a mixture conforming to the requirements of Section 301 may be used. If this option is exercised, the aggregate gradation and type of bituminous material, content and viscosity shall be as directed.

305.044 Spreading, Compacting and Finishing. The pre-mixed materials shall be uniformly spread in the required amount by self-propelled mechanical spreaders, bituminous pavers or other approved mechanical spreading devices. Power graders for the initial placement of the pre-mixed materials will not be permitted.

Regardless of which method of pre-mixing is used the liquid content, water and volatiles and bituminous material, shall be low enough so that the mixture can be properly compacted on the roadway.

After the material is placed, the surface shall be rolled. Rolling shall be parallel to the road centerline and shall commence at the outer edges of the road, overlapping the shoulders and progressing toward the center, overlapping on successive passes by at least one-half the width of the roller, except that on superelevated curves rolling shall progress from the lower to the upper edge. Each pass shall terminate at least 3 feet in advance or to the rear of the end of the preceding pass. During the compaction the surface shall be dragged or bladed as necessary to fill ruts and to remove incipient corrugations or other irregularities. Rolling shall continue until the surfacing is of uniform texture and satisfactory compaction is obtained. Initial rolling shall be performed with a steel wheel roller followed with a pneumatic tire roller. Rolling shall be discontinued whenever it begins to produce excessive pulverizing of the aggregate or displacement of the mixture. Rolling shall be completed before any section is opened to public traffic.

305.05 Surface Requirements. The completed surface of the designated course shall be shaped to a tolerance of 3/8 inch above or below the required cross sectional shape.

305.06 Method of Measurement. Pre-mixed bituminous base including the bituminous material will be measured by the cubic yard in place measure or a conversion factor of 1.98 tons per cubic yard may be used with weigh delivery slips in accordance with Section 109 -- Measurement and Payment.

305.07 Basis of Payment. The accepted quantities of pre-mixed bituminous base course will be paid for at the contract unit price per cubic yard for the mixture, including aggregates and bituminous material, complete in place.

Payment will be made under:

Pay Item	Pay Unit
305.10 Pre-mixed Bituminous Base Course	Cubic Yard

SECTION 306 -- RECLAIMED MATERIAL FOR STABILIZED BASE

Reserved

SECTION 307 -- SAND LEVELING COURSE

307.01 Description. This work shall consist of furnishing and placing sand for leveling and filling depressions of the aggregate surface upon which bituminous pavement is to be later placed, all in accordance with the specifications and in reasonably close conformity with the thickness and width shown on the plans or established.

MATERIAL

307.02 Aggregate. Aggregate for sand leveling course shall to the requirement of Subsection 703.05.

CONSTRUCTION REQUIREMENTS

307.03 General. After the Aggregate Subbase Course has been constructed to grade, compacted, checked and approved, sand leveling material may be dumped and spread as directed. The quantity of sand leveling shall be limited to the amount necessary to fill the depressions and minor low areas in the aggregate subbase course. After the sand leveling has been spread, completely rolled by a rubber tired roller (truck rolling acceptable) and water applied, if required, the surface of this material shall be maintained until the pavement has been placed.

307.04 Method of Measurement. Sand leveling will be measured in cubic yards in vehicles at the point of delivery as shown on Delivery Slips in accordance with Subsection 109.01(f).

307.05 Basis of Payment. The accepted quantity of Sand Leveling will be paid for at the contract unit price per cubic yard complete in place, which price shall include addition of water when required.

Payment will be made under:

Pay Item

Pay Unit

307.20 Sand Leveling

Cubic Yard

SECTION 308 -- VACANT

SECTION 309 -- VACANT

SECTION 310 -- BITUMINOUS STABILIZED BASE

310.01 Description. This work shall consist of furnishing aggregate mixed with bituminous material and placed on an approved surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established.

MATERIALS

310.02 Mixtures. The mixture of aggregates and residual bitumen shall have a Hveem stability of at least 25 when tested according to AASHTO T 246. Test specimens will be prepared according to AASHTO T 247. Compaction temperature for all mixtures containing emulsified asphalt shall be 60°C (140°F).

310.03 Bituminous Materials. Either asphalt cement or a mixing grade emulsion shall be used. The method of mixing shall determine the type of bituminous material. The grade shall be as specified in the contract. The bituminous material shall meet the applicable requirements of Section 702 -- Bituminous Materials. Bituminous materials may be conditionally accepted at the source.

310.04 Aggregates. Aggregates shall meet the requirements of Subsection 703.17 before the addition of the bituminous materials.

CONSTRUCTION REQUIREMENTS

310.05 General. The materials for bituminous stabilized base shall be mixed and placed according to the Construction Requirements of Section 301 -- Plant Mix Bituminous Base Course. The bitumen content will be determined by the Engineer.

When the base course is placed in two or more layers each layer, except the top of the last layer, shall be coated with an application of approximately .05 gallons of emulsified asphalt. The maximum thickness of a single layer shall not exceed 3 inches when compacted.

310.06 Weather Limitations. The plant mix bituminous stabilized base course shall be placed in conformity with Subsection 401.07. Mixing operations using emulsified asphalt may be permitted after September 15 provided the air temperature is 40°F or above and a heated mixture at 130°F-220°F is discharged from the plant.

310.07 Compaction. Whether a heated or cold mix method is used the minimum dry compaction requirement for the bituminous stabilized base course will be 92 percent of the laboratory specimen compacted to meet the requirements specified in Subsection 310.02. The residual bitumen will be included as part of the unit dry weight.

310.08 Surface Tolerance. The surface will be tested with a 10 foot straightedge. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed 1/4 inch. All humps or depressions exceeding the specified tolerances shall be eliminated.

310.09 Method of Measurement. Plant mix bituminous stabilized base will be measured by the ton in accordance with Subsection 401.21, except that no separate measurement of the bituminous material will be made.

310.10 Basis of Payment. The accepted quantity of plant mixed bituminous stabilized base will be paid for at the contract unit price per ton for the bituminous mixture, including bituminous material complete in place.

Payment will be made under:

Pay Item	Pay Unit
310.13 Plant Mix Bituminous Stabilized Base	Ton

DIVISION 400 -- PAVEMENTS

SECTION 401 -- PLANT MIX PAVEMENTS -- GENERAL

401.01 Description. This work shall consist of furnishing and placing one or more courses of bituminous mixture constructed on an approved base in accordance with these specifications and the specific requirements of the type of mixture under contract, and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established.

MATERIALS

401.02 Composition of Mixtures. The bituminous plant mixture shall be composed of aggregate, filler if required and bituminous material. The several aggregate fractions shall be sized, uniformly graded and combined in proportions that will provide a mixture meeting the grading requirements of the job-mix formula.

The Contractor shall submit, for approval, a job-mix formula for each mixture to be supplied. The job-mix formula shall be used to establish a single percentage of aggregate, passing each required sieve size which, with the allowable tolerances given, shall be within the master gradation range specified for the particular type of mixture. The job-mix formula shall state the source, gradation and percentage to be used of each portion of the aggregate, and filler if required. It shall state the name(s) of the source(s) and supplier of the bituminous material to be used.

At the time the job-mix formula is submitted, the Contractor shall indicate and make available for sampling and testing, the stockpiles of all aggregates proposed for use. A minimum of 10 days shall then be allowed for testing prior to approval of the job-mix formula.

Upon approval of the mix, the Engineer will establish, as a part of the job-mix formula, a percentage of residual bituminous material for the mixture, and temperatures for the mixture at the two points of discharge. Should the kinematic viscosity of the proposed bituminous material(s) at 275°F be found to vary by more than the 50 centistokes, different mixing temperatures may be established. A notation shall be made for each new bituminous material added to a job-mix formula already approved, showing the material source, the viscosity at 275°F, and the adjusted mixing temperature, if necessary. The bitumen content aim shall be within the range as shown in the special provisions or on the plans.

After the job-mix formula is established, the components and temperatures of the mixture shall conform within the following tolerances, except that no gradation tolerance will be applied to Grading "E" mixture for which the gradation shall be within the limits given in Subsection 703.09:

Aggregate portion of mix:	Tolerance
Passing 2 inch to 3/4 inch sieves	+ 10 percent
Passing 1/2 inch to Number 4 sieves	+ 7 percent
Passing Number 8 sieve	+ 6 percent
Passing Number 16 sieve	+ 5 percent
Passing Number 30 to Number 50 sieve	+ 4 percent
Passing Number 100 sieve	+ 3 percent
Passing Number 200 sieve	+ 2 percent
Bituminous Material	
Percent of mixture	+0.4 percent
Temperature of Mix - All gradings	
In the truck at the mixing plant	+ 20°F
At the paver	+ 20°F, but also to maximum plant temperature

If there is a change in sources of aggregates or filler, a new job-mix formula shall be established before the new material is used. When unsatisfactory results or other conditions make it necessary, a new job-mix formula may be established.

401.03 Aggregates. Aggregates shall meet the applicable requirements of Section 703 -- Aggregates, in the stockpiles at the plant site.

401.04 Vacant

401.05 Vacant

401.06 Bituminous Materials. The type and grade of bituminous material will be specified in the contract. The bituminous material shall meet the applicable requirements of Section 702 -- Bituminous Materials and may be conditionally accepted at the source.

CONSTRUCTION REQUIREMENTS

401.07 Weather and Seasonal Limitations. For weather limitations the State will be considered to be divided into 2 paving zones:

- (a) Zone 1. All area north of US Route 2 from Gilead to Brewer and north of Route 9 from Brewer to Calais.
- (b) Zone 2. All area south of Zone 1 including the US Route 2 and Route 9 boundaries.

Bituminous plant mix for use other than traveled way wearing course may be placed in either zone between the dates of April 15th and November 15th, provided that the air temperature as determined by an approved thermometer placed in the shade at the paving location is 35°F or higher and the area to be paved is not frozen. Plant mix to be placed as traveled way wearing course may be placed in Zone 1 between the dates of May 1st and October 1st and in Zone 2 between the dates of April 15th and October 15th provided the air temperature determined as above is 50°F or higher.

Any hot bituminous base or binder course that is to be subject to traffic during the winter months shall have its gradation densified or asphalt content (percent of mix) adjusted through a change in the job mix formula as submitted by the Contractor and approved by the Engineer.

Hot bituminous mixtures used for curb, driveways, sidewalks, islands or other incidentals are not subject to seasonal limitations unless otherwise directed by the Engineer.

Weather conditions shall be otherwise satisfactory for proper handling and finishing of the mixture. Unless otherwise specified, bituminous plant mix shall not be placed on a wet surface.

When it is in the public interest for service to traffic, the Department may authorize construction of bituminous pavements at lower atmospheric temperatures than those specified or extend the dates of the paving season.

401.08 Bituminous Mixing Plant.

401.081 General Requirements. Mixing plants shall be of sufficient capacity and be coordinated to adequately handle the proposed bituminous construction.

- (a) Aggregate Storage. Sufficient storage space shall be provided for uniform stockpiles of various sized or blended aggregates which shall be kept separate until they have been introduced into the cold feed bins.

The storage yard shall be maintained in a neat and orderly manner and the separate stockpiles shall be readily accessible for sampling.

- (b) Cold Bins. A minimum of 3 cold bins will be required. The bin dimensions shall be such as to promote free flow of material. Partitions shall be sufficiently high to eliminate intermingling of aggregate from adjacent bins. If a front end loader is being used to load, the dumping width of the loader bucket shall be no wider than the width of the top of the bins.
- (c) Bitumen Storage. Tanks for the storage of bituminous material shall be equipped to heat and circulate the material at the required temperature. The heating shall be accomplished by steam coils, electricity or other approved means so that no flame shall be in contact with the tank. The circulation system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provisions shall also be made for measuring the amount of material in storage tanks.

A valve for sampling the bituminous material shall be provided. The valve shall be located in a circulating feed line connecting the storage tank with the mixing plant or in a line of the storage circulation system. The valve shall be placed in a readily accessible location offering protection from danger, and shall be maintained in a workable condition. A drainage receptacle shall be provided.

- (d) Feeder for Drier. The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier to provide uniform production and temperature.
- (e) Drier. The plant shall include a drier or driers which continuously agitate the aggregate during the heating and drying process.
- (f) Screens. Plant screens, capable of screening all aggregates to the specified sizes and proportions and having normal capacities in excess of the full capacity of the mixer, shall be provided. The screen deck shall have a tailing pipe of sufficient size to prevent any oversize material from entering the bins.

- (g) Hot Bins. The plant shall have hot storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. The bins shall be arranged to assure separate storage of appropriate fractions of the mineral aggregate. Each bin shall be provided with overflow pipes with outlets of sufficient size and located so as to prevent back up of aggregate material into other compartments or bins. The overflow outlet pipes shall be open at all times during plant operations. Each bin shall be provided with its individual outlet gate which shall be capable of quick and complete cutoff.

The bins shall be equipped with adequate tell tale devices to automatically indicate the position of the aggregates in the bins at the lower quarter points.

The bins shall also be constructed so that samples of aggregates may be easily taken.

When required, separate dry storage shall be provided for filler or hydrated lime with provisions to feed this material into the mixer.

- (h) Bituminous Control Unit. Satisfactory means shall be provided, either by weighing or by metering, to obtain the proper quantity of bituminous material in the mix within the tolerances specified. Means shall also be provided for checking the quantity or rate of flow of bituminous material as it passes into the mixer.
- (i) Thermometric Equipment. An armored thermometer, of adequate temperature range, shall be affixed to the bituminous feed line at a location near the charging valve at the mixer unit. The plant shall also be equipped with either an approved dial scale, mercury-actuated thermometer, electric pyrometer or other approved thermometric instrument so placed at the discharge chute of the drier to register automatically or indicate the temperature of the heated aggregates.
- The hot bin containing fine aggregate shall be equipped with a thermometer or other approved thermometric instrument to indicate the temperature of the heated aggregate immediately before it enters the mixer. The dial or other indicator shall be plainly visible and readable from the mixing platform.
- (j) Dust Collector. The plant shall be equipped with a dust collector constructed to waste or return uniformly to the hot elevator all or any part of the material collected.

(k) Truck Scales. The bituminous mixture shall be weighed on scales meeting the requirements of Section 109 -- Measurement and Payment. The scales shall be inspected and sealed by the State Sealer as often as the Engineer deems necessary to assure their accuracy.

(l) Safety Requirements. 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 points where accessibility to plant operations is required. Accessibility to top of truck bodies shall be provided by a platform or other suitable device, placed in an acceptable location near the testing laboratory, to enable the Engineer to obtain samples and mix temperature data.

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.

All gears, pulleys, chains, sprockets and other dangerous moving parts shall be thoroughly guarded and protected.

(m) Hot Mix Storage Bins. The hot storage system shall be capable of conveying the hot-mix from the plant to insulated storage bins and storing the hot-mix without a loss in temperature, segregation of the mix or oxidation of the mix. Storage time duration shall be limited by the ability of the bins to maintain the hot-mix so that, upon delivery to the spreader, the temperature will be not less than the minimum temperature stated on the job mix formula.

The storage bins shall be designed to prevent segregation of the hot-mix during discharge from the conveyor into the bins and shall be equipped with discharge gates that will not cause segregation of the hot-mix while loading the mix into the trucks. The storage bin heating system shall be capable of maintaining the mix temperature without localized heating (hot spots).

Unless otherwise permitted, material placed in a surge or storage bin must be drawn from that bin and used during the same working day. When such permission is given in an emergency, material remaining overnight must be used within 24 hours of the time of mixing.

Approval for the use of storage bins may be withdrawn in event there is an excessive amount of heat loss, segregation and/or oxidation of the hot-mix due to the use of storage bins.

401.082 Requirements for Batch Plants.

- (a) Weigh Box or Hopper. The batch plant 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 hold a full batch without hand raking or running over. The gate shall close tightly so that no material leaks into the mixer while a batch is being weighed.
- (b) Bituminous Control. When a metering system is used to measure the bituminous material it shall be accurate to plus or minus 0.1 percent of nominal batch size. In the event of malfunction of the system, the Contractor may provide a calibration chart for the indicator of the metering device which will show the quantity of material delivered at each setting. Production using such a chart may be continued for a period not to exceed the next 48 hours.

The bucket for bituminous material shall be a non tilting type bucket with a capacity of at least 15 percent capacity greater than the bituminous material required in any batch. Its discharge valve or valves and spray bar shall be adequately heated. If steam jackets are used they shall drain efficiently and all connections constructed so as not to interfere with the operation of the bituminous scales. A heated quick-acting, non-drip charging valve shall be located as close to the bucket as practical.

The length of the discharge openings or spray bar shall deliver the bituminous material in a thin uniform sheet or in multiple streams over the full length or width of the mixer. The flow of bituminous material shall be automatically controlled so that it will begin when the dry mixing period is over.

The controls shall be constructed so that they may be locked at any dial setting and will automatically reset to that reading after addition of bituminous material to each batch. All dials shall be in full view of the plant batching operator. The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of bituminous material used in a batch.

The section of the bituminous line between the charging valve and the spray bar shall be provided with a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

- (c) Mixer. The batch mixer shall be an approved type capable of producing a uniform mixture within the job-mix tolerances.

The clearance of the blades from the inner surface of the pugmill liner shall not exceed 1 inch unless the maximum diameter of the aggregate in the mix exceeds 1 1/4 inches, in which case the clearance shall not exceed 1 1/2 inches.

- (d) Control of Mixing Time. The mixer shall be equipped with an automatic accurate time lock to control the operations of a complete mixing cycle. It shall lock the weigh box gate after charging the mixer until the closing of the mixer gate at the completion of the cycle. It shall also lock the bituminous material bucket throughout the dry mixing period and the mixer gate throughout the dry and wet mixing periods. The control of the timing shall be flexible and capable of being set at intervals of 5 seconds or less throughout a total mixing cycle.

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 defined as the interval of time between the start of introduction of bituminous material and the opening of the mixer gate.

A mechanical batch counter shall be installed as a part of the timing device, and shall be designed to register only completely mixed batches. The setting of the time intervals shall be performed in the presence and at the direction of the Engineer who shall then lock the case covering the timing devices until such time as a change is to be made in the timing period.

- (e) Plant Scales. Plant scales shall meet the following requirements:

Aggregate Scales

Minimum Graduations = (Batch Size) x .0025
Sensitivity = (Batch Size) x .00125
Accuracy = (Batch Size) x .005

Asphalt Scales:

Minimum Graduations = (Batch Size) x .0005
Sensitivity = (Batch Size) x .00025
Accuracy = (Batch Size) x .001

Poises shall be designed to be locked in any position to prevent unauthorized change of position.

Plant scales shall be checked prior to the start of the paving season. Subsequent checks will be made if the Engineer deems it necessary to ensure continued accuracy. The Contractor shall have on hand not less than 10 fifty-pound weights for testing of the scales.

401.083 Vacant

401.084 Requirements for Continuous Drum Type Mixing Plants.
The continuous drum type mixing plant shall consist of a drier capable of drying, heating and mixing the aggregate to the temperature requirements established in the Job Mix Formula. This type mixer shall also conform to the following specifications:

- (a) Aggregate Storage. Sufficient storage space shall be provided for uniform stockpiles of various sized or blended aggregates which shall be kept separated until they have been introduced into the cold bins that feed the drier. A minimum of 4 cold feed bins shall be required. The storage yard shall be maintained in a neat and orderly manner and the separate stockpiles shall be readily accessible for sampling.
- (b) Bitumen Storage. Storage tanks shall be provided for the bituminous material, equipped to heat and hold the material at the required temperature. The heating shall be accomplished by steam coils, electricity or other approved means so that no flame shall be in contact with the tank.

The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provisions shall be made for measuring and sampling these storage tanks.

- (c) Cold Feed System. The plant shall have a device at each cold bin to feed the aggregate accurately and uniformly. Gravity type feeders will not be permitted.

Each adjustable opening shall be provided with indicators graduated to allow proportioning. Each aggregate feeder shall be interlocked in such a manner that production is interrupted if one or more cold bins become empty or the flow is obstructed.

A mineral filler bin, when required, shall be added to the standard plant cold feed bins and shall feed the mineral filler at adjustable rates accurately and uniformly. The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed.

The aggregate weighing equipment for all aggregates, including mineral filler, shall consist of a continuous weighing device either as it is proportioned by the individual feeders or after all materials have been deposited on a common belt. Belt scales shall meet the requirements of NBS Handbook 44 and shall be installed according to the scale manufacturers recommendations.

The plant shall have an adjustable feed rate control for each aggregate cold bin feeder and mineral filler feeder. The plant shall proportion the total aggregate quantity to the drum mixer with such accuracy and uniformity that the variation of material per interval of time shall not exceed an amount equal to 1.5 percent of the total weight of bituminous mixture per interval of time.

An automatic aggregate sampling device shall be provided which will divert a representative combined aggregate sample, including mineral filler, into a hopper or container for the purpose of gradation testing. The container shall cut the full width and depth of the aggregate flow. The sampling point shall be after the aggregate is proportioned and prior to its mixing with bitumen.

- (d) Bituminous Control Unit. The bitumen shall be proportioned by a meter accurate to 0.1 percent. A flow switch designed to interrupt production if the bitumen flow is discontinued shall be installed in the delivery line between the meter and the mixer.

The bitumen delivery system shall be coupled with the aggregate delivery system to automatically maintain the required proportions as the aggregate flow varies. The delivery tolerance for bitumen shall be ± 0.2 percent of the total mixture weight.

The bitumen feed line shall be equipped with a thermometer and an approved bitumen sampling valve.

- (e) Mixer Unit. The plant shall include a continuous mixer unit having an automatic burner control and capable of producing a uniform mixture within the Job Mix Tolerances. The mixture shall be discharged into a hot bituminous mixture holding bin meeting the requirements of 401.084 (g) Hot Bituminous Mixture Holding Bins. The moisture content of the mixture upon discharge from the mixer shall not exceed 1.5 percent by weight.

- (f) **Safety Requirements.** Guarded ladders shall be provided to all points where accessibility to plant operations is required. Accessibility to top of truck bodies shall be provided by a platform or other suitable device, placed in an acceptable location near the testing laboratory, to enable the Engineer to obtain samples and mix temperature data.

All gears, chains, pulleys, sprockets and other dangerous moving parts shall be thoroughly guarded and protected.

A clear and unobstructed passage shall be maintained at all times in and around the truck loading area.

- (g) **Hot Bituminous Mixture Holding Bin.** Hot bituminous mixtures may be stored in holding bins, especially designed for that purpose. Each holding bin shall be inspected by the Department to determine acceptance at specific holding times. Acceptance will be based upon the ability of the holding bin to hold and discharge mixtures within the quality criteria specified in the Job Mix Formula.

401.09 Hauling Equipment. Trucks for hauling bituminous mixtures shall have tight, clean, smooth metal bodies which have been thinly coated with a small amount of fuel oil, lime solution or an approved soap solution or detergent to prevent the mixture from adhering to the bodies. If fuel oil is used, it shall be applied as a fog spray. During or after each application, the truck bodies shall be raised for a sufficient time to allow the excess to drain.

All trucks shall have a cover of canvas or other suitable material of such size to completely cover the mixture. The cover shall be securely fastened on the loaded truck at all times except when unloading.

When necessary, so that the mixture will be delivered to the project at the specified temperature, the truck body shall be adequately insulated. Trucks shall be loaded no later in the day than will allow completion of the spreading and compacting of the mixture during daylight hours.

401.10 Bituminous Pavers. Bituminous pavers shall be self-contained, self-propelled units, provided with an activated screed, heated if necessary, and capable of spreading and finishing courses of bituminous plant mix material in lane widths to the specified typical section and thicknesses shown on the plans. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant mix material in widths shown on the plans.

When called for in the Special Provisions, bituminous pavers used to place base, binder, level and wearing courses shall be equipped with approved automatic transverse screed and longitudinal grade screed controls. The controls shall automatically adjust the screed and increase or decrease the layer thickness to compensate for irregularities in the preceding course. The controls shall be capable of maintaining the proper transverse slope and be readily adjustable so that transitions and superelevated curves can be properly paved. The controls shall be operated from a fixed or moving reference as directed.

The paver shall have a receiving hopper with sufficient capacity for a uniform spreading operation and a distribution system to place the mixture uniformly and without segregation in front of the screed.

The screed assembly shall produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture.

The paver shall be capable of being operated, when laying mixtures, at forward speeds consistent with satisfactory laying of the mixture.

Bituminous pavers shall be at the project site sufficiently ahead of the start of paving operations to be inspected and approved. Any paver found worn or defective either before or during its use shall be repaired or replaced to the satisfaction of the Engineer.

401.11 Rollers. Rollers shall be either approved vibrator type, static steel, or pneumatic tire type. Rollers shall be in good mechanical condition, operate free of excessive backlash and at a speed slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers shall be sufficient to satisfactorily compact the mixture to the required density while still in a workable condition. Final rolling of each course shall be accomplished by a roller of the 3-axle type, locked. Use of rollers which result in excessive crushing of the aggregate or displacement of the mixture will not be permitted.

Pavement placed with a paving machine after Labor Day shall be rolled and kneaded with an approved pneumatic roller in addition to the steel rollers.

The minimum unballasted weight of any roller used in the rolling train shall be 8 tons.

401.12 Conditioning of Existing Surface. The surface upon which bituminous mixture is to be placed shall be thoroughly cleaned of all objectionable material. When the surface of the existing base or pavement is irregular, it shall be brought to uniform grade and cross section as directed.

401.13 Bituminous Material Documentation. The Contractor shall determine with the Engineer to the extent that the amount of bituminous material used each day on a specific contract can be determined.

401.14 Preparation of Aggregates. The aggregates for the mixture shall be dried and heated to the required temperature. Flames used for drying and heating shall be properly adjusted to avoid physical damage to the aggregate and to avoid soot on the aggregate.

The aggregates, immediately after heating and drying, shall be screened into two or more fractions and conveyed into separate compartments ready for batching and mixing with bituminous material.

401.15 Mixing. The dried aggregates shall be combined in the mixer in the amount of each fraction of aggregate required to meet the job-mix formula. The bituminous material shall be measured or gaged and introduced into the mixer in the amount specified by the job-mix formula.

For hot bituminous pavement, the mixture shall be produced at the temperature established by the job-mix formula. This temperature will be determined and will be a temperature at which the viscosity of the bituminous material is between 150 and 300 centistokes.

The aggregate shall be sufficiently dried so that the mixture will not flush, foam excessively, or displace excessively under the action of the rollers. It shall be introduced into the mixer at a temperature of not more than 25°F above the temperature at which the viscosity of the bituminous material being used is 150 centistokes.

The bituminous material shall be stored and introduced into the mixer at a uniformly maintained temperature which shall be within the limits at which the viscosity of the material is between 150 and 300 centistokes.

After the required amounts of aggregate and bituminous material have been introduced into the mixer, unless otherwise specified, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is obtained. Wet mixing time will be determined by the Engineer for each plant and for each type of aggregate used.

401.16 Spreading and Finishing. The mixture shall be laid upon an approved surface, spread and struck off to the grade and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable. During placing operations, pavers shall be operated at a speed to provide, as continuously as possible, placement of the mixture as normally produced by the plant, regardless of haul distance.

Automatic screed control by means of the fixed reference will only be required when and to the extent stated in the Special Provisions. The moving reference shall consist of a manufacturer approved ski-type attachment or travelling string line, not less than 30 feet in length, attached to the paver and operating parallel to its line of travel. A short shoe or joint maker, maybe permitted to construct the matching joint on the last course of surface mixture.

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 with hand tools. For such areas the mixture shall be dumped, spread and screeded to give the required compacted thickness. The mixture shall be placed on dump boards or on unfinished surfaces and must be completely rehandled and spread.

When production of the mixture can be maintained and when practical, pavers shall be used in echelon to place the course in adjacent lanes.

On roads opened to two way traffic, the placement of each course shall be completed over the full width of the traveled way section being paved on each days run unless otherwise approved.

401.17 Compaction. Immediately after the bituminous mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

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. To prevent adhesion of the mixture to the rollers or vibrating compactors, the rolls of contact surfaces shall be kept moistened with water or water mixed with small quantities of detergent, or other approved method. Oil will not be permitted.

Unless otherwise directed, rolling shall begin at the sides and proceed longitudinally parallel to the road centerline, each trip overlapping one half the roller width, gradually progressing to the crown of the road. When paving in echelon or abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure. On super-elevated curves the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the centerline.

Rollers shall move at a slow uniform speed with the drive roll wheels nearest the paver. Rolling shall be continued until all roller markings are eliminated.

After compaction the minimum percentage of the Theoretical Maximum Density (TMD) obtained shall be 91.0 percent for all machine placed courses, except the wearing course which shall be 92.0 percent. The test for TMD shall be performed in accordance with AASHTO T 209 on laboratory specimens of mixture combined in the proportions of the job-mix formula.

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 rakes or lutes and additional fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical vibrating compactors. Hand tamping will be permitted only for areas inaccessible to other compaction equipment. 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.

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. Mixture showing an excess or deficiency of bituminous material shall be removed and replaced.

401.18 Joints. Placing bituminous mixture shall be as continuous as possible. The edge of the layer shall be constructed vertically. Rollers shall not pass over the unprotected end of freshly laid mixture unless authorized by the Engineer.

Transverse joints of the wearing course shall be at right angles with the longitudinal edge and shall be straight and neatly trimmed. A vertical face exposing the full depth of the course may be formed by inserting a header, by braking the bond with the underlying course or by cutting back with hand tools. Feathered or "lap" joints may be permitted on lower courses or when matching existing low type pavements.

Edges of joints that are to form longitudinal joints shall be maintained vertically.

A coating of emulsified asphalt shall be supplied to all joints except those formed by pavers operating in echelon. The application shall be by an approved spray apparatus designed for covering a narrow surface. Application of this material by a brush may be approved for small surfaces, or in the event of a malfunction of the spray apparatus, but for a period of not more than one working day. The bituminous material shall be applied immediately after the mixture has been laid.

Where pavement under this contract joins an existing pavement, and when directed, the existing pavement shall be cut along a smooth line and to a neat, even vertical joint. Broken or raveled edges will not be permitted. All work necessary for the preparation of this joint will be considered as incidental to the related contract items.

401.19 Pavement Samples. On the morning of the following working day the Contractor shall cut samples from the compacted wearing surface for testing by the Engineer. Samples of the mixture shall be taken for the full depth of the course at the locations directed. Samples shall be presented for measurement and forwarded to the plant inspector prior to 10:00 A.M.

All holes in the pavement resulting from sampling by the Engineer or by the Contractor shall be filled with acceptable mixture no later than the following work day. Before filling, the holes shall be carefully cleaned and coated with emulsified asphalt.

401.20 Surface Tolerances. The surface shall be tested by the Engineer with a 16 foot straightedge or string line placed parallel to the centerline of pavement and with a 10 foot straightedge or string line placed transversely to the centerline of pavement on any portion of the pavement surface. Variations exceeding 1/4 inch shall be corrected by removing defective work and replacing it with new material as directed.

401.21 Method of Measurement. Plant mix pavement will be measured by the ton in accordance with Section 109 -- Measurement and Payment. Batch weights will not be permitted as a method of measurement, unless the alternate provisions of Section 401.082(e) are met, in which case the cumulative weight of all the batches will be used for payment. The tonnage shall be the weight used in the accepted pavement and no deduction will be made for the weight of bituminous material or additives in the mixture.

Due to possible variation in the specific gravity of the aggregate and field changes in areas to be paved, the quantity of mixture used may vary from the estimated quantities and no adjustment in contract unit price will be made because of the variations.

401.22 Basis of Payment. All work performed and measured as prescribed above will be paid for as provided in respective sections for each type specified.

Work specified in Subsection 401.12 will be paid for at the contract unit prices for the material used except that cleaning objectionable material from the pavement and furnishing and applying bituminous material to joints and contact surfaces will be incidental.

SECTION 402 -- VACANT

SECTION 403 -- HOT BITUMINOUS PAVEMENT

403.01 Description. This work shall consist of constructing one or more courses of bituminous pavement on an approved base in accordance with these specifications, and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established.

The bituminous pavement shall be composed of a mixture of aggregate, filler if required, and bituminous material.

MATERIALS

403.02 General. The materials and their use shall conform to the requirements of Subsections 401.02 through 401.06 and to the designated gradation requirements of Subsection 703.09.

CONSTRUCTION REQUIREMENTS

403.03 General. The construction requirements shall be as prescribed in Subsections 401.07 through 401.20.

403.04 Method of Measurement. Hot bituminous pavement will be measured as specified in Subsection 401.21.

403.05 Basis of Payment. The accepted quantities of hot bituminous pavement will be paid for at the contract unit price per ton for the bituminous mixtures, including bituminous material complete in place.

Payment will be made under:

Pay Item	Pay Unit
403.06 Vacant	
403.07 Hot Bituminous Pavement, Grading B	Ton
403.08 Hot Bituminous Pavement, Grading C	Ton
403.09 Hot Bituminous Pavement, Grading C (Crushed Ledge)	Ton
403.10 Hot Bituminous Pavement, Grading D	Ton
403.101 Hot Bituminous Pavement, Grading D (Sidewalks Drives, Shim, etc.)	Ton
403.11 Hot Bituminous Pavement Grading D (Crushed Ledge)	Ton
403.12 Vacant	
403.121 Hot Bituminous Pavement, Grading E (Shimming)	Ton
403.13 Vacant	

SECTION 404 -- VACANT

SECTION 405 -- ROAD MIX BITUMINOUS PAVEMENT

405.01 Description. This work shall consist of constructing one or more courses of road mix bituminous pavement on an approved base or road surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established.

MATERIALS

405.02 Bituminous Material. The type and grade of bituminous material will be specified in the contract.

The bituminous material shall meet the applicable requirements of Section 702 -- Bituminous Materials.

Bituminous material may be conditionally accepted at the source.

405.03 Aggregate. Aggregates in stockpiles shall meet the requirements of Subsection 703.11 for the grading size and type specified.

CONSTRUCTION REQUIREMENTS

405.04 Weather Limitations. The construction of road mix bituminous pavement shall be carried on only when the surface on which the material is to be placed is dry and when the atmospheric temperature is above 50°F and has not been below 40°F during the preceding 24 hours.

No material shall be mixed or placed between September 15 and May 1 except with written approval.

405.05 Equipment. The equipment used by the Contractor shall include scarifying, mixing, spreading, finishing, compacting equipment, a bituminous distributor and equipment for heating bituminous material.

The aggregate spreader shall be a type that a uniform and accurately controlled amount of aggregate will be distributed regardless of the speed of the spreader or the towing vehicle.

The distributor shall be designed, equipped, maintained and operated so that bituminous material at constant temperature may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard, with uniform pressure and with an allowable variation from any specified rate not to exceed 0.02 gallon per square yard. Distributor equipment shall include a tachometer, pressure gages, accurate volume measuring devices or a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

All liquid and cement bituminous material bulk delivery vehicles and distributors shall be equipped with an acceptable sampling valve.

On bulk delivery vehicles the valve shall be located in an accessible area in the lower half of the front or rear bulkhead. The valve shall be similarly located on distributors, except that it may be installed in a circulating line having a rising flow.

Traveling or stationary mixing plants or other equipment of proven performance may be used by the Contractor in place of the specified equipment if approved.

Rollers shall be self-propelled steel wheel tandem or 3 wheel rollers weighing not less than 8 tons each and pneumatic tire rollers having a total compacting width of not less than 60 inches and the gross weight adjustable within the range of 200 to 350 pounds per inch of compaction width. The operating weight shall be as directed. Tire pressure or contact pressure may be specified for pneumatic tire rollers.

405.06 Preparation of Base. Before spreading materials for road mixing, the surface of the base or road surface on which the road mix is to be placed shall be conditioned as specified in Subsection 401.12.

After a prime coat is applied, it shall be left undisturbed not less than 24 hours. The Contractor shall maintain a primed surface until the road mix material has been placed. This maintenance shall include the spreading of sand or other approved material, if necessary, to prevent adherence of the prime coat to the tires of vehicles using the primed surface and patching any breaks in the primed surface with additional bituminous material. Any area of the primed surface that has become damaged shall be repaired before the road mix material is placed.

After a tack coat is applied, it shall be allowed to dry until it is in the proper condition of tackiness to receive the road mix material. This coat shall be applied only as far in advance of the placing of road mix material as is necessary to obtain a proper bond. Any breaks in this coat shall be repaired.

405.07 Placing Aggregates. Aggregates shall be uniformly spread on the road by the use of spreader boxes, or other approved mechanical spreading devices. When two or more sizes of aggregates are used, each size of aggregate shall be placed in the proper amount such that the combined total of the aggregates will provide sufficient material for the surfacing of the required width and thickness. Each size of aggregate shall be windrowed to a uniform section and left undisturbed until measuring and sampling are completed, after which they shall be mixed until they are uniformly blended and then spread over the road surface.

If the surface moisture of the aggregate is more than 2 percent of the dry weight of the aggregate, except when the bituminous material is emulsified asphalt, the aggregate shall be turned by blades or otherwise aerated until the moisture content is reduced to 2 percent or less.

The aggregate shall be spread smoothly in successive passes, each pass spreading a portion of the previously mixed aggregates in a uniform layer over half the road width being surfaced. The material may be spread over more or less of the road width if convenient or necessary. Each spread of aggregate shall receive in turn an application of bituminous material. When a traveling mixing plant is used the aggregate shall, after mixing, be placed to provide the required cross section after compaction.

405.08 Application of Bituminous Material. The bituminous material shall be uniformly distributed in successive applications, with the first application being on the portion of the existing surface to be covered and on each portion of the aggregate spread, as directed above, in such amounts and at such intervals as directed. The mixing equipment shall follow immediately behind the distributor after each application of bituminous material to partially mix the aggregate and the bituminous material.

405.09 Mixing. Spreading and mixing of the several successive portions of the aggregate shall continue until all of the aggregate has been treated. The bitumen applied in the several treatments shall amount to the total required in the Contract or designated by the Engineer.

After the last application of bituminous material and partial mixing, the entire mass of bituminous material and aggregate shall be windrowed on the road surface and then mixed, by blading the mixture from side to side of the road or by manipulations producing equivalent results, until all aggregate particles are coated with bituminous material and the whole mass has a uniform color and the mixture is free from fat or lean spots, balls or uncoated particles. During the mixing operations, care shall be taken to avoid cutting into the underlying course or contaminating the mixture with earth or other extraneous matter. When directed, the mixing process shall be confined to part of the width or area of the road so as to allow traffic to pass.

Should the mixture show an excess, deficiency or uneven distribution of bituminous material, the condition shall be corrected by the addition of aggregate or bituminous material as required and re-mixing. If the mixture contains excessive amounts of moisture or volatile matter, it shall be bladed, aerated or otherwise manipulated until the moisture and volatile content are satisfactory. The spreading of the mix shall not be done when the surface to be covered is in an unsatisfactory condition.

At the end of each day's work, or when the work is interrupted by weather conditions all loose material shall be bladed into a windrow, whether mixing is completed or not, and shall be retained in a windrow until operations are resumed.

When the mixing operations have been satisfactorily completed, the mixture shall be formed into a windrow of uniform cross section.

If the Contractor elects to use traveling or stationary mixing plants instead of the specified equipment, the same requirements regarding residual moisture and evaporation of volatiles given above shall apply.

405.10 Spreading, Compacting and Finishing. The material shall be spread by a self-propelled, pneumatic-tire blade grader or a mechanical spreader of approved type. While spreading from the windrow, care shall be taken to avoid cutting into the underlying base.

After the material is spread, the surface shall be rolled. Rolling shall be parallel to the road center line and shall commence at the outer edges of the road, overlapping the shoulders and progress toward the center, overlapping on successive passes by at least one-half the width of the roller, except that on superelevated curves rolling shall progress from the lower to the upper edge. Each pass shall terminate at least 3 feet in advance or to the rear of the end of the preceding pass. During the compaction the surface shall be dragged or bladed as necessary to fill ruts and to remove incipient corrugations or other irregularities. Rolling shall continue until the surfacing is of uniform texture and satisfactory compaction obtained. Initial rolling shall be performed with a pneumatic tire roller and final rolling with a 3-wheel or tandem-type steel wheel roller. Rolling shall be discontinued whenever it begins to produce excessive pulverizing of the aggregate or displacement of the mixture.

This course shall be placed in a minimum of two layers except when the course is 2 inches or less in thickness. The maximum thickness of a single layer shall not exceed 2 inches when compacted.

While the surface is being compacted and finished the Contractor shall trim the edges neatly to line.

405.11 Surface Requirements. The surface will be tested by the Engineer 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 3/16 inch. All humps or depressions exceeding the specified tolerance shall be corrected.

405.12 Method of Measurement. Aggregate for road mix bituminous pavement will be measured by the number of cubic yards of material forming this course, completed and accepted in accordance with the typical cross sections. Measurement will be determined as shown on the plans for in-place measure according to average end area computations. Additional authorized work will also be measured according to the end area method. The length will be determined horizontally along the centerline of the roadway.

Bituminous material will be measured by the gallon in accordance with Section 109 -- Measurement and Payment.

405.13 Basis of Payment. The accepted quantities of road mix bituminous pavement will be paid for at the contract unit price per cubic yard for the aggregates and per gallon for the bituminous material complete in place.

Payment will be made under:

Pay Item	Pay Unit
405.14 Aggregate for Road Mix Bituminous Pavement	Cubic Yard
405.15 Bituminous Material for Road Mix Bituminous Pavement, Applied	Gallon

SECTION 406 -- VACANT

SECTION 407 -- SLURRY SEAL

Reserved

SECTION 408 -- ASPHALT RUBBER MEMBRANE

Reserved

SECTION 409 -- NON-WOVEN POLYPROPYLENE

Reserved

SECTION 410 -- BITUMINOUS SURFACE TREATMENT

410.01 Description. This work consists of furnishing and applying one or more courses of bituminous treatment and aggregate cover material when required on an approved surface in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or established.

- (a) Tack coat shall consist of a light application of bituminous material to provide bond with a superimposed course. A cover coat will not be required.
- (b) Prime coat shall consist of an application of low viscosity liquid bituminous material to coat and blend mineral particles preparatory to placing a bituminous base or surface course. A light coat of cover material may be required.
- (c) Seal coat shall consist of an application of bituminous material and cover material. A double Seal coat shall consist of a second application of bituminous material and may require a second application of cover material.

MATERIALS

410.02 Bituminous Material. The types and grades of bituminous material will be specified in the contract. The grade may be changed one step by the Engineer during construction at no change in unit price.

The bituminous material shall meet the applicable requirements of Section 702 -- Bituminous Materials. The bituminous material may be conditionally accepted at the source.

410.03 Aggregates. The type of cover coat material will be specified in the contract.

Cover material for prime coat shall meet the requirements of Subsection 703.13, Sand Cover or Subsection 703.14.

Cover material for Seal Coat shall meet the requirements of Subsection 703.13, Stone Chips or Sand Cover.

The cover material will be accepted in stockpile at the source.

CONSTRUCTION REQUIREMENTS

410.04 Weather Limitations. Bituminous material shall not be applied on a wet surface, after sunset or before sunrise or when

the atmospheric temperature is below 50°F in the shade or when weather conditions are otherwise unfavorable to proper construction procedures.

410.05 Equipment. The following equipment or its equivalent shall be furnished:

A power broom.

Equipment for heating and applying bituminous material meeting the requirements of Subsection 405.05.

Rolling equipment for seal coat meeting the requirements of Subsection 405.05. A minimum of one steel wheel roller and one pneumatic tire roller will be required.

Equipment for applying aggregate cover coat material for seal coat shall consist of: 1 self-propelled aggregate spreader of approved design supported by at least 4 wheels equipped with pneumatic tires on 2 axles. The aggregate spreader shall be equipped with a means of applying the larger cover coat material to the surface ahead of the smaller cover coat material and with positive controls so that the required amount of material will be deposited uniformly over the full width of the bituminous material. Other types of aggregate spreaders may be used provided they accomplish equivalent results and are approved.

410.06 Preparation of Surface. The surface to be treated shall be smooth, stable, uniformly compacted, free of ruts, corrugations or other irregularities. Prior to placing tack coat or seal coat the surface shall be thoroughly cleaned of all loose and objectionable material.

Unless otherwise authorized, a 5 day curing period shall be required between successive applications of bituminous material and cover material when specified, for construction of a multiple course surface treatment.

The cover material shall be evenly distributed and all excess material removed prior to the second application of bituminous material for a double seal coat.

410.07 Application of Bituminous Material. Bituminous material shall be applied by a pressure distributor in a uniform, continuous spread over the section to be treated and within the temperature range specified in Subsection 702.05.

The width of treatment and quantity of bituminous materials to be used per square yard shall be as directed.

When the item for payment for Bituminous Surface Treatments is by the square yard, the type, grade and approximate quantity of bituminous material per square yard will be specified.

Junctions of spreads shall be carefully made. For seal coats the spray bars of the distributor shall be started on building paper. Skipped areas and deficiencies in distribution for all types of surface treatments shall be corrected.

When traffic is maintained, one way passage of vehicles will be permitted on the untreated portion of the roadbed. Following satisfactory penetration and covering of prime coat, traffic may be transferred to the treated portion of the roadway.

When the rolling operation is finished, traffic may be transferred to the newly completed seal coat. Protection from fast moving vehicles shall be furnished as provided for in the contract or as directed.

The length of spread of bituminous material shall not be in excess of that which trucks, loaded with aggregate can immediately cover. Under no circumstances shall bituminous material be allowed to chill or set up, dry or otherwise impair retention of the cover coat.

410.08 Application of Aggregate Cover. If after the application of the prime coat, the bituminous material fails to penetrate satisfactorily and the roadway must be used by traffic, the specified cover coat material shall be spread in the amounts required to absorb any excess bituminous material. The primed surface shall be maintained by subsequent spreading of additional cover material.

When the item for payment for Bituminous Surface Treatment is by the square yard, the type and approximate quantity of aggregate cover per square yard for prime coat and seal coat will be specified.

Immediately following the application of the bituminous material, the specified cover material for seal coat shall be spread in quantities as designated. Cover material for seal coat shall be spread with a self-propelled aggregate spreader unless otherwise specified or directed. Spreading shall be in such a manner that the tires of the trucks or aggregate spreader at no time contact the uncovered and newly applied bituminous material.

When the aggregate cover material specified for seal coat is stone chips, the Engineer may require drag brooming before rolling. If deemed necessary sand cover shall be uniformly distributed with a wire fabric drag.

Following completion of the rolling operation the seal coat shall be maintained by distributing aggregate cover over the surface to absorb any excess bituminous material and to cover any areas deficient in cover material. Light brooming may be required.

Maintenance shall continue until the treated surface has become stable. When directed all excess aggregate cover material shall be removed by rotary brooms.

410.09 Rolling. Initial rolling of cover material for seal coat shall begin immediately after brooming and shall consist of one complete coverage with a steel wheel roller. Rolling with a pneumatic roller shall follow the initial rolling. The amount of pneumatic tire rolling shall be sufficient to seal the aggregate cover material and shall not be less than 2 complete coverages. At all times rollers shall move at a slow speed that will avoid loosening embedded aggregate cover.

410.10 Method of Measurement. Unless otherwise specified bituminous material will be measured by the gallon, aggregate cover material and blotter material by the ton or cubic yard, measured in the truck.

When specified in the contract as a pay item, Bituminous Surface Treatment will be measured by the square yard.

All quantity determinations will be made in accordance with Section 109 -- Measurement and Payment.

410.11 Basis of Payment. The accepted quantity of bituminous material will be paid for at the contract unit price per gallon for the designated type of material complete in place.

The accepted quantity of aggregate cover material will be paid for at the contract unit price per ton or per cubic yard in accordance with the contract pay item for the type of material complete in place.

The accepted quantity of bituminous surface treatment will be paid for at the contract unit price per square yard complete in place which price shall include furnishing and applying bituminous materials, aggregates and additives when required.

Payment will be made under:

Pay Item	Pay Unit
410.12 Asphalt Cement, Applied	Gallon
410.13 Tar, Applied	Gallon
410.14 Cut-back Asphalt, Applied	Gallon
410.15 Emulsified Asphalt, Applied	Gallon
410.16 Cover Coat Material, Sand	Cubic Yard
410.17 Cover Coat Material, Stone Chips	Cubic Yard
410.18 Cover Coat Material, Stone Chips	Ton
410.19 Blotter Material	Cubic Yard
410.20 Bituminous Surface Treatment	Square Yard

SECTION 411 -- UNTREATED AGGREGATE SURFACE COURSE

411.01 Description. This work shall consist of constructing a surface course or levelling course of untreated aggregate on an approved base in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established.

MATERIALS

411.02 Aggregate. Aggregates shall conform to the requirements of Subsection 703.10, Aggregate for Untreated Surface Course and Levelling Course.

CONSTRUCTION REQUIREMENTS

411.03 Placing. The surface course material shall be spread evenly in one layer upon the prepared base course to a depth that will insure the required depth after being compacted. The aggregate, when spread, shall be well graded with no pockets of fine or coarse material and shall be bladed and shaped with a power grader.

411.04 Compaction. Compacting shall be done with rollers, heavy construction equipment or any combination capable of satisfactorily compacting the course. The Contractor shall maintain the moisture content of the material to attain the required compaction.

When the aggregate surface material lacks sufficient fines to obtain compaction, binder material of an approved quality shall be added. The binder material shall be uniformly incorporated into the surface material by means of harrowing or by other methods capable of obtaining satisfactory results. The amount added shall not increase the total fines in the mixture to exceed the limits specified.

411.05 Surface Tolerance. The entire surface shall be shaped and maintained to a tolerance of 3/8 inch above or 3/8 inch below the required cross-sectional shape.

411.06 Levelling Course. When Aggregate Levelling Course for fine grading aggregate base and subbase course is called for, it shall be placed, measured and paid for under the bid item for Untreated Aggregate Surface Course.

411.07 Method of Measurement. Untreated aggregate surface course will be measured by the cubic yard in place unless designated by pay item to be measured by truck measure. When measured in place, the width and thickness for measurement will be the width and thickness of aggregate surface as shown on the plans or as modified. The length will be along the centerline. All measurements will be in accordance with Section 109 -- Measurement and Payment. When designated by pay item to be measured by truck measure, the measurement will be in vehicles at the point of delivery as shown on delivery slips in accordance with Subsection 109.01(f).

Aggregate surface course, designated by pay item to be measured in place and used for driveways and other locations difficult to accurately measure in place, may be measured in vehicles at 80 percent of the number of cubic yards accepted and used, at the point of delivery as shown by "Delivery Slips" in accordance with Subsection 109.01(f). The quantity so measured shall not exceed 300 cubic yards per contract.

411.08 Basis of Payment. The accepted quantities of untreated aggregate surface course of the type specified will be paid for at the respective contract price per cubic yard. Payment shall include purchasing material, stripping pits, excavating, crushing and screening when necessary, hauling, placing, compacting and other necessary processes which are required to furnish acceptable material under this item.

Water added or fines added or both added to the material to aid compaction and to prevent raveling will be at the Contractor's expense.

Payment will be made under:

Pay Item	Pay Unit
411.09 Untreated Aggregate Surface Course	Cubic Yard
411.10 Untreated Aggregate Surface Course (Truck Measure)	Cubic Yard

SECTION 412 -- BITUMINOUS MULCH SURFACE COURSE

Reserved

SECTION 413 -- COLORED SYNTHETIC BINDER PAVEMENT

Reserved

SECTION 414 -- PLANT MIXED SURFACE TREATMENT

Reserved

SECTION 415 -- PLANT MIXED WEARING COURSE

Reserved

SECTION 416 -- HOT BITUMINOUS TRENCH SURFACING

Reserved

SECTION 417 -- STABILIZED AGGREGATE SURFACE COURSE

Reserved

SECTION 418 -- HOT ROADWAY SURFACE COURSE

Reserved

SECTION 419 -- SAWING AND SEALING JOINTS IN BITUMINOUS PAVEMENT

Reserved

SECTION 420 -- PORTLAND CEMENT CONCRETE PAVEMENT

Reserved

SECTIONS 421 THROUGH 459 VACANT

SECTION 460 -- HOT BITUMINOUS PAVEMENT FOR SPECIAL AREAS

460.01 Description. This work shall consist of one or more courses of bituminous mixture constructed on an approved foundation in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections established.

MATERIALS

460.02 Composition of Mixtures. The bituminous plant mix shall be composed of a mixture of aggregate and bituminous material. The several aggregate fractions shall be sized, uniformly graded and combined as follows:

Sieve	Gradation B	Sieve	Gradation B
1"	100	16	14-39
3/4"	90-100	50	6-24
1/2"	50-90	100	4-16
4	28-60	200	1-8
8	20-50		

460.03 Aggregates-General. Aggregates in the stockpiles at the plant site shall meet the following requirements:

- (a) Coarse Aggregates (retained on the No. 8 sieve) shall be crushed stone or crushed gravel, and shall consist of clean, tough, durable fragments, free from an excess of flat, elongated, soft or disintegrated pieces and free from stone coated with dirt or other objectionable material.
- (b) Fine aggregate, that passing the No. 8 sieve shall consist of natural sand or sand prepared from stone or gravel or a combination thereof. It shall consist of hard, tough grains, free from injurious amounts of clay, loam or other deleterious substances.

460.04 Vacant

460.05 Bituminous Material. Bituminous material shall meet the requirements of the latest revision of Section 702 -- Bituminous Material, including the latest revisions for the type and grade chosen by the contractor and approved. The bitumen content (percent of mix) shall be within the range of 4.5 to 6.5 percent.

CONSTRUCTION REQUIREMENTS

460.06 Weather Limitations. Unless otherwise specified, hot bituminous pavement for special areas shall not be placed on a wet surface or when the air temperature is too cool to allow proper compaction. Plant-mixed bituminous pavements shall be constructed between the dates of May 1st and November 15th.

Weather conditions shall be satisfactory for the safety of the personnel, general public, and proper handling and finishing of the mixture.

When it is in the public interest for service to traffic, the Department may extend the dates of the paving season.

460.07 Bituminous Mixing Plant. The bituminous mixing plant shall be capable of heating and drying the aggregate. The plant shall be capable of delivering a uniformly mixed material containing an accurately measured amount of bitumen.

460.071 Vacant

460.072 Automatic Ticket Printer. In place of plant and truck scales, the Contractor may provide an approved automatic printer system, which will print the weights of the material delivered. The printer system must be used with an approved automatic batching and mixing control system showing weights on a weight ticket for each load.

Each weigh ticket shall be signed by a representative of the Contractor.

In the event of a malfunction of the automatic printer system, production may be continued for a period not exceeding the next 48 hours, providing total weights of each batch are recorded on weight tickets and certified by a Licensed Weighmaster. Plant scales shall be inspected as often as the Engineer may deem necessary to assure their continued accuracy. The Contractor shall have on hand not less than ten 50-pound weights for testing of the scales.

460.08 Hauling Equipment. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth, metal beds which have been thinly coated with a minimum amount of fuel oil, lime solution or other approved material to prevent the mixture from adhering to the beds. If fuel oil is used, it shall be applied as a fog spray. During or after each application, the truck bodies shall be raised to allow the excess to drain. The trucks shall have a cover of canvas or other suitable material of such size as to protect the mixture from the weather. When necessary, so that the mixture will be delivered on the road at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

460.09 Bituminous Pavers. Mixture produced under this contract shall be placed on the roadway with an approved self-propelled bituminous finishing machine designed for highway paving.

460.10 Rollers. Immediately after the material is spread, it shall be rolled with a sufficient number of steel rollers, to properly compact the mixture before it cools.

460.11 Conditioning the Existing Surface. The surface upon which bituminous mixture is to be placed shall be thoroughly cleaned of all objectionable material.

When the surface of the existing base or pavement is irregular, it shall be brought to uniform grade and cross section as directed.

460.12 Preparation of Bituminous Material. The bituminous material shall be heated in a manner that will avoid overheating, and provide a continuous supply of the bituminous material to the mixer at uniform temperature at all times.

The Contractor shall cooperate with the Engineer to the extent that the amount of bituminous material used each day on a particular project can be determined.

460.13 Preparation of Aggregates. The aggregates for the mixture shall be dried and heated to the required temperature. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid soot on the aggregate.

460.14 Mixing. The processing of the aggregate, handling bitumen, drying the aggregate and mixing shall conform to acceptable practices of the paving industry, except screening of the aggregate into individual hot bins will not be required.

The aggregate shall be sufficiently dried so that the mixture will not flush, foam excessively, or displace excessively under the action of the rollers.

After the required amount of aggregate and bituminous material have been introduced into the mixer and unless otherwise specified, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is obtained.

460.15 Spreading and Finishing. The mixture shall be laid upon an approved surface, spread and struck off to the grade and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial widths as may be practicable.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be dumped, spread and screeded to give the required compacted thickness.

460.16 Compaction. Immediately after the bituminous mixture has been spread, struck-off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

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.

Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture. To prevent adhesion of the mixture to the rollers, the wheels shall be kept moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.

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.

460.17 Vacant

460.18 Vacant

460.19 Vacant

460.20 Method of Measurement. Plant mix bituminous pavement will be measured by the ton in accordance with Section 109 -- Measurement and Payment. Batch weights will be permitted as a method of measurement, if the provisions of Subsection 460.072 are met, in which case the cumulative weight of all the batches will be used for payment. The tonnage shall be the weight used in the accepted pavement and no deduction will be made for the weight of bituminous material or additives in the mixture.

Due to possible variation in the specific gravity of the aggregate and field changes in areas to be paved, the quantity of mixture used may vary from the estimated quantities and no adjustment in contract unit price will be made because of the variations.

460.21 Basis of Payment. Price per ton shall be considered full compensation for furnishing and hauling the mixture, placing, rolling, sweeping and all labor and equipment necessary to complete the work. All handwork required will be considered incidental.

Payment will be made under:

Pay Item	Pay Unit
460.22 Hot Bituminous Pavement	Ton

DIVISION 500 -- STRUCTURES

SECTION 501 -- FOUNDATION PILES

501.01 Description. This work shall consist of furnishing and driving piles, of the size and type called for, in accordance with these specifications and in reasonably close conformity with the lines, grades and locations shown on the plans or authorized.

MATERIALS

501.02 Materials. Materials shall meet the requirements of the following Subsections of Division 700 -- Materials:

Steel Pipe Piles	711.01
Structural Steel	713.01

H-beam piles shall be structural steel and shall meet the requirements of ASTM A 36. Mill test reports will be required. Notch toughness tests will not be required.

Concrete for Steel Pipe Piles shall be Class Y and shall meet the requirements of Section 502 -- Structural Concrete.

CONSTRUCTION REQUIREMENTS

501.03 Length of Piles. The number and estimated length of piles required for a structure are shown on the plans. The estimated pile lengths are based on subsurface interpretations made as stated in Subsection 102.07. The driven pile lengths will vary to suit the actual conditions encountered in the field.

501.04 Loading Tests.

- (a) Loading tests are intended to serve one of two purposes. They are made to enable the Engineer to determine the number and size of piles required or they are made to confirm that piles have attained the required load bearing capacity.
- (b) A loading test consists of the application of a known load to the pile or group of piles and the accurate measurement of the resulting settlement.

- (c) A load may be applied by weights, hydraulic jacks or any means by which it can be increased or decreased by known and variable amounts. The method of applying load to the test pile shall be submitted to the Engineer prior to starting the loading procedure.
- (d) In the case of Steel Pipe Piles, no load shall be placed on the pile for at least 7 days after the concrete has been placed in the shell.
- (e) Reference points for measuring pile settlement shall be so located as to preclude all possibility of disturbance.
- (f) The entire apparatus shall have a working capacity of not less than three times the proposed design load.
- (g) A load test shall be conducted under the direction of the Engineer but the Contractor shall furnish all labor and equipment.

501.05 Driving. Piles shall be driven to ledge rock or practical refusal unless otherwise noted on the plans. The Contractor shall furnish all assistance required to make any observations and measurements. Practical refusal shall be considered attained if the penetration does not exceed 1 inch in 10 successive blows, of a power or gravity hammer, with the weight of the striking part of the hammer approximately equal to the weight of the pile being driven.

In addition, when a gravity or vibratory hammer is used, the Contractor may be required to demonstrate to the satisfaction of the Engineer, that the maximum pile load, as called for on the plans, is attained and that an acceptable method of measuring the maximum pile load of each pile is provided. The demonstration may be accomplished by a pile loading test or by comparison driving, using a power hammer. Each pile driven by a vibratory hammer may require proof testing by the use of a conventional hammer. No additional compensation will be made for demonstrations or proof testing.

When not driven to practical refusal and when the capacity of a pile is not determined by a loading test, the following formulas may be used to obtain approximate load value.

- (a) For gravity hammers:

$$P = \frac{2 WhH}{S + 0.4 \frac{Wd}{Wh}} *$$

$$S = \frac{2 WhH}{P_1} - 0.4 \frac{Wd}{Wh}$$

- (b) For single acting steam or air hammers or diesel hammers having unrestricted rebound of ram:

$$P = \frac{2 \text{ WhH}}{S + 0.1 \frac{\text{Wd}^*}{\text{Wh}}} \quad S = \frac{2 \text{ WhH}}{P_1} - 0.1 \frac{\text{Wd}^*}{\text{Wh}}$$

- (c) For double acting steam or air hammers or diesel hammers having enclosed rams:

$$P = \frac{2E}{S + 0.1 \frac{\text{Wd}^*}{\text{Wh}}} \quad S = \frac{2E}{P_1} - 0.1 \frac{\text{Wd}^*}{\text{Wh}}$$

*When $\frac{\text{Wd}}{\text{Wh}}$ is less than one, use one.

Where: P = Allowable pile load in pounds.

P₁ = Required working value of a pile, in pounds.

Wh = Weight of the striking part of the hammer, in pounds.

Wd = Weight driven (pile, driving head, etc.), in pounds.

H = Average height of fall in feet of the striking part of the hammer for the blows used to obtain the penetration, S.

S = Average penetration per blow, in inches, for the last 5 to 10 blows of a gravity hammer and the last 10 to 20 blows of a power hammer.

E = Effective output energy of the hammer, in foot pounds per blow. When a diesel hammer having an enclosed ram is used to drive friction piles, it shall be equipped with an instrument which measures the effective output energy of the hammer.

- (d) Jets, if used, must be withdrawn before taking data for use in the above formulas.

- (e) Any one or all of the above formulas are not applicable when:

1. The hammer or striking part does not have a free fall.
2. The head of the pile is broomed or crushed.
3. The penetration is not reasonably quick and uniform.
4. There is an appreciable bounce after a blow.
5. A follower is used.
6. The steam, air or diesel hammer is operated at a speed less than that recommended by the manufacturer.

- (f) When determining the bearing capacity of a pile by means other than a loading test, due consideration shall be given to the character of the soil; size, length and weight of pile; type and weight of hammer and general driving conditions.
- (g) Pile formulas may be modified by the Engineer on the basis of information obtained from a loading test.
- (h) The load bearing capacity of a pile properly driven to refusal or practical refusal shall be computed as for a point bearing pile.

501.06 Ground Preparation. Before driving any piles, the ground surface shall be brought to the elevation called for on the plans. Obstacles shall be removed as directed by the Engineer.

After the piles are properly driven, the ground surface shall be brought to the correct elevation either by excavation or by filling with granular material, thoroughly compacted.

501.07 Pile Tips. Steel H-Beam Piles shall have reinforced tips as shown on the plans. Steel Pipe Piles shall have tips as shown on the plans.

501.08 Cutting Off Piles. A pile cut-off is defined as that length of pile above cut-off elevation. Each pile shall be cut off on a true plane perpendicular to the axis of the pile.

The length of pile above cut-off elevation shall be sufficient to permit complete removal of all material injured by driving; however, should the damage to the pile extend below cut-off elevation, special corrective measures as specified in Subsection 501.14 shall be taken.

501.09 Splicing Piles. Full length piles shall be used wherever practicable. Piles shall not be spliced unless approved by the Engineer. Piles fabricated from multiple pieces will be acceptable only if they comply with the following:

- Piles to 20' long-no splices allowed
- Piles over 20' to 35'-1 splice, maximum
- Piles over 35' to 70'-2 splices, maximum
- Piles over 70'-3 splices, maximum

When splicing is authorized, piles shall be spliced as follows:

- (a) Damaged material, shall be removed from the end of the driven pile. The ends of both sections to be spliced shall be cut off square with the longitudinal axis of the pile and scarfed as required. All cutting shall be done with the use of a mechanical guide and no free hand cutting will be allowed except for minor trimming.

- (b) A full penetration butt weld shall be used for the entire cross section of the pile.
- (c) All welding shall comply with the requirements of Section 504 -- Structural Steel, except as modified hereinafter.
 - 1. No run-off tabs will be required for flange butt welds, on H-Beam Piles.
 - 2. No welding shall be done when the temperature in the immediate vicinity of the weld is below 0°F; when the surfaces are damp or exposed to rain, snow or high wind; or when the welders or welding operators are exposed to inclement conditions.
 - 3. The pile shall be preheated to and maintained at 150°F minimum, within 6 inches from the weld while welding.
 - 4. The maximum electrode size shall be 3/16 inch.
 - 5. Formal welding procedures need not be submitted.
- (d) Welders shall be prequalified in accordance with Section 504 -- Structural Steel.
- (e) The Contractor may use other methods for splicing piles, if approved by the Engineer.

501.10 Hammers. The type of hammer: gravity, steam, air, diesel or vibratory, will be the Contractor's choice, subject to the Engineer's approval. If a power hammer is to be used, the Contractor shall furnish to the Engineer a descriptive catalog of the hammer, containing all necessary information for the proper operation and for computing the load bearing capacity of driven piles.

The size of hammer shall be dependent upon the size and type of pile, the type of hammer and the soil conditions involved.

The following limitations are intended as guides and are to be applied only with sound engineering judgment.

- (a) A gravity hammer shall weigh no less than the combined weight of the pile and the driving head or 3,000 pounds, whichever is greater. The drop of the hammer shall be regulated to avoid injury to the piles. For steel H-beam piles, the drop shall not exceed 15 feet. For steel pipe piles, the drop shall not exceed 8 feet.

- (b) A power hammer shall deliver at each full stroke of the piston, not less than 1 foot-pound of energy for each pound of weight driven or 6,000 foot-pounds, minimum.
- (c) If the value of "S" as determined by the appropriate formula in Subsection 501.05 comes out less than 0.1 inch or negative, it is an indication that the hammer contemplated or being used is too small.

501.11 Supplemental Equipment. Pile driver leads shall be constructed in such a manner as to afford freedom of movement of the hammer. They shall be held in position by guys or stiff braces to insure proper support of the pile during driving. Scale boards graduated in feet and inches shall be attached to the leads when requested by the Engineer.

Followers shall not be used except under unusual conditions and then only with the permission of the Engineer. When a follower is used, one pile from every group of 10 shall be a long pile driven without the follower and shall be used to determine the average bearing power of the group. This determination may be made by means of the appropriate formula in Subsection 501.05.

Jetting shall be done only with the permission of the Engineer. When water jets are used the number of jets and the volume and pressure of the water at the nozzles shall be sufficient to erode freely the material adjacent to the piles. The plant shall have sufficient capacity to deliver at all times at least 100 pounds per square inch pressure at two 3/4 inch 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.

501.12 Driving Procedures and Tolerances. The sequence of driving piles in any unit shall be subject to the approval of the Engineer.

When driving is interrupted before final penetration is reached, data for the bearing capacity of the pile shall not be taken until at least 12 inches penetration or refusal has been attained, after driving has been resumed.

Piles which have heaved during the driving of other piles in a group shall be reseatd to the required penetration or bearing capacity.

Piles shall be driven with a variation of not more than 1/4 inch per foot from the vertical or from the batter shown on the plans, 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. Foundation piles shall not be out of position shown on the plans by more than 6 inches. Actual embedment of the piles in the concrete shall be within 6 inches of that shown on the plans.

501.13 Special Requirements for Steel Pipe Piles. Pipe piles shall be inspected and approved by the Engineer immediately before concrete is placed. Pipe piles shall be free from rupture and undue deformation and shall be free from water. The Contractor shall provide lights and other equipment necessary to inspect each pipe pile.

Portland cement concrete for filling the pipe piles shall be placed in the pile in one continuous operation, care being taken to fill the pile completely. An internal type vibrator shall be used in the top 25 feet of the pile. Pile heads shall be protected and cured in accordance with Section 502 -- Structural Concrete.

The placing of concrete and the driving of piles shall be so scheduled that fresh and setting concrete will not be injured by the driving.

501.14 Defective Piles and Corrective Measures. The procedure incident to the driving of piles shall not subject the piles to excessive and undue abuse causing deformation. Any pile damaged by reason of internal defects or by improper driving or driven below cut-off elevation or otherwise crippled, shall be considered defective and shall be corrected by and at the expense of the Contractor.

The method of correcting a defective pile shall be approved by the Engineer and may be one of the following:

- (a) The pile may be pulled and replaced by a new and, if necessary, longer pile.
- (b) A second pile may be driven adjacent to the defective pile. The position of the second pile shall be approved by the Engineer prior to driving.
- (c) The pile may be spliced or built up as provided in Subsection 501.09 or a sufficient portion of the footing enlarged to properly embed the pile.

It is not the intent of this Subsection to be all inclusive in deficiencies and corrective measures.

501.15 Method of Measurement. Piles will be measured by the number of linear feet of piles satisfactorily driven and remaining in the completed structure. The measured length shall include the length of the pile tip. Additional length of pile required for the driving, reheading or otherwise correcting defective piles will not be measured for payment and shall be provided at the Contractor's expense. The measured length shall not include any length above the embedment length shown on the plans.

Loading tests will be measured by the number of unit tests authorized and satisfactorily made.

501.16 Basis of Payment. The accepted quantities of piles will be paid for at the contract unit price per linear foot complete in place. Such payment will include full compensation for any necessary excavation or backfilling required after driving, to bring the foundation area to the correct elevation.

Pile splices, pile tips, pile cut-offs and concrete for pipe piles will not be paid for separately but will be considered as incidental to the related Pay Items.

Loading tests will be paid for at the contract unit price each.

Payment will be made under:

Pay Item	Pay Unit
501.211 Steel H-beam Piles 36 lbs/ft	Linear Foot
501.212 Steel H-beam Piles 42 lbs/ft	Linear Foot
501.213 Steel H-beam Piles 57 lbs/ft	Linear Foot
501.214 Steel H-beam Piles 53 lbs/ft	Linear Foot
501.215 Steel H-beam Piles 74 lbs/ft	Linear Foot
501.216 Steel H-beam Piles 73 lbs/ft	Linear Foot
501.217 Steel H-beam Piles 89 lbs/ft	Linear Foot
501.218 Steel H-beam Piles 102 lbs/ft	Linear Foot
501.219 Steel H-beam Piles 117 lbs/ft	Linear Foot
501.20 through 501.22 Vacant	
501.23 Loading Tests	Each
501.24 Steel Pipe Piles	Linear Foot

SECTION 502 -- STRUCTURAL CONCRETE

502.01 Description. This work shall consist of furnishing and placing portland cement concrete for structures and incidental construction in accordance with these specifications and in reasonably close conformity with the lines, grades and dimensions shown on the plans or established.

502.02 Classification. The portland cement concrete shall be the class indicated on the plans.

MATERIALS

502.03 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Portland Cement	701.01
Water	701.02
Air Entraining Admixtures	701.03

Water Reducing Admixtures	701.04
Set Retarding Admixtures	701.05
Curing Materials	701.06
Waterstops	701.07
Heavy Roofing Felt	701.08
Fine Aggregate for Concrete	703.01
Coarse Aggregate for Concrete	703.02
Preformed Expansion Joint Filler	705.01
Bridge Drains	711.04
Calcium Chloride	712.02

502.04 Shipping and Storage. Cement may be shipped in bags or in bulk from pre-tested and approved silos at the cement mill. The cement shall be completely protected from rain and moisture and any cement damaged by moisture or which fails to meet any of the specified requirements shall be rejected and removed from the site. If requested by the Engineer, cement stored for a period longer than 60 days shall be retested before being used in the work.

Bags of cement in shipment or storage shall not be piled more than 8 bags high. Bags of cement which for any reason have become partially set or which contain lumps of caked cement shall be rejected. Shipments of cement in bags shall be separately stored in a manner as to provide easy access for identification and inspection of each shipment.

Handling, shipping and stockpiling of aggregates shall be done in such a way as to minimize segregation and breakage.

Fine aggregate and each size of coarse aggregate shall be stored in definitely separated stockpiles on prepared bases constructed of the same material as is to be stockpiled with a minimum thickness of one foot. The ground under the prepared bases shall be reasonably graded to drain away from the stockpile and free of brush or other harmful vegetation. The base shall be left in place, undisturbed for the duration of the use of the stockpile. Prepared bases can be salvaged for re-use provided this material is reprocessed. Barge floors, wood, metal or other hard surfaces shall be considered acceptable alternates for the above described prepared bases.

CONSTRUCTION REQUIREMENTS

502.05. Composition and Proportioning. Concrete shall be composed of a homogeneous mixture of portland cement, fine aggregate, coarse aggregate, water and admixture proportioned according to these specifications. All material, including admixtures, shall be approved prior to use.

MASTER LIMITS TABLE

	CLASS OF CONCRETE				
	AA	A	B	S	Y
Designated Size of Coarse Aggregate Subsection 703.02	3/4	1	1 1/2	1 1/2S	3/4
Minimum Cement Content in Bags/ Cu. Yds. (Pounds)	6.75 (635)	6.5 (611)	5.5 (517)	6.75 (635)	6.75 (635)
Maximum Gross Water Content Gals/ Bag of Cement (W/C)	5.1 (0.45)	5.2 (0.46)	6.0 (0.53)	5.5 (0.49)	5.5 (0.49)
Slump, In Inches	2 1/2	3	3	5	3

Notes: Water-Cement Ratio (W/C) is by weight. One gallon of water shall be considered to weigh 8.34 pounds at 70°F. One bag of cement shall be considered to weigh 94 pounds.

With the approval of the Engineer, Class AA may be substituted for Class A and Class A or Class AA may be substituted for Class B.

The slump as shown in the Master Limits Table shall have a tolerance of plus or minus 1 inch.

Concrete to be placed by pumping equipment shall have a slump that does not exceed the specified master limit by more than 2 inches when deposited into the hopper of the pumping apparatus. Concrete slump at the point of discharge shall not exceed the limits specified in the Master Limits Table.

All concrete shall be air-entrained by the addition of an air-entraining admixture. If the air content of the plastic concrete varies by more than plus or minus 1 percent from a nominal air content of 6 percent, corrective adjustments shall be made. Concrete that has an air content exceeding these tolerances may be used only with the approval of the Engineer.

The air content of plastic concrete includes entrapped and entrained air. An entrapped air void is one millimeter or more in size and an entrained air void is less than one millimeter.

The Engineer may determine the percentage of entrained air in the hardened concrete. The testing procedure shall be in accordance with ASTM C 457, Microscopical Determination of Air-void Content and Parameters of the Air-void System in Hardened Concrete. The specification will have been met if the entrained air in the hardened concrete is between 3.0 and 7.5 percent.

A set-retarding admixture shall be used in the concrete mix when called for on the plans, in the specifications or when authorized or directed by the Engineer.

Concrete shall conform to the Master Limits Table and shall be designed in the laboratory to obtain a concrete with compressive strengths established on the basis that not more than 1 out of 10 28-day compressive strength tests determined by statistically projected values in accordance with ACI 214, shall be less than the following:

Class AA	4,000 psi
Class A	4,000 psi
Class B	3,000 psi
Class S	3,500 psi
Class Y	3,500 psi

These compressive strength values are for laboratory mix design purposes only.

The following procedure will be used for approval of concrete mix ingredients and proportions. The mix ingredients furnished by the Contractor shall be tested by the Central Laboratory and must meet all specification requirements before concrete mix proportions are designated by the Engineer. In addition, the concrete mix design shall be in accordance with either of the following subparagraphs, under (a) or (b).

- (a) Concrete mix design proportions will be designated by the Engineer or
- (b) As an alternative, the Contractor shall have the option to submit his own concrete mix design proportions to the Engineer for approval. The approval will be contingent upon the ability of the mix design proportions to produce concrete which meets the specified water-cement ratio, strength requirement and other factors which affect durability.

All concrete mixes shall be designed in accordance with the criteria of this subsection. The portion of fine aggregates designated as a percent of the total aggregate shall provide a practical water-cement ratio not exceeding the maximum in the Master Limits Table. The design proportions must be stated in terms of aggregates in a saturated, surface-dry condition and the batch weights will be adjusted by the Engineer to account for the actual moisture of the aggregate at the time of use. If the quality and gradation of the aggregates proposed for the mix does not permit the design criteria to be achieved, then, instead of changing aggregates, additional cement, not to exceed a total cement content of 110 percent of the specified minimum, water reducers or a combination of additional cement and water reducers may be designated by the Engineer.

The Engineer may require 45 days from the date of availability of mix ingredients for sampling to allow testing these ingredients and designating the design proportions or checking the design proportions as submitted by the Contractor.

No change in the source or character of the mix ingredients may be made without notice to the Engineer and no new mix ingredients shall be used until the Engineer has approved such ingredients and new mix proportions, if they change.

502.06 Batching. Measuring and batching of materials shall be performed at an approved batching plant, either commercial or otherwise.

In batching aggregate for contracts having an estimated quantity of less than 25 cubic yards of concrete, the Contractor may use approved volumetric measuring devices for both fine and coarse aggregate.

In batching aggregates for contracts having an estimated quantity of 25 cubic yards of concrete or over but less than 100 cubic yards, the fine aggregate shall be weighed. When permitted by the Engineer, the Contractor may use approved volumetric measuring devices for the coarse aggregate. The volume of coarse aggregate to be used in each batch shall be determined by weighing a sample batch and using the volume, so determined, in each batch of concrete produced.

In batching aggregates for contracts having an estimated quantity of 100 cubic yards of concrete or over, all aggregates shall be weighed.

The weighing and batching equipment shall be of such design and construction that the materials for each batch can be quickly and accurately weighed.

- (a) Portland Cement. Either bagged or bulk cement may be used. No fraction of a bag of cement shall be used in a batch of concrete unless the cement is measured.

All bulk cement shall be weighed on an approved weighing device. Accuracy of batching shall be plus or minus 1 percent of the required weight.

- (b) Water. Water shall be measured by an approved device either by volume or by weight. The accuracy of the device for measuring the water under all operating conditions shall be within a range of error of not over 2 percent of the total mixing water. Measuring tanks shall be equipped with an outside tap and valve to provide for checking the setting unless other means are provided for readily and accurately determining the amount of water in the tank.

The water measuring device at the batching plant shall be so arranged that the flow of water will be automatically stopped when the required quantity has been delivered to the mixer drum. All water measuring systems shall be capable of discharging the total quantity of measured water into the mixer drum within a limit of not greater than $1/3$ of the specified mixing time or $1/3$ of the specified required revolutions.

The water measuring device shall be so arranged that the measurements will not be affected by varied water pressure.

All wash water shall be removed from truck mixers and truck agitators prior to charging with a fresh load.

- (c) Aggregates. Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to secure a uniform grading of the material. Aggregates that have become segregated or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods and all washed aggregates, shall be stockpiled or binned for a sufficient length of time, as determined by the Engineer, to attain proper draining before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning, only if the car bodies permit free drainage. In case the aggregates contain high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Engineer.

Batching of aggregates shall be so conducted as to result in the weights of materials being accurate within plus or minus 2 percent of the required weights.

- (d) Admixtures. Admixtures shall be added to the batch at the plant by means of an approved mechanical dispenser or other approved method capable of accurate measurement within a limit of accuracy of 3 percent. Admixtures shall be dispensed in such a manner as will insure uniform distribution of the material throughout the batch within the specified mixing period.

When 2 or more admixtures are added in the same concrete mix they shall not be allowed to mix prior to charging the mixer and shall be added separately.

The Engineer will designate the quantity of admixture to be added to each batch.

- (e) Bins and Scales. The batching plant shall include separate bins or compartments for fine aggregates and each size of coarse aggregate. One or more weighing hoppers and scales shall be provided for aggregates.

If cement is used in bulk, a separate bin, hopper and scale for cement only shall be included. The bulk cement weighing hopper shall be properly sealed and vented to preclude dusting during operations, it shall be self-cleaning and it shall be fitted with an attached vibrator to insure complete discharge. The discharge chute shall be so arranged that cement will not lodge in it nor leak from it.

For total project concrete quantities less than 500 cubic yards, the cement weigh hopper compartment need not be entirely separate from the aggregate weigh hopper compartment(s) as long as the cement and aggregate are each weighed and discharged separately before the other is introduced. In this case, one scale is allowed to weigh both cement and aggregate. The accuracy of this scale shall be plus or minus 1 percent of the required weight of cement.

Bins shall have adequate separate compartments for fine aggregate and each size of coarse aggregate and shall be amply partitioned to prevent spilling of separated aggregates into adjacent compartments.

Each aggregate and bulk cement, if used, shall be discharged efficiently and freely into the appropriate weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision. A port or other opening for removing an overload and for sampling materials from the hopper shall be provided. Weighing hoppers shall be so constructed that: (1) there will be no attachments that might effect the free movement of the weighing mechanism; (2) they shall discharge fully; and (3) there shall be no possibility for accumulation of materials on the inside or outside. The cement shall be kept separate from the aggregate until the batch ingredients are released for discharge.

The scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type and shall be accurate when static load tested to 0.5 percent of the total capacity of the scale. All exposed fulcrums, clevises and similar working parts of the scales shall be kept clean. Poises shall be designed to be locked in any position to prevent

any unauthorized change of position. When beam type scales are used, provisions shall be made for indicating to the operator that the required load in the weighing hopper is being approached. The device shall indicate within the last 200 lbs. of load and within 50 lbs. overload. All weighing and indicating devices shall be in full view of the operator while charging the hopper and he shall have convenient access to all controls.

The scales shall be tested and sealed as often as the Engineer may deem necessary to assure their continued accuracy. The Contractor shall have readily available not less than 10 fifty-pound weights for scale testing purposes.

Batching plants may be equipped to proportion aggregates and bulk cement by automatic weighing devices of an approved type.

- (f) Transportation. When batches are hauled to the mixer, bulk cement shall be transported either in waterproof compartments or, if approved by the Engineer, between layers of fine and coarse aggregates. When cement is placed in contact with the aggregates, batches may be rejected unless mixing is begun within 30 minutes of such contact. Baged cement may be transported on top of the aggregates.

Batches shall be delivered to the mixer separate and intact. Each batch shall be dumped cleanly into the mixer, without loss and when more than one batch is carried on the truck without spilling of material from one batch compartment into another.

The Contractor shall keep the batching equipment clean and in good adjustment and working order, including the scales and bins. The equipment shall be accurately operated when used for proportioning batches.

All batches which do not contain the proper amount of material shall be rejected.

If, for any reason, equipment previously approved becomes unsatisfactory, it shall be repaired or replaced before proceeding with the work.

The Engineer shall have the authority to require all batch trucks used for transporting unmixed batches from the batching plant to the mixer to be properly covered; that gates between the compartments shall fit properly to prevent leakage of material from one compartment to another; and that the size of the compartments be adequate to handle the volume of material being hauled.

502.07 Mixing and Delivery.

(a) Mixers and Agitators.

1. Mixers may be stationary or truck mixers. Agitators may be truck mixers or truck agitators. Each mixer and agitator shall have attached thereto, in a prominent place by the manufacturer, a metal plate or plates on which is plainly marked the various uses for which the equipment is designed, the capacity of the drum or container in terms of the volume of mixed concrete and the speed of rotation of the mixing drum or blades. These plates shall be kept in readable condition at all times.
2. Stationary mixers shall be equipped with approved water measuring devices as specified in Subsection 502.06 and timing devices that will not permit a batch to be discharged until the specified mixing time has elapsed. The timing device shall be equipped with a bell or other suitable warning devices that will give a clearly audible signal each time the lock is released. In case of failure of the timing device, the Contractor will be permitted to operate while it is being repaired, provided he furnishes an approved time-piece equipped with minute and second hands. If the timing device is not in good working order within 24 hours, further use of the mixer will be prohibited until repairs are made.
3. All mixers and agitators shall be examined, as frequently as considered necessary, for changes in the condition of the drum, due to accumulation of hard concrete or mortar and for wear of blades.

(b) Loading.

1. No mixer or agitator shall be loaded in excess of the manufacturer's rated mixing or agitating capacity. No material for a batch of concrete shall be placed in the drum of a stationary mixer until all of the previous batch has been discharged.
2. For stationary mixers, batches shall be so charged into the mixer drum that some water will enter in advance of the cement and aggregate and all the water shall be in the drum by the end of the first 1/4 of the specified mixing time.

(c) Mixing.

1. For stationary mixers, the total mixing time shall be not less than the following: 60 seconds for mixers of less than 2 cubic yards capacity; 75 seconds for mixers of 2 to 4 cubic yards capacity; and 90 seconds for mixers of more than 4 cubic yards capacity. Mixing time shall be measured from the time all aggregates and cement are in the drum, water is being added as required in paragraph (b) of this Subsection and the drum or blades are rotating at the manufacturer's recommended mixing speed. This speed shall be maintained throughout the mixing period. Mixing time ends when the discharge chute opens. If such mixing does not result in a uniform and smooth texture, mixing shall be continued at the same rate of speed until satisfactory results are obtained.
2. For transit truck mixers, mixing shall be accomplished by 60 to 150 revolutions of the drum or blades at the manufacturers designated mixing speed. Mixing shall be considered as started only after all of the mix ingredients, including enough water to achieve a minimum slump of 1 inch below the specified slump, are in the mixer drum. All mixing revolutions will be performed at the project site except some mixing revolutions may be allowed at the batch plant in the presence of the inspector. Before any concrete load is discharged at the project site, additional water may be added up to the maximum amount permitted under Subsection 502.05, to adjust the concrete mix to the required slump. Should it be necessary to hold the concrete in the mixer after mixing has been completed, the drum or blades shall be rotated at the manufacturer's designated agitating speed.
3. Retempering concrete by adding water or by other means will not be permitted, after a concrete load has been accepted at the project site as specified in 2, above.
4. Mixing of concrete, in all cases, shall begin within 30 minutes of the time that the cement has been added to the aggregate.

(d) Discharging.

1. Concrete, when discharged from mixers or agitators, shall be of the consistency and workability required for the job and shall be in accordance with Subsection 502.05.
2. The rate of discharge from a truck mixer shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate, if any, fully opened.

(e) Delivery.

1. Delivery and discharge from the mixer in all cases shall be completed within a maximum of 1 1/2 hours from the time the cement is added to the aggregate, except that in hot weather when the concrete mix temperature exceeds 70°F or under other conditions contributing to quick stiffening of the concrete, delivery and discharge from the mixer shall be completed within 1 hour. The use of a retarding admixture for increasing the discharge time limits will not be allowed.
2. When a truck agitator or truck mixer is used for transporting concrete that has been mixed, it shall be operated at the speed designated by the manufacturer as agitating speed so long as the concrete is in the drum.
3. When approved, concrete which has been designed for the purpose may be transported in suitable non-agitating equipment. The bodies or non-agitating equipment shall be of metal, smooth with rounded corners, watertight and equipped with gates which will control the discharge of the concrete. Approved covers shall be provided for protection against the weather. Concrete transported in non-agitating equipment shall be delivered to the site of the work in a thoroughly mixed and uniform mass. Slump tests of representative samples taken during the discharge shall not differ by more than 2 inches. Discharge shall be completed within 45 minutes after introduction of the mixing water to the cement and aggregate.
4. Concrete which has been condemned for any reason shall be removed immediately from the job site and disposed of.

- (f) Certification of Batches. The Department will provide a delivery ticket system when ready-mixed concrete is used.

The ticket will be issued to the truck operator at the batching plant for each truck load. The tickets shall be delivered to the Engineer or his inspector at the time and place of delivery. Loads for which tickets are not provided shall not be used in the work.

502.08 Cold Weather Concrete. Unless authorized by the Engineer, the mixing and placing of concrete shall be discontinued when the atmospheric temperature is below 40°F in the shade and dropping and shall not be resumed until the atmospheric temperature is as high as 35°F in the shade and rising. If authorization is granted for the mixing and placing of concrete under atmospheric conditions different from those specified above, the water shall be heated to a temperature not exceeding 180°F. When either the aggregate or water is heated to above 120°F, they are to be combined first in the mixer before the cement is added. If the atmospheric temperature is below 25°F, the aggregate shall also be heated when directed by the Engineer. Materials containing frost or lumps of frozen material shall not be used. Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over a fire. When aggregates are heated in bins, steam coil or water coil heating or other methods which will not be detrimental to the aggregates may be used. The heating apparatus shall be capable of heating the mass uniformly and preventing the occurrence of spots of overheated material. The temperature of the mixed concrete shall be between 50°F and 70°F when it is placed in the forms. Salt or other chemicals shall not be added to the concrete for any reason whatsoever, except by written permission of the Engineer.

When the use of calcium chloride is authorized for the purpose of hastening the initial set of concrete, it shall be in solution. The solution shall be prepared by dissolving one 100-pound bag of Type 1 (regular) or one 80-pound bag of Type 2 (concentrated) in approximately 15 gallons of water and then adding sufficient water to make 25 gallons of solution. The amount of solution used shall be as directed by the Engineer, but shall not exceed 1/2 gallon for each sack of cement and shall be considered as a portion of the mixing water.

When concrete is placed under the above cold weather conditions or when concrete has been in place less than the minimum curing period specified under Subsection 502.15 and the ambient temperature drops below 35°F, the Contractor shall furnish sufficient canvas and housing framework or other type of covering, to enclose and protect the structure. Sufficient insulation or heating apparatus and fuel to furnish all required heat, shall be supplied. When dry heat or approved insulation is used, means of preventing loss of moisture from the concrete shall be provided. The temperature of the concrete and its surfaces shall be kept above 50°F for 4 days and above 32°F for the remainder of the minimum curing period specified under specification 502.15 and in the 24 hours following the curing period the temperature of the concrete shall be gradually decreased but not to exceed a total of 50°F for thin deck and similar sections; 40°F for moderate sections such as abutments and pier bents; and 30°F for mass sections such as massive piers.

When permitted by the Engineer, footings may be protected by completely submerging them by admitting water inside the cofferdam. Until submersion takes place the temperature of the concrete and its surface shall be controlled as specified above. Submersion shall proceed slowly and the temperature of the air or water shall be maintained sufficient to prevent ice from forming within the cofferdam for a period of 7 days after the placing of the concrete.

When depositing concrete under water, there shall be no ice inside the cofferdam.

Permission given to place concrete under the conditions mentioned above shall not relieve the Contractor of responsibility for obtaining satisfactory results. Unsatisfactory concrete placed under such conditions shall be removed and replaced at the Contractor's expense.

502.09 Consistency. The required consistencies for the various classes of concrete shall meet the requirements of Subsection 502.05. The consistency shall be measured in inches of slump of the mixed concrete.

Consistency tests shall be made, at the discretion of the Engineer, at intervals during the placing of concrete, for the purpose of controlling the uniformity of the mix.

The slump of mixed concrete shall be determined in accordance with the requirements of AASHTO T 119.

502.10 Forms and Falsework.

- (a) Construction of Forms. All forms shall be well built, substantial and unyielding, securely braced, strutted and tied to prevent motion and distortion while concrete is being placed in them, and strong enough to support safely, in addition to the weight of the concrete, all superimposed loads (such as runways, concrete buggy loads, workmen, scaffolding, etc.) placed upon them.

All lumber used for exposed surface forms shall be made of sized and dressed tongue and groove lumber with a minimum thickness of 25/32 inch; or lumber that is dressed on 1 or both sides and both edges to a uniform thickness after dressing of not less than 1 1/4 inches or plywood of an exterior plyform grade, 5-ply, bonded with a waterproof glue and having a minimum thickness of 5/8 inch. Other form material may be used with permission of the Engineer.

Undressed lumber of uniform thickness, otherwise fulfilling the requirements for lumber dressed on 1 side, may be used for surfaces that will not be exposed in the finished structure.

Lumber for studding, walings, struts, braces, etc., shall be free from winds, cracks and other structural defects rendering it unsatisfactory for the purpose for which it is to be used.

Forms shall be built to conform to the dimensions, location, contours and details shown on the plans. The faces of forms against which the concrete is to be placed shall be dressed smooth and uniform and shall be free from winds, twists, buckles and other irregularities.

Stay-in-place forms of any type will not be permitted for any part of the slab structures, unless otherwise indicated on the construction plans.

The placing of concrete in excavated pits and trenches without forms will be permitted only in exceptional cases and then at the discretion of the Engineer.

Except in the construction of forms for columns and round ended piers, the form lumber shall be placed horizontally.

All corners within the forms shall be fitted with chamfer strips mitred at their intersections, except that chamfer strips will not be required as follows: (1) on corners of slab blocking of interior steel beams and the inside of exterior steel beams; (2) on corners constructed transversely at the underside of the slab of superstructures which consist of a concrete slab on steel beams; (3) on footings not exposed to view; and (4) on all structures when more than 2 feet below the final finished ground line.

Chamfer strips shall have a width across the diagonal face between $1/2$ and $3/4$ inch. The size to be adopted for a given portion of the work shall depend upon the general dimensions. Except where special size chamfer strips are shown on the plans, the size of chamfer strips shall be uniform on individual projects. Provision shall be made for the chamfering of the top edges of abutment bridge seats and wing walls, tops of piers and retaining walls, tops of through girders, roadway curbs, etc., by nailing chamfer strips inside the forms. Unless otherwise provided, all chamfer strips shall produce plain flat surfaces on the concrete.

The forms for beams, girders and spandrel arches shall be so constructed as to permit the sides to be removed without disturbing the supports.

All sawdust, chips, blocks, shavings and other foreign matter within the forms shall be removed before depositing concrete in them. To ensure and to facilitate thorough cleaning of forms, clean out ports shall be provided in the forms at all horizontal construction joints of abutments, piers, retaining walls and columns; and narrow forms may be built with removable sections.

All forms shall be held rigidly to correct alignment and location by ample supports, waling and braces. In all cases where metal anchorages or ties within or through the face forms are required to hold the forms in their correct position, such anchorages or ties shall be of ample strength and shall be so constructed that the metal work can be removed to a depth of not less than one inch from the face and back surfaces of the concrete without damaging such surfaces.

Elevations will be taken on the top flanges of structural steel beams and girders for the purpose of determining the depth of blocking necessary for the construction of the forms for the concrete slab, after the following conditions have been satisfied:

1. The satisfactory erection of the superstructure structural steel beams or girders, including any required flooring beams and stringers.
2. No foreign loads supported by the beams or girders.

The Contractor shall submit working drawings for approval of the proposed forms and falsework supporting the overhanging portion of the superstructure slab in accordance with Subsection 105.02. The working drawings shall show the size and location of the supporting members, the proposed loads and the weight of concrete forms to be carried by the members.

In the construction of forms and falsework for the portion of superstructure slabs overhanging the exterior members of steel beam and girder spans, forms and supporting devices resulting in point loadings on the webs of the exterior stringers shall not be used. Loads resulting from such supporting devices shall be distributed over sufficient area of the stringer webs to eliminate deflection of the webs and the resulting settlement of the forms. Such loads may be transferred directly to the stringer flanges by means of brackets or braces.

All forms shall be inspected and approved before the placing of any concrete within them.

- (b) Surface Treatment of Forms. In order to insure the non-adhesion of the mortar to the forms, the inside surfaces shall be uniformly coated with raw paraffin or other non-staining mineral oil, soaped or thoroughly wetted with water (except in freezing weather). If soap is used, it shall be mixed with sufficient water to produce a thin jelly-like substance. When forms are used more than once they shall be thoroughly cleaned before each setting and recoated with oil, soap or other approved surface treatment.

When materials for surface treatment other than plain water are to be used the application shall be done before the placing of the reinforcing steel.

Whenever forms are constructed several days in advance of filling with concrete, they shall be kept moist or otherwise protected against warping and other defects caused by the drying out of the lumber.

In order to protect the concrete from the damaging effect of pitch in knots, all knots in the exposed surfaces of forms shall be thoroughly shellacked before treating forms as described above.

- (c) Construction of Falsework. All falsework used for supporting reinforced concrete superstructures shall be composed of members having ample structural sections to resist, without appreciable deformation or settlement, the loads imposed upon them. In addition to the weight of the superstructure, these loads shall include all forms, bracing, runways and other loads that may be imposed during construction. The

weight of the superstructure shall be taken as the weight of all concrete to be placed before the removal of falsework. Falsework shall be well built, rigid and unyielding, securely braced, struttred and tied to prevent distortion and movement tending to produce vibration and deformation of the superstructure forms.

When the vertical members of falsework consist of piles or when framed or other falsework is supported upon piles, the piles shall be driven to secure a safe load resistance.

When falsework is supported upon mud sills, the sills shall consist of at least 2 layers of timbers, the upper layer being laid transversely to the one beneath. The foundation pressures resulting from the imposed loads upon mud sills (falsework, forms, fresh concrete, scaffolding, etc.) shall, in general, not exceed the following:

1. For firm sand, gravel, rotten rock, very firm clay and other similar soils in confined thick beds, 2 tons per square foot.
2. For loose sand and gravel and ordinary clay soils in confined thick beds, 1 ton per square foot.
3. For soft clay and firm alluvial soils, 1/2 ton per square foot.

All arch centering and falsework shall be subject to approval, but the work shall be done entirely at the risk of the Contractor, the Engineer's approval in no way relieving the Contractor of his responsibility.

Falsework shall be so constructed that the forms will have a camber, the amount depending upon the length of span, load and conditions of falsework framing.

Forms supported upon falsework shall be provided with a satisfactory means for their adjustment in the event of settlement or deformation of the falsework due to overloading or other causes.

Provisions shall be made by means of suitable wedges, sand boxes or other devices for the gradual lowering of falsework and rendering the supported structure self supporting.

(d) Removal of Forms and Falsework.

1. Location, weather conditions, materials used and the character of the structure involved shall be considered in determining the time for the removal of forms. In general, forms shall not be removed until the concrete has set sufficiently to give forth a distinct "stony ring" when struck with a small hammer. In general, depending upon conditions, forms for vertical surfaces as well as supporting forms and falsework for slabs having a clear span of less than 10 feet shall not be removed for at least 7 days. Under similar conditions, supporting forms and falsework for slabs and beams having a clear span of 10 feet or more shall not be removed for a period of 14 to 21 days.

At the Contractor's option, the vertical forms of footings, walls, columns and sides of beams and slabs may be removed 48 hours after placement of concrete, exclusive of the time the ambient air temperature is below 45°F and provided the following conditions are met:

Immediately after the forms are removed, defects in the concrete surface shall be repaired in accordance with Subsection 502.13 and the repaired area thoroughly dampened with water. The surfaces of exposed concrete shall be cured for the remainder of the 7 days by the application of an approved liquid membrane-forming compound applied in accordance with Subsection 502.15. Other methods of curing concrete may be used with the prior approval of the Engineer.

2. In cold weather, the Engineer may require that the length of time that forms and falsework are to remain in place, be increased.
3. Forms and Falsework shall not be removed without the consent of the Engineer. The Engineer's consent shall not relieve the Contractor of responsibility for the safety of the work. 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. In general as the forms are removed, all projecting wire or metal devices which have been used for holding the forms in place, shall be removed or cut back at least 1 inch from the exposed surface of the concrete and the holes filled as required in Subsection 502.13.

- (e) Re-use of forms. When forms are to be re-used they shall be maintained at all times for shape, strength, rigidity, water-tightness and surface smoothness. Any warped or bulged lumber shall not be used. Forms failing to meet these requirements will be considered unsatisfactory and shall not be used.

502.11 Placing Concrete.

- (a) General. Concrete shall not be placed until forms and reinforcing steel have been checked and approved. The forms shall be clean of all debris. The method and sequence of placing the concrete shall be approved before any concrete is placed.

All concrete shall be placed before it has taken its initial set and, in any case, within 30 minutes after mixing, except as modified under Subsection 502.07. Concrete shall be placed in such a manner as to avoid separation and segregation of coarse or fine portions of the mixture and shall be spread in horizontal layers. Comparatively rich mixes, as directed by the Engineer, may be required initially in slabs and girders to facilitate the placing and compacting of the concrete around nests of reinforcing steel, so as to eliminate rock pockets or air bubbles. A sufficient number of men for the proper handling, tamping and operation of vibrators shall be provided to compact each batch before the succeeding one is dumped and to prevent the formation of joints between batches. Extra consolidation shall be done along all faces to obtain smooth surfaces. Care shall be taken to prevent mortar from spattering on structural steel, reinforcing steel and forms. Any concrete or mortar which becomes dried on the structural steel, reinforcing steel or forms shall be thoroughly cleaned off before the final covering with concrete. Following the placing of the concrete, all structural steel surfaces shall be thoroughly cleaned as required, with care not to injure any painted surfaces.

Concrete shall not come in contact with sea water during placing and for a period of 72 hours thereafter, except as follows:

For seal concrete or any authorized concrete deposited under water, the above requirements will not apply.

For concrete footings constructed in the dry and located entirely below low tide or final ground elevation, the requirement that concrete shall not come in contact with sea water for a period of 72 hours after placing will not apply.

Concrete in any section of a structure which has a depth greater than 18 inches, shall be placed in approximately horizontal layers of such thickness that the entire surface may be covered and succeeding layers placed before the underlying layer has taken its initial set. Layers shall not exceed 18 inches in thickness and shall be so compacted as to become an integral part of the layer below. Every effort shall be made to produce a structure monolithic between the joints. However, should the placement be unavoidably delayed long enough to allow the underlying layer to take initial set or produce a so called "cold joint", the following steps shall be taken:

An incomplete horizontal layer shall be bulk-headed off to produce a vertical joint.

Horizontal joints shall be treated as required in this Subsection 502.11.

Should a cold joint occur in such a way as would produce a feather edge in the succeeding layer, inset form work shall be built to make the succeeding layer in a body of concrete not less than 6 inches thick.

The concrete in superstructures shall be placed monolithically except when construction joints are shown on the plans or are authorized in accordance with approved details submitted by the Contractor. If the concrete in the stems of T-beams is to be placed independent of the slab section, the construction joint shall be located at the under side of the slab and the bond between stem and slab shall be a mechanical one. The bond shall be produced by embedding 2 by 4 inch wooden blocks having a length approximately 4 inches less than the width of the stem and placed horizontally at right angles to the centerline of the beam in the top surface of the concrete immediately following the completion of the concrete placement. To provide for the uniform spacing of the blocks and their ready removal when the concrete has taken a set sufficient to hold its form, the blocks shall be firmly nailed upon a board at a distance of 1 foot center to center. The blocks shall be thoroughly oiled to facilitate their ready removal from the concrete.

In arch spans, the order of construction or sequence of the work, as shown on the plans, shall be followed in the placing of concrete.

In no case shall the work on any section or layer be stopped or temporarily discontinued within 18 inches below the top of any face, unless the plans provide for a coping having a thickness less than 18 inches, in which case at the option of the Engineer, the construction joint may be made at the under side of the coping. When placing concrete in columns for the bearing of girders, beams or slabs, the work shall not be continued above the top of the columns until a period of at least 2 hours has elapsed. Each column shall be examined for accumulations of "laitance" or other foreign matter which, if present, shall be removed in preparation for resuming the placing of concrete. Concrete in columns shall be placed in one continuous operation, unless otherwise directed.

Sloping top surfaces of abutment wings or retaining walls, when too steep to be struck off in the manner of horizontal surfaces, shall be treated as follows:

1. A series of form baffles shall be constructed on the top of and at right angles to the wing, to permit over filling the forms in steps. The spacing of the baffles shall depend upon the slope of the wing. The steeper the slope, the closer together the baffles shall be placed.
2. As soon as the concrete will support itself, the baffles shall be removed.
3. Immediately following removal of the baffles, the excess concrete shall be removed and the surface shall be finished with a wood float to the neat line at the top of the chamfer strips.

Fresh concrete, threatened with damage by rain shall be protected with a covering of canvas, tarpaulins, waterproof paper or by other approved means. Sufficient material for covering the work expected to be done in one day shall be on hand at all times for emergency use. The covering shall be supported above the surface of the concrete by suitable frames.

- (b) Chutes, Troughs, Pipes and Buckets. Sectional drop chutes or short chutes, troughs, pipes and buckets when used as aids in placing concrete, shall be arranged and used in such a manner that the ingredients of the concrete do not become separated or segregated. Where steep slopes are required, troughs and chutes shall be equipped with baffles or shall be

short lengths that reverse the direction of movement. All chutes, sectional drop chutes, troughs, pipes and buckets shall be kept clean and free of coatings of hardened concrete by flushing thoroughly with water after each run. Water used for flushing shall be discharged clear of the concrete in place. Chutes, troughs, pipes and buckets shall be of metal or shall be lined with metal or its equal and when used for placing concrete shall extend as nearly as possible to the point of deposit. When buckets are used, they shall be placed as close as possible to the point of deposit before opening for discharge. Aluminum chutes, troughs, pipes or buckets are not acceptable and shall not be used.

When discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

Dropping the concrete a distance of more than 6 feet, unless confined by closed chutes or pipe or depositing a large quantity at any point and running it or forcing it along the forms will not be permitted. The concrete shall be deposited at or as near as possible to its final position. The coarse aggregate shall be worked back from the forms. After the initial set of the concrete and before the completion of the curing period, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

The placing of concrete shall be so regulated that the pressures caused by plastic concrete shall not exceed those for which the forms were designed.

- (c) Vibrating. Mechanical, high frequency internal vibrators shall be used, operating within the concrete, for compacting the concrete in all structures and precast and cast-in-place piles, with the exception of concrete placed under water, unless otherwise directed by the Engineer. The vibrators shall be an approved type, with a minimum frequency of 5,000 cycles per minute and shall be capable of visibly affecting a properly designed mixture with a 1 inch slump, for a distance of at least 18 inches from the vibrator. A spare vibrator shall be available at all times during the placing of concrete.

Sufficient vibrators shall be used to consolidate the incoming concrete within 15 minutes after placing. Vibrators shall not be held against forms or reinforcing steel nor shall they be used for flowing the concrete or spreading it into place. Vibrators shall be so manipulated as to produce concrete that is free of voids, of proper texture on exposed faces and of maximum consolidation. Over-vibrating, tending to cause segregation, shall be avoided.

- (d) Unwatering Forms. Unless otherwise provided, all forms shall be unwatered before concrete is placed in them. Pumping will not be permitted from the inside of forms while concrete is being placed. Moving water shall not be permitted to come in contact with fresh concrete.
- (e) Depositing Concrete under Water. Unless permitted by the Engineer, no concrete shall be deposited under water except for cofferdam seals. Pumping will not be allowed within the cofferdam while concrete is being placed.

If concrete, other than for cofferdam seals, is permitted to be deposited under water, the proportion of cement to be used shall be increased by 25 percent and the extra cement shall be at the expense of the Contractor.

To prevent segregation, the concrete shall be placed carefully in a compact mass in its final position by means of a tremie or by other approved means and shall not be disturbed after being deposited. Bottom dump buckets will not be permitted. Special care must be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water. The method of depositing concrete shall be so regulated as to produce approximate horizontal surfaces. Each seal shall be placed in one continuous operation.

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 or equivalent water tight couplings. The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire top of the seal and to permit its being lowered rapidly, when necessary to choke off or retard flow. The tremie shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall be kept full to the bottom of the hopper. The flow shall be regulated by raising or lowering the tremie.

When the horizontal area of the tremie seal is large, several tremie hoppers shall be provided and positioned strategically to allow easy deposit of concrete near the point where it is needed to avoid moving concrete horizontally through the water. The number of tremie hoppers and the work plan shall be approved by the Engineer.

All laitance or other unsatisfactory material shall be removed from the surface of the seal before placing additional concrete. The surface shall be cleaned by scraping, chipping or other means which will not injure the concrete.

The placing and unwatering of seal concrete within cofferdams shall be in accordance with Section 511 -- Cofferdams.

- (f) Construction Joints. Construction joints shall be located where shown on the plans or permitted by the Engineer. When the concrete is in sea water, except concrete cores for stone masonry, no horizontal construction joint will be permitted between low tide and high tide elevations. Construction joints shall be perpendicular to the principal lines of stress and in general, shall be located at points of minimum shear.

At horizontal construction joints, temporary gage strips having a minimum thickness of 1 1/2 inches shall be placed inside the forms along all exposed faces to give the joints straight lines. The joint shall be so constructed that the surface of the concrete will not be less than 1/4 inch above the bottom of the gage strip. Before placing fresh concrete, the temporary gage strip shall be removed, the surfaces of construction joints shall be thoroughly cleaned, drenched with water until saturated and kept saturated until the new concrete is placed. Immediately prior to placing new concrete the forms shall be drawn tight against the concrete already in place. When requested by the Engineer the old concrete surface shall be coated thoroughly with a very thin coating of neat cement paste or mortar. Concrete in substructures shall be placed in such a manner that all horizontal joints will be horizontal and if possible, in locations such that they will not be exposed to view in the finished structure.

Where vertical construction joints are necessary, reinforcing bars shall extend across the joint in such a manner as to make the structure monolithic. Special care shall be taken to avoid construction joints through paneled wing walls or other large surfaces which are to be treated architecturally. All vertical construction joints in abutments and retaining walls shall contain waterstops as shown on the plans. The waterstops shall be one continuous piece for each designated location.

Construction joints in the wearing surface shall be located where called for on the plans. At the Contractor's option, a construction joint may be made at

the line between the traveled lanes and sealed in the same manner as for transverse joints. Construction joints in the wearing surface shall have the edges on both sides of the joint rounded with an approved edging tool to a radius of not more than 1/4 inch. Care shall be taken not to depress the surface of the concrete in the area adjacent to the rounded corner. After the edging is completed, the area shall be broomed to match the adjacent broomed surface.

All joints shall be formed in the manner detailed on the plans. The forms at the sealing slot shall not be treated with oil or any other bond breaking material that will adhere to the concrete.

After the concrete has been cured, the sealing slot shall be sandblasted with approved equipment to remove all laitance and foreign material on the surfaces of the slot. The joint shall then be filled within 1/8 inch of the surface with a poured sealant conforming to the following requirements and in accordance with the manufacturer's recommendations. When primer is required by the manufacturer to be used with the joint sealant furnished, it shall be applied as indicated by the instructions from the manufacturer.

The joint sealant supplied shall be a 2 component, polymer-type modified urethane. Both components shall be in liquid form and the combining ratio of components by volume shall be as recommended by the manufacturer.

The sealant shall be formulated to meet the requirements of Federal Specification SS-S-200D.

A list of approved sealants is maintained at the office of the Department at Augusta and from the list the Contractor shall make a selection or shall submit certified test data on the sealant for evaluation and approval by the Department.

- (g) Concrete Wearing Surface. A separate concrete wearing surface shall be bonded to the supporting slab. No surface preparation of a new structural concrete slab shall begin before completion of the specified curing period.

The entire area of the deck surface and the faces of curb and barrier walls or other median devices, up to a height of 1 inch above the top elevation of the overlay, shall be cleaned to a bright, clean appearance which is free from curing compound, laitance, dust, dirt, oil, grease, bituminous material, paint and all other foreign matter. Air lines shall be equipped with effective oil traps. The cleaning of an

area of the deck shall normally be performed within the 24 hour period preceding placement of the wearing surface. The cleaning shall be performed by dry sand blasting or other methods approved by the Engineer.

All debris from the cleaning operation shall be thoroughly removed by compressed dry air from the cleaned surfaces and adjacent areas. The cleaned areas shall be protected against contamination prior to placement of the wearing surface. Contaminated areas shall be recleaned by dry sand blasting. Prepared areas which have not received the wearing surface within 36 hours, shall be recleaned by dry air blasting (150 psi minimum).

The supporting slab shall preferably be dry but, in any case, shall be free of excess moisture prior to placement of the bonding grout.

The vertical faces in contact with the wearing surface shall be broomed with bonding grout up to the elevation of the top of the wearing surface by brooming with the narrow width of a stiff bristled street broom. All horizontal surfaces in contact with the wearing surface shall receive a coating of bonding grout. Except as otherwise approved by the Engineer, the grout shall be applied from a metal or plastic container which has a series of 3/8 inch diameter holes uniformly spaced on the bottom and close to the bottom on the sides. As much as practicable, street brooms shall be used to brush the grout onto the surface and under the reinforcing steel. In general, the coating shall not exceed 1/8 inch in thickness. The rate of progress in applying grout shall be limited so that the grout does not become dry before it is covered with new concrete.

During delays in the surfacing operations, should the surface of the grout indicate an extensive amount of drying, additional grout shall be brushed on the area, as directed by the Engineer. In areas where the grout becomes thoroughly dried, the grout shall be removed by sand blasting or other methods as approved by the Engineer.

The bonding grout shall have portland cement and fine aggregate proportioned 1 to 1 by volume. The fine aggregate from which the material larger than 1/8 inch has been removed shall be the same source as used in the concrete. The cement and fine aggregate shall be measured separately in equal size containers. The fine aggregate shall be deposited in an approved mechanical mortar mixer prior to adding cement. Both the fine aggregate and cement shall be dry mixed for 1 minute. After dry mixing, water shall be added in sufficient quantity to result in a workable consistency. An additional 3 minutes of mixing shall be

required after adding water to obtain a workable consistency. Workable consistency is defined as the minimum of water necessary to allow flow of most of the grout without segregation of the grout ingredients. No further water shall be added. The grout shall not be allowed to separate prior to placement. The cement to water contact time of the grout shall not exceed 30 minutes before it is placed. Any grout that has dried or become unworkable prior to application, as determined by the Engineer, shall not be incorporated into the work.

502.12 Expansion and Contraction Joints. Expansion and contraction joints shall be located and constructed as shown on the plans.

- (a) Expansion Joints. In filled expansion joints, the thickness, shape and size of the filler to be installed shall be as shown on the plans. If preformed expansion joint filler is required, it shall be fixed firmly against the surface of the concrete already in place in such a manner that it will not be displaced when concrete is deposited against it and it shall be permanently secured to the concrete at one side of the joint by rust resistant nails cast in the concrete or other suitable means.

When necessary to use more than one piece of filler to cover any surface, the abutting pieces shall be placed in close contact and the joint between them shall be so treated as to prevent the entry of any concrete mortar from subsequent placements. Immediately after the forms are removed, the expansion joints will be inspected and any concrete or mortar that has sealed across the joint shall be cut neatly and removed. During construction when an opening of 1/8 inch or more appears in any joint over which any traffic passes, the opening shall be completely filled with an approved material, as directed.

Polyvinylchloride waterstops shall be placed in all vertical expansion joints. The waterstop shall be of one continuous piece for each designated location.

- (b) Contraction Joints. Polyvinylchloride waterstops shall be placed in all vertical contraction joints. The waterstop shall be of one continuous piece for each designated location. Bond shall be broken in all vertical contraction joints by a method approved by the Engineer.

502.13 Repairing Defects and Filling Form Tie Holes in Concrete Surfaces. After the forms and ends of form ties are removed, all porous areas, stone pockets, open or porous construction joints and holes left by the form ties shall be repaired.

All fins and irregular projections shall be removed from the following: Surfaces which are visible in the completed work; surfaces to be waterproofed; and the portion of face surfaces of substructure units which is below the final ground surface to a depth of 12 inches, not including underwater surfaces.

In patching porous areas, all coarse or fractured material shall be chipped away until a dense uniform surface, exposing solid coarse aggregate is obtained. Feathered edges shall be cut away to form faces having a minimum depth of one inch perpendicular to the surface. All surfaces of the cavity shall be saturated thoroughly with water, after which a thin layer of neat cement paste shall be applied. The cavity shall then be filled with thick, reasonably stiff mortar, not more than 30 minutes old, composed of material of the same type and quality and of the same proportions as that used in the concrete being repaired. The surface of this mortar shall be floated with a wooden float before initial set takes place and shall be neat and workmanlike in appearance. The patch shall be kept wet for a period of 5 days.

If the removal of defective concrete materially impairs the soundness or strength of the structure, the affected unit shall be removed and replaced by the Contractor at his expense.

The holes left by form ties, on the portions of substructure concrete which are to be permanently covered in the finished work, may be filled with an acceptable grade of plastic roofing cement when the temperature of the concrete or ambient temperature is below 35°F and with the approval of the Engineer. Holes in the bottom of slabs caused by supporting hangers need not be filled.

502.14 Finishing Concrete Surfaces. Neat cement paste, dry cement powder or the use of mortar for topping or plastering of concrete surfaces will not be permitted.

- (a) Float Finish. A float finish for horizontal surfaces shall be achieved by placing an excess of concrete in the form and removing or striking off the excess with a template or screed, forcing the coarse aggregate below the surface. Creation of concave surfaces shall be avoided. After the concrete has been struck off, the surface shall be thoroughly floated to the finished grade with a suitable floating tool of wood, cork or other approved material.

Float finish, unless otherwise required, shall be given to all horizontal surfaces except those intended to carry vehicular traffic and those of curbs and sidewalks.

- (b) Structural Concrete Slab Structures, such as structural concrete deck slabs, wearing surfaces, top and bottom slabs of box culverts, approach slabs, rigid frame structures and simple slab spans, as applicable. Screed rails shall be set entirely above the finished surface of the concrete and shall be supported in a manner approved by the Engineer. Where shear connector studs are available, welding to the studs will be permitted. Where no studs are available other means of attaching the screed rail supports shall be provided. No welding will be permitted directly on the stringer flanges in tension areas, nor in areas subject to stress reversal, for attaching either screed rail supports or form supports of any type. Any welding in compression areas shall be approved by the Engineer.

Screed rail supports set in the concrete shall be so designed that they may be removed to at least 2 inches below the surface of the concrete. Voids created by removal of the upper part of the screed rail supports shall be filled with mortar having the same proportions of sand and cement as that of the slab or wearing surface. The mortar shall contain an approved additive in sufficient proportions to produce non-shrink or slightly expansive characteristics.

An approved bridge deck finishing machine complying with the following requirements shall be used, except as otherwise specified, for finishing structural concrete slab structures. The finishing machine shall have the necessary adjustments to produce the required cross section, line and grade. The supporting frame shall span the section being cast in a transverse direction without intermediate support. The finishing machines shall be self-propelled and capable of forward and reverse movement under positive control. Provisions shall be made for raising all screeds to clear the screeded surface for traveling in reverse. The screed device shall be provided with positive control of the vertical position. The finishing machine shall be self-propelled with either one or more oscillating screeds or one or more rotating cylinder screeds. An oscillating screed shall oscillate in a direction parallel to the centerline of the structure and travel in a transverse direction. A rotating cylinder screed shall rotate in a transverse direction while also traveling in the same direction. Either type of screed shall be operated transversely in overlapping strips in the longitudinal direction not to exceed 6 inches. One or more

powered augers shall be operated in advance of the screed(s) and a drag (pan-type) float shall follow the screed(s). For concrete placements less than 6 inches in depth, a vibratory pan(s) having a minimum of 3000 vpm (vibrations per minute) shall be operated between the oscillating screed(s) or rotating cylinder screed(s) and the power auger(s). For concrete placed in excess of 3 1/2 inch but less than 6 inch thicknesses, hand-operated spud vibrators shall be used in addition to the machine vibratory pan(s).

Hand-operated, vibrating screeds may be used on slab structures which are more than 12 inches below the roadway finish grade or have a length of 30 feet or less.

The rate of placing concrete shall be limited to that which can be finished without undue delay and shall not be placed more than 10 feet ahead of strike-off.

When using a bridge deck finishing machine, the concrete mixture shall be placed and struck off to approximately 1/4 inch above final grade by the advance auger(s). It shall be consolidated with the vibrating pan(s) and then finished to final grade.

A small hand-held pan vibrator shall be required at edges and adjacent to joint bulkheads. In lieu of the hand-held pan vibrator equipment, the Engineer may approve small spud vibrator(s).

The Contractor shall furnish a minimum of two work bridges behind the finishing operation, capable of spanning the entire width of the deck and supporting at least a 500 pound load without deflection to the concrete surface, to be supported on the screed rails. These working bridges shall be used by the Contractor for touch-up and curing cover application and shall be available for inspection purposes. When the overall length of the structure is 60 feet or less only one working bridge will be required.

Supporting slabs for bituminous wearing surfaces shall receive a light machine texture or the Contractor may use an approved barn or street broom and hand-finish by lightly and uniformly brooming at right angles to the centerline of the road. Texturing of supporting slabs for concrete wearing surface is not required.

On all concrete wearing surfaces, immediately following the machine float finishing, a machine texturing device shall be used. This machine texturing device may be completely separate from the screed finishing machine or it may be as a modification attachment and trailing the drag float. This texture

device shall be of an approved open-pile, stiff bristle texturing mat used at right angles to the centerline of the road. This mat shall be rigidly attached so that it is draped onto the surface to obtain a uniform, medium texture.

On all concrete wearing surfaces, a 1 foot wide margin shall be finished adjacent to curbs with a magnesium float.

Immediately after screeding, floating and texturing, the surface of the concrete shall be tested for true-ness, by the Contractor, with a 10 foot straightedge and all irregularities corrected at once in order to provide a final surface within the tolerance required in the following table. The surface shall be checked both transversely and longitudinally. Any area that requires finishing to correct surface irregularities shall be retextured which may be performed with a hand-operated texture mat wrapped in a roll or attached to a round or curved shape base.

The straightedges shall be furnished and maintained by the Contractor. They shall be fitted with a handle and all parts shall be made of aluminum or other light weight metal. The straightedges shall be made available for use by the Inspector when requested.

Type of Surface	*Maximum deviation of surface below a 10 foot straightedge
Concrete Wearing Surface	1/8"
Concrete Slab Surfaces to be Covered by Membrane Waterproofing or Concrete Wearing Surfaces	1/4"
Concrete Slab Surfaces with Integral Concrete Wearing Surface	1/4"
Concrete Slab Surfaces to be Covered by Earth or Gravel	3/8"
Concrete Surface of Box Culvert Bottom Slabs	3/8"

*Allowance shall be made for crown, camber and vertical curve.

After the concrete has cured, the surface shall be tested again with the 10 foot straightedge. Areas not within the above tolerance table shall be corrected as directed by the Engineer.

In the event of a delay during a concrete placement an approved evaporation retardant that forms a monomolecular film shall be sprayed on to the concrete which has been deposited and not screeded. This evaporation retardant may later be mixed into the concrete by the finishing machine.

No vehicles will be allowed, either directly or indirectly, on reinforcing steel prior to concrete placement.

- (c) Curb and Sidewalk finish on Bridges. Curb and sidewalk finish is a float finish produced by using a short float of wood or other acceptable material, moved in small circles to produce a shell-like pattern on the surface of the concrete.

When a concrete curb is monolithic with a sidewalk or refuge walk and when the combined width is greater than 2 feet, a 6 inch wide smooth margin shall be made along the top of the curb with a magnesium float.

Unless shown on the plans, the sidewalk area shall not be divided into sections by transverse grooves. At all transverse construction and expansion joints, except where structural steel expansion plates are used, the edges of the joints, on the surface of the sidewalk, shall be finished with a sidewalk edging tool, 2 inches in width, with a 1/4 inch radius lip.

- (d) Form Surface Finish. The character of the materials used and the care with which forms are constructed and concrete placed shall be considered in determining the amount of rubbing required. If, through the use of first class form material, well constructed forms and the exercise of special care, concrete surfaces are obtained that are satisfactory to the Engineer, the Contractor may be relieved in part from the requirement of rubbing.

1. Ordinary Finish. An Ordinary Finish is defined as the finish left on a surface after the removal of the forms, the filling of all holes and the repairing of all defects. The surface shall be true and even, free from stone pockets and depressions or projections and of uniform texture.

Immediately following the removal of the forms, all defects shall be repaired as provided in Subsection 502.13.

All formed concrete surfaces shall be given an ordinary finish.

Repaired areas which do not meet the above requirements or areas which cannot be satisfactorily repaired to meet the requirements for ordinary finish shall be given a rubbed finish. When a rubbed finish is required on any part of a surface, the entire surface shall be given a rubbed finish.

2. Rubbed Finish. After removal of forms the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work the concrete shall be thoroughly saturated with water. Sufficient time shall have elapsed before wetting down to allow the mortar used in ordinary finish to become thoroughly set. Surfaces to be finished shall be rubbed with 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 as used in the concrete being finished. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled and a uniform surface has been obtained. A thin layer of paste produced by this rubbing shall be left on the surfaces.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by a second rubbing with a fine carborundum stone using only water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color. The paste produced by this second rubbing shall be carefully spread with a moist whitewash brush to form a very thin uniform coating upon the surface of the concrete.

After the final rubbing is completed and the surface has dried, it shall be rubbed lightly with clean and dry burlap to remove excess loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks. This finish shall result in a surface of smooth texture and uniform color.

No surface finishing shall be done in freezing weather or when the concrete contains frost. In cold weather the preliminary rubbing necessary to remove the inert sand and cement materials and the surface inequalities may be done without the application of water to the concrete surfaces.

The following portions of concrete structures shall be given a rubbed finish unless otherwise indicated on the plans or in the special provisions:

Railings and posts, including parapet walls-All surfaces except the bottoms of rail bars.

Superstructures-Exterior vertical surfaces except below copings and except where a protective coating is required.

Abutment wings and retaining walls-Top and the back to 1 foot 6 inches below top.

For roadway grade separation structures and their approaches, in addition to the above, the following surfaces shall also be given a rubbed finish unless otherwise indicated on the plans or in the special provisions.

Retaining walls and the breast and wing walls of abutments-Face surfaces to 12 inches below the finished ground line.

Piers-All vertical surfaces and the underside of overhanging portions of caps, except that for overpass structures, the piers beyond the outside limits of the roadway pavement, the vertical surfaces on the back which are not visible from the roadway or sidewalk will not require a rubbed finish.

If, in the opinion of the Engineer, the general appearance of a concrete structure, due to the excellence of workmanship, cannot be improved by a rubbed finish, this requirement may be waived.

502.15 Curing Concrete. All concrete surfaces shall be kept wet with clean fresh water for at least 7 days after placing of concrete.

All slabs and wearing surfaces shall be water cured only and kept continuously wet for the entire curing period by covering with one of the following systems:

Two layers of wet burlap,

Two layers of wet cotton mats,

One layer of wet burlap and either a polyethylene sheet or a polyethylene coated burlap blanket,

One layer of wet cotton mats and either a polyethylene sheet or a polyethylene coated burlap blanket.

Curing protection for slabs and wearing surfaces shall be applied within 30 minutes after the concrete is screeded and before the surface of the concrete has lost its surface "wetness" or "sheen" appearance. The first layer of either the burlap or the cotton mats shall be prewetted and shall be applied as soon as it is possible to do so without damaging the concrete surface. When the first layer of wet burlap or wet cotton mats cannot be placed without damage to the new concrete surface within the 30 minutes after screeding of any concrete, an approved evaporation retardant that forms a monomolecular film shall be applied. The application rate, the desired equipment and the mixing and application procedures shall be as designated by the manufacturer. The evaporation retardant shall be applied before the concrete surface has lost all its surface "wetness". Successive applications or heavier applications of this evaporation retardant shall be applied as necessary to retain the required surface "wetness" appearance.

At the option of the Contractor, an approved curing compound may be used on approach slabs below grade and bottom slabs, to provide the initial curing protection to the concrete in place of the above procedure. After the concrete surface has developed a firm set, it shall be covered with at least 1 layer of burlap or other suitable fabric and kept continuously wet for the entire curing period. Polyethylene sheets shall not be used directly on the concrete, but may be placed over the fabric cover to prevent drying.

All other surfaces, if not protected by forms, shall be kept thoroughly wet either by sprinkling or by the use of wet burlap, cotton mats or other suitable fabric until the end of the curing period. If wood forms are allowed to remain in place during the curing period, they shall be kept moist at all times to prevent openings at joints. Polyethylene sheets shall not be used on the concrete, but may be placed over the fabric cover to prevent drying.

When liquid-forming compounds for curing concrete are used they shall serve as the initial protection and curing as well as final curing except as stated above. Prior to transfer from containers to application equipment, the curing compound shall be agitated by a method approved by the Engineer, to assure uniformity of the mixture or solution.

The compound shall be applied immediately following final finishing and before any marked dehydration of the concrete or surface checking occurs.

The curing compound shall be applied continuously by an approved pressure spraying or distributing equipment at a rate necessary to obtain an even, continuous membrane, but at a rate of not less than 1 gallon per 200 square feet of surface.

If rain injures the film before it 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 area. The treated surface shall be protected from injury for a period of 7 days.

When the ambient temperature is expected to fall below 35°F, the Contractor shall make suitable provision to maintain the temperature of the concrete and its surface above the temperatures required in Subsection 502.08.

Special attention shall be given by the Contractor to the proper curing of concrete handrails and all surfaces requiring rubbed finishes.

502.16 Loading Structures and Opening to Traffic. In general, no superstructure concentrated loads such as structural steel beams, girders and trusses shall be placed upon finished concrete substructures until the concrete has been in place for a period of 7 days.

No load or work will be permitted on reinforced concrete superstructure slabs of composite construction for a period of 7 days, following the placement of the concrete. However, depending on curing conditions, after a shorter period of time the Engineer may permit handwork for form construction and setting stone bridge curb. No curbing or other materials shall be stored on the bridge during the 7 day period, except that if handwork is permitted, curb stones may be stored in a line near to their final location until ready to be set.

Neither traffic nor fill material shall be allowed on superstructures of concrete bridges or culverts for a period of from 14 to 21 days after the placing of the concrete has been completed, dependent upon conditions as specified in Subsection 502.10 and with the approval of the Engineer.

When a separate portland cement concrete wearing surface is required, the time after the placing of the concrete and prior to opening the surface to traffic shall be not less than 10 days, provided the superstructure on which the wearing surface is placed has been properly cured for the required period as stated in Subsection 502.15.

Concrete approach slabs at the end of structures may be opened to traffic, with the approval of the Engineer, 10 days after the placing of the concrete, provided that a minimum thickness of 6 inches of gravel, free of stones greater than 3 inches in size, is placed over the slab for traffic to travel on.

502.17 Bridge Drains and Incidental Drainage. All drains shall be accurately placed at the locations shown on the plans or authorized and adequate means provided for securely holding them in the required positions during the placing of concrete.

Bridge drains shall conform to the details shown on the plans. Welding shall be in accordance with Section 504 -- Structural Steel. Painting shall be in accordance with Section 506 -- Painting Structural Steel. Painting will not be required where the structural steel is specified to be unpainted.

Drains or weep holes through abutments and retaining walls shall be pipe of the size and shape shown on the plans and shall be of approved cast iron, tile, fiber or other material that will maintain its shape and alignment during placing of concrete.

For the purpose of providing drainage for any moisture which may collect between the floor slab and the bituminous concrete roadway surface, approved 1 inch inside diameter plastic tube drains shall be installed at the low points of the slab surface, adjacent to the end dam or dams. The exact location will be determined in the field by the Engineer and the discharge from them shall be such as to clear the bridge seats and any other portion of the structure in their proximity. The tops of the drains shall be depressed $\frac{3}{8}$ of an inch below the surface of the slab and the outlets shall project 2 inches below the underside of the slab. Care shall be exercised not to cover the tops of the drains with the required floor slab membrane waterproofing, when it is installed.

502.18 Method of Measurement.

- (a) Structural concrete satisfactorily placed and accepted will be measured by the cubic yard, in accordance with the dimensions shown on the plans or authorized changes in the plans, except as follows:
 - 1. Structural Concrete Superstructure Slabs, Structural Concrete Roadway and Sidewalk Slabs on Steel Bridges, Structural Concrete Superstructure T-beam Type, Structural Concrete Wearing Surfaces on Bridges, Structural Concrete Box Culverts and Structural Concrete Approach Slabs, complete and accepted, will each be measured by the lump sum, unless indicated otherwise in the schedule of items.
 - 2. Structural Concrete for foundations placed on rough and irregular ledge rock; or when used for jacketing or capping of rough and irregular stone masonry abutments, retaining walls and piers, if directed by the Engineer, may be measured by the cubic yard as determined from the theoretical yield of the design mix or in the case of ready-mixed concrete, by delivery ticket, in accordance with the paragraph (e) or (f) of this Subsection.

(b) The limits to be used in determining the quantities of the aforementioned structural concrete items for the purpose of arriving at a lump sum price will be as follows:

1. Structural Concrete Superstructure Slabs, Structural Concrete Roadway and Sidewalk Slabs on Steel Bridges and Structural Concrete Superstructure T-beam Type. The limits will be the entire concrete superstructure of the concrete portion of the superstructure, outside to outside, both transversely and longitudinally.
2. Structural Concrete Wearing Surfaces. The limits will be the entire concrete wearing surface bounded transversely by the roadway curbs and longitudinally by the extreme ends.
3. Structural Concrete Box Culverts. The limits will be the entire structure, meaning the bottom floor slab, abutments, wings, superstructure floor slab and headwalls or curbs.
4. Structural Concrete, Approach Slabs. The limit will be the entire approach slab or slabs, as shown on the plans.

(c) No deduction will be made for the volume of concrete displaced by structural steel, reinforcing steel, pile heads, expansion joint material, drains, chamfers on corners, inset panels of 1 1/2 inches or less in depth, pipes, weep holes and authorized openings for utilities of 1/4 cubic yard or less in volume, when any of these items occur in structural concrete which is to be paid for on a cubic yard basis.

(d) When foundations for concrete structures are required to be at a definite elevation within rock excavation, as shown on the plans or otherwise designated, the quantity to be measured will be the number of cubic yards of concrete actually and satisfactorily placed above a plane at 1 foot below the above specified plan elevation and within the neat lines of the structure as shown on the plans or on authorized changes in the plans. If the ledge rock is excavated below the plane at 1 foot below the plan elevation, without authorization, then this space shall be replaced with concrete of the same composition as required for the structure foundation but will not be measured for payment.

- (e) Concrete for structures which are to rest on either undisturbed or prepared ledge rock, when the ledge rock is rough and irregular, making it impracticable to measure the quantity within the limits as specified in the preceding paragraph from the ledge up to a horizontal plane or elevation selected by the Engineer, in the proximity of the high point of ledge rock and within the designated area where concrete is to be placed, may be determined from the theoretical yield, in cubic yards, computed from the design mix. When ready-mixed concrete is used for this type of construction delivery tickets as specified in this Section for each load satisfactorily delivered and placed, will be used for measurement purposes.
- (f) Concrete for jacketing or capping of stone masonry abutments, retaining walls and piers, when the masonry is rough and irregular, making it impracticable to measure the quantity by the three dimensional method, the quantity in cubic yards up to the elevation of the stone masonry, may be determined in accordance with the applicable requirements of paragraph (e) of this Subsection.

502.19 Basis of Payment. The accepted work done under structural concrete, of the classes and for the types of work required, will be paid for at the contract unit price per cubic yard, except that Structural Concrete Superstructure Slabs, Structural Concrete Roadway and Sidewalk Slabs on Steel Bridges, Structural Concrete Superstructure T-beam Type, Structural Concrete Wearing Surfaces on Bridge, Structural Concrete Box Culverts and Structural Concrete Approach Slabs will be paid for at the contract lump sum price of the respective contract items unless otherwise indicated in the schedule of items. Payment for both the unit price and the lump sum price items will be full compensation for furnishing and installing bridge drains including painting, water stops, expansion joint filler, fiber or plastic tube drains, roofing felt, asphalt for painting or covering various type of joints, all required sandblasting, bonding, curing and joint sealing and all incidentals necessary to complete the work satisfactorily.

No direct payment will be made for any concrete admixture.

Payment for structural concrete culvert connection shall include drilling and grouting the dowels into the existing headwall. Excavation required to construct the connection will be paid for under Pay Item 206.081, Structural Earth Excavation, Abutments, Retaining Walls, Box Culverts and Structural Plate Units. Reinforcing will be paid for under Pay Item 503.12, Reinforcing Steel, Fabricated and Delivered and Pay Item 503.13, Reinforcing Steel, Placing.

Reinforcing steel, railings, stone curbing and any material which may be required for bridge lighting systems, will be measured and paid for separately as provided in the appropriate Sections.

Payment will be made under:

Pay Item	Pay Unit
502.21 Structural Concrete, Abutments and Retaining Walls	Cubic Yard
502.22 Structural Concrete, Abutments and Retaining Walls (placed under water)	Cubic Yard
502.23 Structural Concrete Piers	Cubic Yard
502.24 Structural Concrete Piers (placed under water)	Cubic Yard
502.25 Structural Concrete Superstructure Slabs	Lump Sum
502.26 Structural Concrete Roadway and Sidewalk Slabs on Steel Bridges	Lump Sum
502.27 Structural Concrete Superstructure T-beam Type	Lump Sum
502.28 Structural Concrete Rigid Frame Structures	Cubic Yard
502.29 Structural Concrete Wearing Surface on Bridges	Lump Sum
502.30 Structural Concrete Box Culverts	Lump Sum
502.31 Structural Concrete Approach Slabs	Lump Sum
502.32 Structural Concrete Culvert Endwalls	Cubic Yard
502.33 through 502.39 Vacant	
502.40 Structural Concrete Box Culverts	Cubic Yard
502.41 Structural Concrete Superstructure Slab	Cubic Yard
502.42 Structural Concrete Roadway and Sidewalk Slabs on Steel Bridges	Cubic Yard
502.43 Structural Concrete Superstructure T-beam Type	Cubic Yard
502.44 Structural Concrete Wearing Surface on Bridges	Cubic Yard
502.45 Structural Concrete Approach Slabs	Cubic Yard
502.46 Structural Concrete Culvert Connection	Cubic Yard

SECTION 503 -- REINFORCING STEEL

503.01 Description. This work shall consist of furnishing and placing reinforcing steel in accordance with these specifications and in conformity with the plans.

MATERIALS

503.02 Materials. Materials shall meet the requirements of the following Subsections of Division 700 -- Materials:

Reinforcing Steel	709.01
Welded Steel Wire Fabric	709.02

503.03 Schedule of Material. When steel schedules are not furnished by the Department, the Contractor shall submit order lists and bending diagrams to the Engineer for approval. No material shall be ordered until these lists have been approved; however, such approval shall not relieve the Contractor of full responsibility for the satisfactory completion of this item.

CONSTRUCTION REQUIREMENTS

503.04 Protection of Material. Steel reinforcement shall be stored on skids or other supports above the ground and protected at all times from injury and surface contamination.

503.05 Fabrication and Delivery. The inside diameter of bends for Number 5 bar and smaller stirrups and ties shall not be less than 4 times the diameter of the stirrup or tie bar. For all other bars up to and including Number 8 bar, the inside diameter of bend shall not be less than 6 times the diameter of the bar. For bars larger than Number 8, the inside diameter of bend shall not be less than 8 times the diameter of that bar. Unless otherwise specifically authorized, bars shall be bent cold.

Bending tolerances shall be in conformance to that established in the latest edition of the "Manual of Standard Practice of the Concrete Reinforcing Steel Institute" and the "Detailing Manual of the American Concrete Institute".

Delivery shall be to the project unless otherwise specified.

503.06 Placing and Fastening. All steel reinforcement shall be accurately placed in the positions shown on the plans and shall be firmly held there during the placing and setting of the concrete. Immediately before placing concrete, steel reinforcement shall be free from all foreign material which could decrease the bond between the steel and concrete. Such foreign material shall include but not be limited to dirt, loose mill scale, excessive rust, paint, oil, bitumen and dried concrete mortar.

Bars shall be fastened together at all intersections except where spacing is less than 1 foot in either direction, in which case, fastening at alternate intersections of each bar with other bars will be permitted providing this will hold all the bars securely in position. This fastening may be tightly twisted wire or by tack welding when permitted by the Engineer. All tack welding shall be in accordance with Section 504 -- Structural Steel. No tack welding for fastening or supporting reinforcing steel in areas of high tensile stresses will be permitted.

In general, no welding will be permitted on the main reinforcing steel of superstructure slabs.

Proper distances from the forms shall be maintained by means of stays, blocks, ties, hangers or other approved means. Blocks used for this purpose shall be precast portland cement mortar blocks of approved shape and dimensions or approved metal or plastic chairs. Layers of bars may be separated by precast portland cement mortar blocks or other approved devices. The use of pebbles, pieces of broken stone or brick, metal pipe or wooden blocks shall not be permitted. The placing of reinforcement as concrete placement progresses, without definite and secure means of holding the steel in its correct position, shall not be permitted except in the case of welded steel wire fabric or bar mats.

Bars in bridge seats shall be placed so as to clear anchor bolts.

Reinforcement shall be inspected and approved by the Engineer before any concrete is placed.

503.07 Splicing. Splicing of bars other than as shown on the plans shall not be permitted without the approval of the Engineer. When so approved, splices shall be staggered as far as possible.

In lapped splices, the bars shall be placed in contact and wired together in such a manner as to maintain a clear distance no less than the minimum permitted to other bars and to the surface of the concrete. Splice welding of reinforcing bars shall be done only if called for on the plans or authorized by the Engineer.

503.08 Lapping. Sections of welded steel wire fabric shall overlap and be securely fastened to adjoining sections. All laps shall be in accordance with Wire Reinforcement Institute Manual of Standard Practice.

Bar mats shall be spliced as required for the individual bars.

503.09 Substitution. Substitution of different size bars shall not be permitted except with the written authorization of the Engineer.

503.10 Method of Measurement. Reinforcing steel shall be measured by the computed number of pounds of steel reinforcement authorized.

Weights will be computed on the following basis:

For structural steel . . Nominal weight of the section.

For Bars:

Size Plain	1/4"	3/8"	1/2"	5/8"	3/4"
Size Deformed		#3	#4	#5	#6
Wt. per foot in pounds	.167	.376	.668	1.043	1.502
Size plain	7/8"	1"	1"	1 1/8"	1 1/4"
Size Deformed	#7	#8	#9	#10	#11
Wt. Per foot in pounds	2.044	2.670	3.400	4.303	5.313

For welded steel wire fabric:

Sizes in
inches and
gage

6x6-W1.4xW1.4 3x6-W1.4xW1.4 4x4-W1.4xW1.4 6x6-W2.9xW2.9

Wt. in
pounds per
100 sq.feet

21

30

31

42

For other sizes of fabric, the commercially recognized weights will be used.

503.11 Basis of Payment. The accepted quantity of reinforcing steel will be paid for at the contract unit price per pound for each item involved, completed and accepted.

Payment will not be made for any materials used to hold reinforcement in place nor for extra weight due to substitutions and splices made for the Contractor's convenience.

Payment will be made under:

Pay Item	Pay Unit
503.12 Reinforcing Steel Fabricated and Delivered	Pound
503.13 Reinforcing Steel Placing	Pound
503.16 Welded Steel Wire Fabric Complete in Place	Pound

SECTION 504 -- STRUCTURAL STEEL

504.01 Description. This work shall consist of detailing, fabricating, shop painting, and erecting the structural steel portions of bridges, including self-lubricating bronze or copper-alloy bearing and expansion plates and other related materials as required under this contract.

504.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Structural Steel	713.01
High Strength Bolts	713.02
Preformed Pads	713.03
Bronze or Copper-Alloy Bearing and Expansion Plates	713.04
Cold-Finished Carbon Steel Shafting	713.05
Castings	713.06
Metal Bridge Paint (Shop Coat)	708.02

504.03 Drawings. The Contractor shall prepare shop detail, erection and any other necessary working drawings in accordance with the requirements of Subsection 105.02.

Substitutions of sections, materials or details, differing from those shown on the contract plans or on previously approved drawings prepared by the Contractor, shall be made only when approved by the Engineer.

All changes and revisions to the approved working drawings shall be subject to further approval by the Engineer in accordance with Subsection 105.02.

Preferred plan dimensions shall be 36 inches in length by 22 inches in width, with a border line located 1/2 inch inside the edge on the top, bottom and right end of the plans and 2 inches from the edge on the left end, and shall show the state's project number in the title block. Alternate plan dimensions may be used provided the plan width does not exceed 24 inches.

504.04 Design. Design, detail and load requirements shall conform to Division 1, Design, of the latest edition of the AASHTO Standard Specifications for Highway Bridges and any applicable Interim Specifications thereto, designated on the design drawings and to these specifications.

504.05 Facilities for Inspection. The Contractor shall furnish facilities for the inspection of materials and workmanship in shop and the Inspectors shall be allowed free access to the necessary parts of the works.

The Contractor shall furnish a private office at the fabrication plant for inspection personnel authorized by the Department of Transportation.

The office shall have an area not less than 100 square feet and shall be conveniently located to the work. The office shall be heated, lighted and have the exit(s) closed by a door(s) equipped with a lock(s) and 2 keys which shall be furnished to the Inspector(s). The office shall be equipped with a desk or table having a minimum size of 4 by 2.5 feet, 2 chairs, a telephone, a plan rack and a 2-drawer, minimum, letter size file cabinet with a lock and 2 keys which shall be furnished to the Inspector(s).

The facilities and all furnishings shall remain the property of the Contractor upon completion of the work. Payment for the facilities, its heating and lighting, telephone installation, basic monthly telephone charges and all furnishings shall be incidental to the contract.

504.06 Inspector's Authority. The Inspector will have the authority to reject any material or work which does not meet the requirements of these specifications. The acceptance of any material or finished members by the Inspector will not preclude their subsequent rejection, if found defective at a later date.

504.07 Rejections. Rejected material and workmanship shall be replaced promptly or corrected by the Contractor.

FABRICATION AND DELIVERY

504.08 General. The type of construction, whether bolted, welded or a combination thereof, shall be as shown on the plans. Workmanship and finish shall be equal to the best general practice in modern bridge shops.

504.09 Notice of Beginning Work. The Contractor shall give the Engineer ample notice of the beginning of work in the shop, so that inspection may be provided. No work shall be done in the shop before the Engineer has been so notified.

504.10 Mill Orders. When requested by the Engineer the Contractor shall furnish the Engineer with two copies of the mill orders.

504.11 Mill Tests. The Contractor shall furnish the Engineer, without charge, certified copies of the mill tests of all structural steel supplied. In addition to the results of chemical and physical tests, these test reports shall show the heat numbers, name of the manufacturer and the name of the testing laboratory or other concern making the test if other than the producer.

504.12 Storage of Materials Prior to Fabrication. Plain, as-rolled, structural material shall be stored above the ground on platforms, skids or other supports. It shall be kept free from dirt, grease and other foreign matter, and, as far as practicable, shall be protected from corrosion.

504.13 Material Identification and Control. Structural steel plates and shapes shall be marked as specified in AASHTO M 160 (ASTM A 6), Section 12, except as specified under Subsection 504.14. Upon delivery of structural steel plates and/or shapes to the fabrication shop the Engineer will verify mill test reports and heat numbers for conformance with the specifications and no material shall be used in the fabrication unless it is so verified. Any plates and/or shapes that are to be cut shall have the heat number transferred to all pieces, other than scraps, including those to be stored for future use on the same project or on future bridge projects. Failure to comply with this specification may be cause for rejection of the material.

504.14 Die Stamping. No die stamping shall be used for any purpose, either at the mill or in the fabricating shop, on rolled shapes or plates to be used as main stress carrying members. Identification marks, either required by AASHTO M 160 (ASTM A 6) or in the shop, shall be stencilled or marked.

504.15 Correcting Materials. Materials requiring correction for straightness, before being incorporated in a fabricated unit, may be corrected by any method that will not injure the metal, subject to the approval of the Engineer. If heating of the material is required it shall be done in accordance with a procedure submitted to and approved by the Engineer prior to the corrective work being done.

If the Engineer so directs, rolled beams or welded plate girders or other fabricated units having improper camber or sweep, shall be corrected by the application of heat, in accordance with a procedure submitted to and approved by the Engineer prior to the corrective work being done.

The procedure as submitted shall specify the following:

- Proposed heating pattern, including size and shape of heated areas, sequence of heating, location and distribution of heated areas,
- Method of support of the member,
- Temperature proposed to be used,
- Size of nozzle,
- Gas mixture and gas flow rate,
- Method of cooling and rate of cooling.

At no time shall heat be used for correction of defects on steel conforming to ASTM A 514 or A 517.

Following the corrective work, the metal shall be carefully inspected with the use of methods acceptable to the Engineer. The presence of cracks or fractures shall be cause for rejection of the material.

For general use a fabrication shop may submit a procedure for prequalification by the Engineer.

504.16 Flame Cutting. Structural steel permitted by these specifications may be flame cut, provided a smooth surface free from cracks and notches is secured and provided that an accurate profile is secured by the use of a mechanical guide. Hand cutting shall be done only where approved by the Engineer.

In all flame cutting, the cutting flame shall be so adjusted and manipulated as to avoid cutting beyond (inside) the prescribed lines. Flame cut surfaces shall meet the ANSI Specification B46.1 surface roughness rating of 1,000, except that flame cut surfaces of members not subject to calculated stress shall meet the surface roughness rating of 2,000. Flame cut surfaces of members carrying calculated stress shall have their corners rounded to 1/16 inch radius by grinding after flame cutting.

Re-entrant cuts shall be filleted to a radius of not less than 3/4 inch.

Surface roughness, exceeding the above values, and occasional gouges not more than 3/16 inch deep on otherwise satisfactory flame cut surfaces, shall be removed by machining or grinding. Corrections of the defects must be faired with the surface of the cut on a bevel of 1 to 6 or less. Occasional gouges on flame cut edges more than 3/16 inch deep but not more than 7/16 inch deep may be repaired by welding with low-hydrogen electrodes not exceeding 5/32 inch in diameter and with a preheat of 250°F. The completed weld shall be ground smooth and flush with the adjacent surface.

504.17 Bent Plates. Cold-bent, rolled steel plates shall conform to the following:

- (a) They shall be so taken from the stock plates that the bend line will be at right angles to the direction of rolling.
- (b) The radius of bends shall be such that no cracking of the plate occurs. Generally accepted minimum radii, measured to the concave face of the metal, are shown in the following table in which "T" is the thickness of the plate:

AASHTO ASTM	Thickness in inches		
	Up to 1/2	Over 1/2 to 1	Over 1 to 2
M 183 (A 36)			
M 223 (A 572)	2 T	2 1/2 T	3 T
M 222 (A 588)			

- (c) If a shorter radius is essential, the plates shall be bent hot at a temperature not greater than 1150°F. Hot-bent plates shall conform to the requirements of (a) above. Before bending, the edges of the plates shall be rounded to a radius of 1/16 inch throughout that portion of the plate where the bending is to occur.

504.18 Plates for Fabricated Members. Steel plates for flange cover plates, flange plates and splice plates shall be universal mill edge plates, except that flame cut plates, cut so that the primary direction of rolling is parallel to the main tensile or compressive stress, may be used for those plate sizes not commercially produced as universal mill edge plates. Steel plates for web plates shall be sheared or flame cut edge plates and shall have the primary direction of rolling parallel to the main tensile and/or compressive stress.

504.19 Edge Planing. Sheared edges of plates more than 5/8 inch in thickness for use as flanges of welded beams, cover plates and bearing stiffeners shall be planed to a depth of 1/4 inch. Re-entrant cuts shall be filleted to a radius of not less than 3/4 inch before cutting.

504.20 Welding. All welding both in the shop and in the field shall be done in accordance with the provisions of the contract documents.

504.21 Prequalified Welders. The fabrication shop shall maintain a file of certificates of prequalification for its welders and welding operators and make the file available to the Engineer upon request. Each certificate of qualification shall state the name of the welder or welding operator, the name and title of the person who conducted the examination, the kind of specimens, the position of welds, the results of the tests and the date of the examination.

For each project the fabrication shop shall submit a letter of compliance to the Engineer, listing by name all welders and welding operators to be employed on the fabrication of structural steel for the project. The letter shall certify that these welders or welding operators have been prequalified and that they have been continuously engaged in metal-arc welding, with no lapses in such employment in excess of six months, since being prequalified. For large projects the fabrication shop may be required to submit interim lists for portions of the work, at the request of the Engineer.

504.22 Camber. If camber is required for beams or girders, the camber will be so specified on the plans and for more complicated designs, such as continuous beams or girders, a camber diagram will be a part of the plans. Provision shall be made by the fabricator to compensate for changes in the camber, resulting from the welding of structural members, when such welding is required.

504.23 Holes for High Strength Bolts. Holes for high strength bolts shall be subpunched or subdrilled $3/16$ inch smaller and after assembling, shall be reamed to $1/16$ inch larger or shall be drilled from the solid to $1/16$ inch larger than the nominal diameter of the bolts except as follows. Holes for high strength bolts in material for X-frames or diaphragms and their associated end connections may be punched $1/16$ inch larger than the nominal bolt diameter whenever the thickness of the metal is not greater than $3/4$ inch for AASHTO M 183 (ASTM A 36) steel, $5/8$ inch for AASHTO M 222 (ASTM A 588) and AASHTO M 223 (ASTM A 572) steel or $1/2$ inch for AASHTO M 244 (ASTM A 514) and ASTM A 517 steel. When any material is thicker than the foregoing limits, punching will not be allowed and holes shall be subdrilled and reamed or drilled full size.

For any connection the fabricator may, at his option, subpunch and ream, subdrill and ream or drill holes full size with all thicknesses of the material assembled in proper position or drill holes full size in each individual piece of a connection separately, provided that the requirements of Subsection 504.24 are met by the fully assembled connection.

For punched holes the diameter of the die shall not exceed the diameter of the punch by more than $1/16$ inch. Holes must be clean cut, without torn or ragged edges.

Reamed or drilled holes shall be cylindrical and perpendicular to the member. Where practicable, reamers shall be directed by mechanical means. Burrs caused by drilling or reaming shall be removed from all parts.

Oversize or short-slotted holes may be used in all connections other than splices of main load carrying members and end connections of floor beams. The size and application of oversize and short-slotted holes shall be governed by the requirements of Subsection 504.04.

504.24 Accuracy of Holes. All holes punched full size, subpunched or subdrilled, shall be so accurately located that, after assembling and before any reaming is done, a cylindrical pin $1/8$ inch smaller in diameter than the nominal size of the punched or drilled hole may be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the contiguous holes in the same plane. If this requirement is not fulfilled, the badly punched or drilled pieces will be rejected. If any hole will not pass a pin $3/16$ inch smaller in diameter than the nominal size of the punched or drilled hole, this will be cause for rejection.

Following the completion of the drilling or reaming of all holes in any contiguous group and with all plies of a connection in their proper relationship for assembly, no hole shall show an offset greater than $1/32$ inch between adjacent thicknesses of metal.

No finished hole shall be located more than 1/8 inch laterally from its theoretical location. Repair of mislocated holes shall be subject to the approval of the Engineer.

504.25 Vacant

504.26 Shop Assembling. Abutting members at field splices of continuous beams and girders, rigid frames and bents shall be placed in the exact relative field position for erection and shall be assembled with their associated splice material and shall be checked for conformance with the requirements of Subsection 504.24. Joint openings shall conform to the requirements of Subsection 504.24. All material shall be match marked before being dissambled.

Bearing assemblies shall be shop assembled and the individual pieces match marked or they shall be shop assembled and shipped as a unit.

504.27 Match marking. Connecting parts assembled in the shop for the purpose of reaming or drilling holes in field connections shall be match marked and a diagram showing such marks shall be furnished to the Engineer.

504.28 Connections Using High Strength Bolts. This subsection covers the assembly of structural joints using AASHTO M 164 (ASTM A 325) high strength carbon steel bolts tightened to a high tension. The bolts are used in holes conforming to the requirements of Subsection 504.24.

- (a) Bolts, Nuts and Washers. All bolts, nuts and washers shall conform to the requirements of Subsection 713.02 except as hereinafter provided.
- (b) Bolted Parts. Surfaces of bolted parts in contact with the bolt head and nut shall not have a slope more than 1 to 20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material.

When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of scale except tight mill scale and free of dirt, burrs, and other defects that would prevent solid seating of the parts.

Joints will be of the friction type unless otherwise specified. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, galvanizing or other coating unless otherwise specified.

- (c) Installation. Bolts shall be installed with a hardened washer under the nut or bolt head, whichever is the element turned in tightening, except that bolts in oversized or short-slotted holes shall have a washer under both the head and the nut. A flat washer may be used when the abutting surface adjacent to the bolt head or nut does have a slope of not more than 1 to 20 with respect to a plane normal to the bolt axis. Where an outer face of the bolted parts has a slope of more than 1 to 20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of parallelism.

All bolts and other fasteners shall be tightened to give at least the required minimum bolt tension values shown in Table 1 of this subsection, on completion of the joint. Tightening shall be done with properly calibrated wrenches or by the turn-of-nut method. If required because of bolt entering and/or wrench operation clearances, tightening by either procedure may be done by turning the bolt while the nut is prevented from rotating. Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.

TABLE 1 -- BOLT TENSION

Bolt Diameter (Inches)	:	Required Minimum Bolt Tension ¹ (pounds)
1/2	:	12,050
5/8	:	19,200
3/4	:	28,400
7/8	:	39,250
1	:	51,500
1 1/8	:	56,450
1 1/4	:	71,700
1 3/8	:	85,450
1 1/2	:	104,000

¹Equal to the proof load of bolt in AASHTO M 164 (ASTM A 325).

When calibrated wrenches are used to provide the bolt tension specified in Table 1, their setting shall be adjusted to induce a bolt tension 5 percent to 10 percent in excess of this value. These wrenches shall be calibrated at least once each working day by tightening, in a device capable of indicating actual bolt tension, not less than 3 typical bolts from the lot to be installed. Power wrenches shall be adjusted to stall or cut-out at the selected tension. If manual torque wrenches are used, the torque indication corresponding to the calibrating tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in tightening motion when torque is measured. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be returned to "touch up" bolts previously tightened and which may have been loosened by the tightening of subsequent bolts, until all are tightened to the prescribed amount.

The turn-of-nut method for tightening high strength bolts shall be used only with the prior approval of the Engineer, in locations where the use of calibrated wrenches is impractical.

When the turn-of-nut method is used to provide the bolt tension specified in Table 1, there shall first be enough bolts brought to a "snug tight" condition to insure that the parts of the joint are brought into full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a person using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table 2 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

The Engineer shall be given full opportunity to witness the calibration tests prescribed above and the Engineer will observe the installation and tightening of the bolts to determine that the selected tightening procedure is properly used.

TABLE 2
Nut Rotation¹ from Snug Tight Condition

Disposition of Outer Faces of Bolted Parts			
Bolt length measured from underside of head to extreme end of point	:	One face : normal to bolt axis and other face sloped : not more than 1 to 20 (bevel washer not used)	: Both faces : sloped not more than 1 to 20 from axis (bevel washers not used)
Up to and including 4 diameters	:	1/3 turn:	1/2 turn : 2/3 turn
Over 4 diameters but not exceeding 8 diameters	:	1/2 turn:	2/3 turn : 5/6 turn
Over 8 diameters but not exceeding 12 diameter ²	:	2/3 turn:	5/6 turn : 1 turn

¹Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn and less, the tolerance should be plus or minus 30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.

²No research work has been performed by the Research Council on Riveted and Bolted Structural Joints to establish the turn-of-nut procedure when bolt lengths exceed 12 diameters. Therefore, the required rotation must be determined by actual tests in a suitable tension device simulating the actual condition.

- (d) Inspection. The Contractor, in the presence of the Engineer, shall, upon completion of the tightening of all bolts in a connection, use either a torque wrench or a power wrench as an inspection wrench. The inspection wrench shall be used to apply the inspecting torque specified below to a minimum of 10 percent of the bolts, but not less than two bolts, in each connection. If any nut or bolt in a connection is turned

by the inspecting torque, this torque shall be applied to all bolts in that connection and all bolts whose nut or head is turned by this torque shall be retightened by the Contractor and thereupon re-inspected. Alternately the Contractor may, at his option, retighten all bolts in a connection and then resubmit that connection for inspection.

The inspecting torque will be established by the Engineer, using a device capable of indicating actual bolt tension and using bolts of the same grade, size and condition and of a length representative of the bolts under inspection.

Unless otherwise specified, the Contractor shall provide all necessary torque or power wrenches, all calibration equipment and all material and labor required to perform the above testing and no separate payment will be made for said testing. Any costs will be considered incidental to the related bid items.

504.29 Facing of Bearing Surfaces. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the American Standards Institute surface roughness requirements as defined in ANSI B46.1, Surface Roughness, Waviness and Lay, Part 1 as follows:

Steel Slab	2000 micro inch
Heavy plates in contact in shoes to be welded	1000 micro inch
Milled ends of compression members, stiffeners and fillers	500 micro inch
Bridge rollers and rockers	250 micro inch
Pins and pin holes	125 micro inch
Sliding bearings	125 micro inch

The above finishes are maximum roughness values and shall preferably be 10 percent less. Acceptability of a finished surface may be established by comparison of that surface with Roughness Comparison Specimens.

Additionally, mating surfaces shall be in contact over not less than 90 percent of the contact area.

When ordering material that is to be machined, an allowance for machining shall be included in the ordered dimension such that the finished dimension shall not be less than the dimension given on the plans.

504.30 Abutting Joints. Abutting joints in compression members and where so specified on the drawings, in tension members, shall be faced and brought to an even bearing. Where joints are not faced, the opening shall be 1/4 inch, with a tolerance of plus or minus 1/8 inch.

504.31 Tolerances. Finished members shall be true to line and free from twists or bends and shall be subject to the following tolerances unless otherwise specified.

When no camber or sweep is specified, variations in straightness of rolled beams, with and without cover plates, shall not exceed

$\frac{1}{8}$ inch x total length of member in feet

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Variations from specified camber in rolled beams, with and without cover plates, shall not exceed the values given in Table 3.

TABLE 3
CAMBER ORDINATE TOLERANCES
(Rolled Beams)

Lengths	Plus Tolerance	Minus Tolerance
50 ft. and Less	1/2 inch	0
Over 50 ft.	1/2 inch plus 1/8 inch for each 10 ft. or fraction thereof in excess of 50 ft.	0

Dimensional tolerances for welded beams and girders shall be as specified in the applicable edition of AWS Structural Welding Code D1.1 and as amended by AASHTO.

Any member having camber or sweep in excess of the above tolerances shall be corrected if so directed by the Engineer.

504.32 Fit of Stiffeners. Stiffeners shall be fitted as detailed on the Contract plans.

504.33 Vacant.

504.34 Screw Threads. Unless otherwise specified, threads for all pins and bolts for structural steel construction shall be the Unified Coarse Thread Series as specified in the American Standard for Unified Screw Threads (ANSI B1.1) and shall have Class 2A tolerances for pins and bolts and Class 2B tolerances for nuts, unless otherwise specified.

504.35 Bronze or Copper-Alloy Bearing and Expansion Plates. Bronze or copper-alloy bearing and expansion plates shall be fabricated in accordance with the details as shown on the plans and the provisions of Subsection 713.04 and shall be self-lubricating.

The matching steel sliding surface or surfaces shall be shop coated with a lubricant compatible with the lubricating compound in the bearing or expansion plate. This lubricant shall be recommended and supplied by the manufacturer of the bearing or expansion plates.

504.36 Shop Coat. Steel work specified to be painted shall be painted one coat of shop coat paint, in conformance with Section 506 -- Painting Structural Steel, after it has been accepted by the inspector, with the following modifications.

Masonry plates and bearing surfaces of expansion bearing rockers shall be painted two coats of shop paint.

Surfaces not in contact but inaccessible after assembly or erection shall be painted three coats of shop paint. Contact surfaces for friction type connections shall not be painted or coated in any way unless specified otherwise. If it is expected that there will be a prolonged period of exposure before the steel can be erected, the fabricator and/or contractor shall take such measures to prevent unacceptable corrosion of contact surfaces as the Engineer may direct or approve.

Surfaces which will be in contact with concrete shall not be painted. Structural steel which is to be welded shall not be painted before welding is complete. If it is to be welded only in the fabricating shop and subsequently erected by bolting, it shall be painted one coat of shop paint after shop welding is finished. Steel which is to be field welded shall be given one coat of boiled linseed oil or other approved coating after shop welding and shop fabrication is completed.

Machine finished surfaces with a roughness height of 125 micro inches or less shall be coated with a noncorrosive, waterproof, high pressure lubricant having a temperature range of -30°F to 150°F, an National Lubrication and Grease Institute number not lower than 2 and an OK load of not less than 20 lbs as measured by the requirements of ASTM D 2509, except as follows. All sliding surfaces of self-lubricating bearings shall be coated with a lubricant recommended and supplied by the manufacturer of the self-lubricating plates. Metal surfaces designed for sliding contact with TFE coated bearing surfaces shall not be lubricated.

Material shall not be loaded for shipment until the paint is thoroughly dry and in any case not less than 24 hours after the paint has been applied.

504.37 Unpainted Steel. Structures fabricated of AASHTO M 222 (ASTM A 588) steel are to remain in the bare unpainted condition, unless otherwise noted on the plans. All surfaces of all members of such structures shall be blast cleaned to remove mill scale. Blast Cleaning shall be done in accordance with the provisions of Steel

Structures Painting Council's "Surface Preparation Specification SSPC - SP6 No. 6, Commercial Blast Cleaning", or equivalent. Slag, flux, spatter and discoloration shall be carefully removed from welded areas by power tool or blast cleaning. Acids shall not be used to remove scale or stains. Any miscellaneous steel work for use in conjunction with an unpainted structure, shall be cleaned as specified above and painted as specified on the contract plans.

504.38 Marking and Delivery. Each member shall be painted or marked with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon.

Erection marks for the field identification of members and weight marks, when required, shall be painted upon surface areas previously painted with the shop coat.

Erection marks, match marks and weight marks on AASHTO M 222 (ASTM A 588) steel, intended for use in the unpainted condition, shall be placed where they will not be exposed in the finished structure.

The Contractor shall furnish the Engineer as many copies of material orders, shipping statements and erection diagrams as the Engineer may direct.

Bolts of each length and diameter and loose nuts and washers of each size shall be packed separately. Pins, small parts and packages of bolts, washers and nuts shall be shipped in boxes, crates, kegs or barrels. A list and description of the contained material shall be plainly marked on the outside of each shipping container.

504.39 Handling and Storing Materials. Fabricated materials, which are stored at the fabricating shop, at the project site or elsewhere, shall be placed upright on platforms, skids or other supports above the ground. They shall be kept clean and properly drained. Members shall be supported in a manner that will prevent injury due to excessive deflection or torsion.

On all members fabricated of AASHTO M 222 (ASTM A 588) steel and intended for use in the unpainted condition, contamination by grease, oil, paint or other foreign material shall be avoided, but if such contamination does occur, it shall be removed as soon as practical. In areas exposed to direct view only nonabrasive means may be used for such removal.

In handling fabricated members, care shall be exercised to prevent gouges, scratches and dents. Chains and wire rope slings shall not be used in immediate contact with fabricated members when such members are being lifted or transported.

Structural members shall be loaded on trucks or cars in such a manner that they may be transported to and unloaded at their destination without being excessively stressed, deformed or otherwise damaged.

ERECTION

504.40 General. If the substructure and superstructure are built under separate contracts, the Department will provide the masonry, constructed to correct lines and elevations and properly finished and will establish the lines and elevations required for placing the steel.

The Contractor shall erect the structural steel, erect and remove any falsework and do all work required to complete the structural steel for the bridge or bridges as covered by the agreement, all in accordance with the plans and these specifications.

504.41 Plans. If fabrication and erection of the superstructure are done under separate contracts, the Department will furnish detail plans for the bridge or bridges to be erected, including shop details, camber diagrams, erection diagrams, list of field bolts and copies of shipping statements, showing a list of parts to the Contractor for the erection.

504.42 Plant. The Contractor shall provide the falsework and all tools, machinery and appliances, including drift pins and fitting-up bolts, necessary for the expeditious conduct of the work.

504.43 Delivery of Materials. If the contract is for erection only, the Contractor shall receive the materials entering into the finished structure, free of charges, at the place designated and loaded or unloaded as specified. The Contractor shall unload promptly upon delivery any material delivered on railroad cars or barges which he is required to unload, otherwise he shall be responsible for any demurrage charges incurred. The Contractor shall check the material turned over to him against the shipping lists and report promptly in writing any shortage or damage discovered. He shall be responsible for the loss of any material while in his care and for any damage to it after being received by him. Storage of material shall comply with the requirements of Subsection 504.39.

504.44 Methods and Equipment. Before starting the work of erection, the Contractor shall inform the Engineer fully as to the method of erection he proposes to follow, and the amount and character of equipment he proposes to use, which shall be subject to the approval of the Engineer. The Contractor shall prepare and

submit to the Engineer, for his approval, plans for any falsework and/or for modifications to an existing structure necessitated by construction loading. The falsework and/or modifications shall be properly designed and substantially constructed and maintained for the loads which will be placed upon it. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his method or equipment, or from carrying out the work in full accordance with the plans and specifications. No work shall be done until such approval by the Engineer has been obtained.

504.45 Bearings, Expansion Devices and Anchorages. Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise shown on the plans or directed by the Engineer, they shall be placed on a preformed pad, the same size and shape as the bearing plate and with holes for the accommodation of the anchor bolts, accurately punched to match the holes in the plate.

The Contractor shall drill the holes and set the anchor bolts, except where the bolts are built into the masonry. The bolts shall be set accurately and fixed with portland cement grout containing an approved non-shrink additive. At the option of the Contractor and with the approval of the Engineer, a quick setting non-shrink grout may be used. The grout shall completely fill the holes. The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of erection. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit the free movement of the span.

When bronze or copper-alloy bearing and expansion plates are used, the sliding surfaces of the steel in contact with the bearing and expansion plates shall be recoated, just prior to their installation, with a lubricant recommended and supplied by the manufacturer of the bronze or copper-alloy plates.

Unless otherwise indicated on the plans, rocker bearing assemblies shall be set so as to be plumb and expansion devices set so as to have the specified opening, both at 45°F. The change in span length due to dead load deflection shall be considered in setting the bearing assemblies. After all dead loads are substantially in place, the bearing shall be checked and shall be adjusted to conform to the requirements of this specification.

504.46 Straightening Bent Material. Material requiring straightening may be corrected under the provisions of Subsection 504.15, provided that the bend or other deformation is not so extensive or severe as to require replacement of the member, in the opinion of the Engineer.

504.47 Assembling Steel. The parts shall be accurately assembled as shown on the plans and all match marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged. Hammering which will injure or distort the members shall not be done. Surfaces to be in permanent contact shall be cleaned before the members are assembled, unless otherwise specified.

504.48 Field Welding. Welders shall be prequalified in accordance with paragraph 504.49.

Welding shall not be done when the ambient temperature is lower than zero degrees F, when surfaces are wet or exposed to rain, snow or high winds or when welders are exposed to inclement conditions.

504.49 Field Welder Certification. A field welder must hold a current certificate, issued by the Maine Department of Transportation. A certificate may be obtained by successfully completing the welder qualification test administered by the Maine Department of Transportation. The test shall consist of the successful completion of three groove welds, in respectively the horizontal (2G), vertical (3G) and overhead (4G) positions, using low hydrogen electrodes and in conformance with the requirements of the Maine Department of Transportation welding procedure specifications for those test welds. As an alternate, successful completion of the pipe welding test in the 6G position, as administered by the Maine Department of Manpower Affairs, Bureau of Labor, will qualify a welder for a certificate issued by the Maine Department of Transportation. Certificates shall be valid for one year from date of issuance, and may be renewed free of charge, upon submission of a notarized statement, signed by the applicant, certifying that during the preceding year there has been no period in excess of 3 consecutive months during which the applicant was not engaged in welding in the positions for which he was previously qualified. If there is a lapse in certification in excess of 6 months or if an application for renewal is received more than 6 months after the expiration date of a certificate, renewal shall only be upon satisfactory completion of one of the above tests.

504.50 Misfits. The correction of minor misfits involving non-harmful amounts of reaming, cutting and chipping, will be considered a legitimate part of the erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the Engineer and his approval of the method of correction obtained. The correction shall be made in his presence. If the contract provides for complete fabrication and erection, the Contractor shall be responsible for all misfits, errors and injuries and shall make the necessary corrections and replacements. If the contract is for erection only, the Engineer, with the cooperation of the Contractor, shall keep a correct record of labor and material used and the Contractor shall present to the Engineer for approval, within 30 days, a duplicate itemized bill, made out to the Department.

504.51 Painting Joints and Retouching Defective Paint Areas. As soon as the inspector has examined and approved a completed joint, all exposed surfaces specified to be painted shall be cleaned and thoroughly painted with shop coat paint in conformity with Section 506 -- Painting Structural Steel.

All surface areas from which the shop coat paint has been worn off or has otherwise become defective shall be cleaned in accordance with Subsection 506.03 and retouched with shop coat paint.

504.52 Removal of Falsework and Clean-up. Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excavated or useless earth material, rubbish and temporary buildings, replace or renew any damaged fences and restore to an acceptable condition all property, both public and private, which may have been damaged during the conduct of his work and shall leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the Engineer. All excavation and other earth material and falsework placed in the stream channel during construction shall be removed by the Contractor before final acceptance.

504.53 Method of Measurement. Unless otherwise specified, structural steel will be measured as one lump sum complete and accepted, consisting of all metal and related materials in the fabricated and erected structure as shown on the plans, excluding railings and drains. Related materials shall include, but not necessarily be limited to, preformed pads placed under the bearings, and when required, self-lubricating bronze or copper-alloy bearing and expansion plates.

504.54 Basis of Payment. Structural steel will be paid for at the contract lump sum price for the respective contract items involved.

Payment will be made under:

Pay Item	Pay Unit
504.70 Structural Steel Fabricated and Delivered	Lump Sum
504.71 Structural Steel Erection	Lump Sum

SECTION 505 -- SHEAR CONNECTORS

505.01 Description. This work shall consist of furnishing and installing stud shear connectors for the purpose of transmitting shear between steel beams and concrete in composite members in accordance with these specifications and in conformity with the plans.

MATERIALS

505.02 Materials. Materials shall meet the requirements of Stud Shear Connectors, Subsection 711.06.

CONSTRUCTION REQUIREMENTS

505.03 Construction Requirements. Welding shall not be done when the ambient temperature or the temperature of the base metal is below 0°F, when the surfaces are damp or exposed to rain, snow or high wind or when the welders or welding operators are exposed to inclement conditions.

Studs shall be end welded to the beams or girders with automatically timed stud welding equipment connected to a suitable power source. If two or more stud welding guns are to be operated from the same power source, they shall be interlocked so that only one can operate at a time and so that the power supply shall have fully recovered from making one weld before another weld is started.

While in operation and after the weld is completed, the welding gun shall be held in position without movement until the weld metal is solidified.

At the time of welding, the studs shall be free from any rust, rust pits, scale, oil or other deleterious matter which would adversely affect the welding operation. When necessary to obtain satisfactory welds, the area of the beam or girder to which the studs are to be welded shall be wire brushed or ground free of scale or rust.

Longitudinal and lateral spacings with respect to each other and to edges of beam or girder flanges shall not vary more than one-half inch from the dimensions shown on the plans, except that a variation of two inches will be permitted where required to avoid obstruction with other attachments on the beam or where a new stud is being welded to replace a defective one. The minimum distance from the edge of a stud shank to the edge of a beam or plate shall be one inch, but preferably not less than 1 1/2 inches.

In areas of the flanges that are always in compression, a new stud may be welded adjacent to a defective one in lieu of repair and replacement on the existing weld area. In areas that are in tension or subject to stress reversal, a defective stud shall be removed and the area shall be ground smooth and flush before welding a new stud. In case of a pullout of metal, the corrective procedure shall be in accordance with Section 504.

If studs are installed or repaired by a process other than the use of a stud welding gun, the welder must be prequalified in accordance with Section 504 -- Structural Steel.

505.04 Testing (Shop-Field). The first two studs welded on each beam or girder, after being allowed to cool, shall be bent 45 degrees by striking the stud with a hammer. If failure occurs in the weld of either stud, the procedure shall be corrected and two successive studs shall be successfully welded and tested before any more studs are welded to the beam or girder. When the temperature of the base metal is below 32°F, one stud in each 100 studs welded shall be bent 45 degrees in addition to the first two bent as specified above. The Engineer shall be promptly informed of any change in the welding procedure at any time during construction.

Studs on which a full 360 degrees weld is not obtained may be repaired by adding a 3/16 inch fillet weld in place of the lack of weld, using the shielded metal-arc process with low-hydrogen welding electrodes.

If the reduction in the height of studs as they are welded becomes less than normal, welding shall be stopped immediately and not resumed until the cause has been corrected.

If visual inspection reveals any stud which does not show a full 360 degrees weld, any stud that has been repaired by welding, or any stud in which the reduction in height due to welding is less than normal, such stud shall be struck with a hammer and bent 15 degrees from the correct axis of installation. For studs showing less than 360 degrees weld, the direction of bending shall be opposite to the lack of weld. Studs that crack either in the weld or in the shank shall be replaced. The Engineer may select additional studs at random to be subjected to the bend test. The studs tested that show no signs of failure shall be left in the bent position.

Studs that are to be replaced for any of the above reasons or because they have been otherwise rendered unacceptable may be manually welded with a full 360 degrees, 1/4 inch fillet weld for 3/4 inch studs and with a full 360 degrees, 5/16 inch fillet weld for 7/8 inch studs.

If, during the progress of the work, inspection and testing indicate that the shear connectors being obtained are not satisfactory, the Contractor will be required, at his expense, to make such changes in welding procedure, welding equipment and type of shear connector, as necessary to secure satisfactory results.

505.05 Methods of Measurement. Shear connectors will be measured as one lump sum consisting of all shear connectors required and acceptably installed.

505.06 Basis of Payment. The accepted quantity of shear connectors will be paid for at the lump sum price, complete in place.

Payment will be made under:

Pay Item	Pay Unit
505.08 Shear Connectors	Lump Sum

SECTION 506 -- PAINTING STRUCTURAL STEEL

506.01 Description. This work shall consist of furnishing paint and painting of structural steel, including, unless otherwise provided in the contract, the preparation of the metal surfaces, protection and drying of the paint coatings, the protection of public property, the supply of all tools, scaffolding, labor and materials necessary for completion of the work involved in the cleaning and painting of the steel surfaces.

506.02 Materials. The paint shall meet the requirements of Metal Bridge Paint, Subsection 708.02.

506.03 Surface Preparation. Surfaces of structural steel shall be thoroughly cleaned prior to the application of any paint. All oil, grease, dirt, rust, weld slag, mill scale, old paint and other foreign matter shall be removed from the surface.

Four methods of cleaning, Method A, B, C and D are provided herein. Method D, unless otherwise specified, shall be used for the preparation of both new and existing structural steel surfaces, supplemented as necessary, by methods A, B and C to obtain the required surface finish.

All methods of surface preparation shall be in accordance with the provisions, unless otherwise specified, of the "Steel Structures Painting Council", "Surface Preparation Specifications" as referenced to hereinafter as SSPC Specification Number.

Method A-Solvent Cleaning. Solvent cleaning shall be done in accordance with SSPC Specification No. 1 "Solvent Cleaning".

Method B-Hand Cleaning. Hand cleaning shall be done in accordance with SSPC Specification No. 2 "Hand Tool Cleaning".

Method C-Power Cleaning. Power cleaning shall be done in accordance with SSPC Specification No. 3 "Power Tool Cleaning".

Method D-Blast Cleaning. Blast cleaning shall be done in accordance with SSPC Specification No. 6 "Commercial Blast Cleaning".

The surface preparation of existing structural steel, unless otherwise specified on the plans, will not require the removal of sound, adherent old paint. All corrosion and all paint which show evidence of corrosion, peeling, brittleness, blistering, checking, scaling or general disintegration shall be removed by impact tools, as specified in Method C, prior to blast cleaning by Method D. Removal of the old paint shall be carried back around the edges of the spot or area until an area of completely intact and adhering paint film, with no rust or blistering underneath remains. Edges of

tightly adherent paint remaining around the cleaned area shall be feathered such that the repainted surface will have a smooth appearance. The remaining old paint shall have sufficient adhesion such that it cannot be lifted as a layer by inserting a blade or putty knife under it.

Surface areas of existing structural steel around expansion joints and other inaccessible areas shall be cleaned as thoroughly as conditions allow.

All surface preparation methods shall be done in such a manner that no damage is done to partially or entirely completed portions of the work.

If cleaned surfaces rust or are contaminated with foreign material before painting is accomplished, they shall be recleaned by the Contractor at his own expense.

All surfaces shall be approved by the Engineer prior to the application of any paint.

The Contractor shall provide access for representatives of the Department of Transportation to all work locations where cleaning and painting may be in progress.

506.04 Weather Conditions. Paint shall not be applied when the following conditions exist:

- (a) Temperature of the surrounding air or temperature of the metal is below 40°F.
- (b) Temperature of the air is expected to drop to or below, 32°F before the paint has dried.
- (c) The metal is hot enough to cause the paint to blister and produce a porous paint film or is otherwise detrimental to the life of the paint.
- (d) The surrounding air is foggy, misty, rainy, snowy or dusty.
- (e) The surfaces to be painted are wet, damp, frosted or when in the opinion of the Engineer, conditions are otherwise unsatisfactory for the work.

Subject to approval of the Engineer, the Contractor may provide a suitable enclosure to permit painting during inclement weather. Provisions shall be made to artificially control atmospheric conditions inside the enclosure within limits suitable for painting throughout the painting operation. Full compensation for providing and maintaining such enclosures shall be considered as included in the prices paid for the various contract items of work involving painting and no additional compensation will be allowed.

506.05 Number of Coats and Color. New structural steel shall be painted one coat of the First Coat-Orange, applied in the shop. New structural steel surfaces which will remain exposed upon completion of the work shall be field painted three coats consisting of one coat each of the following: Second Coat-Maroon, Third Coat-Gray and Fourth Coat-Green. At the Contractor's option, the Second Coat-Maroon may be applied in the shop in addition to the First Coat-Orange.

Existing structural steel which will remain exposed upon completion of the new work shall be field painted four coats consisting of one coat each of the following: First Coat-Orange, Second Coat-Maroon, Third Coat-Gray, and Fourth Coat-Green.

506.06 Shop Painting. Shop painting shall comply with the requirements of this section and of Section 504 -- Structural Steel.

506.07 Preparation of the Paint. The paint shall be thoroughly mixed by mechanical mixers before being removed from the original containers, and shall be kept thoroughly mixed while being applied.

506.08 Thinning of Paint. The specified paints are formulated to be ready for application when thoroughly mixed and no thinning will be allowed unless permitted by the Engineer. If it is necessary, in cool weather, to thin the paint, this shall be done by heating in hot water or on steam radiators.

506.09 Application of Field Paint. Except as otherwise provided, field painting shall not commence until after erection of the steel is complete, the field joints have been painted, surfaces of the structural steel thoroughly cleaned, worn off or defective shop painted surface areas retouched and the paint has thoroughly dried.

At the Contractor's option, the Second Coat-Maroon may be applied before erection of the structural steel.

Worn off or defective shop painted surface areas shall be retouched and the field joints painted with either the First Coat-Orange or the Second Coat-Maroon.

The application of the third Coat-Gray shall be deferred until adjoining concrete work has been placed and finished. If concreting operations have damaged any previously applied paint, the damaged surfaces shall be recleaned and repainted.

Each coat of paint shall be applied in a neat and workmanlike manner. The paint shall be applied by brush, roller, spray equipment or any combination thereof. The paint shall be smoothly and uniformly applied with no running, streaking, sagging, wrinkling or other film defects.

All small cracks and cavities that have not become sealed in a watertight manner shall be filled with Red-Lead Paste-in-oil, meeting ASTM D 83, applied by brush or spatula before the succeeding field coats are applied. A small amount of additional linseed oil may be added to the Red-Lead Paste at the time of use to reduce the paste to workable consistency for spatula or brush.

On all surfaces which are inaccessible for normal methods, the paint shall be applied with sheepskin daubers especially constructed for the purpose; any other method of mechanical application will require approval of the Engineer.

Skips, thin areas or other deficiencies shall be corrected before each succeeding coat is applied. The surface of the paint being covered shall be free from moisture, dust, grease or any other deleterious materials which would prevent bonding of the succeeding applications.

The wet film thickness of each coat shall be a minimum of four mils and shall be checked regularly by an approved type of gage.

Brushes, when used, shall have sufficient body and length of bristle to spread the paint in a uniform flow. The brushes shall be of sufficient quality such that loss of bristles into the paint film will be avoided. In general, the primary movement of the brush in applying the paint shall describe a series of small circular arcs to fill thoroughly all irregularities in the surface after which the coating shall be smoothed and thinned by a series of parallel strokes.

Rollers, when used, shall be of a type which will not leave a stippled texture on the paint film.

The paint shall be worked into all joints, open spaces, bolts, lapped seams, rivets and edges. When application of paint is by brush or roller, the edges and corners of all metal work, bolts and rivets shall be striped by brush painting to provide a full paint film on all edges and corners in advance of the application of paint to the other parts.

Spray equipment, when used, shall be approved by the Engineer and if the work done by spraying is not satisfactory, hand brushing or rollers will be required. Power spraying equipment shall apply the paint in a fine, even spray without requiring the addition of any thinner.

Paint when applied with spray equipment shall be immediately followed by brushing or other satisfactory means when necessary to secure a uniform coverage and to eliminate wrinkles, airholes, runs and sags.

506.10 Removal of Paint. If the painting is determined to be unsatisfactory by the Engineer, the paint shall be removed and the metal thoroughly cleaned and repainted with the required number of coats.

506.11 Protective Measures. Care shall be taken to prevent paint dripping or spattering on other painted surfaces or other parts of the structure and any such drippings or splatterings shall be cleaned off before the paint is dry.

The Contractor shall provide appropriate safeguards for the protection of the public against damage from paint drippings, wind blown paint and falling objects. The Contractor shall be fully responsible for property damage of any kind which may result from operations incidental to the cleaning of metal work and application of any paint.

In general, paint materials shall not be stored on the bridge structures. The quantity of paint materials brought on the bridge shall be sufficient for the day's painting only. Proper precautions against fire shall be taken by the Contractor.

Containers used must be secured in a manner that will prevent them from upsetting or falling. During suspension of work, containers and other paint materials and equipment shall be removed from the bridge.

If, in the opinion of the Engineer, traffic produces an objectionable amount of dust, the Contractor shall, at his own expense, allay the dust for the necessary distance on each side of the bridge and take any other precautions necessary to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces before the paint is applied.

506.12 Method of Measurement. Field painting new structural steel will be measured for payment as one lump sum unit, consisting of all work, as previously described for new structural steel, complete and accepted.

Field painting existing structural steel will be measured for payment as one lump sum unit, consisting of all work, as previously described for existing structural steel, complete and accepted.

Surface preparation of existing structural steel will be measured by the man hours of work actually performed measured to the nearest 1/4 hour. The Contractor shall supply daily the names and number of hours each person works under this item. No additional allowance will be made for premium time.

506.13 Basis of Payment. The accepted quantity of field painting new structural steel and for field painting existing structural steel will be paid at the contract lump sum price, which price shall be full compensation for furnishing all materials, labor, equipment, scaffolding and incidentals necessary for the satisfactory performance of the above work.

Shop painting will not be paid for separately but will be considered as incidental to Item 504.70, Structural Steel, Fabricated and Delivered.

Payment for surface preparation of existing structural steel for the application of field paint will be paid for at the contract unit price per man hour of acceptable manual labor which price shall be full compensation for all materials, labor, supervision, payment of premium time, insurances, taxes, equipment, scaffolding and incidentals necessary for the satisfactory performance of the above work.

Surface preparation of new structural steel for application of shop paint will not be paid for separately but will be considered as incidental to Item 504.70, Structural Steel, Fabricated and Delivered.

Payment will be made under:

Pay Item	Pay Unit
506.141 Field Painting New Structural Steel	Lump Sum
506.142 Field Painting Existing Structural Steel	Lump Sum
506.16 Surface Preparation of Existing Structural Steel	Man Hours

SECTION 507 -- RAILINGS

507.01 Description. This work shall consist of the furnishing of all materials for and the construction of bridge railings and hand railings in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer. Railings will be considered as that portion of a structure attached to curbs, sidewalks, parapets, slabs, retaining walls and steps for the protection of traffic.

MATERIALS

507.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Steel Bridge Rail

Structural Steel	713.01
Preformed Pads	713.03

Aluminum Bridge Rail

Preformed Pads	713.03
Aluminum Railings	716.01

Steel pipe for Steel Pipe Hand Railing shall be galvanized seamless steel pipe conforming to the requirements of ASTM A 120.

CONSTRUCTION REQUIREMENTS

507.03 Steel Bridge Railing.

- (a) Railings shall be fabricated and erected in accordance with the requirements of Section 504 -- Structural Steel. When called for on the plans, railings shall be painted in accordance with Section 506 -- Painting Structural Steel.
- (b) Anchor bolts or anchor bolts sleeves shall be set with a template and shall be in their final position prior to the placement of the embedding concrete. Post bearing areas shall be dressed smooth and true to grade. Preformed pads shall be used in adjusting the rail posts for height and alignment. The number of pads to be supplied shall be 10 percent in excess of the theoretical minimum number required. After erection of the railing, the Contractor shall clean the whole assembly, to present a neat and uniform appearance.

507.04 Steel Pipe Hand Railing. Steel pipe hand railing shall conform to the requirements of Subsection 507.03(a).

507.05 Aluminum Bridge Railing. Aluminum sections may be sheared, sawed or milled. Cut edges shall be smooth and free of burrs. Flame cutting of aluminum will not be permitted.

Holes for rivets shall be drilled full size from the solid or subpunched and reamed.

Rivets shall be cold-driven in the "as-received" condition and the driven head shall be of the cone-point type.

Welding will not be permitted except as specifically called for on the plans or approved by the Engineer. All welding shall be done in conformance with Section 1.5.5 "Fabrication of Welded Aluminum Structures", of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. No welding shall be performed prior to the approval of the welding procedure. No field welding will be permitted.

As an alternate, the post base may be welded to the rail post, subject to the approval by the Engineer of the size and design of the welded connection. Under this alternate procedure welding will not be permitted transversely across the flanges of the post.

As an alternate, the post base may be fabricated as a single extrusion, subject to the approval of the Engineer.

To facilitate bending, aluminum extrusions of Alloy 6061-T6 or 6351-T5 may be heated to a maximum temperature of 400°F for a period of not more than thirty minutes.

Threaded fasteners shall be threaded to conform to the requirements of ANSI Standard B 1.1, Class 2A for external and Class 2B for internal threads.

Aluminum Bridge Railing shall conform to the requirements of Subsection 507.03(b).

507.06 Method of Measurement. Railings will be measured by the number of linear feet of railing erected and accepted. Measurements will be along the face of traffic rails from out to out of rail projections unless otherwise shown on the plans. The length for payment will include clear openings of 1 foot or less between the ends of the railing projections.

507.07 Basis of Payment. The accepted quantity of railings will be paid for at the contract unit price per linear foot, complete in place. Payment for painting, when required, will be included in the unit price for the respective railing item.

Payment will be made under:

Pay Item	Pay Unit
507.081 Steel Bridge Railing, 2 Bar	Linear Foot
507.082 Steel Bridge Railing, 3 Bar	Linear Foot
507.083 Steel Bridge Railing, 4 Bar	Linear Foot
507.084 Steel Pipe Hand Railing	Linear Foot
507.092 Aluminum Bridge Railing, 2 Bar	Linear Foot
507.093 Aluminum Bridge Railing, 3 Bar	Linear Foot
507.094 Aluminum Bridge Railing, 3 Bar, with Pales	Linear Foot
507.095 Aluminum Bridge Railing, Pedestrian	Linear Foot

SECTION 508 -- VACANT

SECTION 509 -- STRUCTURAL PLATE PIPES, PIPE ARCHES AND ARCHES

509.01 Description. This work shall consist of furnishing and installing structural plate pipes, pipe arches or arches in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established.

MATERIALS

509.02 Materials. Materials shall meet the requirements of the following Subsections of Division 700 -- Materials:

Asphalt Filler for Structural Plate Arches	702.09
Steel Structural Plates	707.09
Aluminum Alloy Structural Plates	707.14

509.03 Fabrication. Structural plate pipes shall be circular with a vertical elongation of approximately 5 percent unless otherwise specified on the plans.

Plates shall be formed to provide lap joints for bolted assembly. Joints shall be staggered so that no more than three plates come together at one point.

Bolt holes shall be made so that all plates having like dimensions, curvature and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved, before assembly, to the radius necessary to produce the final cross section called for.

End plates shall be neatly cut to the skew and slope shown on the plans. Burnt edges shall be free of oxide and burrs and shall be completely galvanized. Special plates and part plates shall be legibly marked to correspond to markings on an erection diagram which shall be furnished by the Contractor. Two sets of shop detail drawings and erection diagrams shall be supplied to the Engineer.

Bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in two rows, 2 inches apart for steel structural plates and shall be in two rows, 1 3/4 inches apart for aluminum structural plates. Holes shall be in the valley and crest of the corrugations. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall be no more than 12 inches apart. The distance from the center of a hole to the edge of the plate shall not be less than 2 times the diameter of the bolt. The nominal diameter of the bolt holes, not including corner holes, in the longitudinal seams shall be 1/8 inch greater than the diameter of the bolts.

509.04 Vacant

509.05 Vacant

CONSTRUCTION REQUIREMENTS

509.06 General. Excavation for the structure and for the bedding material shall be in conformance with Section 206 -- Structural Excavation.

Structures shall be assembled in the sequence and manner recommended by the Fabricator, and in such a way that no distortion of plates will occur. Bolts of the Fabricator's recommended length shall be used in all holes. Nuts shall be tightened to 200 foot pounds plus or minus 100 foot pounds of torque. Any nuts loosened by subsequent procedures shall be retightened.

The Contractor shall maintain a minimum cover of three feet over the top of the structure where construction equipment is used or traffic is maintained.

509.07 Structural Plate Pipes and Pipe Arches. The use of cofferdams and unwatering of the stream will not be a requirement for the installation of pipes and pipe arches unless otherwise specified on the plans. Prior to placing the structure or any plates, the bed shall be brought to the required line and grade and shaped to its required section as much as practicable. When practicable, the pipe or pipe arch shall be moved back and forth longitudinally on the bedding material to shape and compact the bedding material prior to releasing the structure in its final position. The bedding material and structure shall not be placed at times of high water. The Contractor shall obtain approval prior to placing the bedding material and the structure.

The specified bedding material may be omitted if the existing material under the pipe is suitable.

When not otherwise specified on the plans, backfill shall be a selected material of a granular nature with a minimum of clay. It shall contain no frozen material, vegetable matter nor anything which will not pass through a 3 inch square opening screen. The 3 inch size limitation shall not apply to areas 5 feet or more from the structure.

Fill material shall be deposited evenly on both sides of the structure in layers not exceeding 6 inches in depth, loose measure, until the 3/4 point is reached. It shall be thoroughly compacted under the pipe or pipe arch on both sides of the structure. Above the 3/4 point, fill layers shall not exceed a depth of 8 inches, loose measure.

Backfilling and compacting shall be done in the presence of the Engineer.

509.08 Structural Plate Arches. Structural plate arches shall be anchored to concrete substructures by unbalanced channels as shown on the plans. When erection is complete and before any backfilling, the spaces between the structural plates and the legs of the unbalanced channel, on both sides, shall be completely filled with asphalt filler.

When backfilling arches before headwalls are built, a narrow ramp of backfill material shall be built up evenly at each side of the arch and midway between its ends until a minimum cover of 3 feet over the top of the arch is reached. The backfill material used in the ramps shall be thoroughly compacted as it is placed. The remainder of the backfill shall be deposited from the top of the ramp, both ways from the center toward the ends as evenly as possible on both sides of the arch.

If the headwalls are built before the arch is backfilled, the same procedure as above shall be followed, except that the backfill material shall first be placed in the form of a narrow ramp adjacent to one headwall. When the aforementioned height above the arch is reached, the backfill material shall be deposited from the top of the ramp toward the other headwall.

In all cases the filling material shall be thoroughly but not excessively compacted. Compacting the backfill by means of flooding or ponding the material with water will not be permitted.

509.09 Method of Measurement. Structural plate pipe, pipe arches and arches will be measured as one lump sum.

509.10 Basis of Payment. The accepted structure will be paid for at the respective contract lump sum price, which price shall include full compensation for preparation of the bed for pipes and pipe arches; and the asphalt filler and unbalanced channel for arches.

Whenever the minimum cover material extends above the subgrade line, the removal of the material which is necessary to complete the work in accordance with the plans will be measured and paid for as Common Excavation as provided in Section 203 -- Excavation and Embankment.

Payment will be made under:

Pay Item	Pay Unit
509.11 ___ Inch Steel Structural Plate Pipe	Lump Sum
509.12 ___ Inch Span, ___ Inch Rise, Steel Structural Plate Pipe Arch	Lump Sum
509.13 ___ Inch Span, ___ Inch Rise, Steel Structural Structural Plate Arch	Lump Sum
509.18 ___ Inch Aluminum Alloy Structural Plate Pipe	Lump Sum
509.19 ___ Inch Span, ___ Inch Rise Aluminum Alloy Structural Plate Pipe Arch	Lump Sum
509.20 ___ Inch Span, ___ Inch Rise Aluminum Alloy Structural Plate Arch	Lump Sum
509.21 ___ Inch Structural Plate Pipe (Steel or Aluminum Alloy Option)	Lump Sum

SECTION 510 -- SPECIAL DETOURS

510.01 Description. This work shall consist of the construction, maintenance and removal of temporary structures and approaches required for the satisfactory maintenance of vehicular and pedestrian traffic. Easements or right-of-way for the Special Detour will be furnished by the Department and will be shown on the contract Right-of-way plans. The Contractor may obtain additional easements at no cost to the Department. When there is no pay item for Special Detours, traffic shall be maintained as specified in Section 652 -- Maintenance of Traffic.

MATERIALS

510.02 Materials. Materials used for the Special Detour structure and approaches shall be approved before they are incorporated in the structure and approaches.

CONSTRUCTION REQUIREMENTS

510.03 Vehicular and Pedestrian Traffic Not Separated. Special detours, shall be located as close as practicable to the new work and shall be constructed in such a manner as to provide safe and easy passage at all times. They shall be provided with suitable curbs and railings, satisfactory to the Engineer.

Structures and approaches shall be of sufficient strength to carry safely the legal load permitted on the highway. They shall have a clear traveled way width no less than that indicated in the contract and shall at all points be higher than the high water elevation that may be expected during the construction period. Grades on the detour shall not exceed 10 percent, and curves, both vertical and horizontal, shall be such as will not be hazardous nor inconvenient to traffic.

510.04 Pedestrian Traffic Only. The provisions of Subsection 510.03 shall apply to this item with the following modifications:

- (a) Structures shall be designed for a live load of 65 pounds per square foot.
- (b) The detour shall have a minimum clear width of 5 feet.
- (c) Structures and approaches shall be adequately lighted.

510.05 Vehicular and Pedestrian Traffic Separated. The provisions of both Subsections 510.03 and 510.04 shall apply to this item. If vehicles and pedestrians are carried on the same structure, each shall have its own lane as specified. The pedestrian lane shall be protected from vehicular traffic by being at least 9 inches above the roadway surface or suitably protected by means of an adequate curb at least 9 inches in height above the roadway surface.

510.06 Contractor's Responsibility. The provisions of Sections 105, 107 and 652 shall apply to work under this section. The Contractor shall be responsible for removal of snow from areas provided for pedestrian traffic as well as vehicular traffic in accordance with Section 104. In addition to normal maintenance, should any part or all of the detour be damaged by any cause prior to opening the new structure to traffic, it shall be repaired or replaced by the Contractor without additional compensation.

Erosion control shall be accomplished in accordance with Special Provision, Section 107, Legal Relations and Responsibility to Public, Soil Erosion -- Water Pollution Control.

510.07 Removal of Detour. When the new structure has been opened to traffic, the temporary structures and approaches shall be removed to or below the streambed or finish ground line and the approaches shall be obliterated and the approach areas rehabilitated and stabilized to original or better than original conditions. The provisions of Section 104 shall apply.

510.08 Method of Measurement. Special detours will be measured by the specified special detour lump sum.

510.09 Basis of Payment. The accepted special detour will be paid for at the contract lump sum price for the respective items, as called for in the contract, constructed, maintained, completely removed and the affected areas rehabilitated and stabilized.

When erosion control is required due to runoff from the detour roadway surface, erosion control will be paid under applicable contract items. Other erosion control work required for the special detour will not be paid for directly and all costs for such erosion control will be considered included in the lump sum payment for special detour. Traffic control devices and dust control will be paid for under the applicable contract items.

Payment will be made under:

Pay Item	Pay Unit
510.10 Special Detour, _____ foot Roadway Width Vehicular and Pedestrian Traffic not Separated	Lump Sum
510.11 Special Detour, Pedestrian Traffic Only	Lump Sum
510.12 Special Detour, _____ foot Roadway Width Vehicular and Pedestrian Traffic Separated	Lump Sum

SECTION 511 -- COFFERDAMS

511.01 Description. This work shall consist of the complete construction, maintenance and removal of all cofferdams, caissons, cribs, sheeting, embankments, temporary diversion channels and other similar work, including unwatering, required to allow for the excavation of foundation pits and to permit and protect the construction of structural units, in accordance with these specifications.

MATERIALS

511.02 Materials. If requested, the Contractor shall submit for approval, plans showing the materials to be used and the proposed method of protecting the foundation construction. Construction shall not be started on cofferdams until such plans are approved. Approval of the plans shall not relieve the Contractor of the responsibility for the satisfactory functioning of the cofferdam.

CONSTRUCTION REQUIREMENTS

511.03 Cofferdam Construction. Cofferdams shall, in general, be carried well below the elevation of the bottom of footings and shall be well braced and as watertight as necessary for the proper construction of the foundation. Unless it is contemplated that a concrete foundation seal will be placed under water, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction and inspection of forms and to permit pumping outside of forms. Cofferdams shall be so constructed that sea water will not come in contact with concrete, as required in Section 502 -- Structural Concrete.

During the placing of seal concrete, the elevation of the water inside the cofferdam shall be controlled to prevent any flow through the concrete.

No timber or bracing shall be used in cofferdams or cribs in such a way as to remain in the substructure masonry.

Cofferdams shall be constructed so as to protect fresh concrete against damage from the sudden rising of the stream and to prevent damage by erosion.

Unless otherwise provided, cofferdams or cribs, including all sheeting and bracing involved, shall be removed after the completion of the substructure, care being taken not to disturb or otherwise injure the finished masonry.

All embankments serving as cofferdams shall be removed, temporary diversion channels filled in, and all areas left in a neat and workmanlike appearance and in an approved stabilized condition.

511.04 Pumping. Pumping from the interior of any foundation enclosure shall be done in such manner as to prevent any current of water which would carry away or segregate the concrete.

Pumping to unwater a sealed cofferdam shall not commence until the seal concrete has set sufficiently to withstand the hydrostatic pressure but in no case will pumping be permitted within 5 days under normal conditions or 7 days when the temperature of the water outside the cofferdam is less than 40°F.

511.05 Method of Measurement. Cofferdams will be measured as one lump sum unit, as indicated on the plans or called for in the contract.

511.06 Basis of Payment. The accepted quantity of cofferdam will be paid for at the contract lump sum price for the respective cofferdam items.

When required, the elevation of the bottom of the footing of any substructure unit may be lowered, without change in the price to be paid for Cofferdams, provided, however, that if the average elevation of more than 25 percent of the area of the excavation is more than 3 feet below the elevation shown on the plans, and at the Contractor's request, the entire cost of the cofferdam will be paid for in accordance with Subsection 109.04 instead of at the contract lump sum price.

Payment will be made under:

Pay Item	Pay Unit
511.07 Cofferdam	Lump Sum

SECTION 512 -- FRENCH DRAINS

512.01 Description. This work shall consist of furnishing, placing and compacting stone and gravel for French Drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established.

MATERIALS

512.02 Materials. Materials shall meet the requirements of the following Subsections of Division 700 --Materials.

Aggregate for Subbase	703.06(b)
Gravel Borrow	703.20
Stones for French Drains	703.24

Gravel for French Drains shall meet the requirements of either Aggregate for Subbase, Type D or Gravel Borrow at the Contractor's option.

CONSTRUCTION REQUIREMENTS

512.03 Drains. Stones shall be placed behind and against the structures with the bottom of the stones at the elevation of the flow line of the weeper drains. The stones shall form a box section, 2 feet wide and 2 feet high, for the entire length of the structure. Gravel shall be placed to form a box section around the stones, to the limits of 2 feet above the stones, 2 feet behind the stones and 2 feet below the stones, but not to be placed below the top of the footing.

Gravel for French Drains shall be compacted in the same general manner and to the same extent as the adjacent embankment.

512.04 Method of Measurement. The accepted quantity of French Drains will be measured by the linear foot, satisfactorily placed and accepted. Measurement will be made along the interface of the structure and the French Drains.

Excavation for French Drains will be measured for payment in accordance with Section 206 -- Structural Excavation.

512.05 Basis of Payment. French Drains will be paid for at the contract unit price per linear foot.

Payment will be made under:

Pay Item	Pay Unit
512.08 French Drains	Linear Foot

SECTION 513 -- SLOPE PROTECTION

513.01 Description. This work shall consist of excavating for and placing a protective covering on designated slopes in accordance with these specifications and in reasonably close conformity with the lines, grades and thickness as shown on the plans or established.

MATERIALS

513.02 Materials. Materials shall meet the requirements of the following Subsections of Division -- 700 Materials.

Crushed Stone	703.31
Reinforcing Steel	709.01

Portland cement concrete for slope protection shall be Class "Y" and shall meet the requirements of Section 502 -- Structural Concrete.

CONSTRUCTION REQUIREMENTS

513.03 Portland Cement Concrete. The slope on which the concrete for slope protection is to be placed shall be free of frost and frozen material and shall be well compacted. If additional fill material is required to bring the slope to the proper grade, it shall be of the same type material as that required for the slope protection foundation. Immediately prior to placing the concrete the area to be covered shall be thoroughly dampened.

The portland cement concrete shall be placed in alternate sections. Each individual section shall be placed by starting at the lowest extremity of the section and progressing upward on the slope. The reinforcement shall not extend through the construction joints and the bond between sections shall be broken by the application of an approved asphalt cement on the edges of the previously placed slabs.

The surface of the concrete shall be float finished in accordance with the requirements of Section 502 -- Structural Concrete and textured by brooming lightly and uniformly with an approved broom. An edging tool shall be used on the surface edges of each section and a groover at the transverse centerline of each section. The exterior surface from the edging or grooving shall be finished to match the interior surface.

Construction procedures shall be in accordance with Section 502 -- Structural Concrete, except that the curing period will be 5 days.

513.04 Crushed Stone. Crushed stone shall be placed on granular material as shown on the plans. The finished slope shall be worked to present a smooth and uniform surface.

513.05 Method of Measurement. Slope protection will be measured by the number of square yards of surface area acceptably covered in accordance with the plans and specifications.

513.06 Basis of Payment. The accepted quantity of slope protection will be paid for at the contract unit price per square yard, which payment shall include shaping and compacting the slope prior to placing, and excavation required for the placement of the slope protection and bedding material.

Payment for portland cement concrete slope protection shall be full compensation for furnishing and placing all material, including reinforcement, and for all labor and other incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
513.09 Slope Protection-Portland Cement Concrete	Square Yard
513.22 Crushed Stone Slope Protection	Square Yard

SECTION 514 -- CURING BOX FOR CONCRETE CYLINDERS

514.01 Description. This item shall consist of furnishing, installing, operating and maintaining an approved thermostatically controlled curing box for concrete test cylinders, with the equipment as herein specified.

514.02 General. The curing box shall be for the sole use of the Engineer for the duration of the contract. The Contractor shall relocate the curing box to a new location, as directed, whenever considered necessary during the progress of the work. The Contractor shall furnish the electrical power and all utility connections necessary for the operation of the curing box. The Engineer shall be provided 2 locks, each with 2 keys, to be used with the 2 securing latches. A lock for the switch box, with 2 keys shall be furnished.

CONSTRUCTION REQUIREMENTS

514.03 Construction Details. The curing box for concrete cylinders shall have the approximate internal dimensions of 3 feet 6 inches long, 1 foot 6 inches wide, and 1 foot 7 inches deep. The top of the curing box shall be a lid hinged at the back, with 2 securing latches on the front which are suitable for use in locking the box. The free movement of the lid shall be restricted to an angle of approximately 100 degrees from a closed position to an open position by means of a chain made of a rustproof metal. All the interior surfaces of the curing box shall be of rustproof construction and the exterior surfaces shall be substantially painted with and approved paint. A moisture-proof seal, constructed of an approved cellular strip of 2BE520F26 synthetic rubber complying with the requirements of ASTM D 2000, shall be provided between the lid and body of the curing box.

The curing box shall be constructed so that the required temperature and humidity within the box can be supplied by an immersible heater, minimum 1000 watts, when immersed in a pool of water, approximately 4 inches in depth at the bottom of the box. The heating element shall be located so as to provide free access for cleaning and for adequate circulation of the surrounding water. A drain shall be provided for the water, located at the lower front edge of the box. Access shall be provided to all parts of the box for cleaning. The electrical utility connection to the source of power shall be made in a lockable switch box which is securely attached to one end of the curing box.

All electrical connections from the curing box to the utility connection shall conform to the latest requirements of the NEC. The curing box shall be effectively grounded. Grounding shall be accomplished in one of the following ways:

- (a) By means of a grounding conductor run with the circuit conductors in cable assemblies or flexible cords, provided an approved plug is used, 1 fixed contacting member for the purpose of connecting such grounding conductor to the grounded metal raceway or to a grounding conductor installed only for equipment grounding purposes; the grounding conductor in a cable assembly may be uninsulated but where an individual covering is provided for such conductors it shall be finished to show a green color.
- (b) A direct connection from the grounding wire, green color, on the Curing Box wiring to an 8 foot non-ferrous metal driven ground rod and ground rod clamp.

For installation, where the Curing Box is outside and exposed to the weather, all wiring and fittings shall be of the weatherproof type.

An approved bimetallic thermometer shall be installed within the Curing Box which will measure the internal temperature and which can be read from the outside without opening the box. This thermometer shall have minimum graduations of 2°F and shall be protected from physical damage by suitable shielding. Suitable folding metal handles shall be provided on the ends of the box for use in moving.

The Curing Box shall be suitable for maintaining: (a) an internal temperature of 70°F plus or minus 5°F when the ambient temperature is as low as minus 10°F.

514.04 Method of Measurement. Curing Box for Concrete Cylinders will be measured by each unit, furnished and satisfactorily maintained.

514.05 Basis of Payment. The accepted quantity of curing box for concrete cylinders will be paid for at the contract unit price each, which payment shall be full compensation for furnishing and maintaining, for all materials, labor, tools, equipment, electrical power, temporary utility changes and adjustments, and all necessary incidentals. At the completion of the contract, the Curing Box shall remain the property of the Contractor and shall be removed from the site of the work.

Payment will be made under:

Pay Item	Pay Unit
514.06 Curing Box for Concrete Cylinders	Each

SECTION 515 -- PROTECTIVE COATING FOR CONCRETE SURFACES

515.01 Description. This work shall consist of furnishing and applying a protective coating on concrete surfaces as called for on the plans or as designated by the Engineer in accordance with these specifications.

MATERIALS

515.02 Materials. Materials shall meet the requirements of Sub-section 711.05, Protective Coating for Concrete Surfaces.

CONSTRUCTION REQUIREMENTS

515.03 Surface Preparation. On surfaces to be treated all voids shall be filled with mortar and the entire surface shall be dressed by dry rubbing to remove form marks and blemishes to present a neat appearance. The concrete shall remain dry for at least 48 hours before treatment and shall be free of laitance, oil, grease, dirt and dust. All traces of dust shall be removed immediately before applying the linseed oil mixture.

The treatment shall not be done until at least 14 days after casting the concrete and completed at least 24 hours before the treated portion is opened to traffic.

515.04 Application. Enough material shall be used to coat the surfaces thoroughly. Two coatings shall be applied 24 hours or more apart. The minimum rates of application shall be .025 gallons per square yard for the first coat and .015 gallons per square yard for the second coat.

The method of application may be dependent on available equipment and the area involved. Hand spray methods or pressure distributors may be used and application by rollers or brushes may be desirable under some conditions. Care shall be taken to prevent discoloration of areas and parts not requiring treatment.

Twenty four hours after application, excess coating materials, if any, must be removed.

When practical, treatment of the concrete surfaces shall be completed before exposure to deicing salts. The temperature of the concrete shall be above 40°F.

515.05 Method of Measurement. Protective Coating for Concrete Surfaces will be measured for payment by the square yard satisfactorily applied and accepted.

515.06 Basis of Payment. Protective Coating for Concrete Surfaces will be paid for at the contract unit price per square yard.

Payment will be made under:

Pay Item	Pay Unit
515.20 Protective Coating for Concrete Surfaces	Square Yard

SECTION 516 -- STYRENE-BUTADIENNE LATEX MODIFIED PORTLAND CEMENT
MORTAR AND CONCRETE

Reserved

SECTIONS 517 to 519 VACANT

SECTION 520 -- EXPANSION DEVICES

Reserved

SECTION 521 -- VACANT

SECTION 522 -- MODULAR EXPANSION DEVICES

Reserved

SECTION 523 -- BEARING PEDESTALS

Reserved

SECTION 524 -- VACANT

SECTION 525 -- GRANITE MASONRY

Reserved

SECTION 526 -- CONCRETE BARRIER

526.01 Description. This work shall consist of the setting, resetting and removing of temporary concrete barrier and elements in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or as established.

Temporary Concrete Barrier, Type I shall consist of a double faced barrier of a shape designated on the plans with attachments that allow sections to be connected into a continuous barrier. The connections shall be of a type which allows disassembly, moving and reassembly of the barrier. Provisions shall be made in the casting of the barrier for attaching the barrier to the roadway and to bridge decks, when such attachment is specified on the plans.

MATERIALS

526.02 Materials. Concrete shall be portland cement concrete. The State reserves the right to take test core samples from the barriers in accordance with ASTM C 42. Average compressive test strengths below 2,500 pounds per square inch will result in rejection of the barriers.

Reinforcing steel shall meet the requirements of ASTM A 615, Grade 40 or Grade 60.

CONSTRUCTION REQUIREMENTS

526.03 General. Temporary concrete barrier shall generally be free of fins and porous areas and shall present a neat and uniform appearance.

Permissible dimensional tolerances for temporary concrete barrier shall be as follows:

1. Cross sectional dimensions shall not vary from design dimensions by more than 1/4 inch. The vertical centerline shall not be out of plumb by more than 1/4 inch.
2. Longitudinal dimensions shall not vary from the design dimensions by more than 1/4 inch per 10 feet of barrier section and shall not exceed 3/4 inch per section.
3. Location of anchoring holes shall not vary by more than 1/2 inch from the dimensions shown in the concrete barrier details on the plans.
4. Surface straightness shall not vary more than 1/4 inch under a 10 foot straightedge.

The barrier shall have no significant cracking. Significant cracking is defined as fractures or cracks passing through the section or any continuous crack extending for a length of 12 inches or more, regardless of position in the section.

526.04 Installation. Temporary concrete barrier shall be placed, relocated and removed as shown on the plans or as directed.

Temporary concrete barriers which have been damaged, by other than the traveling public while in use or show signs of deterioration shall be replaced, as directed, at no additional cost to the State.

526.05 Method of Measurement. Temporary concrete barrier will be measured for payment by the linear foot from end to end of each run of barrier measured along the centerline of the barrier complete in place. No deduction in pay length will be made for joints between abutting barrier sections.

Barrier reinforcing steel, cable and fixtures will not be measured separately for payment and payment will be considered included in the unit bid price for temporary concrete barrier.

Sections of temporary concrete barrier damaged by the traveling public shall be replaced by the Contractor, when directed by the Engineer and will be measured for payment.

526.06 Basis of Payment. The accepted quantities of Temporary Concrete Barrier, Type I, will be paid for at the contract unit price per linear foot complete in place. Such payment shall be full compensation for furnishing all material, assembling and all incidentals necessary to complete the work.

Payment for resetting temporary concrete barrier shall be full compensation for removing, transporting, temporary storing, resetting and furnishing new parts when necessary. No additional payment will be made for temporary concrete barrier removed and not reset. The temporary barrier shall become the property of the Contractor upon completion of the use of the barrier on the project and shall be removed from the project site by the Contractor.

Payment will be made under:

Pay Item	Pay Unit
526.30 Temporary Concrete Barrier, Type I	Linear Foot
526.40 Resetting Temporary Concrete Barrier, Type I	Linear Foot

SECTION 527 -- ENERGY ABSORBING UNIT

Reserved

SECTION 528 -- STRUCTURAL TIMBER

Reserved

DIVISION 600 -- INCIDENTAL CONSTRUCTION

SECTION 601 -- GABIONS

601.01 Description. This work shall consist of furnishing, assembling, filling with stones and lacing hexagonal mesh wire baskets, hereafter called gabions, constructed in accordance with these specifications and placing the gabions in conformity with the lines, grades and dimensions shown on the plans or established.

MATERIALS

601.02 Materials. Materials shall conform to the requirements specified in the following Subsections of Division 700 -- Materials.

Gabions	711.02
Stones for Gabions	711.03

601.03 Fabrication. Gabions shall be manufactured so that their sides, ends, lid and diaphragm(s) can be assembled to form rectangular units of the specified dimensions.

Gabions shall be of a single unit construction. The front, base, back and lid shall be woven into a single unit. The ends and diaphragm(s) shall be factory connected to the base.

Perimeter edges of the mesh forming the gabion shall be securely selvaged so that joints have at least the same strength as the wire mesh itself.

The wire mesh shall be fabricated to be non-raveling. Non-raveling is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single wire in a section of mesh is cut and the section of mesh then subject to the load test described in the materials specification.

The gabion length shall be 1 1/2, 2, 3 or 4 times its horizontal width. The horizontal width shall not be less than 36 inches. However, all gabions furnished by the manufacturer shall be of uniform width. Where the gabion length exceeds 1 1/2 times its horizontal width, the gabion shall be equally divided into cells by diaphragm(s) of the same mesh and gauge as the gabion body.

601.04 Assembling. Gabions shall be supplied folded flat, tied in pairs and packed in bundles. Single gabions shall be removed from the bundle, unfolded flat on the ground and all kinks and bends flattened.

The gabion unit shall then be assembled individually, by erecting the sides (front and back), ends and diaphragm(s), assuring that all creases are in the correct position and the tops of all sides level.

The four corners of the gabion unit shall be laced first, followed by the edges of internal diaphragm(s) to the sides.

The lacing procedure shall consist of cutting a length of lacing wire approximately 1 1/2 times the distance to be laced, not to exceed 5 feet, securing wire terminal at the corner by looping and twisting, then proceeding to lace with alternating single and double loops at approximately 5 inch intervals and securely fastening the other wire terminal.

601.05 Installation. The assembled gabion units shall be placed in the proper location. All adjoining empty gabions shall be placed along the perimeter of the gabion contact surfaces to obtain a monolithic structure.

The following method applies to 3 foot high gabions; once the gabion units are laced together, they shall be stretched to effective alignment. This operation shall be carried out after several empty gabion units have been positioned. The first gabion in the line shall be partially filled to provide the necessary anchorage. Any stretching shall be carried out using a means of at least one ton capacity.

While under tension, the gabion shall be carefully controlled against any possible unraveling.

Whenever gabion structures require more than one tier, the upper empty gabion tier under tension shall be laced to the top of the lower one.

601.06 Filling Gabions. Gabions shall be filled by earth-handling equipment such as backhoe, gradall, crane and/or by hand.

Care shall be taken when placing fill material to assure that the sheathing on coated gabions will not be broken or damaged.

Gabions shall be filled in layers, 1 foot at a time. Two connecting wires shall be placed between each layer in all cells along all exposed faces of the gabion structure. All connecting wires shall be looped around 2 mesh openings and the wire terminals shall be securely twisted to prevent their loosening.

The cells in any row shall be filled in stages so that local deformation will be avoided. At no time shall any cell be filled to a depth exceeding 1 foot more than the adjoining cell.

Along all exposed gabion faces, the outer layer of stone shall be carefully placed and packed by hand to ensure proper alignment and a neat, compact, square appearance.

The last layer of stone shall be leveled with the top of the gabion to allow proper closing of the lid and provide an even surface for the next course.

Gabions shall be well packed and full, without excessive bulging.

601.07 Lid Closing. The lids shall be stretched tightly over the filling, using crow bars or lid closing tools, until the lid meets the perimeter edges of the front and end panels. The lid shall then be tightly laced along all edges, ends and diaphragms in the same manner as described above for assembly.

601.08 Cutting and Folding Mesh. Where shown on the drawings or when otherwise directed, the gabion mesh shall be cut, folded and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely or folded back and neatly wired to an adjacent gabion face. The cut edges of the mesh shall be securely laced together with lacing wire in the manner described above for assembling.

601.09 Method of Measurement. Gabions will be measured by the cubic yard to the neat line dimensions shown on the plans.

601.10 Basis of Payment. Payment for gabions will be made at the contract unit price per cubic yard in place, which price shall include preparing and fine grading the foundation, furnishing and placing all necessary gabion units, lacing wire, gabion mesh, fill material and all labor and equipment required to complete the work.

Payment will be made under:

Pay Item	Pay Unit
601.20 Gabions	Cubic Yard

SECTION 602 -- VACANT

SECTION 603 -- PIPE CULVERTS AND STORM DRAINS

603.01 Description. This work shall consist of the construction or reconstruction of pipe culverts and storm drains, in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established.

603.02 Materials. Material shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Joint Mortar	705.02
Flexible Gaskets	705.03

Flexible Culvert

Zinc Coated (Galvanized) Corrugated Iron or Steel Pipe and Pipe Arches	707.02
Bituminous Coated Corrugated Iron or Steel Pipe and Pipe Arches	707.03
Corrugated Aluminum Alloy Pipe and Pipe Arches	707.06
Smoothlined Corrugated Iron or Steel Pipe	707.10
Smoothlined Corrugated Aluminum Alloy Pipe	707.11
Bituminous Coated, Smoothlined Corrugated Iron or Steel pipe	707.12
Precoated, Smoothlined, Corrugated Iron or Steel Pipe	707.13

Rigid Culvert

Non-Reinforced Concrete Pipe	706.01
Reinforced Concrete Pipe and Pipe Arches	706.02
Asbestos Cement Pipe	706.10

Flexible culverts with a diameter of 48 inches or more shall have the ends cut to a partial bevel as called for on the plans. The cut ends shall be regalvanized or painted with a zinc aluminum paint conforming to Federal Specification TT-P-1561A and, or approved equal if required, bituminous coated before shipping.

Rigid culverts, designated to have the ends shaped to a partial bevel, shall be either cast or cut to the required shape and dimensions. In either case the edges of the pipe shall be even and true with no exposed reinforcing.

CONSTRUCTION REQUIREMENTS

603.03 General. Culvert pipe shall be furnished under the following options unless otherwise specified.

Option I. The Contractor may furnish any of the following type of pipe under Option I:

- Zinc Coated (Galvanized) Corrugated Iron or Steel Pipe
- Bituminous Coated Corrugated Iron or Steel Pipe
- Corrugated Aluminum Alloy Pipe
- Smoothlined Corrugated Iron or Steel Pipe
- Smoothlined Corrugated Aluminum Alloy Pipe
- Bituminous Coated, Smoothlined Corrugated Iron or Steel Pipe
- Precoated Smoothlined Corrugated Iron or Steel Reinforced Concrete Pipe
- Non-Reinforced Concrete Pipe
- Asbestos Cement Pipe (14 inch and 20 inch diameter pipe will be acceptable for Items 603.16 and 603.18 respectively, for this type of pipe only).

Option II. The Contractor may furnish any of the following types of pipe under Option II:

Bituminous Coated Corrugated Iron or Steel Pipe
Corrugated Aluminum Alloy Pipe
Bituminous Coated Smoothlined Corrugated Iron or Steel Pipe
Smoothlined Corrugated Aluminum Alloy Pipe
Precoated Smoothlined Corrugated Iron or Steel Pipe
Reinforced Concrete Pipe
Asbestos Cement Pipe (14 inch and 20 inch diameter pipe will be acceptable for Items 603.18 and 603.188 respectively, for this type of pipe only. Not available in sizes 42 inch and over.)

Option III The Contractor may furnish any of the following types of pipe under Option III:

Reinforced Concrete Pipe
Precoated Smoothlined Corrugated Iron or Steel Pipe
Asbestos Cement Pipe (14 inch and 20 inch diameter pipe will be acceptable for Items 603.169 and 603.189 respectively, for this type of pipe only. Not available in sizes 42 inch and over.)

603.031 Excavation. Trenches shall be excavated in accordance with the requirement of Section 206 -- Structural Excavation wide enough to allow jointing the culvert and compacting the bedding and backfill material under and around the culvert. Unless otherwise designated, all trench walls shall be as nearly vertical as possible and the trench width no greater than necessary for installation of the culvert.

603.04 Bedding. Culverts less than 42 inches in diameter shall be bedded on a firm foundation of uniform density. After placing the culvert pipe, backfill material shall be placed along the bottom of the trench and thoroughly tamped against the lower portion of the pipe with special care taken not to move the bedded pipe.

For culverts 42 inches in diameter and larger, the bottom of the trench shall be compacted to uniform density and shaped to fit a template with reasonable closeness for at least 10 percent of the culvert's total height.

On all bedding, when bell and spigot pipe is used, the portion of trench at the joints shall be shaped to fit the bell.

603.05 Laying Culvert. The Contractor shall not be installed nor backfilled culverts between December 15 and April 1 without written permission. Installing shall begin at the downstream end of the culvert line. Bell or groove ends of rigid culverts shall be

placed facing upstream. Metal culverts shall be placed with the longitudinal laps or seams at the sides and the outside laps of circumferential joints pointing up grade. Paved or partially lined culvert shall be laid with the lining on the bottom.

Elliptical shaped metal culverts shall be placed with the major axis within 5 degrees of the vertical. Elliptical shaped and elliptically reinforced concrete pipe shall be placed with the vertical axis indicated by the manufacturer within 5 degrees of the vertical.

603.06 Joining Culverts. The method of joining rigid culvert sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even. Joints shall be made with portland cement mortar, portland cement grout, rubber gaskets or flexible plastic gaskets.

The pipe ends shall be thoroughly cleaned before the joint is made. Mortared joints shall be made with an excess of mortar to form a bead around the outside of the culvert and finished smooth inside. For grouted joints, molds or runners shall be used to retain the poured grout.

Joints with rubber ring gasket or flexible plastic gasket shall be made in accordance with the manufacturer's recommended procedures.

When portland cement mixtures are used, the completed joints shall be protected against drying by covering.

Flexible culvert section and metal end sections shall be firmly jointed by coupling bands. These bands shall meet the same applicable requirements as the flexible culvert being joined.

603.07 Shop Strutting. All flexible culvert pipe 48 inches in diameter and larger shall be elongated along the vertical diameter in accordance with one of the following two methods:

- (a) The pipe shall be elongated by the manufacturer after fabrication by increasing the diameter along the vertical axis approximately 3 percent with a corresponding decrease along the horizontal axis. The elongation shall be obtained by installing rods and tightening the rods, uniformly from end to end of the pipe, obtaining approximately one-quarter of the required elongation each time throughout the length of the pipe.

The rods shall be 5/8 inch diameter threaded 7 inches at both ends with washers and nuts. The length of the rods shall be the diameter of the pipe plus 8 inches. The rods shall be placed on the horizontal axis of the pipe at 2 foot spacing and located halfway between the circumferential riveting. A block of soft wood 2 inches by 4 inches by 12 inches long, shall be

placed over the rods at each end to provide contact against the outside of the pipe. The long dimension of the blocks shall be parallel with the horizontal axis of the pipe. The rods shall be left in the pipe until the fill is completed and compacted, unless for some unusual condition their removal is ordered. The rods shall be removed by cutting from the inside adjacent to the pipe.

- (b) The pipe shall be elongated by the manufacturer by increasing the diameter along the vertical axis approximately 5 percent with a corresponding decrease along the horizontal axis by applying sufficient pressure to the sides of the pipe after fabrication to produce the specified distortion. The elongation shall be maintained by drilling holes in the ends of the pipe sections and placing and tightening horizontal wires. After the pipe sections have been installed with coupling bands, the wires shall be removed.

Helically corrugated culvert sections shall be match marked before being elongated by the manufacturer or before the 5/8 inch diameter rods are installed.

603.08 Backfilling Culverts and Storm Drains. After the pipe is installed it will be inspected before any backfill material is placed. All pipe found to be out of alignment, unduly settled or damaged to the extent that full performance is impaired, shall be taken up and relaid or replaced.

Trenches shall be backfilled in accordance with Subsection 206.03 and as follows. The backfill material shall be thoroughly rammed under the haunches of the pipe with power or pneumatic operated hand tampers. The remainder of the backfill shall be thoroughly compacted with power tampers or vibratory compactors or other approved equipment or combination of equipment.

When the top of the pipe is exposed above the top of the trench, the embankment material around the pipe shall be placed and compacted on each side of the pipe in the aforementioned manner described for backfilling trenches, for a width of 5 feet measured from the outside diameter of the pipe. Only that portion of the embankment on each side and top of the pipe, for a minimum distance of 15 inches measured from the outside diameter of the pipe, must be of material conforming to the requirements described for backfilling in Subsection 206.03. Backfill material beyond these limits may contain stones larger than 3 inches but no greater than the thickness of the layer being placed. The embankment construction around the pipe shall continue up to an elevation 15 inches above the top of the pipe. Above and beyond these limits the embankment shall be placed and compacted in accordance with the embankment construction requirements specified for the work except where the imperfect trench method is called for on the plans.

When construction equipment is used or traffic is maintained the Contractor shall maintain a minimum cover of 3 feet over all pipes. Whenever this cover extends above the subgrade the Contractor shall temporarily place earth which shall be removed when necessary to complete the work in accordance with the plans or as directed. Any deviation from this practice shall have prior approval.

603.09 Induced Trench. Under this method, for designated rigid pipes only, the embankment shall be completed as specified above, to a height above the culvert equal to the vertical outside diameter of the pipe plus 1 foot. A trench equal in width to the outside horizontal diameter of the pipe shall then be excavated to within 1 foot of the top of the pipe. Trench walls shall be as nearly vertical as possible. The trench shall be loosely filled with highly compressible soil. Hay, bales shall be used to fill the lower 1/4 to 1/3 of the trench. Construction of embankment above shall then proceed in a normal manner.

603.10 Removing and Relaying Culverts. The pipe shall be carefully removed from its existing location, transported to and installed in the new location in accordance with these specifications for the particular type of pipe involved. Pipe damaged by the Contractor shall be replaced with pipe of similar type by the Contractor without additional compensation.

New metal bands or joint material shall be supplied and installed when necessary.

603.11 Method of Measurement. Culvert and storm drain pipe of the different types and sizes, both new and relaid, will be measured by the length in linear feet along the invert, laid as directed, complete in place and accepted. Pipe laid in excess of the authorized length will not be included.

When the ends of a pipe are sloped or skewed the amount to be included for payment shall be the length along the invert of the pipe.

Inlet grate units will be measured by each unit installed, complete in place and accepted.

603.12 Basis of Payment. The accepted quantities of pipe for culverts and storm drains will be paid for at the contract unit price per linear foot, for the types and sizes specified, complete in place.

No payment will be made for pipe ordered without written approval of the Engineer when such pipe is not required to be installed for completion of the work.

Excavation for culverts and storm drains, including excavation below the pipe, for induced trench and for bedding and backfilling will be measured and paid for as provided in Section 206 -- Structural Excavation.

Whenever minimum cover material extends above the subgrade, removal of the cover material necessary to complete the work will not be paid for directly but shall be considered part of the work specified herein.

Coupling bands and joint material will not be paid for separately but shall be considered included in the unit bid price for the type of pipe being used or relaid.

Existing culverts to be relaid, salvaged or wasted shall be removed and disposed of as directed. The excavation for removal of these culverts that is not paid for under other items or incidental to other items shall be paid for as Common Excavation.

Payment will be made under:

Pay Items	Pay Unit
603.13 8 inch Culvert Pipe Option I	Linear Foot
603.14 10 inch Culvert Pipe Option I	Linear Foot
603.15 12 inch Culvert Pipe Option I	Linear Foot
603.16 15 inch Culvert Pipe Option I	Linear Foot
603.17 18 inch Culvert Pipe Option I	Linear Foot
603.18 21 inch Culvert Pipe Option I	Linear Foot
603.19 24 inch Culvert Pipe Option I	Linear Foot
603.20 30 inch Culvert Pipe Option I	Linear Foot
603.21 36 inch Culvert Pipe Option I	Linear Foot
603.138 8 inch Culvert Pipe Option II	Linear Foot
603.148 10 inch Culvert Pipe Option II	Linear Foot
603.158 12 inch Culvert Pipe Option II	Linear Foot
603.168 15 inch Culvert Pipe Option II	Linear Foot
603.178 18 inch Culvert Pipe Option II	Linear Foot
603.188 21 inch Culvert Pipe Option II	Linear Foot
603.198 24 inch Culvert Pipe Option II	Linear Foot
603.208 30 inch Culvert Pipe Option II	Linear Foot
603.218 36 inch Culvert Pipe Option II	Linear Foot
603.228 42 inch Culvert Pipe Option II	Linear Foot
603.238 48 inch Culvert Pipe Option II	Linear Foot
603.248 54 inch Culvert Pipe Option II	Linear Foot
603.258 60 inch Culvert Pipe Option II	Linear Foot
603.268 66 inch Culvert Pipe Option II	Linear Foot
603.278 72 inch Culvert Pipe Option II	Linear Foot
603.288 84 inch Culvert Pipe Option II	Linear Foot
603.159 12 inch Culvert Pipe Option III	Linear Foot
603.169 15 inch Culvert Pipe Option III	Linear Foot
603.179 18 inch Culvert Pipe Option III	Linear Foot
603.189 21 inch Culvert Pipe Option III	Linear Foot
603.199 24 inch Culvert Pipe Option III	Linear Foot
603.209 30 inch Culvert Pipe Option III	Linear Foot
603.219 36 inch Culvert Pipe Option III	Linear Foot
603.229 42 inch Culvert Pipe Option III	Linear Foot
603.239 48 inch Culvert Pipe Option III	Linear Foot
603.249 54 inch Culvert Pipe Option III	Linear Foot
603.259 60 inch Culvert Pipe Option III	Linear Foot
603.269 66 inch Culvert Pipe Option III	Linear Foot
603.279 72 inch Culvert Pipe Option III	Linear Foot
603.289 84 inch Culvert Pipe Option III	Linear Foot

603.29	17 inch span 13 inch rise Pipe Arch	Linear Foot
603.30	21 inch span 15 inch rise Pipe Arch	Linear Foot
603.31	24 inch span 18 inch rise Pipe Arch	Linear Foot
603.32	28 inch span 20 inch rise Pipe Arch	Linear Foot
603.33	35 inch span 24 inch rise Pipe Arch	Linear Foot
603.34	42 inch span 29 inch rise Pipe Arch	Linear Foot
603.35	49 inch span 33 inch rise Pipe Arch	Linear Foot
603.36	57 inch span 38 inch rise Pipe Arch	Linear Foot
603.37	64 inch span 43 inch rise Pipe Arch	Linear Foot
603.38	71 inch span 47 inch rise Pipe Arch	Linear Foot
603.39	24 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.40	30 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.41	36 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.42	42 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.43	48 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.44	54 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.45	60 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.46	66 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.47	72 inch Reinforced Concrete Pipe Class IV	Linear Foot
603.48	8 inch Asbestos Cement Pipe Class _____	Linear Foot
603.49	10 inch Asbestos Cement Pipe Class _____	Linear Foot
603.50	12 inch Asbestos Cement Pipe Class _____	Linear Foot
603.51	14 inch Asbestos Cement Pipe Class _____	Linear Foot
603.52	16 inch Asbestos Cement Pipe Class _____	Linear Foot
603.53	18 inch Asbestos Cement Pipe Class _____	Linear Foot
603.54	20 inch Asbestos Cement Pipe Class _____	Linear Foot
603.55	24 inch Asbestos Cement Pipe Class _____	Linear Foot
603.56	30 inch Asbestos Cement Pipe Class _____	Linear Foot
603.57	36 inch Asbestos Cement Pipe Class _____	Linear Foot
603.58	through 603.72 Vacant	
603.73	Remove and Relay _____ inch Metal Pipe	Linear Foot
603.74	Remove and Relay _____ inch Concrete Pipe	Linear Foot
603.75	6 inch Inlet Grate Unit	Each
603.76	12 inch Inlet Grate Unit	Each
603.77	15 inch Inlet Grate Unit	Each
603.78	18 inch Inlet Grate Unit	Each
603.79	21 inch Inlet Grate Unit	Each
603.80	24 inch Inlet Grate Unit	Each
603.81	30 inch Inlet Grate Unit	Each
603.82	36 inch Inlet Grate Unit	Each

SECTION 604 -- MANHOLES AND CATCH BASINS

604.01 Description. This work shall consist of the construction or altering or adjusting to grade, manholes and catch basins in accordance with these specifications, and in reasonable close conformity with the lines and grades shown on the plans or established.

MATERIALS

604.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Portland Cement	701.01
Clay or Shale Brick	704.01
Concrete Masonry Blocks	704.03
Joint Mortar	705.02
Reinforcing Steel	709.01
Stone Curbing and Edging	712.04
Precast Concrete Units	712.06
Tops, Traps and Ladder Rungs	712.07
Corrugated Metal Units	712.08

Except as otherwise provided on the plans, concrete for these structures shall meet the requirements of Section 502 -- Structural Concrete.

Catch Basin grates shall be either the type of grate shown on the Standard Details or an approved equal.

CONSTRUCTION REQUIREMENTS

604.03 Construction Requirements. Catch Basins and manholes may be constructed of clay brick or shale brick, concrete masonry blocks, precast concrete units or corrugated metal units. Brick or block walls shall not be less than 8 inches thick.

Catch Basins and manholes constructed of bricks or concrete blocks shall have a concrete base as shown on the plans.

When concrete masonry blocks are used joints shall be no greater than 1/2 inch thickness, completely filled with mortar and neatly tooled on the inside of the structure.

When bricks are used, every fourth course shall be headers. The dome shall be entirely of headers. The joints shall be no greater than 1/2 inch thickness, completely filled with mortar and neatly tooled on the inside of the structure.

Catch Basins or manholes constructed of precast units shall be placed to the required grade on a compacted foundation of uniform density. Concrete masonry blocks may be used around the inlet and outlet pipes and either blocks or precast units used for the remaining upper section of the structure. All joints between precast units shall be mortared as specified for concrete masonry blocks.

Inlet and outlet pipe elevations may vary from the plans depending upon field conditions.

Pipe sections connecting to catch basins with sumps shall be firmly connected to the structure wall with no part of the pipe projecting more than 6 inches inside the wall. When a section of culvert has to be cut, the end shall be finished in a workmanlike manner. When bituminous coated culvert is cut it shall be repainted with bituminous material.

Metal frames and traps, when called for, shall be set in a full mortar bed or otherwise secured as shown on the plans. Castings shall be set accurately to the correct elevation before the next final course of material has been placed.

Upon completion, each catch basin and manhole shall be cleaned of all accumulation of silt, debris or foreign matter and shall be kept clean until final acceptance of the work.

604.04 Altering Catch Basins and Manholes. Existing catch basins and manholes to be altered or adjusted, shall be reconstructed to the required grade using new or existing metal frames and tops as specified.

When altering or adjusting, the existing catch basin or manhole shall be dismantled sufficiently to allow reconstruction in accordance with the applicable requirements as shown on the standard detail plans for complete catch basins and manholes. When existing frames, covers and grates are used they shall be thoroughly cleaned of existing mortar before placing to the new grade.

- (a) Altering Catch Basins. The existing top assembly shall be removed and replaced with a new Type A or Type B frame and special grate set to the required grade as directed.
- (b) Rebuilding Catch Basins. The existing top assembly and cone section shall be removed, the cone section rebuilt and a new frame and grate furnished and installed at the required line and grade as directed.

All unused material salvaged, including grates and frames will become the property of the Contractor unless otherwise specified.

Each catch basin and manhole, reconstructed, altered or adjusted shall be cleaned of all accumulated silt, debris or foreign matter prior to final acceptance of the work.

604.05 Method of Measurement. Catch Basins and manholes and accessories of the respective types will be measured by the number of units, measured as follows, complete and accepted in place.

- (a) Complete Structures. Each catch basin and manhole having a depth up to 8 feet from the top of the grate or cover to the top of the floor, measured to the nearest foot, will be one unit. One-eighth of a unit will be added for each additional foot over 8 feet measured to the nearest foot. Depth measurements in excess of the dimensions authorized will not be included.
- (b) Existing Structures. Existing catch basins and manholes to be rebuilt, adjusted or altered will be one unit.
- (c) Trap. Each trap included in the completed structure will be one unit.
- (d) Step. Each step included in the completed structure will be one unit.

604.06 Basis of Payment. The accepted quantities of catch basins, manholes, traps and steps, will be paid at the contract unit price each of the respective types complete in place. Payment for rebuilding, adjusting or altering catch basins and manholes shall include furnishing all materials including new blocks, bricks, mortar and metal tops and covers and curb inlets when required. Frames, grates and covers for new or rebuilt catch basins and manholes shall be considered part of the structure and no separate payment will be made.

Excavation and backfill will be measured and paid for as provided in Section 206 -- Structural Excavation.

Payment will be made under:

Pay Item	Pay Unit
604.07 Catch Basin Type A1	Each
604.072 Catch Basin Type A1-C	Each
604.08 Catch Basin Type A2	Each
604.082 Catch Basin Type A2-C	Each
604.09 Catch Basin Type B1	Each
604.092 Catch Basin Type B1-C	Each
604.10 Catch Basin Type B2	Each
604.102 Catch Basin Type B2-C	Each
604.11 Catch Basin Type C1	Each
604.12 Catch Basin Type C2	Each
604.13 24 inch Catch Basin Type E	Each
604.14 30 inch Catch Basin Type E	Each
604.15 Manhole	Each
604.16 Altering Catch Basin to Manholes	Each
604.161 Altering Catch Basin	Each
604.164 Rebuilding Catch Basin	Each
604.166 Rebuilding Manhole	Each
604.17 Altering Manhole to Catch Basin	Each
604.18 Adjusting Manhole and Catch Basin to Grade	Each

604.19	8 inch Trap	Each
604.20	12 inch Trap	Each
604.21	15 inch Trap	Each
604.22	18 inch Trap	Each
604.23	Step	Each
604.24	Catch Basin Type F	Each
604.241	Catch Basin Type F-C	Each
604.25	Catch Basin Type A5	Each
604.252	Catch Basin Type A5-C	Each
604.26	Catch Basin Type B5	Each
604.262	Catch Basin Type B5-C	Each

SECTION 605 -- UNDERDRAIN

605.01 Description. This work shall consist of the construction of underdrain, using pipe and filter material and pipe outlets in accordance with these specifications and the special details and in reasonably close conformity with the lines and grades shown on the plans or established.

MATERIALS

605.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Granular Borrow	703.19
Underdrain Backfill Material	703.22

Underdrain Pipe

Perforated Concrete Pipe	706.03
ABS Pipe for Underdrain	706.05
Corrugated Plastic Slot-perforated Pipe	706.06
Asbestos Cement Perforated Pipe	706.11
Bituminized Fiber Perforated Pipe	706.13
Bituminous Coated Corrugated Iron or Steel Pipe for Underdrains	707.05
Corrugated Aluminum Alloy Pipe for Underdrain	707.08

Underdrain Outlet Pipe

Non Reinforced Concrete Pipe	706.01
ABS Pipe	706.04
Asbestos Cement Pipe	706.10
Bituminized Fiber Pipe	706.12
Bituminous Coated Corrugated Iron or Steel Pipe	707.03
Corrugated Aluminum Alloy Pipe	707.06

The material for elbows, tees and wyes for Underdrain pipe shall be at least as thick as the largest size pipe being connected.

CONSTRUCTION REQUIREMENTS

605.03 General. Underdrain pipe for Underdrain, Type B may, at the Contractor's option, consist of any one of the following types:

Bituminous Coated Corrugated Iron or Steel Pipe for Underdrain
Perforated Concrete Pipe
Perforated Asbestos Cement Pipe
Perforated Bituminized Fiber Pipe-homogeneous structure
Corrugated Aluminum Alloy Pipe for Underdrain
Slot-perforated Corrugated Plastic Pipe-not to be used under traffic lanes
ABS Pipe for Underdrain

Underdrain pipe for Underdrain Type C may, at the Contractor's option, consist of any one of the following types:

Bituminous Coated Corrugated Iron or Steel Pipe for Underdrain
Perforated Asbestos Cement Pipe
Perforated Concrete Pipe
Corrugated Aluminum Alloy Pipe for Underdrain

605.04 Underdrain Construction.

- (a) Underdrain, Type B. The trench shall be excavated to the required width and depth and a bed of the of the specified granular material, 3 inches in depth, shall be prepared in the trench. Six inch perforated pipe shall be laid in this bed with the perforations as shown on the Standard Detail plans.

After the pipe has been firmly bedded and joints securely connected, it will be inspected before any backfill is placed. The remaining backfill shall be granular material meeting the same requirements as that used for bedding the pipe.

For underdrain placed under areas of proposed pavement, the material shall be placed in 8 inch layers, loose measure and thoroughly compacted except that the initial layer of backfill around the pipe may be placed in a layer not exceeding 12 inches. For underdrains placed under areas not proposed to be paved, the initial layer of backfill shall not exceed 12 inches and the remaining material may be placed in 1 lift to the elevation of the subgrade and compacted with heavy rubber tired or vibratory compaction equipment to the satisfaction of the Engineer.

The upstream end of all completed underdrain pipe that is to be buried shall be sealed with cement mortar or other acceptable material. Care shall be taken that soil does not enter the pipe. Pipe so contaminated before backfilling shall be removed, cleaned and relaid.

- (b) Underdrain, Type C. The trench shall be excavated to the width and depth as determined by the size and depth of the pipe to be installed.

The perforated pipe shall be laid to line and grade centered on the bottom of the trench with the perforations as shown on the Standard Detail plans.

After the pipe has been firmly bedded and all joints securely connected it will be inspected before any backfill is placed. The backfill shall be placed in accordance with Subsection 603.08 and as shown on the Standard Detail plans using the materials specified.

When Underdrain Type B or Underdrain Type C is constructed, backfill material beyond the underdrain trench lateral limits designated on the plans shall be material conforming to the requirements of Granular Borrow, Underwater Backfill. Material within the underdrain trench limits shall conform to the requirements of the type underdrain being constructed. The Contractor shall take precautions to prevent the underdrain backfill material from becoming contaminated with clay, silts, organic matter or other matter. Methods of placing backfill material shall be limited to the use of equipment which will place material directly into the trench. Pushing material into the trench will not be allowed.

When underdrain is to be constructed in embankment fill, the excavation for the trench shall be done after the embankment has been completed to subgrade elevation.

605.05 Underdrain Outlets. Trenches for underdrain outlets shall be excavated to the required width and depth. These outlets shall be constructed of the same size and type of pipe used in the underdrain, except that the perforations may be omitted.

The pipe shall be laid in the trench with all ends firmly joined by the applicable methods and means. After inspection and approval of the pipe installation the trench shall be backfilled with suitable material in layers and compacted as provided for in Subsection 603.08.

605.06 Method of Measurement. Underdrain and underdrain outlets will be measured by the length in linear feet along the centerline of underdrains and underdrain outlets of the types and sizes completed and accepted.

When elbows, tees, wyes or other special connections are required in underdrain, each connection shall be included for payment as 3 additional linear feet of underdrain of the largest pipe line involved.

605.07 Basis of Payment. The accepted quantities of underdrains and underdrain outlets will be paid for at the contract unit price per linear foot of each type and size specified complete in place. Outlet pipe for Underdrain, Type C will be paid for under Section 603 -- Pipe Culverts and Storm Drains.

Within and beyond the trench limits, backfill, couplings and bands and other related items will not be paid for separately, but shall be considered included in the unit bid price for the type of underdrain being installed.

Excavation will be measured and paid for as provided in Section 206 -- Structural Excavation. No allowance for payment will be made for excavating or material excavated beyond the horizontal dimensions shown for Underdrain, Type B or Underdrain, Type C.

Payment will be made under:

Pay Item	Pay Unit
605.09 6 inch Underdrain Type B	Linear Foot
605.10 6 inch Underdrain Outlet	Linear Foot
605.11 12 inch Underdrain Type C	Linear Foot
605.12 15 inch Underdrain Type C	Linear Foot
605.13 18 inch Underdrain Type C	Linear Foot
605.14 21 inch Underdrain Type C	Linear Foot
605.15 24 inch Underdrain Type C	Linear Foot
605.17 30 inch Underdrain Type C	Linear Foot

SECTION 606 -- GUARD RAIL

606.01 Description. This work shall consist of furnishing and installing guard rail components in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or as established. The types of guard rail are designated as follows:

Type 3-Galvanized steel "w" beam, wood posts or galvanized steel posts.

Type 3a-Galvanized steel "w" beam, wood posts.

Type 3aa-Corrosion resistant steel "w" beam, wood posts.

Type 3b-Galvanized steel "w" beam, galvanized steel posts.

Type 3bb-Corrosion resistant steel "w" beam, corrosion resistant steel posts.

Type 3ab-corrosion resistant steel "w" beam, wood posts or corrosion resistant steel posts.

Thrie Beam-Galvanized steel thrie beam, wood posts or galvanized steel posts.

Median barriers shall consist of two beams of the above types, mounted on single posts. Except for thrie beam, median barriers may include rub rails when called for.

MATERIALS

606.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Timber Preservative	708.05
Metal Beam Rail	710.04
Guard Rail Posts	710.07
Guard Rail Hardware	710.08

Guard rail components shall meet the applicable standards of "A Guide to Standardize Highway Barrier Rail Hardware" prepared and approved by the AASHTO-ARTRA-AGC Joint Cooperative Committee, Technical Bulletin Number 268 B.

Posts for guard rail delineators shall be "U" channel steel, 8 feet long, 2 1/2 pounds per linear foot minimum and have 3/8 inch round holes, 1 inch center to center for a minimum distance of 2 feet from the top of the post.

Single wood post shall be of cedar, white oak or tamarack, well seasoned, straight and sound and have been cut from live trees. The outer and inner bark shall be removed and all Knots trimmed flush with the surface of the post. Posts shall be uniform taper and free of kinks and bends.

Single steel post shall conform to the requirements of Subsection 710.07(b) or 710.07(c) as required.

CONSTRUCTION REQUIREMENTS

606.03 Posts. Posts for guard rail shall be set plumb in holes or they may be driven if suitable driving equipment is used to prevent battering and distorting the post. When posts are driven through pavement the damaged area around the post shall be repaired with approved bituminous patching. Damage to lighting and signal conduit and conductors shall be repaired by the Contractor.

When set in holes, posts shall be on a stable foundation and the space around the posts backfilled in layers with suitable material, thoroughly tamped.

Guard rail delineator posts shall be set plumb with the outstanding legs of the channel facing the oncoming traffic. Posts which become bent or otherwise damaged shall be removed and replaced with new posts.

Single wood posts shall be set in holes and backfilled in layers with suitable material, thoroughly tamped. The elevation and shape of the top will be designated by the Engineer. The posts shall be painted 2 coats of good quality exterior house paint.

606.04 Rails. Rails shall be erected all aligned to provide a smooth, continuous barrier.

Beam rail brackets and fittings shall be placed and fastened as shown on the plans. Rails shall be lapped with the exposed end away from approaching traffic. End assemblies shall be installed as shown on the plans and shall be securely attached to the beam section and end post. Bolts shall be sufficient length to extend beyond the nuts but not more than 1/2 inch. Nuts shall be drawn tight.

606.05 Shoulder Widening. At designated locations the existing shoulder of the roadway shall be widened as shown on the plans. All grading, paving, seeding and other necessary work shall be in accordance with the Specifications for the type work being done.

606.06 Vacant

606.07 Abraded Surfaces. All galvanized surfaces of new guard rail and posts which have been abraded so that the base metal is exposed and threaded portions of all fittings and fasteners and cut ends of bolts shall be cleaned and painted with 2 coats of approved rust resistant paint.

606.08 Method of Measurement. Guard rail will be measured by the linear foot from center to center of end posts along the gradient of the rail except where end connections are made to masonry or steel structures, in which case measurement will be to the face of the structure.

Terminal sections, sloped ends, twisted end sections, break-away cable terminals and single posts will be measured by each unit of the kind specified and installed. Twisted end sections will be measured by the unit for each 25 foot long installation, complete and installed.

Widened shoulder will be measured as units of grading with the limits shown on the plans.

Excavation in solid rock for placement of posts will be measured by the cubic yard determined from the actual depth of the hole and a hypothetical circle diameter of 2 feet.

606.09 Basis of Payment. The accepted quantities of guard rail will be paid for at the contract unit price per linear foot for the type specified complete in place. Terminal sections, buffer ends, flared ends, twisted end sections and single posts will be paid for at the contract unit price each for the kind specified complete in place.

Breakaway cable terminals will be paid for at the contract price each, complete in place which price shall be full payment for furnishing and installing all components including the terminal section, posts, brackets, "w" rail, cable foundation posts, plates and for all incidentals necessary to complete the installation within the limits as shown on the Standard Detail plans. Such payment shall also be full compensation for furnishing all material, excavating, backfilling holes, assembling and all incidentals necessary to complete the work except that excavation for posts or anchorages in solid ledge rock, payment will be made under Pay Item 206.07.

Anchorage to bridge rails will be part of the bridge work and connections thereto costs will be considered included in the unit bid price for guard rail.

Guard rail to be placed on a radius of curvature of 150 feet or less will be paid for under the designated radius pay item for the type guard rail being placed.

Widened shoulder will be paid for at the contract unit price each complete in place and will be full compensation for furnishing and placing, grading and compaction of aggregate subbase, loam, seed and mulch.

Payment will be made under:

Pay Item	Pay Unit
606.15 Guard Rail Type 3a-Single Rail	Linear Foot
606.151 Guard Rail Type 3aa-Single Rail	Linear Foot
606.152 Guard Rail Type 3ab-Single Rail	Linear Foot
606.16 Guard Rail Type 3a-Double Rail	Linear Foot
606.17 Guard Rail Type 3b-Single Rail	Linear Foot
606.171 Guard Rail Type 3b-Single Rail with Rub Rail	Linear Foot
606.173 Bridge Connection	Each
606.174 Guard Rail Type 3bb-Single Rail	Linear Foot
606.18 Guard Rail Type 3b-Double Rail	Linear Foot
606.181 Guard Rail Type 3b-Double Rail with Rub Rail	Linear Foot
606.19 Guard Rail Type 3a-15 foot Radius and less	Linear Foot
606.191 Guard Rail Type 3aa-15 foot radius and less	Linear Foot
606.192 Guard Rail Type 3ab-15 foot radius and less	Linear Foot

606.20	Guard Rail Type 3a-over 15 foot radius	Linear Foot
606.201	Guard Rail Type 3aa-over 15 foot radius	Linear Foot
606.202	Guard Rail Type 3ab-over 15 foot radius	Linear Foot
606.21	Guard Rail Type 3b-15 foot radius and less	Linear Foot
606.214	Guard Rail Type 3bb-15 foot radius and less	Linear Foot
606.22	Guard Rail Type 3b-over 15 foot radius	Linear Foot
606.224	Guard Rail Type 3bb-over 15 foot radius	Linear Foot
606.262	Twisted End Section-Guard Rail Type 3a	Each
606.263	Twisted End Section-Guard Rail Type 3b	Each
606.265	Terminal End-Single Rail-Galvanized Steel	Each
606.266	Terminal End-Single Rail-Corrosion Resistant Steel	Each
606.275	Terminal End-Double Rail-Galvanized Steel	Each
606.276	Terminal End-Double Rail-Corrosion Resistant Steel	Each
606.35	Guard Rail Delineator Post	Each
606.47	Single Wood Post	Each
606.48	Single Galvanized Steel Post	Each
606.49	Single Corrosion Resistant Steel Post	Each
606.55	Guard Rail Type 3-Single Rail	Linear Foot
606.551	Guard Rail Type 3-Single Rail with Rub Rail	Linear Foot
606.56	Guard Rail Type 3-Double Rail	Linear Foot
606.561	Guard Rail Type 3-Double Rail with Rub Rail	Linear Foot
606.59	Guard Rail Type 3-15 foot radius and less	Linear Foot
606.60	Guard Rail Type 3-over 15 foot radius	Linear Foot
606.621	Twisted End Section-Guard Rail Type 3	Each
606.64	Guard Rail Thrie Beam-Double Rail	Linear Foot
606.65	Guard Rail Thrie Beam-Single Rail	Linear Foot
606.66	Terminal End Thrie Beam	Each
606.67	Buffer End Thrie Beam	Each
606.68	Buffer End Thrie Beam Modified	Each
606.69	Flared End Thrie Beam	Each
606.70	Transition Section-Thrie Beam	Each
606.71	Guard Rail Thrie Beam-15 foot radius and less	Linear Foot
606.72	Guard Rail Thrie Beam-greater than 15 foot radius	Linear Foot
606.751	Widen Shoulder for Breakaway Cable Terminal	Each
606.77	Breakaway Cable Terminal	Each

SECTION 607 -- FENCES

607.01 Description. This work shall consist of the construction of fence and gates in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established by the Engineer. The construction of fencing shall include the assembly and erection of all parts and materials including barways and gates complete at the locations shown on the plans or as directed.

MATERIALS

607.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Barbed Wire	710.01
Woven Wire	710.02
Chain Link Fabric	710.03
Cedar Rail Fence	710.05
Fence Posts and Braces	710.06

Bars for barways shall be of eastern hemlock, northern white pine, Norway pine, spruce, cedar or tamarack, equal in quality to the wood posts. The bark shall be removed and all knots hewn flush.

Metal gates shall be of galvanized steel.

Staples shall be galvanized or aluminum coated steel.

Concrete for anchoring metal posts, metal braces and wooden gate posts shall meet the requirements of Section 502 -- Structural Concrete, except air entraining will not be required. The class of concrete shall be optional.

Drive anchors shall be an approved anchorage consisting of 2 steel angles driven diagonally into the ground through metal clamps bolted to the post. All parts shall be galvanized.

CONSTRUCTION REQUIREMENTS

607.03 General. The Contractor shall perform clearing and grubbing necessary to construct the fence to the required grade and alignment.

Posts shall be spaced as called for on the plans except that a variation of 2 feet back or ahead on line may be allowed at approved locations. The tops of posts shall be set to the required grade and alignment. Cutting off the posts may be allowed with approval.

Posts for cedar rail fence shall be set plumb in drilled or in hand dug holes. After posts are placed, rails installed and the posts aligned, the post holes shall be backfilled. The completed fence shall have the tops of the posts at uniform height above ground following the gradient of the ground.

Posts for woven wire fence, barbed wire fence and chain link fence shall be braced with Type I or Type II bracing at designated location as hereafter specified. Type I bracing shall include diagonal brace and 1 post of the designated size. Type II bracing shall include 2 diagonal braces and 1 post of the designated size.

When the plans require posts or braces to be anchored into the soil, concrete anchors or metal drive anchors shall be used. If concrete is used, temporary guys to hold the posts in position shall be installed until the concrete has set. Unless otherwise permitted, no material shall be installed on posts or strain placed on guys and bracing set in concrete until 48 hours after the concrete has been placed.

If metal drive anchors are used they shall be installed according to the manufacturer's instructions so all parts will be below the ground surface. One drive anchor shall be used on line posts; 2 drive anchors shall be used on bracing assemblies, Type 1 and Type 2. Where 2 drive anchors are used they shall be placed perpendicular to each other.

Backfilling shall be with earth placed in 8 inch layers, loose measure and each layer thoroughly tamped.

Metal posts to be set in solid rock shall be in drilled holes and grouted with a cement grout composed of 1 part portland cement and 2 parts sand mixed with water.

All surplus material and other debris shall be removed and disposed of.

607.04 Woven Wire or Barbed Wire Fencing. Holes for wood posts shall be dug to full depth. Metal posts shall be set plumb by an approved post driver. Posts which are bent or otherwise damaged shall be removed and replaced.

- (a) Bracing. At changes in horizontal alignment in excess of 30 degrees, bracing will be required. At changes in horizontal alignment of 15 degrees to 30 degrees, bracing may be called for on the plans or required by the Engineer. At changes in horizontal alignment angles of less than 15 degrees, bracing will not be required except at intervals of 660 feet.

In depressions where tension in the fencing may cause lifting, the post will require bracing.

End, corner, grate, barway and intermediate posts shall be braced and anchored as shown on the Standard Detail plans.

If metal posts are to be placed in concrete, the concrete shall be allowed to set before the space around the base is backfilled. Backfilling shall be with satisfactory material thoroughly tamped. If directed, the Contractor shall place a minimum of 6 inches of gravel in the bottom of the post hole.

- (b) Gates. All gates and the bracing assemblies at gates shall be constructed of metal.
- (c) Barways. Barways shall be constructed of posts corresponding to the type of fence posts used. Wood cross bars shall be furnished.
- (d) Erection of Fabric or Wire. Fabric or wire shall be stretched taut. Each strand of barbed wire shall be attached to wood posts with staples. Top and bottom strands of woven wire shall be attached to each post and alternate interior strands of woven wire fencing shall be attached to alternate posts. Staples shall not be driven into line posts so as to restrict the horizontal movement of wire except at corner posts, end posts and bracing where staples shall be fully driven. When attaching fencing to metal posts, approved stay fasteners shall be used.

Except as otherwise provided, splicing wire will be permitted at posts only with each horizontal strand of wire wrapped completely around the post. The wire strand shall be fastened by winding the end of the wire about the same strand where it leads to the post. This type of fastening shall be used at each end post, corner post and gate post and at barway posts. Other devices designed specifically to splice fencing wire may be used, subject to approval.

607.05 Chain Link Fence. Foundations for posts for chain link fence shall be cast portland cement concrete placed in approved forms or shall be approved metal drive anchors. If wood forms are used they shall be removed before backfilling. If fiber forms are used they need not be removed.

- (a) Bracing. At corners, and at terminal sections of chain link fence, bracing shall be installed as shown on the plans. At changes in horizontal alignment of less than 15 degrees, bracing will not be required except at intervals of 330 feet. At changes in alignment of 15 degrees to 30 degrees, bracing may be required as called for on the plans or requested. At changes in alignment in excess of 30 degrees, bracing will be required for all fencing.
- (b) Gates. Where gates are required for chain link fence they shall be constructed of metal.
- (c) Erection of Chain Link Fabric. The grade of fence shall be approximately parallel with the grade of the ground. When directed, abrupt depressions shall be filled.

Top rails shall pass through post caps and be securely fastened to end, corner, brace and gate posts. Joints in top rails shall be made with expansion sleeve couplings. On curves with a radius of less than 500 feet the top rail shall be bent to the arc.

The fabric shall be pulled taut and the ends attached to the posts with stretcher bars and bands or other approved devices. When required, wire fabric shall be joined by weaving a single strand of mesh wire into the ends of the rolls to form a continuous mesh.

607.06 Methods of Measurement. Fence will be measured by the linear foot accepted in place. Measurement will be along the gradient of the fence from outside to outside of end posts for each continuous run of fence and shall include fence at bracing assemblies but shall not include space at gates and barways. Gates, barways and bracing assemblies will be measured by the unit of the size and type specified. Excavation in rock for placement of fence posts in drilled holes will be measured by the cubic yard determined from the actual depth of the drilled hole in the rock and a hypothetical circle diameter of 2 feet.

607.07 Basis of Payment. The accepted quantities of fence will be paid for at the contract unit price per linear foot of the type and size specified complete in place. Barways, gates and bracing assemblies will be paid for at the contract unit price for each type specified complete in place. Payment shall be full compensation for furnishing and assembling all materials, for excavating and backfilling holes, and for all incidentals necessary to complete the work except that in rock, payment for drilled holes will be made under Pay Item 206.07. Excavation of earth to exposed rock shall be incidental to the several items for erection of the fence.

Payment for bracing assemblies shall include furnishing and installing the various larger size and longer length posts, diagonal bracing, ties, anchors and all incidental hardware necessary to complete the type of assembly required, all as shown on the Standard Detail plans. At gateways, payment will be made for bracing assemblies and there will be no separate payment for the gate posts. All extra costs incurred for furnishing and installing the oversize posts at gateways shall be considered included with the various contract items.

Clearing or removal of trees, stumps or boulders, required to install the fence shall be include in the work of the respective pay item of this section.

Payment will be made under:

Pay Item	Pay Unit
607.08 Woven Wire Fence-Wood Posts	Linear Foot
607.09 Woven Wire Fence-Metal Posts	Linear Foot
607.10 Barbed Wire Fence-Wood Posts	Linear Foot
607.11 Barbed Wire Fence-Metal Posts	Linear Foot

607.12	Barway-Wood Posts	Each
607.13	Barway-Metal Posts	Each
607.14	Walk Gateway 4 foot-Metal	Each
607.15	Drive Gateway 16 foot-Metal	Each
607.16	Chain Link Fence-4 foot	Each
607.17	Chain Link Fence-6 foot	Each
607.18	through 607.21 Vacant	
607.22	Cedar Rail Fence	Linear Foot
607.23	Chain Link Fence Gate	Each
607.24	through 607.29, Vacant	
607.30	Bracing Assembly Type I-Wood Posts	Each
607.31	Bracing Assembly Type II-Wood Posts	Each
607.32	Bracing Assembly Type I-Metal Posts	Each
607.33	Bracing Assembly Type II-Metal Posts	Each
607.34	Bracing Assembly Type I-Chain Link Fence-4 foot	Each
607.35	Bracing Assembly Type II-Chain Link Fence-4 foot	Each
607.36	Bracing Assembly Type I-Chain Link Fence-6 foot	Each
607.37	Bracing Assembly Type II-Chain Link Fence-6 foot	Each

SECTION 608 -- SIDEWALKS

608.01 Description. This work shall consist of the construction of bituminous or portland cement concrete sidewalks, plain or reinforced as specified, in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established. This work does not include portland cement concrete sidewalks on bridges.

MATERIALS

608.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Preformed Expansion Joint Filler	705.01
Welded Steel Wire Fabric	709.02

Portland cement concrete for sidewalks shall meet the requirements of Section 502 -- Structural Concrete, Class A.

Bituminous mix for sidewalks shall meet the requirements of Section 403 -- Hot Bituminous Pavement.

CONSTRUCTION REQUIREMENTS

608.03 Portland Cement Concrete Sidewalks.

- (a) Excavation. Excavation shall be to the depth and width that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm even surface conforming to the section shown on the plan. All soft and yielding material shall be removed and replaced with acceptable material.
- (b) Forms. Forms shall be of wood or metal and shall extend for the full depth of the concrete. All forms shall be true, free from warp and of sufficient strength to resist the pressure of the concrete without springing. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.
- (c) Placing Concrete. The foundation shall be thoroughly moistened immediately prior to placing the concrete. The proportioning, mixing and placing of the concrete shall be in accordance with the requirements of Section 502 -- Structural Concrete.
- (d) Finishing. The surface shall be finished with a wooden float which shall be moved in a circular motion to produce a shell-like pattern. No plastering of the surface with mortar will be permitted.

All outside edges of the slab and all joints shall be rounded with a 1/4 inch radius edging tool.

- (e) Joints. Joints shall be located as shown on the plans. Slabs shall be placed alternately and the joints coated with an approved bituminous material before placing the adjacent slab.

When a concrete sidewalk is constructed adjacent to a curb, building, retaining wall or other fixed structure, a 1/4 inch thick preformed joint filler shall be used between the slab and the structure.

- (f) Curing. Concrete shall be cured for at least 72 hours. Curing shall be by moist burlap or mats, white pigmented curing compound or by other approved methods. During the curing period, all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic shall be excluded for such additional time as may be directed.

608.04 Hot Bituminous Sidewalk.

- (a) Excavation. Excavation shall be made to the required depth and width. The foundation shall be shaped and compacted to a firm even surface conforming to the section shown on the plan. All soft and yielding material shall be removed and replaced with acceptable material.
- (b) Base Course. Base course material shall be placed as shown on the plans and each layer thoroughly compacted.
- (c) Placing Bituminous Sidewalk Material. Bituminous sidewalk material shall be placed on the compacted base course in two courses to provide the required depth when rolled. Compaction shall be by a power roller having a minimum total weight of 2,000 pounds with a minimum of 65 pounds per inch of width of the drive roll or by satisfactory power vibratory compaction equipment. In areas inaccessible to other equipment, hand tamping will be permitted. In any case the bituminous sidewalk material shall be uniformly compacted.

608.05 Method of Measurement. Portland cement concrete sidewalks will be measured by the square yard of finished surface. Bituminous concrete sidewalks will be measured by the ton of bituminous mixture placed.

608.06 Basis of Payment. The accepted quantities of sidewalk will be paid for at the contract unit price per square yard for portland cement concrete sidewalk, per ton for hot bituminous sidewalk and cubic yard for base course material complete in place. Excavation will be paid for under Section 203 -- Excavation and Embankment. Expansion joint material and other related items will not be paid for separately but the cost thereof shall be included in the cost of the sidewalk. Base and subbase material will be paid for under Section 304 -- Aggregate Base and Subbase Course. Bituminous mixture for sidewalk will be paid for under Section 403 -- Hot Bituminous Pavement.

Payment for reinforcement will be considered included in the contract unit price for reinforced concrete sidewalk.

Payment will be made under:

Pay Item	Pay Unit
608.07 Plain Concrete Sidewalk	Square Yard
608.08 Reinforced Concrete Sidewalk	Square Yard

SECTION 609 -- CURBING

609.01 Description. This work shall consist of furnishing and installing curb or edging, or removing and relaying existing curbing or edging on highways and bridges in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established. The types of curb are designated as follows:

Type 1-Stone curbing of quarried granite stone
Type 3-Bituminous curbing
Type 5-Stone edging of quarried granite stone

MATERIALS

609.02 Materials. Except as provided below, the materials used shall meet the requirements of the following Subsections of Division 700 -- Materials:

Joint Mortar	705.02
Reinforcing Steel	709.01
Stone Curbing and Edging	712.04
Epoxy Resin	712.35
Bituminous Curbing	712.36

Circular curb, terminal sections and transition sections shall be in reasonably close conformity with the shape and dimensions shown on the plans and to the applicable material requirements herein for the type of curb specified.

Dowels shall be reinforcing steel deformed bars.

CONSTRUCTION REQUIREMENTS

609.03 Vertical Stone Curb, Terminal Section and Transition Sections.

- (a) Installation. The curb stone shall be set on a compacted foundation so that the front top arris line conforms to the lines and grades required. The foundation shall be prepared in advance of setting the stone by grading the proper elevation and shaping to conform as closely as possible to the shape of the bottom of the stone. The required spacing between stones shall be assured by the use of an approved spacing device to provide an open joint between stones of at least 1/4 inch and no greater than 5/8 inch.

- (b) Backfilling. All remaining spaces under the curb shall be filled with approved material and thoroughly hand tamped so the stones will have a firm uniform bearing on the foundation for the entire length and width. Any remaining excavated areas surrounding the curb shall be filled to the required grade with approved materials. This material shall be placed in layers not exceeding 8 inches in depth, loose measure and thoroughly tamped.

When backfill material infiltrates through the joints between the stones, small amounts of joint mortar or other approved material shall be placed in the back portion of the joint to prevent such infiltrating.

- (c) Protection. The curb shall be protected and kept in good condition. All exposed surfaces smeared or discolored shall be cleaned and restored to a satisfactory condition or the curb stone removed and replaced.
- (d) Curb Inlets. Curb placed adjacent to curb inlets shall be installed with steel dowels cemented into each stone with epoxy grout as shown on the Standard Detail plans.

The epoxy grout shall be used in accordance with the manufacturer's instructions. The grout shall be forced into the hole, after which the dowel shall be coated with grout for one-half its length and inserted into the grout filled hole. The hole shall be completely filled with grout around the dowel. All tools and containers must be clean before using.

609.04 Bituminous Curb.

- (a) Preparation of base. Prior to placing the curb, the foundation course shall be thoroughly cleaned of all foreign and objectionable material. String or chalk lines shall be positioned on the prepared base to provide guide lines. The foundation shall be uniformly painted with tack coat as specified under Section 410 -- Bituminous Surface Treatment.
- (b) Placing. The curb shall be placed by an approved power operated extruding type machine. A tight bond shall be obtained between the base and the curb. The Engineer may permit the placing of curbing by other than mechanical curb placing machines when short sections or sections with short radii are required. The resulting curbing shall conform in all respects to the curbing produced by the machine.

- (c) Sealing. The curb shall be sealed with bituminous sealing compound, when directed in accordance with Section 612 -- Bituminous Sealing. Before sealing, the curbing shall be clean, dry and the bituminous material shall have reached the ambient temperature.
- (d) When required, the curb shall be painted and coated with glass beads in accordance with Section 627 -- Pavement Marking. Curb designated to be painted shall not be sealed with bituminous sealing compound before the curb is painted.
- (e) Acceptance. Curb may be accepted or rejected on the basis of appearance in regard to texture and/or alignment. All damaged curb shall be removed and replaced at the Contractor's expense.

609.05 Vacant

609.06 Stone Edging. The curb shall be installed, backfilled and protected in accordance with Subsection 609.03, except as follows:

- (a) Slope. The edging shall be set on a slope as shown on the plans or as directed.
- (b) Joints. Joints shall be open and not greater than 1/2 inch in width.

609.07 Stone Bridge Curb.

- (a) Installation. Each stone and the bed upon which it is to be placed shall be cleaned and thoroughly wetted with water prior to placing the mortar for bedding and setting the stone. The stone shall be set on a fresh bed of joint mortar and well bedded before the mortar has set so that the front top arris line conforms to the line and grade required. Whenever temporary supporting wedges or other devices are used in setting the stones they shall be removed before the mortar in the bed has become set and the holes left by them shall be filled with mortar. Concrete behind the stones shall not be placed until the stones have been in place at least 2 days. Bedding and pointing mortar for joints shall be cured as required under Section 502 -- Structural Concrete.

- (b) Joints. Vertical joints shall be 1/2 inch in width plus or minus 1/8 of an inch. Whenever possible the face and top of the joint shall be pointed with joint mortar to a depth of 1 1/2 inches, before the bedding mortar has set. Joints which cannot be so pointed shall be prepared for pointing by raking them to a depth of 1 1/2 inches before the mortar has set. Joints not pointed at the time the stone is laid shall be thoroughly wetted with clean water and filled with mortar. The mortar shall be well driven into the joint and finished with an approved pointing tool, flush with the pitch line of the stones.

609.08 Resetting Stone Curb, Including Terminal Sections and Transitions.

- (a) Removal of Curbing. The Contractor shall carefully remove and store curb specified on the plans or designated for resetting. Curb damaged or destroyed, as a result of the Contractor's operations or because of his failure to store and protect it in a manner that would prevent its loss or damage, shall be replaced with curbing of equal quality at the Contractor's expense.
- (b) Excavation. Necessary excavation shall be made to the required depth and the base upon which the curb is to be set shall be compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with suitable material which shall be thoroughly compacted.
- (c) Setting Curb. The curb shall be set and backfilled in accordance with Subsection 609.03 or 609.06 whichever is applicable.
- (d) Cutting and Fitting. Cutting or fitting necessary in order to install the curbing at the locations directed shall be done by the Contractor.

609.09 Method of Measurement. Curb, both new and reset will be measured by the linear foot along the front face of the curb at the elevation of the finished pavement, complete in place and accepted. Curb inlets at catch basins, including doweling, will not be measured for payment, but shall be considered included in the cost of the catch basin. New transition sections and terminal curb will be measured by the unit. Reset transition sections and terminal curb will be included in the measurement for resetting curb.

609.10 Basis of Payment. The accepted quantities of curbing will be paid for at the contract unit price per linear foot for each kind and type of curbing as specified.

Payment for terminal curb shall include only that portion of the curbing modified for installation at ends of curb runs shown on the detail plans. Curb adjacent to terminal ends shall be paid for at the contract unit price per linear foot for the type of curb installed.

Vertical Curb Type 1 required to be placed on a radius of 60 feet or less, will be paid for as Vertical Curb-Circular-Type 1.

Curb, Type 5 required to be placed on a radius of 30 feet or less will be paid for as Curb Circular, Type 5.

There will be no separate payment for cement, reinforcing steel, anchors, tack coat, drilling for and grouting anchors, pointing and bedding of curbing, and for cutting and fitting, but these will be considered included in the work of the related curb.

Necessary excavation for installing new or reset curbing will not be paid for directly, but shall be considered to be included in the appropriate new or reset curb pay item. Base and Subbase material will be paid for under Section 304 -- Aggregate Base and Subbase Course.

Payment will be made under:

Pay Item	Pay Unit
609.11 Vertical Curb Type 1	Linear Foot
609.12 Vertical Curb Type 1-Circular	Linear Foot
609.13 Vertical Bridge Curb Type 1	Linear Foot
609.14 Vertical Bridge Curb Type 1-Circular	Linear Foot
609.15 Sloped Curb Type 1	Linear Foot
609.23 Terminal Curb Type 1	Each
609.26 Curb Transition Section B Type 1	Each
609.31 Curb Type 3	Linear Foot
609.34 Curb Type 5	Linear Foot
609.35 Curb-Type 5-Circular	Linear Foot
609.38 Reset Curb Type 1	Linear Foot
609.40 Reset Curb Type 5	Linear Foot

SECTION 610 -- STONE FILL, RIPRAP, STONE BLANKET AND STONE DITCH PROTECTION

610.01 Description. This work shall consist of excavating for and constructing a protective covering of stone, with or without grout.

The types of protective covering of stone are designated as follows:

Stone fill-Machine placed embankment for fill slope
Plain Riprap-Machine placed stones on earth bedding
Hand Laid Riprap-Hand placed stones on earth bedding
Stone Blanket-Machine placed stones around piers and abutments
Heavy Riprap-Machine placed stones on earth bedding
Stone Ditch Protection-Machine placed ditch protection of rock.

MATERIALS

610.02 Materials. Materials shall meet the requirements of the following Subsections of Division 700 -- Materials:

Stone Fill	703.25
Plain and Hand Laid Riprap	703.26
Stone Blanket	703.27
Heavy Riprap	703.28
Stone Ditch Protection	703.29

Portland cement concrete for grouting riprap shall conform to the requirements of Section 502 -- Structural Concrete for Class "Y" Concrete, except that coarse aggregate will not be required and additional water may be used to form a more workable mix.

CONSTRUCTION REQUIREMENTS

610.031 General. Suitable material removed when excavating for the placing of riprap, stonefill, stone blanket or stone ditch protection shall be used in the formation of embankments, subgrade and for backfilling as shown on the plans or as directed.

610.032 Placing Stones.

- (a) Stone Fill and Stone Blanket. Material for stone fill shall be deposited to provide a compact mass. The exposed slope shall be finished to the line and grade required without special handling or hand work.

Material for stone blanket shall be deposited for protection around piers or abutments as shown on the plans. The stones shall be placed individually to form a reasonably compact mass. Spaces between the larger stones shall be filled with stone or spall of suitable size to leave an even surface conforming to the contour required.

- (b) Riprap. Stones for riprap shall be placed upon a slope properly graded and compacted as called for. When required, the bottom of the riprap shall be placed in a trench at the toe of the slope. Stones for plain riprap shall be placed full depth in one operation without special handwork, shall be placed approximately true to the required slope line and grade and be uniform in appearance. Hand laid riprap shall be random rubble, hand laid stones for the full depth placed in one operation to secure interlocking of all face stones and stones placed as backing. Larger stones shall be laid at the base of the slope. The stones shall be laid in close contact with the longer axis perpendicular to the plane of the slope and so as to stagger joints. Except when required to be grouted the openings between the stones in all riprap shall be filled with spall, or gravel and rocks securely rammed into place.

Stones for heavy riprap shall be placed to the full depth in one operation without special handwork or machine work upon a properly graded and compacted slope. Above the low water elevation stones shall be placed to form an approximate uniform surface, free from humps or depressions with no excessively large stones projecting from the general surface. Loose stones or excessively large stones tending to extend above the average general surface shall be embedded, re-oriented or discarded. The openings between stones on the face of heavy riprap shall be filled with spall or small rocks, securely rammed into place.

- (c) Stone Ditch Protection. The ditch shall be excavated below the flow line to allow placement of the rock material to the specified depth. The stone ditch protection shall be placed, full depth, in one operation without special handwork, shall be approximately true to line and grade and shall be uniform in appearance. When directed openings between the stones shall be filled with clean fine gravel or sand.

610.04 Portland Cement Grout. Portland cement grout shall have a consistency suitable to permit flow readily into the voids between the stones. The grout shall be placed upon the stones and swept into the interstices until all voids between the stones are filled to the full depth of the riprap. After placing, the grout shall be protected from drying for at least 3 days. Grout shall not be placed during freezing weather.

610.05 Method of Measurement. Stone fill, plain riprap, hand laid riprap, stone blanket, heavy riprap and stone ditch protection will be measured by the cubic yard, complete in place, except that when placed under water the quantity may be measured by truck load count and the quantity reduced by one-third. Portland cement for riprap grout will be measured by the barrel of portland cement actually used. Riprap grout delivered in transit mix trucks from commercial sources shall be accompanied by a delivery slip in accordance with Subsection 109.01(f).

610.06 Basis of Payment. The accepted quantities of stone fill, plain riprap, hand laid riprap, stone blanket, heavy riprap and stone ditch protection and materials to fill the voids will be paid for at the contract unit price per cubic yard complete in place. Portland cement for riprap grout will be paid for at the contract unit bid price per barrel of cement which price shall include furnishing all sand, aggregates, water, and for mixing, transporting, placing and curing the grout.

Costs for all required excavation for the placement of riprap, stone fill, stone blanket or stone ditch protection will be considered incidental to the various contract items and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
610.07 Stone Fill	Cubic Yard
610.08 Plain Riprap	Cubic Yard
610.09 Hand Laid Riprap	Cubic Yard
610.11 Stone Blanket	Cubic Yard
610.12 Portland Cement for Riprap Grout	Barrel
610.16 Heavy Riprap	Cubic Yard
610.18 Stone Ditch Protection	Cubic Yard

SECTION 611 -- SLAB FOR BACKSLOPE PROTECTION

611.01 Description. This work shall consist of placing slabs on backslopes in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established.

MATERIALS

611.02 Materials. Materials shall conform to the requirements specified in the following Subsections of Division 700 -- Materials:

Joint Mortar	705.02
Precast Concrete Slab	712.37
Reinforcing Steel	709.01
Stone Slab	712.38

CONSTRUCTION REQUIREMENTS

611.03 Excavation. The slope behind the slabs shall be carefully graded, by hand if necessary, to avoid disturbing earth beyond the designated limits.

611.04 Placement of Slab. The slabs shall be placed to conform to the required line and grade. They shall be fitted together to form a vertical joint of not less than 1/4 inch and not greater than 3/4 inch wide. The space behind the slabs shall be backfilled with approved material thoroughly compacted. Special care shall be taken not to disturb the slabs.

The vertical joints shall be filled with joint mortar and neatly smoothed before the mortar has taken its initial set. The surface of the slab shall be protected from all mortar.

The slabs shall be protected and kept in a first class condition and particular care will be required to prevent any discoloration of exposed surfaces. Any exposed surfaces smeared or discolored during the construction operations shall be cleaned and restored to a satisfactory condition or removed and replaced with a new slab.

All holes, including lift holes, shall be filled with cement mortar.

611.05 Method of Measurement. Slab for backslope protection will be measured by the square yard of slab complete in place, measured parallel to the slope but not to exceed the dimensions shown on the plans or authorized by the Engineer.

611.06 Basis of Payment. The accepted quantity of slab for back slope protection will be paid for at the contract unit price per square yard complete in place including mortar of joints.

Excavation to the face of the slab will be measured and paid for as provided in Section 203 -- Excavation and Embankment. Excavation and backfill beyond the face of the slab will be considered incidental to the various contract items and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
611.16 Stone Slab for Backslope Protection	Square Yard
611.17 Concrete Slab for Backslope Protection	Square Yard

SECTION 612 -- BITUMINOUS SEALING

612.01 Description. This work shall consist of sealing bituminous mix surfaces with emulsified bituminous sealing compound of the specified color, applied at locations shown on the plans or designated.

MATERIALS

612.02 Materials. Bituminous material for sealing shall conform to the requirements of Emulsified Bituminous Sealing Compound, Subsection 702.12.

CONSTRUCTION REQUIREMENTS

612.03 General. The sealing compound shall be applied in 2 coats. The first coat shall be diluted by the addition of up to 50 percent water to a liquid consistency and applied with brooms or other approved methods at a rate of 0.25 to 0.50 gallons of diluted sealer per square yard. The second coat shall be diluted only to the extent necessary to obtain workability and applied at a rate of 0.25 to 0.50 gallons of diluted sealer per square yard.

612.04 Method of Measurement. Bituminous sealing will be measured by the square yard of surface sealed measured parallel to the surface.

612.05 Basis of Payment. The accepted quantities of bituminous sealing will be paid for at the contract unit price per square yard complete in place.

Payment will be made under:

Pay Item	Pay Unit
612.06 Bituminous Sealing - Black	Square Yard
612.07 Bituminous Sealing - Green	Square Yard

SECTION 613 VACANT

SECTION 614 -- FERTILIZING GRASSED AREAS

614.01 Description. This work shall consist of furnishing and applying fertilizer in a water spray mixture to areas shown on the plans or designated by the Engineer.

MATERIAL

614.02 Material. Fertilizer shall conform to the requirements of Subsection 717.01(a).

CONSTRUCTION REQUIREMENTS

614.03 General. Areas to be sprayed shall include areas seeded on previous contracts. This work shall not affect the fertilizing requirements of Seeding, Methods 1 and 2.

614.04 Timing. Fertilizer shall be applied only during the period from April 1 to June 30, inclusive, or from August 15 to September 30, except that no fertilizing shall be done on frozen ground.

614.05 Application. The fertilizer shall be thoroughly mixed with water and the mixture sprayed uniformly over the area to be fertilized at the rate of 15 pounds of fertilizer per 1,000 square feet of grassed area. The mixing water shall be applied at the rate of 30 gallons per 1,000 square feet, regardless of the grade of fertilizer used.

Spray must not be so coarse or applied so directly and forcefully as to uproot or damage grass plants.

614.06 through 614.15 Vacant

614.16 Method of Measurement. Applying fertilizer to existing grassed areas will be measured by the pound of dry fertilizer. Delivery slips as specified in Subsection 109.01(f) will be required except that weight will be determined from the weight stated on each bag and the number of bags used. Weighing by a weighmaster will not be required.

614.17 Basis of Payment. The accepted quantity of applying fertilizer to existing grassed areas will be paid for at the contract unit price per pound satisfactorily applied to designated areas at the rate specified.

Payment will be made under:

Pay Item	Pay Unit
614.18 Applying Fertilizer to Existing Grassed Areas	Pound

SECTION 615 -- LOAM

615.01 Description. This work shall consist of furnishing and placing loam topsoil for seeding or sodding, in reasonably close conformity with the thicknesses called for on the plans or as authorized.

MATERIALS

615.02 Materials. Loam shall be a good grade of topsoil from a site approved by the Engineer. The loam shall be loose and friable and shall be free from admixture of subsoil, refuse, large stones, clods or roots or other undesirable foreign matter. It shall be free of weeds, roots or rhizomes of "Witch Grass" (*Agropyronrepens*) or other undesirable grasses. Muck, peat or other excessively acid soil containing excessive proportions of either clay or sand will not be accepted.

When designated on the plans or directed, existing topsoil, found within the lines of improvement in excavation areas, embankment areas or both, shall be excavated and stockpiled by the Contractor for later use as loam on slopes and other areas or on future work. Stockpiles shall be placed at designated locations.

Additional loam to complete the project, if required, shall be obtained by the Contractor from sources beyond the right-of-way. Unless designated for future work, salvaged topsoil not required for use on slopes shall be graded to match the surrounding terrain and the area seeded and mulched.

CONSTRUCTION REQUIREMENTS

615.03 Preparing Areas. All slopes and other areas where loam is to be placed shall be shaped to the required grade. Before placing the loam on hard or compacted soils the areas under preparation shall be scarified and loosened to a depth of at least 2 inches.

615.04 Placing Loam. Loam shall be spread uniformly on prepared areas to the depth shown on the plans or as directed. Any remaining clods, roots, stones over 2 inches in its greatest diameter and all other foreign matter, shall be removed. On areas to be seeded under Method Number 1 as specified in Subsection 618.09(a), all rocks over 1 inch in diameter shall be removed. All loam shall be brought to a true, even surface, meeting the required grade.

615.05 Method of Measurement. Loam will be measured by the cubic yard complete in place after finishing to the required depths as shown on the plans or directed. Lateral measurements will be parallel with the slope of the ground.

Removal of existing topsoil from within the lines of improvement, as specified in Subsection 615.02, will be measured for payment in accordance with subsection 203.18. The depth of the salvaged topsoil to be included for payment shall be the depth authorized. There will be no deduction from borrow quantities resulting from the authorized excavation of salvaged topsoil.

615.06 Basis of Payment. The accepted quantities of loam will be paid for at the contract unit price per cubic yard complete in place. Existing topsoil removed from within the lines of improvement and stockpiled for later use as loam will be paid for under Pay Item 203.20, Common Excavation, after removal and stockpiling, and will be paid for under Pay Item 615.07, Loam, when placed in its final position. Grading surplus topsoil, salvaged but not required for use on slopes as loam, will be paid for under the appropriate items of Section 631 -- Equipment Rental, Section 618 -- Seeding and Section 619 -- Mulch.

Payment will be made under:

Pay Item	Pay Unit
615.07 Loam	Cubic Yard

SECTION 616 -- SODDING

616.01 Description. This work shall consist of furnishing and placing approved live sod on a bed of soil for the protection of slopes, drainageways and on other areas as called for on the plans or as authorized.

MATERIALS

616.02 Materials. Materials shall meet the requirements in the following Subsections of Division 700 -- Materials:

Fertilizer	717.01(a)
Agricultural Ground Limestone	717.02

Sod may be either Field Sod or Cultivated Sod, except that only Field Sod will be permitted in drainage ditches, downspouts or for culvert end protection.

- (a) Field Sod. The sod shall consist of a dense, well rooted, vigorous growth of turf forming perennial grasses indigenous to the locality where it is to be used. Sod shall be taken from approved sources where the soil is of such character that the sod will not break or crumble during cutting, transporting and laying. Sod shall be reasonably free from noxious weeds, annual grasses, moss, large stones, tree roots or other materials harmful to growth or material that will interfere with future mowing or subsequent maintenance of the sodded areas. Field sod shall be cut to a uniform minimum thickness of approximately 2 inches.
- (b) Cultivated Sod. The sod shall consist of turf obtained from an approved commercial sod farm and shall be substantially free from objectionable grassy and broad leaf weeds. Cultivated sod shall be cut to a uniform minimum thickness of approximately 1 inch.

Pegs for holding sod shall be of approved sound wood and at least 3/4 inch in thickness and at least 8 inches long.

CONSTRUCTION REQUIREMENTS

616.03 Cutting and Transporting. The area from which sod is to be cut shall be mowed to a height of approximately 2 inches and cleared of excess grass clippings and other foreign matter shortly before sod cutting starts.

The sod shall be freshly cut by an approved sod cutter in strips of uniform thickness having a minimum width of 12 inches and not less than 18 inches long and transported in an unbroken condition to the area to be sodded. Sod shall be placed in its final position promptly after cutting. No storage of sod will be allowed unless specifically authorized. Cut sod shall be protected from drying from sun and wind during the time between cutting and placing.

616.04 Site Preparation. When sod is to be placed over loam, the areas to be sodded shall be brought to the grades shown on the plans, allowing for the thickness of the sod. Areas to be sodded shall be cleared of large stones, roots, clods and other debris that might interfere with laying sod or subsequent maintenance of the sodded area. Fertilizer and agricultural limestone shall be ap-

plied, either before or after laying sod, at the rate of not less than 30 pounds per 1,000 square feet for fertilizer and not less than 25 pounds per 1,000 square feet for agricultural limestone. On hard packed soil the areas under preparation shall be scarified, harrowed or otherwise loosened to a depth of at least 2 inches before laying sod, unless otherwise directed.

616.05 Laying Sod. Sod shall be moist when laid and shall be placed on a moist soil bed. The sod shall be placed at right angle to the flow of water, commencing at the lower end and tightly fitted, edge to edge, to provide a uniform surface. Transverse joints shall be staggered. Gaps shall be filled with sod plugs or loam to produce a tight surface.

The inlet edges of sod in waterways and other edges exposed to water scour, shall be turned down and buried to a depth of at least 3 inches with tamped earth. Where the sod is in danger of being displaced during sodding operations the workmen shall work from ladders or planks.

The sod shall be compacted and bonded to the soil with an approved tamper or light roller. After tamping or rolling the sod shall have a smooth, even surface free from humps and depressions.

Unless otherwise directed on slopes and on all drainageways with a gradient of 2 horizontal to 1 vertical or steeper, the sod shall be anchored with wooden pegs. The pegs shall be spaced not over 2 feet apart in any direction and driven through the sod into the ground approximately perpendicular to the ground surface. The top of the pegs shall be driven flush with the surface of the sod.

During July, August and periods of drought, the Contractor may place sod only if he will water the sod and assure continued growth of the grasses. Sod placed during such time and not surviving shall be removed and replaced by the Contractor at his expense.

Frozen sod shall not be used, nor shall sod be placed upon frozen soil.

616.06 Method of Measurement. Sodding will be measured by the square yard, measured along the slope, complete in place.

616.07 Basis of Payment. The accepted quantities of sodding will be paid for at the contract unit price per square yard complete and accepted in place, which price shall include supplying and applying fertilizer and agricultural limestone. Necessary excavation for placing sod will not be paid for separately but will be considered incidental to the contract unit price for sodding.

Payment will be made under:

Pay Item	Pay Unit
616.08 Sodding	Square Yard

SECTION 617 -- EROSION CONTROL MESH

617.01 Description. This work shall consist of furnishing and placing erosion control mesh in waterways and on other areas called for on the plans or as authorized.

MATERIALS

617.02 Materials. Materials shall meet the requirements specified in the following Subsection of Division 700 -- Materials:

Erosion Control Mesh

717.06

Loam shall meet the requirements specified in Subsection 615.02.

CONSTRUCTION REQUIREMENTS

617.03 Loaming. Areas to be covered with erosion control mesh shall have a prepared bed of loam brought to the proper grade. The loam shall be loose, smoothly raked and free of stones, litter and of irregularities which will prevent the mesh from close contact with the ground.

617.04 Seeding. Seeding, fertilizing and applying agricultural limestone shall be as specified in Section 618 -- Seeding, Method Number 2, except that mulch will be required only when directed.

617.05 Installation. Erosion control mesh, either jute or excelsior blanket type at the option of the Contractor, shall be applied over the specified area.

- (a) Jute Erosion Control Mesh. Strips shall be rolled on in the direction of the flow of water. Where strips are laid parallel to each other they shall overlap at least 4 inches. Ends shall be overlapped at least 6 inches with the upgrade section on top. The up-slope end of each strip of the mesh shall be turned down and buried with the soil firmly tamped against it. The Engineer may require other edges of the mesh, exposed to more than normal flow of water, to be buried a vertical depth of not less than 6 inches. Edges of mesh placed around catch basins and adjacent to structures shall also have the edges buried to a depth of 6 inches.

Check slots shall be placed between the ends of strips by inserting a tight fold of the mesh into the ground, tamped and stapled the same as up-slope ends. Check slots shall be spaced so that one check slot or one end occurs within each 50 feet of length of erosion control mesh.

After the mesh has been spread so that it is in close contact with the ground at all points, it shall be pressed into the ground with a light lawn roller or by other means and held tightly to the soil with staples driven vertically into the ground, spaced as shown on the plans.

- (b) Excelsior Blanket Erosion Control Mesh. Strips shall be unrolled so that the netting is on top and the fiber in full contact with the soil. In ditches the blankets shall be applied in the direction of the flow of water, butted snugly at the ends and sides. On slopes, the strips may be applied either laterally across the slope or up and down the slope. Ends and sides shall be butted snugly. Check slots, anchor ditches or buried ends will not be necessary.

Each strip shall be stapled to the ground with staples spaced approximately 6 feet apart on each side and one row in the middle of the strip alternately spaced between the side staples.

617.06 Maintenance. The Contractor shall maintain the installation during the life of the contract and shall repair all damage due to excess flow of water or any other cause.

617.07 Method of Measurement. Erosion control mesh will be measured by the square yard based on the width of the roll of mesh prior to installation and the length measured on the ground.

617.08 Basis of Payment. The accepted quantities of erosion control mesh will be paid for at the contract unit price per square yard.

Loam, seed and mulch will be paid for as provided in Section 615 -- Loam, Section 618 -- Seeding, and Section 619 -- Hay Mulch.

Payment will be made under:

Pay Item	Pay Unit
617.09 Erosion Control Mesh	Square Yard

SECTION 618 -- SEEDING

618.01 Description. This work shall consist of preparing the soil and furnishing and applying agricultural ground limestone, fertilizer and grass seed to areas shown on the plans or authorized.

- (a) Seeding, Method Number 1 shall consist of soil preparation and the application of "Park Mixture" to loamed areas.
- (b) Seeding, Method Number 2 shall consist of soil preparation and the application of "Roadside Mixture" to loamed or unloamed areas.
- (c) Temporary Seeding shall consist of the application of fertilizer and seed to slopes and other areas to prevent or control erosion of soil during construction and prior to completion of permanent erosion control and landscape requirement.

MATERIALS

618.02 Materials. Materials shall meet the requirements in the following Subsections of Division 700 -- Materials:

Fertilizer	717.01(a)
Agricultural Ground Limestone	717.02
Seed	717.03

Seed for temporary seeding shall be oats, grain, rye or seed conforming to the requirements of Subsection 717.03.

CONSTRUCTION REQUIREMENTS

618.03 Rates of Application. Agricultural ground limestone shall be applied at the rate of 25 pounds per unit, each method. One unit shall be 1,000 square feet. Agricultural ground limestone will not be required with temporary seeding.

Fertilizer shall be applied at the rate of 30 pounds of 10-10-10 fertilizer per unit, each method.

The seed mixture shall be sown at the rate of 3 pounds per unit each method. For temporary seeding rates greater than 3 pounds per unit shall be applied as directed.

618.04 Time of Seeding. The recommended seeding time is from April 1 to September 15. The Contractor may seed at other times. Regardless of the time of seeding, the Contractor shall be responsible for each seeded area until it is accepted as hereinafter specified.

618.05 Fertilizing and Applying Agricultural Ground Limestone - Conventional Method. Fertilizing and applying agricultural ground limestone shall be done when the soil is moist and at least 24 hours before sowing the seed. The fertilizer and lime shall be applied to the soil by a mechanical spreader or other approved method capable of maintaining a uniform rate of application and shall be thoroughly harrowed, raked or otherwise mixed with the soil to a depth of not less than 1 inch. The fertilizer and agricultural limestone shall not be applied together unless applied hydraulically.

618.06 Sowing Seed - Conventional Method. Seed of the required mixture and quality shall be sown by a mechanical seeder or other method which will sow the seed uniformly at the required rate. Unless seeding is to be mulched the same day, seeded areas shall be lightly raked by hand to mix the sand with the topsoil. Lawn areas shall be rolled with a light lawn roller.

618.07 Sowing Seed and Distributing Fertilizer - Hydraulic Spray Method. The hydraulic spray method of sowing seed may be used where approved. This work shall be done with an approved machine operated by a competent crew. Seed and fertilizing materials shall be mixed with water in the tank of the machine and kept thoroughly agitated so the materials are uniformly mixed and suspended in the water at all times during operation. The spraying equipment must be designed and operated to distribute seed and fertilizing materials evenly and uniformly on the designated areas at the required rates. Seed must be lightly raked into the surface of the soil unless seeding is to be followed the same day by mulching.

618.08 Mulching. Where called for, mulch shall be applied as specified in Section 619 -- Mulch.

Mulch will normally be applied directly after sowing the seed, but where hydraulic seeding is used, the Engineer may direct that mulch be applied upon completion of the grading, with hydraulic seeding to follow the mulching at the proper season.

618.09 Construction Method.

(a) Method Number 1.

1. Preparing the Soil. After the areas to be seeded have been brought to grade and loamed, the top 2 inches of soil shall be harrowed or otherwise loosened. On freshly graded areas the Engineer may allow the harrowing to be omitted

if, in his judgment, the surface soil is loose enough to provide a bedding for the seed. The Engineer may require hand raking unless a satisfactory surface is produced by other means.

2. Fertilizing and Applying Agricultural Ground Limestone. Fertilizer and agricultural ground limestone shall be applied to the prepared area as called for under Subsections 618.05 or 618.07.
3. Sowing Seed. The seed shall be sown on the prepared areas as called for under Subsection 618.06 or 618.07. Unless mulch is to be used, seed, fertilizer and lime will be applied as called for under Subsections 618.05 and 618.06 unless otherwise directed.
4. Mulching. Where directed, mulch shall be applied as specified under Subsection 618.08.

(b) Method Number 2.

1. Preparing the Soil. After the loamed or unloamed areas to be seeded have been brought to grade, all ground not loose and friable shall be scarified to a depth of at least 2 inches immediately before seeding or mulching. All stones over 4 inches in the greatest measurement and all objects which would be detrimental to mowing, shall be removed and disposed of as directed. Hand raking will not be required provided an acceptable surface can be obtained by other means.
2. Fertilizing and Applying Agricultural Ground Limestone. Fertilizer and agricultural ground limestone shall be applied to the prepared areas as specified in Subsections 618.05 or 618.07 unless otherwise called for on the plans or as directed.
3. Sowing Seed. The seed shall be sown as specified under Subsections 618.06 or 618.07 unless otherwise called for on the plans or as directed.
4. Mulching. Mulch shall be applied as specified under Subsection 618.08 unless otherwise called for on the plans or as directed.

618.10 Maintenance and Acceptance.

- (a) Seeding, April 1 to September 15 inclusive. The Contractor shall maintain each seeded area until acceptance of the individual area. Maintenance shall consist of providing protection by erecting necessary signs and barriers and by repairing damaged areas as directed. Damaged areas and areas which do not produce a satisfactory stand of grass shall be repaired to re-establish the condition and grade of the area prior to the original seeding and then refertilized, reseeded and remulched as specified for the original work as many times as necessary to produce satisfactory results.

Areas fertilized and seeded during the above time period by the conventional method will be accepted only upon attainment of a reasonably thick uniform stand of grass free from sizeable thin or bare spots.

Areas fertilized and seeded from May 15 to August 15 inclusive by the hydraulic method and mulched as specified in Subsection 618.08, will be accepted at the time they are seeded and mulched. Any additional work on the seeded and mulched areas as directed thereafter will be paid for under the appropriate contract bid item or by force account extra work.

Areas fertilized and seeded during April 1 to May 15 and August 15 to September 15 by the hydraulic method will be accepted only upon attainment of a reasonable thick uniform stand of grass free from sizeable thin or bare spots. Maintenance shall be as required in Subsection 618.10.

- (b) Seeding by either method, September 16 to March 31, inclusive. The Contractor shall maintain each seeded area until acceptance of the individual area. Maintenance shall consist of providing protection by erecting necessary signs or barriers and by repairing damaged areas as directed. Damaged areas shall be repaired by re-establishing the grade of the area prior to damage and by re-applying mulch. Refertilizing and reseeded will not be required during this period. Necessary maintenance or repairs will not be paid for but shall be considered incidental to the Contract. Areas fertilized, seeded and mulched by either method between September 16 and March 31 will be accepted only upon attainment of a reasonably thick uniform stand of grass free from sizeable thin or bare spots.

When all other work on the project has been completed and some seeded areas still have not been accepted, the Contractor shall maintain for those areas for an additional 60 days, exclusive of the periods from November 15 to April 15. The seeded areas will be accepted upon attainment of a reasonably thick uniform stand of grass. If, at or near the termination of the 60 day period, unaccepted areas still remain, the Engineer may direct a final reseeding by the Contractor or may deduct the contract value of the unaccepted area from moneys due the Contractor. In either event, the Contractor's responsibility for the seeded areas will terminate at the end of 60 days and the seeded areas will be accepted as complete.

The acceptance of any seeded area will be in writing. After acceptance, the Contractor will be relieved of further expense for maintaining the areas, except for damage resulting from his own or his subcontractor's operations.

618.11 Method of Measurement. Seeding will be measured by the area of seeded surface in units of 1,000 square feet.

Measurements will be made along the slope of the ground or, at the discretion of the Engineer, the quantity of seeding used for spot repairs and on other areas difficult to measure on the ground, may be determined from the number of units loaded into the hydro-seeder and applied at the rates specified in Subsection 618.03.

Temporary seeding will be measured by the number of pounds of seed satisfactorily applied, computed from delivery slips as specified in Subsection 109.01(f) except that a certified weighmaster and check weighing will not be required.

618.12 Basis of Payment. The accepted quantities of seeding will be paid for at the contract price per unit for the method specified which price shall include furnishing and spreading limestone, fertilizer and seed.

The accepted quantity of temporary seeding will be paid for at the contract unit price per pound which price shall include furnishing fertilizer and either type of seed designated and for applying the seed and fertilizer at the designated rates of application.

Upon completion of seeding the amount due for these items shall be payable. The Engineer may, at his discretion, accept any individual area showing a reasonably thick, uniform stand of grass free from sizeable thin or bare spots. Upon acceptance of each area, the Contractor will be relieved of further responsibility for maintaining the area or repairing damage other than that resulting from his own or subcontractor's operations.

Loam and mulch will be measured and paid for as provided in Section 615 -- Loam and Section 619 -- Mulch.

Payment will be made under:

Pay Item	Pay Unit
618.13 Seeding Method Number 1	Unit
618.14 Seeding Method Number 2	Unit
618.15 Temporary Seeding	Pound

SECTION 619 -- MULCH

619.01 Description. This work shall consist of furnishing and applying hay, straw or cellulose fiber for covering slopes and other areas with a mulch as shown on the plans or authorized.

MATERIALS

619.02 Mulch. Material shall conform to the requirements specified in the following Subsections of Division 700 -- Materials:

Mulch	717.04
Mulch Binder	717.05

CONSTRUCTION REQUIREMENTS

619.03 General. In areas where mulch is primarily used to prevent erosion, hay or straw mulch shall be applied. Cellulose fiber mulch shall not be applied in those areas.

Cellulose fiber mulch may only be used on areas approved, which may include, but are not limited to, lawns adjacent to developed property, areas subject to high air blasts created by moving vehicles, areas where hay mulch would create a hazard and on projects where small amounts of mulch are required.

619.04 Applying Mulch. Mulch shall be any of the following types of material.

- (a) Hay or straw mulch shall be spread evenly and uniformly over the designated areas. Unless otherwise directed, mulch shall be applied at the rate of 1 to 2 tons per acre. Too heavy application of mulch shall be avoided. Lumps and thick mulch material shall be thinned.

Unless otherwise authorized, the mulch shall be anchored in place by uniformly applying an acceptable mulch binder. Application of a concentrated stream of mulch binder will not be allowed. Asphalt mulch binder may be omitted when authorized and when there is a danger of the asphalt defacing the surface of nearby structures, houses, vehicles or other objects. Other methods of anchoring mulch may be used subject to the approval.

- (b) Cellulose Fiber Mulch shall be applied as a water-borne slurry. The cellulose fiber and water shall be thoroughly mixed and sprayed on the area to be covered so as to form a uniform mat of mulch at the rate of not less than 60 pounds of mulch material per 1000 square feet unit of area.

Cellulose fiber mulch may be mixed with the proper quantities of seed, fertilizer and agricultural limestone as required under Section 618 -- Seeding or may be applied separately the next day after seeding.

619.05 Maintenance. The Contractor shall maintain the mulch by repairing all damaged mulch and by correcting all shifting of the mulch due to wind, water or other causes, until an acceptable growth of grass has been achieved, regardless of the acceptance status of the seeding. He shall supply additional mulch necessary as a result of damage or seed failure. Repairs to mulched areas and furnishing of additional mulch shall be incidental to this item.

If cellulose fiber mulch is used, any reseeding will require additional cellulose fiber mulch.

619.06 Method of Measurement. Mulch will be measured by the area of mulched surface in units of 1000 square feet.

Measurements will be made along the slope of the ground or, at the discretion of the Engineer, the quantity of mulch used for spot repairs, temporary erosion control and on other areas difficult to measure on the ground, may be determined from the number of 40 pound bales applied at the rate specified in Subsection 619.04.

619.07 Basis of Payment. The accepted areas mulched will be paid for at the contract price per unit, which price shall be full compensation for furnishing and spreading the hay, straw or cellulose fiber mulch and the mulch binder when required for hay and straw mulch. When binder is omitted for hay and straw mulch, such mulch will be paid for at 90 percent of the contract price per unit.

When mulch is measured by bales, each bale will be paid for at 60 percent of the contract price per unit for Pay Item 619.12 when applied with mulch binder and 54 percent of the contract price per unit for Pay Item 619.12 when applied without mulch binder.

Payment will be made under:

Pay Item	Pay Unit
619.12 Mulch	Unit

SECTION 620 -- VACANT

SECTION 621 -- LANDSCAPING

621.0001 Description. This work shall consist of furnishing and planting trees, shrubs, vines and other plants and shall include all planting operations and material as well as the care and replacement of the plants during the establishment period, all in accordance with the specifications, planting plans and schedules and the directions of the Engineer. Planting operations will be divided into 3 classes.

- (a) Class A Planting requires particular care in planting with extra loam usually furnished and excess excavated material disposed of.
- (b) Class B Planting will usually be done with whatever backfill soil is available at the plant site.
- (c) Class C Planting consists of deciduous shrubs or evergreen seedlings set in the existing soil.

MATERIALS

621.0002 General. All non-planting material shall conform to the requirements specified in the following Subsections of Division 700 -- Materials.

Tree Paint	708.04
Fertilizer	717.01
Agricultural Ground Limestone	717.02
Mulch	717.04
Manure	717.08
Peat Humus	717.09
Aluminum Sulphate	717.10
Plant Supporting Material	717.11
Wrapping Material	717.12

Loam shall meet the requirements specified in Subsection 615.02.

Water shall be free from oil, acids, alkalis, salts or any other substances harmful to plantings.

621.0003 Plant Material-All Classes.

- (a) All plants shall be first class representatives of their normal species or varieties, unless otherwise specified. All plants must have a good, healthy, well-formed upper growth and a large, fibrous, compact root system. Plants sheared into stiff or formal shapes will be rejected unless they have out-grown such shearing.

Large-growing, deciduous trees shall have straight trunks and a single leader or as may be characteristic of the species. Tops shall be thickly branched, densely foliated, well balanced and in good proportion to the height of the tree. Trees with weak trunks, thinly or irregularly branched or with unnatural shape of proportions due to undesirable pruning or for any other cause will be rejected. Trees with leaders or branched too severely cut back or with bottom limbs trimmed too high will be rejected or reduced to an applicable pay item.

Small-growing deciduous trees shall be thickly branched with a well-balanced, natural shape. Plants which are poorly furnished or have grown or been pruned into unnatural shapes will be rejected.

Tree "Clumps" shall have 3 or more main stems starting from the ground.

"Bush-form" trees shall be those with branches which start from the main trunk close to the ground.

- (b) All conifers and broadleaved evergreens, except Class C stock, shall be balled and burlapped and any other plants shall be balled and burlapped when called for on the plans or in the specifications. The depth of the ball shall be sufficient to encompass the fibrous and feeding root system necessary for the full recovery of the plant.
- (c) All plants shall have been grown under climatic conditions similar to those in the locality of the site of the project under construction or have been acclimated to such conditions for at least 2 years. All plants must have been grown in a latitude north of Washington, D.C. The Engineer may require a sworn affidavit stating the source where all plants were grown. Payment for plants may be withheld until this affidavit is received.

All plants shall be nursery grown unless otherwise stipulated. No plant will be considered nursery grown unless it has been transplanted at least once and has been growing in a nursery for at least 2 years. Where collected stock is allowed, all plants in addition to meeting all other requirements for nursery-grown stock, shall have a diameter of ball or root spread at least one-third greater than that required for nursery stock. Plants showing signs of lack of root pruning, cultivation or other proper nursery care will be classified as collected stock regardless of their source.

- (d) All plants shall conform to the current edition of the "USA Standard Nursery Stock" sponsored by the AAN, unless otherwise indicated in the plans or specifications.
- (e) All plants must be healthy and vigorous; free from disease, injurious insects and their eggs or larva, mechanical wounds, broken branches, decay or any other defects. All dealers in nursery stock operating in Maine must obtain a license from the State Horticulturist, State House, Augusta, Maine. It is suggested that the Contractor contact the Plant Pest Control Division, USDA, State House, Augusta, for information about required plant inspections.
- (f) All plants shall be true to name. Each bundle or each plant which when not tied in bundles, shall be legibly and securely labelled. The current edition of "Standardized Plant Names" prepared by the Editorial Committee of the American Joint Committee on Horticultural Nomenclature shall be the authority for all plant names.

Care shall be taken throughout the operation to keep each plant species or variety segregated and labelled. The Engineer will reject any plants concerning any doubt or confusion arising as to nomenclature, either at the time of delivery or at any subsequent time.

- (g) All precautions that are customary in good trade practice shall be taken to insure upon arrival at the planting site the plants are in good condition for successful growth. All plants must show appearance of normal health and vigor. Plants with loose or broken balls; dried out roots, twigs or needles; or plants which have become overheated in transit or are found not to comply with these specifications in any way will be rejected. The Engineer will not assume responsibility for such rejected material.

The Engineer reserves the right to plainly mark all rejected plants with paint or by other means to ensure that they are not used on the job. Rejected plants may not be used on the project, will not be paid for and must be replaced with approved plants. If plants with communicable diseases are not removed or destroyed immediately, upon discovery of the disease, all plants they were left in contact with will also be rejected.

621.0004 Plant Size and Root Balls.

- (a) Class A and Class B Plants. The plant sizes specified in the "USA Standard for Nursery Stock" are the minimum sizes acceptable. Plants that meet the sizes specified but do not have a normal shape and balance between height and spread will be rejected. Thin, poorly branched or sparsely rooted plants will be rejected, regardless of whether they meet the minimum technical requirements of the USA Standard.

Where bare roots are irregular, the size of the root spread will be the average root spread considering all sides of the plant and not the maximum root spread. The Engineer may allow moderate deviations from exact sizes of plants which normally have irregular root systems.

Coarse-rooted plants which, lack sufficient fibrous feeding roots will be rejected.

Recently cut stubs of large roots on either balled or bare root stock will be considered evidence of lack of proper nursery care and root-pruning and will be sufficient grounds for rejecting such plants or classifying them as collected stock requiring a diameter of ball or root spread, one-third greater than for nursery stock. Acceptable roots will retain sufficient fibrous feeding roots.

Where a size range with a maximum and minimum is given, an average size is required. At least 40 percent of the plants in a size range shall be at or above the average for this size range. Basis for payment for all undersized plants will be reduced to an applicable pay item, unless conditionally directed by the Engineer. This will apply to delivered plants, excessively pruned plants and replacement plants.

Where a ball is referred to as encompassing the roots of a plant, a solid ball is meant. A solid ball shall consist of the soil in which the plant was originally grown. The ball shall have been dug

up in such a manner as not to disturb the roots. Where such a ball is required the designation B and B, Balled and Burlapped, will be used. No B and B stock will be accepted if this solid soil ball has disintegrated or if loose soil apparently has been packed around the roots.

Peat Balls and other fiber material will not be acceptable where B and B stock is called for, but said root balls may be furnished where bare root stock is called for if approved by the Engineer.

Caliper of trees shall be the diameter of the trunk taken 6 inches above the root collar.

- (b) Class C Plants. Unless otherwise specified, plants used in Class C planting shall be seedlings or lining out stock with heavy, fibrous, compact root systems. The comparative size of the plants shall be as stated under the heading "Seedling Trees and Shrubs" in the "USA Standard for Nursery Stock". All conifers must have dormant buds and secondary needles. Where B and B plants are designated, ball sizes shall be the same as Class A and B plants. There will be no waiver of oversized stock herein.

621.0005 Plants Purchased from the Department. The Contractor will be required to purchase certain plants, when listed on the plans, from the Department. The Contractor will be charged for the plants at prices listed by the Department and this cost should be included as part of the bid item. If any plants are required as replacements for plants which failed to survive on the job, additional charges will be made at the same prices. These plants are grown in the State Forest Nursery, Greenbush, Maine.

Quantities of plants will be listed as coming from the State Forest Nursery based on inventories prior to the letting of the Contract. Unexpected losses may occur due to various natural causes, prior to planting time. In the event that shortages occur in certain sizes and varieties and acceptable substitutes are not available in the nursery, the Contractor shall furnish such plants at the same contract price for plant and planting.

Procedures in handling these plants shall be as follows:

- (a) The Contractor shall dig the plants at the nursery, after first assuring himself that the plants are alive and in good condition. Digging and handling shall be the same as for all other plants of the same class. The Contractor will furnish burlap or other necessary materials for wrapping plant balls and will transport the plants to the job site.

- (b) Every effort shall be made to move these plants while they are still dormant and before the leaf buds open. The Engineer may require that any deciduous plants moved after the leaves start to develop shall be balled and burlapped or potted at the Contractor's expense.
- (c) The State Forest Nursery is under the control of the State Forest Service. The Contractor shall carefully conform to any rules and regulations, in regard to the use of the nursery, which have been promulgated.
- (d) The Contractor shall notify the Engineer at least 24 hours in advance of digging plants in the nursery. He shall at no time enter the nursery or dig plants except under the supervision of a job inspector or nursery personnel authorized by the Engineer and by the Forest Service to perform this function. Upon arriving at the nursery, he shall report to the nursery superintendent or his representative before starting any digging operation.
- (e) The Contractor shall dig only those plants designated for removal by the Engineer. He shall use great care not to damage plants in the nursery or to unnecessarily clutter or damage the nursery grounds. His operation shall be kept clean and neat at all times. Earth excavated when digging plants shall be replaced in the holes, but fine grading will not be required. The Contractor will be held liable for any damage to plants or nursery property.
- (f) Plants from the State Forest Nursery shall be planted on the project as soon as feasible after digging. Authorization to dig plants will not be given until preparations have been made for prompt planting, unless the Engineer directs otherwise.
- (g) The Contractor's liability under each bid item for plants purchased from the Department of Transportation shall be the same as for all other plant bid items.

621.0006 Inspection. On request, any nursery stock within the State of Maine will be inspected prior to delivery to the job site. Unless plants are inspected in the nursery, the Contractor may be required to submit samples of each size and variety of plant for approval prior to the delivery of large numbers of plants to the job site. A preliminary check of the plants will be made at the time of delivery for condition of the plants and conformity to the specifications. Another inspection of individual plants will be made just prior to planting. No plants shall be planted which have not been inspected. In order to facilitate this inspection, the

Contractor shall inform the Engineer at least 24 hours in advance as to what plants are to be planted and in what location. Any plants which are planted without receiving this inspection may be rejected and must be removed and replaced with inspected stock. Due to the difficulty of identifying dormant plants and to the detrimental effect that excessive handling can have on the health and vigor of plants, conditional approval only will be given to plants in preliminary and intermediate inspections. Inspection will continue throughout the life of the contract up to the time of Final Acceptance. Plants which are not true to name, do not conform to the specifications, show evidence of improper handling or lack of proper care or which appear to be in a seriously unhealthy condition must be removed by the Contractor at once and replaced by acceptable plants as soon as the planting season allows. Dead or unhealthy plants will not be allowed to remain on the job site. Any such plants when pointed out to the Contractor by the Engineer shall be removed at once. If this occurs during the planting season these plants shall be replaced at once; if between planting seasons they shall be replaced at the next subsequent planting season, unless conditionally directed by the Engineer for Evergreens and other preferred Spring planted items. Unsatisfactory work will not be paid for during the establishment period.

621.0007 through 621.0016 Vacant

CONSTRUCTION REQUIREMENTS

621.0017 General. Planting operations shall be performed in accordance with the plans and specifications and as directed by the Engineer. Although the work will fall under the jurisdiction of the Engineer, the Contractor shall, nevertheless, be responsible for the performance and completion of the work and shall retain a competent foreman at the site at all times when work is in progress. In addition he shall provide a sufficient number of experienced and capable men to carry out the work efficiently. Specifically, in addition to the foreman, the Contractor must have on the job a sufficient number of men capable and experienced in locating and spacing plants in beds, in plant identification, in handling and planting shrubs and trees, in pruning, in staking and any other skills required to carry out the work efficiently and correctly. Not less than 2 such men shall be employed on the project at all times when staking or any other work is in progress, except when as the Engineer certifies that their services are not needed. They shall be classified as "Landscape Workers".

621.0018 Layout. The location of plants as shown on the plans shall be considered approximate only. The exact locations will be designated on the ground by the Engineer, making such changes as may be required to adjust the planting to local conditions. Plant quantities may, in some cases, be increased or decreased as provided in Section 104.02. Locations for trees and outlines of areas to be planted to shrubs shall be staked out on the ground by the Contractor as directed by the Engineer at least 48 hours before herbicides are applied and any plant pits or beds are dug. Equipment, labor and approved labelled stakes for this purpose are to be furnished by the Contractor.

The Contractor shall furnish at least 2 types of stakes for use in marking plant locations. All shall be of planed lumber and shall be sharpened on one end. Layout stake samples shall be approved by the Engineer prior to Contractor commencing any work on the project.

Type A stakes shall be 3 to 4 feet long and shall be of reasonably strong, sound 1 x 2 inches, 1 x 3 inches or 1 1/2 x 1 1/2 inches stock. These stakes will be used mainly for marking the location of individual trees.

Type B stakes shall be 1 1/2 to 2 feet long. Other dimensions will be the same as for Type A stakes.

The Contractor will be required to mark the stakes legibly with indelible marking material and will be required to supply at least 6 colors of paint to be used in segregating different groups of stakes. He will also be required to furnish personnel, capable of locating plants from plans, to carry out the staking under the direction of the Engineer.

Before actively starting work on the project the Contractor shall provide the Engineer with a planting sequence schedule to be used in establishing priorities in staking plant locations. The Contractor shall give the Engineer at least four days advance notice of any deviations from this schedule. The Engineer will not be responsible for any delay or inconvenience caused by unfinished staking resulting from the Contractors failure to follow the above procedure.

All stakes used to locate plants shall be replaced in the correct plant pits after each operation and shall remain there until the Engineer directs their removal. When plants are set out in wrong locations due to stakes being misplaced during digging and planting operations, the Contractor shall be required to move the misplaced plants to the proper location at his own risk and expense.

The Contractor will also be required to adequately mark the outline of areas planted to evergreen seedlings or similar low plants, to protect the areas from accidental mowing by State maintenance crews. Type A stakes, painted over their entire length,

will be used for this purpose. The Contractor will install these stakes around the perimeter of each area immediately after the area is planted and shall maintain these stakes for the duration of the contract. Although some variation will occur in the spacing of these stakes, the minimum distance between stakes will be fifty (50) feet.

621.0019 Plant Pits and Beds.

- (a) Plant Designation. Plant beds outlined on the plans with solid lines and hatched must have the entire surface cultivated, cleared of weeds and be completely covered with mulch. Actual mulch limit will extend 2 1/2 feet out from the center of plant or to the pavement edge, bridge wall and roadside face of guard rail. Cultivation must include complete removal of all weed and grass roots, loose stones over 3 inches maximum diameter and any other debris. Approved herbicides are permitted for weed control in place of sod removal.

Plant locations outlined by broken lines indicate that the plants will be handled individually and the area of the plant pit only will be cultivated and mulched.

Hatched areas not outlined indicate random planting, usually of seedling stock, for reforestation or erosion control.

- (b) Rock Excavation. When ledge or boulders over 1/4 cubic yard in size are encountered in digging plant pits, the Contractor shall notify the Engineer who will change the location of the plants. No excavation of ledge or boulders over 1/4 cubic yard in volume will be required and no extra payment will be made for rock excavation or for shifting of plant holes due to rock.
- (c) Class A Planting. Size of plant pits shall bear the following relationship to the spread of roots or rootball diameter of the plants to be planted in them:

For root spreads or ball diameters up to two feet, pit diameters shall be 1 1/2 times the root spread. For root spreads or ball diameters over 2 feet and less than and including 4 feet, pit diameters shall be 2 feet greater. For root spreads or ball diameters over 4 feet, the pit diameter shall be three feet greater.

The minimum depth of plant pits shall be as follows:

For vines and for shrubs up to 24 inches in height, the depth shall be not less than 15 inches.

For shrubs and trees from 24 inches to 8 feet in height, the depth shall be not less than 18 inches. For trees above 8 feet in height, the depth shall be not less than 2 feet. For balled and burlapped stock enough additional depth shall be added to provide room for an 8 inch depth of backfill material under the bottom of the ball. In all cases the depth shall be sufficient to contain all the roots of the plant without crowding.

In certain areas of poor drainage or heavy soil the Engineer may require raising the plant elevation or have the soil excavated from the plant pit spread on the ground adjacent to the pit and neatly distributed so as to raise the grade of the area to provide better surface drainage. Where shown on the plans or directed by the Engineer such pits may also require drains. When such drains are required they shall be included as a part of the cost of the plant.

- (d) Class B Planting. For Class B planting, plant pits shall be dug such that the diameter will be 10 inches greater than the maximum root spread and 6 inches deeper than the greatest root depth except that pits shall be dug not less than 8 inches deep for shrubs and vines and not less than 12 inches deep for all trees. Suitable loam existing at the site of the plant pit shall be excavated separately and used as backfill around the roots. The balance of the hole shall then be filled with any remaining subsoil. Stones larger than 3 inches in maximum diameter, large roots, roots or rhizomes of witch grass or other injurious materials shall be removed and not used as backfill. Any additional material needed to fill plant pits to the level of the surrounding ground shall be loam furnished by the Contractor at his own expense, and placed around the roots of the plant.
- (e) Class C Planting. Class C plants will be planted in the existing soil. Plant holes must be deep enough to allow room, for the full depth of the root without doubling or folding and wide enough to allow room for its normal spread. Plants must be set straight and at the same depth at which they were previously growing. Soil must be firmly compacted about the roots leaving no air pockets and liquid fertilized during planting only. In heavy sod the Engineer may require that the sod be removed or folded back to a distance of 4 to 6 inches from the main stem of each plant.

An artificial appearance is not desired. Care must be taken to avoid straight lines and too-uniform spacing. Some variation in spacing is essential except in the case of snow control planting where uniform spacing is required.

621.0020 Planting Seasons. Seasons for planting, unless otherwise directed, shall be within the following dates:

Bare Root Plants	*Spring - April 1 to May 31 Fall - September 15 to Nov. 15
Potted & Container Grown Plants	Spring - April 1 to July 15 Fall - August 15 to Nov. 15
Balled & Burlapped Plants	Spring - April 1 to June 15 Fall - August 15 to Oct. 15
	*Evergreen Seedlings planted in spring season only, April 1 to May 15

Preparations for planting may begin earlier than the specified season and planting work may continue beyond the specified time limits if approved by the Engineer. However, the Engineer may require that all plants planted out of season shall receive special attention as directed. Any out-of-season planting shall be at the Contractor's risk and expense.

621.0021 Notice of Delivery of Plants. Notice of Delivery of Plants shall be given by the Contractor to the Engineer at least 48 hours in advance of the anticipated date unless otherwise authorized.

621.0022 Handling and Care of Plants, All Classes.

- (a) Digging of plants shall be performed immediately before shipment. Care shall be taken to avoid injury to or loss of roots. Cutting of roots, where required, shall be done by workmen skilled in handling and care of plants. Plants required to be balled and burlapped shall be dug with a firm ball of earth encompassing the roots of the plant. B and B plants with loose or broken root balls will not be accepted.
- (b) Plants shall be protected before planting by keeping them moist and fresh, taking all necessary precautions against exposure to sun, wind and freezing temperatures.

- (c) Bare root plants shall be puddled in a wet organic or clay mixture which will adhere to all parts of the root system and shall be wrapped in wet straw, burlap or other approved material, immediately after digging.
- (d) Plants shall at no time be bound in a manner such as may cause damage to the bark, branches or roots or packed so tightly as to cause heating.
- (e) Care shall be taken in placing and handling to avoid injury or damage to the health of the plants. In transit and upon delivery, protection shall continue until the material is planted. Wet cloth, wet straw, or other approved material shall be used to protect plants at all times. Bare roots of plants shall not be exposed to sun and wind for periods of more than a 5 minutes at any stage of handling or planting. Upon delivery to the job site all plants not to be planted within 24 hours must be placed in some form of approved storage. Plants with wind damaged or wilted foliage due to open and exposed transport are unacceptable for planting and will not be allowed to recover in plant pits.
- (f) Storage of plants on the project will preferably be in approved buildings where they are protected from heat, light and wind. Plants will be placed in a vertical position and the roots of individual plants or plant bundles packed separately in wet sawdust, peatmoss or other approved material. Plants and packing material must be kept damp at all times. If indoor storage is not considered satisfactory by the Engineer, he may require that all plant material be moved outside and properly heeled in, irrigated, planted immediately, potted or otherwise treated to keep it in a healthy condition. Inside storage will not be considered satisfactory after new growth has started.

If outside storage is used all bare root stock shall be heeled in trenches after opening the bundles and spacing the plants separately. All roots shall be promptly and carefully covered so as to eliminate air pockets. Balled material shall have the balls completely covered with wet sawdust, peatmoss or other approved material. All plants shall be kept thoroughly watered at all times.

(g) All willow and poplar trees as well as Cornus Alba will be thoroughly sprayed on the project with a fungicide approved by the Engineer before being planted regardless of whether they show signs of disease or not. No plants of these species will be allowed on the job which have not received this treatment. A second spraying will be required after the plants are planted when and as directed by the Engineer.

(h) Failure to comply with the above precautions may result in a poor survival rate for the mistreated plants. Such failure will be sufficient cause for rejecting any of the plants involved at any time. Rejected plants may be marked with paint for identification, should not be planted on the project, will not be paid for and must be replaced by approved plants as specified in Subsection 621.0002 or unless authorized.

621.0023 Setting Plants. The plants shall be set plumb and straight in the prepared pits and beds and at a level such as will result, after settlement, in a normal relationship between the plant and the surrounding ground surface.

621.0024 Backfill Class A and Class B. For all Class A plants backfill shall consist of 3 parts of loam thoroughly mixed with one part of peat humus. Loam shall be used for backfill around Class B plants insofar as it is available as excavation from the plant pit. Approved existing loam may also be used on Class A planting. However, sods or clods may not be used as backfill on either Class A or Class B plants. The roots of bare-root plant materials shall be placed in their natural arrangement with the backfilling carefully performed to prevent damage to the plant's root system. Broken or bruised roots shall be pruned immediately, making a clean cut. The backfill material shall be placed and compacted in the bottom of the planting pit and shall be worked around the roots and thoroughly compacted as the backfilling proceeds, leaving no air pockets. Balled and burlapped plants shall be carefully placed in prepared pits so that the balls rest on the compacted backfill material. The backfill shall then be filled in around the rootball to half the depth of the ball and tamped or watered in. The remaining burlap around the balls shall then be loosened and spread out away from the plants or if it is too bulky, cut away and removed. The backfilling shall then be completed, watered and tamped firm. Burlap and plastic weave ball wraps may require slit openings to be cut. Plastic film wraps shall be completely removed during planting. Shallow basins or saucers of earth will normally be required to be placed around each plant as directed by the Engineer. However, when drainage conditions are poor, as in heavy clay soil, the Engineer may require that such saucers be omitted or used only tem-

porarily. All plants shall be thoroughly watered and liquid fed the day they are planted and as often there-after as the Engineer deems necessary for the plants to become safely established. If watering during the establishment period is unsatisfactory, no payment will be made.

621.0025 Fertilizing.

- (a) Water Soluble Fertilizer. The first liquid feeding will be permitted as the first watering only during backfilling of the plant, unless otherwise directed by the Engineer. All seedlings will be liquid fed during planting. The second liquid feeding will be made the following spring season, no later than June 30th.

Liquid fertilizer shall be completely dissolved and mixed in water at the rate of 6 lbs. of the fertilizer concentrate to 100 gallons of water.

The resulting solution shall be poured in the plant pit as directed by the Engineer. A second application at the same rates shall be applied to Class A and Class B plants as directed by the Engineer. The solution shall be applied at the following rates for each application:

Class C evergreen plants-1 pint per plant
Class C deciduous plants-2 quarts per plant
Class A and B plants-plants up to 2 feet in height shall receive 4 quarts.
Plants above 2 feet and up to 6 feet shall receive 6 quarts.
Plants above 6 feet and up to 12 feet shall receive 12 quarts.
Plants above 12 feet shall receive 16 quarts.

- (b) Slow Release Fertilizer Packets. All woody plants except evergreen seedlings shall be fertilized with slow release fertilizer packets at the time of planting, unless otherwise directed by the Engineer. Fertilizer packets shall be placed equidistantly within the planting pit adjacent to the ball or root mass, but not in direct contact with roots. Placement depth shall be 6 to 8 inches. Packets shall not be cut, ripped or damaged.

If it becomes necessary to remove and replace dead or unhealthy plants, damaged or broken packets shall be replaced with new packets.

The application rates shall be as follows:

<u>Types of Plants</u>	<u>No. of Packets</u>
Evergreen Trees	
Under 18 inches height	1 packet
18 inches to 3 feet height	2 packets
3 feet to 6 feet height	3 packets
Over 6 feet height	4 packets
Deciduous Trees	
Under 6 feet height	2 packets
6 feet to 12 feet height or under 4 inches caliper	3 packets
Over 4 inches caliper	4 packets
Shrubs	
Under 2 feet height or spread	1 packets
2 feet to 3 feet height or spread	2 packets
Over 3 feet height or spread	3 packets
Vines and Ground Covers	1 packet

621.0026 Mulching. The disturbed surface area of plant beds shall be evenly and uniformly covered to a depth of 3 inches with stone or 4 inches with wood chip or bark mulch as indicated on the plans or Subsection 621.0019(a) or as directed by the Engineer.

Plant pits for individual plants shall be similarly covered except that perennials and Class C plants shall have mulch 2 inches deep and the mulch shall extend uniformly to a distance of 6 inches outside the edge of the approved plant pit dimension on all sides. Mulching will not be required on Class C evergreens, unless otherwise stated herein.

Where stone mulch is used the level of the loam in the plants bed will normally be left 1 to 2 inches below the level of the surrounding ground. Excavation, loam backfill and planting shall be adjusted accordingly.

Measurement of the depth of mulch will be made after one heavy rain or after a three-week period without heavy rain.

Plastic membrane shall be layed in overlapping strips between the mulch and the surface of the backfill material. Each strip of membrane shall be three feet in width and long enough to cover the entire width of the plant bed or pit. Plastic membrane shall be used on plant beds or pits as indicated on the plans or as directed by the Engineer.

All plant pits and beds must be entirely free of weed or grass growth and free of the roots of all grasses at the time mulch is applied.

When plant beds are installed near guard rails or as stated in Subsection 621.0019(a) the space between the plants and the guard rail or the nearest pavement when it extends in back of the guard rail, shall be treated as a part of the plant bed and shall be weeded and mulched.

Plants shall not be damaged when the mulch is applied. Smothered or otherwise damaged plants must be replaced. Mulch, in place, will not be permitted to be directly in contact with the base of plant trunks or stems in excess of 2 inches of thickness.

621.0027 Cultivation. All plant pits and beds shall be kept free of weeds and grass by the Contractor from the time the plants are planted until final acceptance. This shall be accomplished by manual weeding or cultivation. Chemical control of weeds or grass will not be allowed except upon written permission of the Engineer and then only at the Contractor's risk. There will be no payment for unsatisfactory work.

621.0028 Supporting of Trees. All deciduous trees over 1 inch in caliper or over 6 feet in height shall be staked or guyed immediately after planting. Support stakes, in place, shall have an above ground height in excess of two thirds the planted height of the trees.

- (a) Deciduous trees up to 8 feet in height and evergreens 3 to 5 feet high shall be supported by 2 posts placed on opposite sides of the tree or as directed by the Engineer. Posts shall be firmly set at least 24 inches into the ground and as close to the tree trunk as possible without injuring the roots. Normally this distance will not be more than 8 inches. The top portion of the stake shall be fastened to the tree by plastic chain-lock tree support ties secured to the posts with approved nails or stapled in such a manner as to prevent injury to the tree.
- (b) Deciduous trees 8 to 12 feet in height and evergreens 5 to 8 feet shall be staked with 2 posts placed on opposite sides of the tree and set firmly at least 24 inches in the ground. The posts shall be as close to the tree trunk as possible without causing injury to the roots for bare root stock and at the perimeter of the ball for B and B stock. The top portion of the stakes shall be fastened as in (a) above.

- (c) All larger trees shall be guyed with three guys arranged evenly about the tree. Guys shall consist of 2 strands of wire twisted together until taut. Guys shall be attached to the bole of the tree directly above a substantial limb at a height of $1/2$ to $2/3$ the height of the tree and attached to stakes firmly driven into the ground at such a distance from the tree that the guy wires shall be at an angle of approximately 45 degrees with the ground. The wire used for guying or staking shall be passed through a piece of garden hose of sufficient length and thickness as to prevent cutting or chafing of the bark of the trunk or branches. Stakes shall not project more than 8 inches above the ground. Where guy wires may be a hazard to pedestrians or be too difficult to install, the Engineer may require that 3 or 4 posts shall be used instead.

Where required by the Engineer, a strip of approved, durable white or red cloth 2 inches wide and 18 inches long shall be firmly tied to each guy wire at a point approximately $2\ 1/2$ feet above finished grade.

621.0029 Wrapping. Wrapping shall be placed around all trunks of deciduous trees 1 or more inches in caliper or as directed by the Engineer. The wrapping shall start at the base of the tree and shall cover the entire trunk surface terminating at the first branches. The wrapping shall be tied at top, bottom, and at intervals of not more than 2 feet. Wrapping shall be done at the time of planting but not before inspection of the plant is completed.

621.0030 Pruning. Pruning shall be done to each plant individually in such manner as to preserve the natural character of the plant and shall be done only after delivery and inspection. All pruning shall be done with sharp tools by experienced men in accordance with the best horticultural practice. Plants pruned in such a manner as to seriously impair the appearance or character of the plant will be rejected. Bench pruning with knives or axes will not be permitted.

Broken or badly bruised branches, soft wood, and sucker growth shall be removed with clean cuts. Cuts over $3/4$ inches in diameter shall be painted with approved tree wound paint. The Engineer may require that one-third or more of the growth of deciduous plants be removed as well as substantial portions of the growth of evergreens.

However, excessive pruning shall not be accepted as a means of disposing of dead wood or unhealthy plants. Plants in such poor condition that they can only be revived by pruning of more than $1/3$ or more of the growth will be considered unsatisfactory and will be rejected or reduced to an applicable pay item. At the time of final acceptance all plants must be approximately the size called for in the specification, due allowance being made for moderate pruning.

621.0031 Potted and Container Grown Plants

- (a) Plants Potted On the Job. In order to protect the health of bare root plants and extend the planting season, such plants may be set in approved pots of the grow-thru type before leaves have developed, using the same loam mixture as is used in the plant pits for Class A plants. The plants shall be pruned, in the approved manner, during the potting operation. Pot sizes shall be large enough to enclose the plant roots without crowding and without excessive root pruning. All pots and plants shall have prior approval for acceptance. At the time of potting all plants shall receive water soluble fertilizer at the approved rate for that plant size. They shall also be watered regularly and receive proper care while remaining in the storage area prior to being planted. The plants shall be planted, pot and all, in pits and beds in the same manner as bare root plants. Plant pit dimensions, backfilling, fertilization mulching and cultivation shall be performed as specified for bare root plants of similar type and size. The space outside the pot, in the plant pit or bed, shall be filled with loam or backfill material for B and B stock as required and shall be carefully tamped in place so as not to leave any air pockets.

Potted plants will not be planted in place until they have at least 14 days to become established in the pots unless the Engineer directs otherwise.

All potting operations shall be carried out by the Contractor using plants delivered to the project as bare root plants and approved as acceptable by the Engineer.

Potted plants shall be handled, planted, maintained and replaced as specified for balled or bare-root plants.

- (b) Plants Supplied in Containers in place of B and B stock. Where there exists a scarcity of certain plants or it is desirable to extend the planting season, the Engineer may, allow the substitution of container grown plants for bare root or B and B stock. Such plants may be accepted with a root ball that is proportionately 25 percent less in size than the required root spread or ball size for such plants. However, such plants must have been established in containers at least one full growing season before planting and shall have a well rooted condition

evidenced by the firmness of the mass of soil and roots. The outside of the ball of soil shall be well matted with healthy working roots, but shall not be pot bound. Plants shall be adequately hardened off before planting.

Containers shall be of such shape as to permit easy removal of the plant.

No plant will be accepted if the container ball is cracked or broken upon removal from the container.

621.0032 Herbaceous Plants.

- (a) Crown Vetch. Crown Vetch shall be 2 year old plants, furnished in pots of not less than 2 1/4 inch diameter. Plants shall have been growing in the pots for not less than 1 full year and shall be heavy and vigorous, exhibiting a well rooted condition which is evidenced by a firm mass of soil and roots throughout the pot.

Crown Vetch plants will be planted in the existing soil. The soil shall be thoroughly loosened to a depth of 8 inches forming a planting pocket not less than 8 inches in diameter before the plant is set. The plants shall be watered at the time of planting and as required to keep them in as healthy growing condition the same as other plants. During planting, they shall be fertilized with water soluble fertilizer at the rate of 1 pint per plant, per application. Each plant shall receive one heaping teaspoonful of ground limestone distributed evenly around the plant.

- (b) Daylilly. Daylilly plants shall consist of root clumps with a minimum diameter of 6 inches containing the full depth of the root. Each root clump shall contain not less than 3 live sprouts. It is expected that collected clumps of naturalized Daylilly will be used but the Engineer may, at his discretion, accept other hardy species or varieties.

Daylillies will be planted in holes 12 inches in diameter and 12 inches deep. They will be handled, planted, maintained and replaced as specified for Class A plants except for the following changes:

- (1) Water Soluble Fertilizer shall be applied at the rate of 1 quart per plant.
- (2) Dry Fertilizer shall be applied at the rate of 1 cupful per plant.

- (c) Monarda. Monarda plants shall consist of root clumps or rooted stolons previously planted in approved "grow-thru" type pots. Each root clump or stolon shall contain not less than 4 live shoots at the time of planting.

Monarda will be planted in holes 10 inches in diameter and 12 inches deep. They will be handled, planted, maintained and replaced as specified for Class A plants except for the following changes:

- (1) Water Soluble Fertilizer shall be applied at the rate of 1 quart per plant.
- (2) Dry Fertilizer shall be applied at the rate of 1/2 cupful per plant.
- (3) Mulch except where plants are too close together Monarda beds shall be covered with a 2 inch depth of wood chip or other approved mulch.

- (d) Lupine. Lupine plants shall consist of well-rooted clumps, each containing not less than four main stems previously planted in approved "grow-thru" pots of not less than 6 inch diameter. Plants will be of hardy species and varieties having predominantly blue, pink or yellow flowers.

Planting and culture shall be the same as for Monarda.

- (e) Columbine. Columbine shall consist of hardy species and varieties having blue, yellow or pink flowers. Type of plant, and planting shall be the same as for Lupine.

621.0033 Protection From Rodents. The trunks of all deciduous trees over 1/2 inch caliper shall be protected to a height of at least 24 inches from the ground by plastic, wire mesh or other rodent proof protective material or similar devices approved by the Engineer. Protection shall start at ground level below the mulch. If wire mesh protectors are used they shall consist of standard galvanized steel wire hardware cloth having openings 1/4 inch square. They shall be set so that the trunk of the tree is approximately in the center of the circle formed by the wire with a clearance of at least 2 inches on all sides of the trunk. Edges of the wire mesh shall overlap at least one inch and shall be firmly wired together.

It will be the responsibility of the Contractor to take necessary steps to protect all plants from rodents during the life of the contract. Protection from rodents will be included in the cost of the individual plants and the Contractor will receive no extra compensation for this work. No payment will be made for unsatisfactory work during the establishment period or planting season.

621.0034 Clean-up and Repair. All excavated material and debris resulting from the planting operation shall be promptly disposed of outside of and out of sight of the project, unless otherwise directed by the Engineer. Any areas disturbed by the Contractor showing bare earth, that do not require mulching, shall be seeded with approved grass seed, fertilized and hay mulched, as directed by the Engineer.

The Contractor shall be responsible for any damage caused by his operations and shall restore the disturbed areas to their original condition. Cost of clean-up and repair shall be considered included in the payment for other items of the work.

621.0035 Prosecution and Progress. It is essential that each portion of the planting work in any area be promptly followed by clean-up of subsoil and debris, fertilization, watering, cultivation, pruning, mulching, staking, spraying as needed, repair and restoration of damage caused by the Contractor, etc. The Contractor shall provide sufficient labor and supervisory personnel to carry out this work without undue delay. Any delay in carrying out this phase of the work which, results either in danger to the health or growth of the plants or a poor appearance of the project from the point of view of the public will be considered due cause for withholding all or part of any payment due the Contractor for plants delivered and planted or for any other work done.

Partial payments on the contract do not constitute approval or acceptance of any specific plants or work operations. The right is reserved to reject any plants or work which are discovered to be unsatisfactory at any time prior to Final Acceptance.

621.0036 Establishment Period. The acceptability of the plant material furnished and planted under this contract shall be at the end of a period of establishment, during which the Contractor, as necessary, shall employ all possible means to preserve the plants in a healthy and vigorously growing condition and to insure their successful establishment. During this period the Contractor shall water, cultivate and prune the plants, repair guy wires and stakes, mouse bait as may be required and do any other work necessary to maintain the plants in a healthy growing condition. This shall include seasonal spraying with approved insecticides or fungicides as as may be required. The Contractor shall also be responsible for protecting the plants from mice and other rodents. All dead or re-

jected plants shall be promptly removed from the project and replaced by live healthy plants meeting the same specifications. If such plants are declared unacceptable during the planting season they shall be replaced during this planting season. Otherwise they shall be replaced during the next subsequent planting season. No payment shall be made for unsatisfactory work during the establishment period.

Such replacement plants are subject to the same requirements as the original plants and must be replaced in turn if they fail to meet the required standards. Plants designated for spring planting only, will be replaced only during the spring planting season unless otherwise directed by the Engineer.

The period of establishment shall commence as soon as each plant is planted and shall extend until the date of Final Acceptance. Necessary replacements shall be made so that at the time of Final Acceptance all plants shall be in a healthy, vigorous growing condition and free from sizeable die-back.

Replacements will be required for plants lost, damaged or rejected, whatever the cause. The Contractor will be considered responsible for the plants until the time of Final Acceptance.

It shall be the sole responsibility of the Contractor to replace any unsatisfactory plants on the project regardless of whether they are specifically designated by the Engineer. In the case of individual doubtful plants the Contractor may call upon the Engineer to make a determination as to their acceptability, but it shall not be incumbent on the Engineer to furnish the Contractor with exact lists of replacements.

All replacements of plants shall be completed by the end of the planting season prior to the Final Acceptance date. Any small quantity of plants which fail between the end of the planting season and the Final Acceptance date shall be cancelled from the list of accepted plants and the Contractor will receive no payment for them. If a sizeable number fails the Engineer may extend the date of Final Acceptance to the subsequent planting season, in which case, the Contractor will be subject to liquidated damages. All replacement planting shall conform in every way to the requirements of the original planting. The Engineer may require that any replacement plants that are not dormant, or that are planted late in the season, be sprayed, as directed with an approved antidesiccant.

621.0037 Method of Measurement. The quantity of plants to be measured for payment will be the number of individual plants furnished and planted as required and accepted, excluding replacements.

621.0038 Basis of Payment. Each item of "Planting" will be paid for at the contract unit price for each accepted plant furnished and planted. Payment shall constitute full compensation for; furnishing and placing plants, digging, delivering, rodent protection,

preparing plant pits, beds and drains; planting, watering, fertilizing, supporting, mulching, pruning, establishing and the clean-up of planting areas; for all loam, fertilizer, mulch and other necessary materials; all labor, equipment, tools and any other incidentals necessary to complete the work.

When a bid item calls for a "Group" of trees, shrubs, vines or other plants, the Contractor shall furnish each individual species within this "Group" for the same unit bid price.

The name and estimated number of individual species within each "Group" will be shown on the estimated quantities sheet of the plans.

Payment will be made under:

Pay Item	Pay Unit
621.... Name plant or plant group as detailed in Schedule of Items in Proposal Book	Each

SECTION 622 -- TRANSPLANTING SHRUBS, HEDGES AND TREES

622.01 Description. This work shall consist of digging, moving and replanting existing shrubs, hedges and trees in accordance with these specifications and in conformity with the plans or as directed.

MATERIALS

622.02 Loam. Loam shall conform to the requirements of Subsection 615.02. Fertilizer shall meet the requirements specified in Subsection 717.01.

CONSTRUCTION REQUIREMENTS

622.03 Shrubs and Hedges.

- (a) Digging. The earth of shrubs and hedges to be moved shall be carefully hand-dug with a solid ball of earth encompassing the roots as is customary in good nursery practice. Minimum size of the rootball shall be as indicated in the current edition of the "American Standard for Nursery Stock" sponsored by the AAN.

- (b) Moving. The earth rootball shall be maintained as a solid unit during the moving of the shrubs and hedges and must be protected from breaking or cracking by careful handling. The rootball shall be tightly wrapped with burlap or similar material. Earth rootballs greater than 18 inches in diameter shall be tightly bound with cord or rope placed over the burlap unless the shrubs or hedges are to be replanted immediately after digging.
- (c) Planting. The plants shall be planted in the designated new location at the same depth below ground surface as before they were moved. Loam shall be placed to a thickness of not less than 8 inches under and around the rootball to eliminate all air pockets and to support the plant. Insofar as feasible when hedges are to be transplanted, the individual plants shall be replanted in the same relationship to each other that existed before they were moved.

Fertilizer shall be mixed evenly into the backfill soil at the rate of 1/4 of a pound per foot of height for each plant. Water soluble fertilizer and slow release fertilizer packets shall be applied at the following rates.

Shrubs to 2 feet high or spread	4 quarts water soluble or 1 packet
Shrubs to 4 feet high or spread	6 quarts water soluble or 2 packets
Shrubs to 6 feet high or spread	8 quarts water soluble or 3 packets

- (d) Time of Transplanting. Plants shall be dug and transplanted only when dormant, preferably in the early spring, unless otherwise directed by the Engineer. When dug, shrubs and hedges shall be moved directly to the final planting site and planted without delay if possible. The rootball must be kept moist at all times during transplanting operations. If construction makes it impossible to replant the plants immediately after digging, the rootballs of the plants shall be kept completely covered with a thick layer of earth, hay, peat moss, or similar material which shall be kept moist at all times while the plants remain unplanted. Shrubs may be held in approved pots under conditions of delayed replanting.
- (e) Pruning. All pruning shall be done in accordance with the best horticultural practice. Dead, diseased or injured shoots and branches shall be removed. In order to restore a normal balance between top and

roots, deciduous shrubs shall be thinned by removing uniformly scattered, selected branches which shall be cut back to the main stem, as directed. The Engineer may require tip pruning in addition. Tip pruning may also be required for evergreens. In the case of hedges, the Engineer may require shearing to uniform, even surfaces.

- (f) Watering. As soon as the plants are planted they shall be thoroughly watered to the point where the roots and the surrounding earth are well saturated. The first application of liquid fertilizer shall be made during planting.
- (g) Mulch. After removing all weeds and grass, the ground surface over the entire area of the planting pit shall be covered to a depth of 3 inches with a mulch of wood chips, stone or other approved material. Sawdust, hay or straw will not be accepted as mulching material.

622.04 Trees.

- (a) Digging. All trees to be moved and replanted shall be dug with a solid ball of earth around the roots as is customary in good nursery practice. The diameter of the ball shall be not less than 10 times the diameter of the trunk of the tree measured 1 foot above the surface of the ground. Depth of the ball shall be not less than 60 percent of its diameter for balls up to 48 inch diameter. For balls over 48 inch diameter the ball shall have sufficient depth to maintain a solid structure and to encompass all the feeding roots under the ball area. Power shovels and similar machinery may not be used in digging the ball except with written permission.
- (b) Moving. The ball must be maintained as a solid unit during the moving of the tree. The ball must be protected from breaking or cracking by careful handling and by being tightly bound with cord or rope over canvas, burlap or similar wrapping. The ball shall be firmly attached to a tree platform of suitable size during moving operation, as required.
- (c) Planting. The trees shall be planted in the designated new location at the same depth in relation to the ground surface as before they were moved. Loam shall be placed to a distance of not less than 12 inches under the ball and around the periphery of the ball. Loam shall be puddled and firmed in place to eliminate all air pockets and give adequate support to the ball. Fertilizer shall be applied as specified in Subsection 621.0025(b).

(d) Protection. Every care shall be taken to prevent injury to the tree during the transplanting operation. All parts of the tree shall be carefully protected. Branches shall be tied out of the way of possible injury. No chain, cable or heavy rope may be attached to the trunk or branches without protective padding adequate to prevent bruising or other injury.

(e) Time of Transplanting. Trees shall be dug and transplanted only when dormant, preferably in the early spring, unless otherwise directed. When dug, trees shall be moved directly to the final planting site and planted without delay if possible. The ball must be kept moist at all times during transplanting operations. If construction problems make it impossible to replant the tree immediately after digging, the ball of the tree must be completely covered with a thick layer of earth, hay, peat moss or similar material which shall be kept moist at all times while the tree remains unplanted. Pruning, watering, fertilizing, mulching and supporting shall be as specified in the applicable Subsections of Section 621 -- Landscaping.

622.05 Maintenance. It shall be the Contractor's responsibility to protect and care for the plants during the life of the contract. They shall be watered weekly during dry weather or as otherwise directed. The Contractor shall take steps required to protect the plants from damage and from diseases and insect pests. Should damage occur it shall be repaired by the Contractor, according to the best horticultural practice.

622.06 Replacement. If the ball is badly broken or the plants are otherwise badly damaged or if, in the opinion of the Engineer, during the life of the contract the plants show such signs of loss of health or appear to be in danger of dying, the Contractor will be required to replace the plants with others of the same size and variety or approved plants of equal value, at the proper season.

622.07 Method of Measurement. Transplanting hedges will be measured by the linear foot in place after transplanting, measured from the extremities of the branches at each end. A hedge shall be defined as an evenly spaced row of plants of uniform size, growing close to each other so that the branches are intermingled.

Transplanting shrubs or trees will be measured in place after transplanting by the single shrub or tree unit.

622.08 Basis of Payment. The accepted quantities of transplanting hedges will be paid for at the contract unit price per linear foot of hedges properly transplanted and accepted, which price and payment shall include digging, binding, moving, replanting, pruning, mulching, care and maintenance and if required, replacement of the hedges and for all loam, mulch and all other materials and incidentals necessary to complete the item.

The accepted quantities of transplanting shrubs or trees will be paid for at the contract unit price for each plant properly transplanted and accepted, which payment shall include digging, binding, moving, replanting, pruning, mulching, care and maintenance and if required, replacement of the shrubs, and for all loam, mulch and other materials, and for all incidentals necessary to complete the item.

Payment will be made under:

Pay Item	Pay Unit
622.09 Transplanting Hedge	Linear Foot
622.10 Transplanting Shrub	Each
622.11 Transplanting Tree	Each

SECTION 623 -- MONUMENTS

623.01 Description. This work shall consist of furnishing and placing or removing and resetting right-of-way monuments and survey monuments at locations shown on the plans or otherwise designated.

MATERIALS

623.02 Materials. Monuments shall be of granite or of reinforced portland cement concrete. When of granite, the stone shall be of a quality conforming to the applicable requirements of Subsection 712.04. When of portland cement concrete, they shall be of Class "Y" concrete as specified in Section 502 -- Structural Concrete. Reinforcement shall conform with the requirements of Section 503 -- Reinforcing Steel.

CONSTRUCTION REQUIREMENTS

623.03 General. Monuments shall be placed in vertical positions in excavated holes at depths shown on the plans or designated, with 2 sides approximately parallel with the roadway. The backfill material shall be placed in layers not exceeding 8 inches in depth, loose measure and firmly tamped.

When removing and resetting monuments special care shall be taken that the stone shall not be broken or damaged. Monuments broken or damaged by the Contractor shall be replaced with monuments of similar type without added compensation.

When a monument is to be set and it is found that rock exists below ground, it will be permissible to cut off the monument at an authorized length to allow setting on the rock. A concrete collar with dowels shall be placed around the monument to secure it to the rock, as shown on the plans. If the rock is rough enough to provide a firm attachments for a concrete collar no dowels will be necessary. The cement concrete shall meet the requirements of Section 502 -- Structural Concrete. The class concrete shall be optional.

When a monument is to be set in the surface of exposed rock it may consist of a bronze pin marker embedded in the ledge as shown on the Standard Detail plans.

623.04 Method of Measurement. Monuments and markers, both new and reset, will be measured by each unit. Excavation in solid rock will be measured by the cubic yard determined from the actual depth of the hole and a hypothetical circle diameter of 2 feet.

623.05 Basis of Payment. The accepted quantities of monuments and markers will be paid for at the contract unit price each complete in place. Payment for placement of monuments in solid rock shall be considered included in the contract unit bid price except that actual excavation into solid rock will be paid for under Pay Item 206.07, Structural Rock Excavation, Drainage and Minor Structures.

Payment will be made under:

Pay Item	Pay Unit
623.06 Right-of-Way Monument	Each
623.07 Survey Monument	Each
623.08 Bronze Pin Marker	Each
623.09 Remove and Reset Monument	Each

SECTION 624 -- PROJECT MARKERS

624.01 Description. This work shall consist of fabricating and installing project markers in accordance with these specifications and at locations designated.

MATERIALS

624.02 Materials. Concrete for project markers shall meet the requirements of Section 502 -- Structural Concrete, Class "Y". The top 2 feet shall be rubbed.

Steel for reinforcing shall meet the requirements of Section 503 -- Reinforcing Steel.

CONSTRUCTION REQUIREMENTS

624.03 General. The project markers shall be precast of portland cement concrete with steel reinforcing, in conformity with the dimensions shown on the Standard Detail plans.

The letters and numerals designating the projects shall be cast on the faces by using beveled castings attached to the forms before placing the concrete. Other methods of forming letters and numerals may be approved by the Engineer. All letter and numeral markings shall be painted with an approved black enamel paint or black concrete paint.

A project marker shall be set at each end of the project with the narrow face facing the highway in the required location, and the project number markings facing toward the project. They shall be set in a vertical position and the backfill thoroughly tamped. When placed in solid rock they shall be set as specified in Sub-section 623.03.

624.04 Method of Measurement. Project markers will be measured by each unit. Excavation in rock will be measured by the cubic yard determined from the actual depth of the hole and a hypothetical circle diameter of 2 feet.

624.05 Basis of Payment. The accepted quantities of markers will be paid for at the contract unit price each, complete in place. Payment for placement of markers in rock shall be considered included in the contract unit bid price except the excavation in rock will be paid for under Pay Item, 206.07 Structural Rock Excavation, Drainage and Minor Structures.

Payment will be made under:

Pay Item	Pay Unit
624.06 Project Marker	Each

SECTION 625 -- WATER SERVICE SUPPLY LINES

625.01 Description. This work shall consist of the installation of water pipe and pipe sleeve in reasonably close conformity with the lines and grades shown on the plans or established. The installation shall include the assembly of all components and materials shown on the plans or as directed.

MATERIALS

625.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Asbestos Cement Pipe	706.10
Copper Tubing	712.32
Non-metallic Pipe, Flexible	712.33
Non-metallic Pipe, Rigid	712.34
Metallic Pipe	712.341

CONSTRUCTION REQUIREMENTS

625.03 General. This work shall be done with as little interruption of water service as possible. Ample notification shall be given to the users of the water before any disruption of water service.

625.04 Sleeve. Pipe for sleeves shall be metallic or non-metallic rigid and be laid on a firm foundation at the line and grade designated. When the pipe installation is in a trench all excavating and backfilling shall be in accordance with Section 206 -- Structural Excavation.

After installation of the pipe, special care shall be taken to protect the pipe from heavy hauling equipment loads, rocks or any other damage caused by the Contractor's work. All pipe broken from such causes shall be removed and replaced at the Contractor's expense.

Pipe sleeves to be placed in concrete shall be supported during placement of concrete. Special care shall be taken while placing and compacting concrete around the sleeves to prevent voids around the outside of the sleeves. Ends of the sleeves shall be capped with end plates until the water pipes are installed through the sleeves.

625.05 Water Pipe. Water pipe shall be copper tubing or non-metallic flexible pipe, as called for. After the sleeve has been placed the water pipe shall be inserted into the sleeve and connected to the existing pipes at each end. All connections to existing pipes shall be done in accordance with recognized plumbing practices. Necessary fittings, adapters, and reducers shall be furnished as required.

625.06 Method of Measurement. Pipe sleeve, copper tubing and non-metallic pipe will be measured by the linear foot.

625.07 Basis of Payment. The accepted quantities of pipe sleeve, copper tubing and non-metallic pipe will be paid for at the contract unit price per linear foot for the types and sizes specified complete in place, which payment will be compensation for furnishing and installing all necessary fittings, for connecting to existing systems and for capping the ends of the pipe sleeve.

Excavation will not be paid for separately but will be considered included in the work of the contract items.

Payment will be made under:

Pay Item	Pay Unit
625.081 3/4 inch Copper Tubing	Linear Foot
625.082 1 inch Copper Tubing	Linear Foot
625.083 1 1/4 inch Copper Tubing	Linear Foot
625.084 1 1/2 inch Copper Tubing	Linear Foot
625.085 1 3/4 inch Copper Tubing	Linear Foot
625.09 Vacant	
625.101 3/4 inch Non-metallic Pipe-Flexible	Linear Foot
625.102 1 inch Non-metallic Pipe-Flexible	Linear Foot
625.103 1 1/4 inch Non-metallic Pipe-Flexible	Linear Foot
625.104 1 1/2 inch Non-metallic Pipe-Flexible	Linear Foot
625.105 1 3/4 inch Non-metallic Pipe-Flexible	Linear Foot
625.141 2 inch Pipe Sleeve	Linear Foot
625.142 3 inch Pipe Sleeve	Linear Foot
625.143 4 inch Pipe Sleeve	Linear Foot
625.144 6 inch Pipe Sleeve	Linear Foot
625.145 8 inch Pipe Sleeve	Linear Foot

SECTION 626 -- FOUNDATIONS, CONDUIT AND JUNCTION BOXES FOR HIGHWAY SIGNING, LIGHTING AND SIGNALS

626.01 Description. This work shall consist of furnishing, installing, modifying or removing concrete foundations, conduits and junction boxes for highway lighting, highway signing and traffic signal installations in accordance with these specifications and in reasonably close conformity with the plans.

MATERIALS

626.02 General. The materials furnished by the Contractor shall be new. Where an existing system is to be modified, the existing material shall be removed and abandoned or salvaged as shown on the plans or as directed.

All electrical equipment shall conform to the standards of the NEMA or the UL, where ever applicable. In addition to these requirements, all materials and workmanship shall conform to the requirements of the NEC, the ASTM Standards; the ANSI; the local electrical utility and any local ordinances which may apply.

Materials shall meet the requirements specified in the following Subsections of the Division 700, Material Details.

Reinforcing Steel	709.01
Precast Concrete Units	712.06
Steel Conduit	715.02
Non-metallic Conduit	715.03
Prewired Conduit	715.04
Metallic Junction and Fuse Box	715.05
Bituminized Fibre Junction Boxes	715.06
Anchor Bolts	720.07

626.021 Miscellaneous Material. Gravel backfill, shall meet the requirements for Aggregate Base-Screened, Subsection 703.06(a), Type A.

Transformer pads shall conform to Utility requirements.

If grouting is necessary to correct surface irregularities in the top of the concrete foundations, a non-shrink material satisfactory to the Engineer shall be used.

All concrete foundations shall be constructed of Class A concrete in accordance with the applicable requirements of Section 502 -- Structural Concrete.

626.022 Equipment List and Drawings. Unless otherwise permitted in writing, the Contractor shall within 30 days following execution of the contract, submit a list of equipment and materials which are to be installed. The list shall include the name of manufacturer, size and identifying number of each item. The list shall be supplemented by such other data as may be required, including detailed scale drawings of proposed minor deviations from the plans. If requested, the Contractor shall submit for review, design data and sample articles of the material proposed for use. All of the above data shall be submitted in duplicate except samples for testing. Following checking, correcting and reviewing, 2 complete sets of drawings shall be submitted. The Department will not be liable for material purchased, labor performed, nor delay to the work prior to such review.

Upon completion of the work, the Contractor shall submit 3 complete sets of corrected plans showing all construction changes.

CONSTRUCTION REQUIREMENTS

626.03 General. All work shall conform to the standards of the NEC and to the NESC as set forth in the NBS Handbook H-32, except when otherwise noted on the plans or in the Special Provisions.

The Contractor shall be responsible for and shall repair all damage caused to underground drainage structures, utilities or lighting conduit which are encountered during construction.

626.031 Conduit. If the trench is located in wet, spongy or otherwise unsuitable ground, the trench shall be further excavated to a depth sufficient to overcome this condition and shall be back-filled with approved gravel. The gravel shall be compacted in layers not more than 8 inches, loose measure. The grade of the bottom of the trench shall be parallel to the proposed grade of the conduit.

Trenches for conduits shall be excavated to a width which will permit proper installation of the conduit and to the depth shown on the plans or as directed.

Junction or pull boxes shall be installed as shown on the plans.

Where conduits enter exposed junction boxes, they shall be sloped to drain to the conduit entrance holes, unless otherwise directed. Weepholes of 1/4 inch diameter shall be placed in all pull, junction and fuse boxes.

After the trench has been excavated as specified, the bottom of the trench shall be prepared with a sand bedding material. After placing the conduit, sand shall be placed around the sides and over the top of the conduit when shown in the special details. The entire trench shall then be backfilled with approved material, placed in layers not exceeding 8 inches and thoroughly tamped.

All underground conduit shall be placed to at least the depth shown on the plans and shall not conflict with poles, guard rail or posts, sign foundations or other objects.

All conduit ends shall be capped with conduit caps until wiring is started. Prewired conduit shall be sealed during construction to prevent entry of moisture, dirt or rocks.

The size and type of conduit required will be noted on the plans, except that the minimum size of conduit risers required for traffic signal installations shall be determined by percentage fill in a single conduit as specified in the latest revision of the NEC. Where more than one conduit is required to be installed in the same location, the conduits may be placed in the same trench.

The weatherhead on conduit risers on utility company poles shall not be less than 1 foot from the utility wires. Conduit risers on utility poles shall be located as required by the utility company.

Within 10 days after completion of each section of conduit, the Contractor, in the presence of the Engineer, shall rod and pull through each duct a mandrel and brush of a pattern satisfactory to the Engineer, but which shall not be more than 1/8 inch smaller than the bore of the ducts. Where obstructions in the ducts prevent passage of the mandrel, the Contractor shall, at his own expense, remove and relay those portions of the ducts necessary to clear the obstruction.

The Contractor shall install Number 9 US Steel Wire Gage galvanized iron pull-wire in all unused conduits. The ends of the wire shall be secured in such manner as to prevent accidental withdrawal of the wire.

626.032 Metallic Conduit Installation. Conduits shall be of the sizes noted on the plans, which are indicated as the nominal inside diameter. All conduits shall be joined with threaded couplings using approved thread sealant. Conduit shall be installed continuous and watertight between boxes or equipment. Running threads will not be permitted. When necessary, the Contractor shall use an approved electrical union type coupling. Conduits shall be protected at all times from the entrance of water or other foreign matter. Conduit runs shall be made with as few couplings as standard lengths will permit. The total angle of all bends in one run and the radius of conduit bends shall conform to the NEC requirements. All field bends and offsets shall be made with approved hickey or conduit benders. Pull boxes shall be used wherever necessary to facilitate the installation of the wires.

In making up a run of conduits, all cut ends shall be reamed to remove rough edges and cut threads shall be painted with an approved thread sealant in such a manner that there will be no unprotected surfaces and joints will be watertight. All conduits shall have electrical continuity and be adequately grounded.

Conduits to be placed in the concrete superstructure of bridges and similar structures shall be securely supported and fastened, in order to maintain the conduits' position within the concrete superstructure as shown on the plans. Pull boxes shall be located as shown on the plans. Clearance between conduit runs shall preferably be 2 inches but shall at no time be less than the maximum size of the aggregate used in the embedding concrete. At all joints where relative movement between adjacent parts of a structure can occur a double O-ring expansion coupling or other approved expansion device shall be installed.

Exposed conduit shall be rigidly and securely fastened with acceptable fasteners or supports as indicated on the plans or approved. Fasteners or supports shall not be placed more than 6 feet apart on centers except as otherwise authorized. Conduits shall generally be supported by an approved spacer at the point of support, so that there is an air space between the conduit and the supporting surface. Ends of conduit runs terminating in a metallic box without a threaded hub shall be provided with a metallic locknut on the outside of the box, and metallic locknut and insulated bushings on the inside. A lock washer and a galvanized steel flat washer shall be installed between the outside locknut and face of the box.

626.033 Polyvinylchloride Conduit Installation. Polyvinylchloride, hereafter called PVC conduits, shall be installed in accordance with the applicable methods as specified in Subsection 626.032 for metallic conduits.

PVC conduit shall be made watertight by joining with solvent or in accordance with the manufacturer's specifications.

Conduit shall be bent carefully to avoid damage and without the use of an open flame. Bends sharper than 45 degrees (1/8 bends) will not be permitted in PVC conduit. The total angle of all bends in one run and the radius of bends shall conform to the NEC requirements.

Conduits to be placed in the concrete superstructure of bridges and similar structures shall be securely supported and fastened, in order to maintain the conduits' position within the concrete superstructure as shown on the plans. Pull boxes shall be located as shown on the plans. Clearance between conduit runs shall preferably be 2 inches but shall at no time be less than the maximum size of the aggregate used in the embedding concrete. At all joints where relative movement between adjacent parts of a structure can occur a double O-ring expansion coupling or other approved expansion device shall be installed.

To allow for expansion and contraction of PVC conduit during installation of long runs, one end shall be left unconnected or a double O-ring expansion coupling shall be inserted near one end of the run until final covering of the conduit is in progress.

Where PVC conduit runs are placed parallel to other conduit runs or cross one over another, they shall be separated by a minimum of 3 inches of sand or soil cushion. The bottom of trenches for PVC conduit shall be lined with a 3 inch minimum bedding of tamped sand or soil prior to laying the conduit. Backfill to a compacted depth of 6 inches above the top of the conduit shall be sand or soil free from rocks or hard lumps.

At locations shown on the plans, or otherwise designated, conduit shall be constructed of schedule 80 PVC non-metallic conduit pipe, encased in approved granular material as shown on the detail sheets.

When prewired conduit is installed, only those junction boxes necessary for underground splices shall be installed unless otherwise directed.

Conduit and wire sizes of prewired conduit shall be as shown on the plans.

If the Contractor elects to plow in the prewired conduit the plowing shall be done with approved vibratory plowing equipment.

When prewired conduit is installed in a trench, the trench shall be prepared as previously noted in this subsection for PVC conduit.

626.034 Concrete Foundations. Prior to placing concrete, the required elbows of entrance conduits, reinforcing steel and anchor bolts shall be carefully positioned. The anchor bolt size and the bolt circle diameter shall be determined from data furnished by the supplier of the poles or as shown on the plans. Anchor bolts for use with breakaway couplings, longitudinally grooved type, shall be 1 inch diameter and shall project between 2 1/2 and 3 inches above the top of the foundation. All other anchor bolts shall be a minimum of 1 inch diameter and shall project sufficiently to accommodate the thickness of the base plus all nuts and washers and to allow approximately 1/2 inch clear below the leveling nut and 1/4 inch projection above the top nut. At least 2 threads on each anchor bolt shall project beyond the outside of the nuts holding the plumbed pole.

Foundations shall be constructed of reinforced concrete with anchor bolts in accordance with the applicable requirements of Section 502 -- Structural Concrete, Section 503 -- Reinforcing Steel and in conformity with the dimensions and details shown on the plans or on the Contractor's approved design.

If the foundation is located in wet, spongy or otherwise unsuitable material, the hole shall be further excavated to a depth sufficient to overcome this condition and backfilled with aggregate subbase material. The aggregate material shall be firmly compacted in layers not more than 8 inches, loose measure. Backfilling of foundation material shall conform to Subsection 206.03.

The area around the foundations shall be loamed and seeded in accordance with the requirements of Section 615 -- Loam and Section 618 -- Seeding Method Number 1.

Concrete foundations designated to be modified or removed shall be modified or removed as shown on the plans. Debris resulting from the modification or removal shall be removed from the site to an approved location. After modification or removal has been completed the area shall be brought to grade by addition of granular material and loam or by loam only, depending on the extent of modification or removal. The area shall then be seeded in accordance with Section 618 -- Seeding Method Number 1.

Backfilling around the foundations shall conform to the requirements of Subsection 206.03. Backfill material shall be excavated material unless considered unsatisfactory in which case the material shall meet the requirements of Aggregate Base-Screened. The finished ground at each foundation shall be graded flush with the top of the foundation except at locations where the foundation is protected by guard rail. If required, approved backfill material shall be added to grade the slopes as specified. There will be no additional compensation for furnishing, placing and compacting material flush around the foundation.

When solid rock is encountered at less than the required distance below existing ground level, the construction method shown on the plans shall be followed.

The concrete portion of the foundations exposed to view shall have a troweled finish. A drainage groove shall be formed in the horizontal surface of the foundation. The top of the concrete foundation shall be horizontal.

When the anchor bolt template is removed, the threads of the anchor bolts shall be greased and protected with a metal sleeve, held in position with nuts and washers furnished with the bolts. This thread protection shall remain in place until the pole or other equipment is installed.

A copper clad steel ground rod shall be installed when shown on the plans.

626.04 Method of Measurement. Precast concrete junction boxes, bituminized fiber boxes, remove or modify concrete foundations, 18 inch, 24 inch and 30 inch foundations, special foundations, sign pole foundations and controller cabinet foundation, will be measured by each unit.

Metallic conduit, non-metallic conduit and prewired conduit, will be measured by the number of linear feet.

626.05 Basis of Payment. The accepted quantity of foundations will be paid for at the contract unit price each for the number of foundations of the respective types, which payment shall include anchor bolts, reinforcing steel, conduit within the foundation and extending 12 inches from the foundation and for loam, seeding, mulching and all incidentals necessary to complete the work.

The accepted quantity of junction boxes will be paid for by the contract unit price each. Payment for junction boxes shall include furnishing and installing precast concrete, or bituminized fiber boxes as designated, including that portion of conduit extending 12 inches outside the box.

Payment will be made for the total number of linear feet of each type of underground or exposed conduit actually furnished, installed and accepted at the contract price per linear foot which price shall include the cost of furnishing and installing the conduit, excavating, furnishing special backfilling materials, pull wire, fittings, groundings and bonding, test cleaning interiors of conduits and all materials, labor, equipment and incidentals necessary to complete the work.

Excavating and backfilling for junction boxes and foundations and excavating, backfilling and sand bedding for conduit ducts will be considered included in the respective contract unit prices and no separate payment will be made, except as hereafter provided.

Excavating and backfilling shown on the plans or required to overcome soft or otherwise unsuitable material or for excavating rock will be paid for as provided in Section 206 -- Structural Excavation. The quantity of earth to be measured for payment below grade will be the amount actually excavated from 1 foot below the bottom of the foundation, junction box or sand bedding to the required elevation, provided the maximum allowable horizontal dimensions do not exceed those bounded by vertical surfaces 9 inches each side the installation as shown on the plans. The quantity of rock to be measured for payment will be the number of cubic yards actually removed provided the maximum allowable horizontal dimensions do not exceed those bounded by vertical surfaces specified herein. Required backfill material, except sand bedding as shown on the detail plan, will be paid for as provided in Section 304 -- Aggregate Base and Subbase Course.

Payment will be made for the total number of linear feet of prewired conduit actually furnished, installed and accepted at the contract price per linear foot which price shall include the cost of hand digging, trenching, or plowing, furnishing and installing the prewired conduit, and of all labor, equipment and incidentals necessary to complete the work.

Prewired conduit within the foundations and extending 12 inches from the foundation and prewired conduit within the junction box and extending 12 inches outside the junction box shall be considered incidental to the respective contract unit prices for light standard foundations and junction boxes and no additional payment will be made.

The accepted quantity of remove or modify concrete foundations will be paid for at the contract unit price each. Such price shall include disposing of concrete removed, backfilling with granular material, loaming, seeding and all incidentals necessary to complete the work.

Payment for restoration of roadway pavement, sidewalks, grass areas and resetting curbing removed in conjunction with this work shall be considered incidental to the respective contract prices for each related item except as otherwise provided.

Payment will be made under:

Pay Item	Pay Unit
626.11 Precast Concrete Junction Box	Each
626.12 Bituminized Fiber Junction Box	Each
626.21 Metallic Conduit	Linear Foot
626.22 Non-metallic Conduit	Linear Foot
626.23 Prewired Conduit Secondary Wiring	Linear Foot
626.24 Prewired Conduit Primary Wiring	Linear Foot
626.31 18 inch Foundation	Each
626.32 24 inch Foundation	Each
626.33 30 inch Foundation	Each
626.34 Signal Pole Foundation	Each
626.35 Controller Cabinet Foundation	Each
626.36 Remove or Modify Concrete Foundation	Each
626.37 Special Foundation	Each

SECTION 627 -- PAVEMENT MARKINGS

627.01 Description. This work shall consist of furnishing and placing reflectorized pavement lines and markings, removing pavement lines and markings and furnishing and applying reflectorized paint to curbing in reasonably close conformity with the plans and as designated.

MATERIALS

627.02 Materials. Materials shall conform to the requirements specified in the following Subsections of Division 700 -- Materials.

Pavement Marking Paint	708.03
Reflectorized Plastic Pavement Marking	712.05

CONSTRUCTION REQUIREMENTS

627.04 General. All pavement lines and markings shall be applied in accordance with the Manual on Uniform Traffic Control Devices.

Longitudinal lines placed on tangent roadway segments shall be straight and true, longitudinal lines placed on curves shall be continuous smoothly curved lines consistent with the roadway alignment. All pavement markings placed shall meet the tolerance limits shown on the plans.

Broken lines shall consist of alternate 10 foot painted line segments and 30 foot gaps.

Temporary pavement markings shall be applied in accordance with the pattern shown on the plans or as directed.

Newly painted lines, markings and curb shall be protected from traffic by cones, stationary vehicles or other approved methods until the paint is dry.

627.05 Preparation of Surface. Immediately before applying the pavement marking paint to the pavement or curb, the surface shall be dry and entirely free from dirt, grease, oil or other foreign matter.

Surface preparation for application of plastic markings shall conform to the manufacturers recommendations.

627.06 Application. Prior to applying paint for final pavement lines and markings, the Contractor shall perform a test for paint thickness by furnishing and placing a piece of smooth, clean metal with an area of at least 144 square inches in the path of the striping truck. The striping truck shall be passed over the piece of metal painting the surface as it passes without applying beads. The result of this test will be used to determine the pressure setting and speed of the truck when applying paint to the project to obtain the specified thickness of paint. Additional paint thickness test may be required on the final paint markings.

The wet thickness of paint without beads on final pavement lines shall be a minimum of 15 mils. On other final pavement markings and curb where the paint is applied by hand painting or spraying, application shall result in complete and uniform coverage.

Glass beads shall be applied to the final pavement marking line at the rate of 6 pounds per gallon of paint and in sufficient quantity to assure complete and uniform coverage of hand painted surfaces.

Temporary painted lines and markings shall be applied with a thickness sufficient to provide an effectively visible line for the period of time needed.

Glass beads shall completely and uniformly cover the entire surface of the temporary painted line.

Temporary pliant polymer marking material shall be used for temporary markings on the final pavement and on pavements not to be resurfaced when such pavement markings do not conform to the final pavement markings.

The plastic final pavement lines and markings shall be applied in accordance with the manufacturer's recommendations by the inlay method of application.

627.07 Establishment Period. The inlaid plastic pavement lines and marking material furnished and installed under this contract for final pavement markings shall be subject to a 6 month period of establishment.

The period of establishment shall commence as soon as the plastic pavement lines and markings are complete and in place and continue for 6 months. At the end of the establishment period, a minimum of 95 percent of the plastic pavement lines and markings shall be in place, to constitute acceptance.

If less than 95 percent of the plastic pavement lines and markings are in place after 6 months, the Contractor shall replace all unsatisfactory plastic pavement lines and markings on the project without additional payment. Plastic pavement lines and markings designated for replacement shall be installed according to these specifications, unless otherwise directed. Plastic pavement lines and markings replaced at the end of the 6 months establishment period will not be subject to a further establishment period.

627.08 Removing Lines and Markings. When it is necessary to remove pavement lines and markings, it shall be done by grinding, high temperature flame, sand blasting, solvent or other acceptable means. The method chosen must be capable of completely eradicating the existing line or marking without damage to the pavement. Burning and grinding will not be permitted to remove temporary markings from final pavement or from existing pavement not to be resurfaced.

627.09 Method of Measurement. Longitudinal 4 inch wide lines parallel to the centerline of the roadway will be measured by the linear foot along the centerline stationing of the roadway. Other 4 inch lines will be field measured or computed. The measurement of broken lines will include the gaps. All other pavement markings will be measured by the square foot.

Reflectorized curb will be measured or computed by the square foot of curb surface actually painted and reflectorized.

Removing pavement markings will be measured by the square foot of pavement marking.

627.10 Basis of Payment. The accepted quantities of pavement lines, markings and reflectorized curb will be paid for at the contract unit price per linear foot or square foot for the colors, widths or shapes specified, complete in place. No direct payment will be made for performing the paint thickness test, nor for furnishing the metal plate to receive the paint, but the cost of such work shall be incidental to pavement markings.

The accepted quantity of removing pavement markings will be paid for at the contract unit price per square foot, except that any lines or marking applied by the Contractor which are not within reasonably close conformity to the markings as laid out by the Engineer shall be removed without compensation.

Payment for final plastic pavement lines and markings will be made in two parts. The first payment of 75 percent will be made when plastic pavement lines and markings are placed. The payment of the remaining 25 percent will be made at the end of the establishment period for all plastic line and pavement markings accepted.

The accepted quantities of 4 inch temporary painted pavement marking lines will be paid for at the contract unit price per linear foot complete in place, of the appropriate color as directed. Repainting and removal of temporary painted pavement marking lines will be incidental to 652.36 and no separate payment will be made.

The accepted quantities of 4 inch temporary plastic pavement marking lines will be paid for at the contract unit price per linear foot complete in place, of the appropriate color as directed. Payment for replacement of temporary plastic pavement marking lines and removal of the plastic material when no longer needed shall be included in Pay Item 652.36 and no separate payment will be made.

Payment will be made under:

Pay Item	Pay Unit
627.401 4 inch Reflectorized Plastic White Solid Line	Linear Foot
627.402 4 inch Reflectorized Plastic White Broken Line	Linear Foot
627.403 4 inch Reflectorized Plastic Yellow Solid Line	Linear Foot
627.404 4 inch Reflectorized Plastic Yellow Broken Line	Linear Foot
627.407 Reflectorized Plastic White or Yellow Pavement Marking	Square Foot
627.61 4 inch Solid White Pavement Marking Line	Linear Foot
627.62 4 inch Broken White Pavement Marking Line	Linear Foot
627.63 4 inch Solid Yellow Pavement Marking Line	Linear Foot
627.64 4 inch Broken Yellow Pavement Marking Line	Linear Foot

627.65	White or Yellow Pavement and Curb Marking	Square Foot
627.67	Removing Pavement Markings	Square Foot
627.68	Temporary 4 inch Painted Pavement Marking Line, White or Yellow	Linear Foot
627.69	Temporary 4 inch Plastic Pavement Marking Line, Yellow or White	Linear Foot

SECTION 628 -- BLASTING

628.01 Description. This work shall consist of furnishing, placing and detonating dynamite in places directed for relief trenches, muck liquification and for the excavation of drainage ditches in accordance with these specifications and in reasonably close conformity to the lines and grades shown on the plans or as established.

MATERIALS

628.02 Materials. Dynamite and caps shall be from fresh stock and of the following minimum strength percentages of ammonia gelatin dynamite for the use designated.

Relief Trenches	40 percent
Muck Liquification	40 percent
Ditches	50 percent

CONSTRUCTION REQUIREMENTS

628.03 General. All blasting plans shall be approved prior to placing the explosive charges.

The explosives shall be detonated by the propagation or electric method and shall be detonated the same day it is placed.

628.04 Relief Trench and Muck Liquification. The loads and spacing of dynamite for relief trenching shall be developed in the field by making test shots.

628.05 Ditching. Dynamite for ditching shall be placed in holes of depths and spacing necessary to excavate to the limits designated.

The finished trench shall have a minimum width of 2 feet at the bottom and shall have no depressions or obstructions which will retard the flow of water. If necessary, hand or machine shaping and smoothing will be done to finish the ditch.

628.06 Method Of Measurement. Dynamite will be measured by the pound shown by the net weight on the box packed by the manufacturer as shown by delivery slips, specified in Section 109 -- Measurement and Payment. Weighing by a public weighmaster will not be required.

628.07 Basis of Payment. The accepted quantity of dynamite will be paid for at the contract unit price per pound of explosive satisfactorily detonated.

Payment will be made under:

Pay Item	Pay Unit
628.15 Dynamite for Relief Trenches	Pound
628.16 Dynamite for Ditching	Pound
628.17 Dynamite for Muck Liquification	Pound

SECTION 629 -- HAND LABOR

629.01 Description. This work shall consist of furnishing and supervising workmen when authorized or directed in accordance with these specifications.

CONSTRUCTION REQUIREMENTS

629.02 General. Work under this section shall require no special skill but shall be accomplished in a workmanlike manner. The personnel shall be physically and mentally capable of efficiently performing the assigned duties.

Nothing in this section shall be construed to relieve the Contractor of his responsibility for furnishing personnel under other contract items. The intent is that this item shall be used to perform necessary work not covered or provided for under existing contract items or other sections of the specifications.

629.03 Method of Measurement. Hand labor will be measured by the man hours of work actually performed, measured to the nearest 1/4 hour. Overtime, when authorized, will be computed in compliance with the labor requirements of the contract. The work week shall be defined as starting on Monday and ending on Saturday, inclusive. The Contractor shall supply daily, the names and number of hours each man works under this item.

629.04 Basis of Payment. The accepted quantities of labor will be paid for at the contract unit price per man hour. Payment for overtime will be made in compliance with the labor requirements of the contract.

The contract unit price shall be full compensation for hiring, transporting, supervising, payment of workmen's compensation, social security taxes, unemployment insurance and for all hand tools, protective clothing and all incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
629.05 Hand Labor, Straight Time	Man Hour

SECTION 630 -- TRAFFIC CONTROLLERS

630.01 Description. This work shall consist of furnishing uniformed personnel for traffic controllers to control vehicular and pedestrian traffic during construction.

SPECIAL REQUIREMENTS

630.02 General. Traffic controllers working under the requirements of this section may be sworn officers having police powers granted by the proper authority when available in the town, city or county in which the projects are located or other individuals specifically trained for controlling traffic. The controllers shall be supplied with an appropriate uniform and display a badge conspicuously and wear blaze orange vests.

630.03 Traffic Control. Arrangements to expedite the flow of traffic shall be made by the Contractor and approved.

630.04 Method of Measurement. Traffic Controllers will be measured by the number of man hours necessary and authorized. Premium time will be included in accordance with the policy of the agency furnishing the controllers and in accordance with the requirements of the Work Hours Act of 1962.

630.05 Basis of Payment. The authorized hours of Traffic Controllers, with or without special equipment, will be paid under the provisions of Subsection 109.04, (g).

When traffic controllers are not available, flaggers may be authorized. Payment will be made as provided in Section 652.

SECTION 631 -- EQUIPMENT RENTAL

631.01 Description. This work shall consist of furnishing, operating and supervising the use of construction equipment when authorized or as directed by the Engineer in accordance with these specifications.

EQUIPMENT REQUIREMENTS

631.02 General. Equipment used for work under this section shall conform to the following minimum sets of requirements:

Equipment	Description	Minimum Size
Aerator	Heavy duty disc harrow - front and rear axle angle adjustable	Two tandem rows, 28 inch minimum diameter discs with 2 inch allowance for wear, 7,500 pounds. Five foot width.
Air Compressor	Gasoline or diesel powered unit with compressor, receiver and adequate air hose	85 cubic feet per minute at 100 pounds per square inch
Air Tool	Single compressed air driven hand drill, tamper, hammer, chipper or pavement breaker	
All Purpose Excavator	Approved truck mounted type	Three tons capacity lifting class at 15 feet radius
Bulldozer	Crawler or pneumatic tired tractor with pushing blade	Engine horsepower (flywheel) 93 Weight (tractor) 17,500 pounds
Chain Saw	Gasoline or electric powered with end-less chain type blade	18 inch cutting blade
Front End Loader	Front end scoop mounted on pneumatic tires	Two cubic yard rated capacity

Equipment	Description	Minimum Size
Grader	Tandem drive	14,001 pounds
Road Broom	Engine driven rotary broom	Seven foot broom
Roller (earth or base course)	Self-propelled pneumatic tire type	Gross weight 2,500 pounds per foot of rolling width, 40 inch width. Tire ground pressure 65 pounds per square inch
Roller (pavement)	Self-propelled pneumatic minimum 7 wheels	Gross weight 56,000 pounds, 12 x 24 inch smooth tread tires capable of 110 psi, inflation pressure; Fully ballasted wheel loads = 8,000 pounds or more
Rototiller	Rotary cultivator mounted on pneumatic tired tractor	25 Horsepower
Stump Chipper	Gasoline powered stump chipping machine	60 Horsepower
Truck, small	Pneumatic tired with dump body	Five to 8 cubic yards, manufacturers rated capacity
Truck, large	Pneumatic tired with dump body	Over 8 cubic yards, manufacturers rated capacity

CONSTRUCTION REQUIREMENTS

631.03 General. Nothing in this section shall be construed to relieve the Contractor of his responsibility for completing work under other contract items. The intent is that these items shall be used to perform incidental and necessary work not covered or provided for under existing contract items or other sections of the specifications.

631.04 Aerating. When roadway excavation materials contain excessive moisture which will not permit proper compaction, the Contractor shall, when directed, aerate the materials until a water content suitable for compaction is obtained.

631.05 Grading. All grading shall be done in a manner to leave the area smooth and suitable for machine mowing and to provide proper drainage or as otherwise directed by the Engineer. Suitable excavated material shall be placed and compacted on embankment slopes or other areas as directed. Unsuitable material shall be disposed of in approved waste areas.

631.06 Rolling. All material under this item shall be compacted to the satisfaction of the Engineer. Only those portions of roadway designated shall be rolled. The work shall be performed under such conditions that maximum compaction can be obtained.

631.07 Method of Measurement. Equipment rental will be measured by the hour to the nearest 1/4 hour. Time spent in moving within the project limits, to and from the site, may be measured for payment when authorized. Time spent in servicing, maintaining and changing attachments will not be measured for payment.

631.08 Basis of Payment. The accepted quantities of equipment rental will be paid for at the contract unit price per hour for each type of equipment used. Payment shall include operators, fuel, grease, oil and other incidentals necessary to operate the equipment. Tractors required to haul aerators will be considered incidental to the contract unit bid price for machine aerating.

Payment will be made under:

Pay Item	Pay Unit
631.09 Aerator (including operator and hauler)	Hour
631.10 Air Compressor (including operator)	Hour
631.11 Air Tool (including operator)	Hour
631.12 All Purpose Excavator (including operator)	Hour
631.13 Bulldozer (including operator)	Hour
631.14 Grader (including operator)	Hour
631.15 Roller, earth and base course (including operator)	Hour
631.16 Roller, Pavement (including operator)	Hour
631.171 Truck-small (including operator)	Hour
631.172 Truck-large (including operator)	Hour
631.18 Chain Saw rental (including operator)	Hour
631.20 Stump Chipper Rental (including operator)	Hour
631.21 Road Broom (including operators and hauler)	Hour
631.22 Front End Loader (including operator)	Hour
631.29 Rototiller (including operator)	Hour

SECTION 632 -- VACANT

SECTION 633 -- VACANT

SECTION 634 -- HIGHWAY LIGHTING

634.01 Description. This work shall consist of furnishing and installing a highway lighting system or modifying or removing an existing highway lighting system in accordance with these specifications and in reasonably close conformity with the plans.

MATERIALS

634.02 General. All material furnished by the Contractor shall be new unless otherwise specified. Substitutes for specified material may be accepted if approved. Substitutes shall provide equal or better service. Where an existing system is to be modified, the existing material shall be removed, upgraded or disposed of as shown on the plans or as directed.

All electrical equipment shall conform to the standards of the NEMA, UL or EIA, wherever applicable. In addition, all materials and workmanship shall conform to the requirements of the NEC, the local electrical utility and all local ordinances which may apply.

634.021 Materials. Materials shall meet the requirements specified in the following Subsection of Division 700 -- Materials:

Steel Conduit	715.02
Non-metallic Conduit	715.03
Prewired Conduit	715.04
Metallic Junction and Fuse Box	715.05
Bituminized Fibre Junction Box	715.06
Secondary Wiring	715.07
Luminaires, Lamps and Ballast	715.08
Luminaires, Lamp and Ballast for High Mast Lighting	715.09
Photo Electric Control	715.10
Service Equipment	715.11
Lowering System for High Mast Lighting	715.12
Astronomical Time Switch	715.13
Aluminum Supports	720.01
Aluminum Mast Arm and Bracket Arm	720.02
Steel Supports	720.03
Steel Mast Arm and Bracket Arm	720.04
High Mast Light Standard	720.05
Steel H-beam Poles	720.06
Anchor Bolts	720.07
Wood Ornamental Light Standard	720.09
Wood Utility Pole	720.10
Mast Arm for Wood Utility Pole	720.11
Breakaway Devices	721.01

Transformer enclosures shall conform to the provisions of the NESC. They shall be approximately 46 inches high, 42 inches wide, 42 inches deep. Dimensions should be verified with the power utility before ordering. Clearances shall be provided as required by the NESC. The enclosure shall be painted inside and outside with one coat of red iron oxide primer and a finish coat of gray baked enamel. Doors shall be furnished with padlock lugs.

The electric portable power unit shall be a heavy-duty reversing electric motor for the voltage and frequency shown on the plans and shall have a remote control.

The following are the minimum requirements for the lowering system:

- Ball bearing motor
- Grounded frame
- Torque limiter
- Power unit mounting frame
- Coupling to winch drive shaft
- Remote control unit with cable
- Cable with twist lock receptacle and plug for operation of power unit

All bolts for mounting lighting fixtures under bridge structures shall conform to the requirements of ASTM A 307. These bolts and other fastening hardware shall be hot-dipped galvanized in accordance with ASTM A 153.

Screened sand for bedding and covering direct buried cables shall meet the requirements of Subsection 703.14, except there shall be 0-10 percent passing the No. 200 sieve.

634.022 Equipment List and Drawings. Unless otherwise permitted in writing, the Contractor shall submit for review, a list of equipment and materials which he proposes to furnish. The list shall include the name of manufacturer, size and identifying number of each item and other necessary data, including detailed scale drawings, wiring diagrams of special equipment and any proposed minor deviations from the plans. If requested, the Contractor shall submit sample articles of the material proposed for use. All of the above data except sample articles, shall be submitted in duplicate. Following checking, correction and approval, not less than 2 complete sets of approved drawings shall be submitted. The Department will not be liable for material purchased, labor performed or delay to the work prior to such review. Where electrical equipment is to be constructed as shown on the plans, the submission of detailed drawings and diagrams will not be required.

Upon completion of the work, the Contractor shall submit 3 complete sets of corrected plans showing all construction changes.

634.023 Miscellaneous Material. Insulating tape shall be of the self-bonding type. Jacket tape shall be of the water-resisting type. Friction tape shall be rubber impregnated woven cotton fabric.

634.024 Light Standards. The terms standard or light standard shall mean the assembled metal base flange, transformer base or breakaway devise, metal columnar shaft, metal overhanging bracket arm and incidental hardware.

The design, materials and fabrication of structural supports for luminaires shall meet the requirements of the current edition of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals" and interims thereto, except as otherwise indicated within these specifications or on the contract plans. Light standards with a luminaire mounting height in excess of 50 feet shall be designed using wind speeds based on a 50-year mean recurrence interval and light standards with a luminaire mounting height of 50 feet or less shall be designed using wind speeds based on a 25 year mean recurrence interval. For luminaire supports mounted on structures and approaches to structures the mounting height shall be measured as follows:

- (a) For bridges over bodies of water: above the prevailing water level or in the case of tidal waters, above mean high tide.
- (b) For overpass structures: above the lower roadway level.
- (c) For approach ramps: above the average adjacent ground level, if said ground level is more than 10' below the base of the light standard.

The design weight of luminaires shall be 60 lbs with an effective projected area of 2.5 square feet, except that pole-top mounted luminaires shall have an effective projected area of 5.0 square feet.

Deflections of light standards and bracket arms shall be limited as follows:

- (d) Light standards shall be able to support a 500 pound transverse load, applied at 18" below the pole top with a maximum deflection of 5 percent of the nominal pole length.
- (e) Bracket arms shall be able to support a horizontal load of 50 pounds and a concurrent vertical load of 100 pounds applied at the luminaire tenon, without developing a measurable permanent set.
- (f) High mast light standards shall have a maximum deflection of 7 percent of the nominal pole length, under full design load, when equipped with 4 luminaires.

Conformance to the above deflection criteria may be substantiated by actual tests on materials produced for delivery under a Maine Department of Transportation contract or by detailed computations.

Fluted aluminum breakaway couplings shall be supplied for use at all locations designated as breakaway, unless the anchor bolt dimensions or other conditions prevent the use of such breakaway couplings. If fluted aluminum breakaway couplings cannot be used, aluminum light standards with breakaway transformer bases or steel light standards with slip bases shall be used as an alternate. Fluted aluminum breakaway couplings shall not be used in conjunction with transformer bases.

After execution of the contract, and before any shop work is commenced, the Contractor shall submit 3 sets of the manufacturer's drawings of all standards and accessories he proposes to furnish and erect under this contract. The drawings shall be of sufficient detail to indicate material and dimensional conformance with these specifications and the contract drawings. Each drawing shall contain a reference to the design criteria and a certification that the design criteria have been met for the standards, bracket arms and associated hardware, fittings and breakaway devices as submitted. Said certification shall be signed by a Registered Professional Engineer under his official seal.

It is the intent of these specifications that the Contractor shall be fully responsible for the adequacy of the sizes, wall thicknesses, materials and connections of the standards, bracket arms and associated hardware, fittings and breakaway devices. Approval of the drawings will signify only approval of the material(s), mounting height(s) and bracket arm length(s).

For high mast lighting standards, the Contractor shall submit, in addition to the manufacturer's drawings, three copies of the design computations. Approval of the drawings and computations will signify approval of all structurally significant details of the light standard and the luminaire mounting and lowering device.

Approval for deviations from the contract drawings and/or specifications shall be requested in writing and shall be approved before being incorporated in the manufacturer's drawings.

A Certificate of Compliance shall be provided for all material in accordance with the requirements of the General Statement of Division 700 -- Materials.

Light standards and anchor bolts shall meet the requirements specified in Section 720 -- Structural Supports for Highway Signs, Luminaires and Traffic Signals.

CONSTRUCTION REQUIREMENTS

634.03 General. The location of the roadway lighting systems and other incidental work will be shown on the plans. They are diagrammatic only, but shall be followed as closely as actual conditions at the site and the work of other Contractors will permit.

As the work progresses, the drawings may be revised or supplemented by the Engineer, and the Contractor shall perform the work required by such revisions or supplements without additional compensation except as provided in Subsection 104.02.

Work shall be scheduled to assure that each highway lighting system shall be completed and ready for operation upon completion of the corresponding section of the roadway or as specified in Section 108 -- Prosecution and Progress.

Before proceeding with any work under this Contract, the Contractor shall conduct continuity and insulating tests to establish the integrity of cable runs already in place. The Contractor shall report all cable faults to the Engineer. In case faults are located while contract work is in progress, and which have not been reported by the Contractor, the Contractor will be responsible for the correcting of those faults without extra compensation.

634.04 Cable Installation. The Contractor shall pull all wires through conduits without overstressing or stretching any wire or scoring, cutting, twisting or damaging the protective covering or insulation. When pulling cable into conduits, if the strain on the cables is likely to prove excessive, the Contractor shall use soap-stone powder as a lubricant. Where two or more cables are to occupy the same conduit, they shall be drawn in together and kept parallel to each other by the use of a pulling head.

When installing wire in temperatures below 40°F, Section 310-3 "Insulating Materials" of the NEC 1971 shall be followed.

Both ends of each length of cable shall be sealed to prevent the entrance of moisture during shipment or during outdoor storage. Defective and damaged cable will be rejected and shall be replaced at no cost to the State.

Secondary wiring shall be installed as shown on the plans. Secondary wiring shall not be spliced except in junction boxes, transformer bases or locations shown on the plans. The wire for secondary circuits pulled through ducts shall be fed slack from the feed end.

Cables in junction boxes shall be provided with adequate slack for splicing and shall be arranged as directed. After cables have been installed and before permanent splicing, the end of each section of cable in light standards, junction boxes and panel boxes shall be carefully sealed, using rubber tape, and painted with a sealing type of waterproof compound. All wiring shall be finished to provide a neat and orderly appearance. Ends of cable not connected to any device shall be insulated and sealed.

The trench for direct buried cable shall be excavated to the width and depth shown on the plans or as directed.

Placement of the sand bedding shall be coordinated with the installation of the cables. After the cables and screened sand are placed, the remainder of the trench shall be promptly backfilled with selected excavated material. Surplus material shall be disposed of as directed and the surface of the trench shall be loamed and seeded in accordance with Section 618 -- Seeding Method Number 1.

When connecting sockets, outlets and other similar equipment, the most accessible bare parts of each piece of equipment shall be connected to the grounded neutral. In order to assure this has been done, each piece of equipment shall be tested after installation, under the supervision of the Engineer, with a test lamp or other instrument, one leg of which has been connected to a definite ground or by other approved means of testing.

All cables in junction boxes and light standards shall be tested for circuit connections which shall be in conformity with those indicated on the plans. After verification of circuit connections, all cables in junction boxes, light standards and service panels shall be provided with individual metal tags, die-stamped with a phase designated A or B, as applicable. The tags shall be securely attached to the cables.

Splices to form continuous circuits, shall be made by the Contractor and will only be permitted in accessible locations. All splices in underground junction boxes shall be made with cast epoxy splice kits to provide a waterproof splice. All other splices shall be made with approved crimp type connectors.

Conductors shall not be pulled into conduit until pull boxes are set to grade, crushed rock sumps installed, grout placed around the conduit, concrete bottom of pull boxes placed and the metallic conduit bonded.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, the existing lighting system shall remain in operation and the final connection to the modified circuit shall be made so that the modified circuit will be in operation by nightfall of the same day.

634.05 Light Standard. Light standards shall be located in accordance with the details governing the spacings and set backs shown on the plans, to provide continuously aligned lamp post installations, unless otherwise directed.

The bracket arms shall be set normal to the edge of roadway unless otherwise directed. The bracket shall be assembled and attached to the shaft before the light standard is erected. If it is anticipated there will be a period in excess of 24 hours between the erection of the light standards and the installation of the luminaires, the Contractor shall install a weight, weighing between 50 to 75 pounds, at the outboard end of each bracket arm. This weight shall be designed and fastened in such a way that it will not pose a hazard to persons passing beneath it.

Light standards shall be erected in a vertical position, with a maximum deviation from the vertical of 1/4 inch in 5 feet, using either the leveling nuts provided with the anchor bolts or the breakaway couplings. Once the light standard is in its final position the top nuts shall be tightened as follows:

- (a) Anchor bolts with breakaway couplings: The manufacturers recommendation shall be used.
- (b) Anchor bolts without breakaway couplings: the nut shall be tightened to snug tight condition by utilizing the full effort of a worker using a standard spud wrench or comparable tool. After all nuts have been brought to a snug tight condition, each nut shall be tightened an additional 1/3 turn using an impact wrench, torque wrench or large crescent wrench.

A minimum of 2 bolt threads shall project beyond the outside face of the nut.

Nuts for bolts other than anchor bolts shall be tightened as outlined, under b above for anchor bolts.

The bottom of all transformer bases shall be coated with a bitumen mastic epoxy paint.

When foundations and anchor bolts for light standards have been installed by others, the Contractor shall verify the anchor bolt dimensions at each location, so that bases will be furnished with the proper bolt holes.

Wires in the shaft shall be supported with a Kellum type braided strain relief grip attached to a "J" hook mounted inside the shaft near the top.

Wood Ornamental Light Standards shall be installed as shown on the plans.

634.051 Removing Light Standards. Before removing light standards, the luminaires shall be removed from the light standards and disposed of as noted on the plans.

Care shall be exercised in removing and transporting the light standards. The Contractor will be required to replace, at his expense any equipment damaged or destroyed by his operations.

634.052 Portable Power Unit for Lowering Luminaires. The number of portable electric power units with remote control required on this project for operation of the high mast luminaire lowering system will be shown on the plans.

634.06 Luminaires. Luminaires shall not be installed until the lamp socket position has been inspected and approved for conformance with the manufacturer's recommended position for the specified distribution. All luminaires shall be adjusted to produce the maximum illumination on the roadway surface.

The connections between the luminaires and connector kits shall be made with single conductor, number 12 wires AWG copper stranded THHN, minimum size. A 14 inch long teflon sleeve shall be placed over each end of each conductor in the luminaire.

Installation of a connector kit, fused or non-fused, shall be in accordance with the manufacturer's instructions to provide completely watertight connections.

634.061 Under Bridge Lighting. Under bridge lighting shall be installed in accordance with the plans and specifications or as directed.

Circuits shall be fused with 5-ampere cartridge type midget fuses, 12/32 inch diameter and 1 1/2 inches long, in fuse boxes unless otherwise indicated on the plans. Wiring connections in the under bridge lighting units shall be made with 150°C wire.

All under bridge lighting luminaires shall be installed and adjusted for maximum illumination of the roadway surface. The beam angle shall be adjusted as indicated on the plans.

In vehicular undercrossings, underpass lights shall be placed in operation as soon as practicable after falsework has been removed from the structure. Lighting for pedestrian structures shall be placed in operation prior to opening the structure to pedestrian traffic.

634.07 Vacant

634.08 Service. The Contractor shall install metal conduit riser with entrance cap, entrance switch, multiple control relay and other equipment as shown on the plans.

The lighting system will be supplied with electrical power by the local power company. The type of service will be single phase, three wire, 240/480 volt or voltage indicated on the plans, 60 hertz, alternating current. The power company will make all connections of the roadway lighting system cables at the power company's service pole. The Contractor shall notify the power company at least 2 weeks in advance of the time he intends to start construction at each of the sites and shall make all necessary arrangements with the power company for the required installation.

Roadway lighting cabinets shall be installed on stub poles with doors accessible from the roadway. All connections to equipment and terminals shall be neat and orderly conforming to the requirements specified.

Details for the fabrication and installation of service poles with cabinets and other equipment are shown on the plans.

Transformer enclosures used to protect overhead type transformers mounted on concrete pads shall be installed as shown on the plans. Transformers will be furnished by the power company.

634.081 Bonding and Grounding. All metal conduit ends, light standards, luminaires, control cabinets and exposed non-current carrying metal parts of fixed equipment shall be connected to the grounding conductor. All grounding and bonding shall conform to the current provisions of the NEC.

No separate payment will be made for bonding, grounding and ground rods, but all costs therefor shall be included in the price bid for the items of conduit, light standards, service panels or other items requiring bonding and grounding.

634.09 Testing. Prior to acceptance of the work and in the presence of the Engineer, the Contractor shall cause the following tests to be made on all lighting circuits.

- (a) Continuity. Each circuit shall be tested for continuity.
- (b) Ground. Each circuit shall be tested for grounds.
- (c) Resistance. The resistance to ground on non-ground conductors shall be at least five megohm at 60°F measured with a 1,000 volt megger. The ground resistance shall not be more than 25 ohms.
- (d) Voltage. Voltage readings shall be made at each service pole, in the load contactor, with load and without load, and at each fixture with load.

- (e) Current. Current readings shall be made on the load side of each load contactor phase and neutral. Readings shall be made at night time with lighting systems in normal operation.
- (f) Test Data. Electrical test data obtained from the above tests shall be furnished in writing.
- (g) The Contractor shall conduct an operational test for the completed installation under normal operating conditions. This operational test shall have a duration of not less than 2 full days. The Engineer shall be the sole authority to judge the adequacy of the length of the testing period in order to assure the satisfactory operation of the entire system or any of its sections. The work will not be accepted until the successful completion of the operational test.
- (h) With all equipment connected to the wiring system, a functional test shall be performed by the Contractor in the presence of the Engineer, to demonstrate that the system and all parts thereof function as specified. All defective materials or faulty installations shall be corrected by repairs or replacements by the Contractor to the satisfaction of the Engineer at no additional cost.

Lighting circuits shall be subjected to such other tests as may be required and it shall be the responsibility of the Contractor to ascertain what tests are required and to perform these tests in the presence of the Engineer. All tests shall be performed at the expense of the Contractor. Cost for power to conduct tests shall be paid by the Contractor.

634.091 Acceptance. All systems shall be complete and in operation to the satisfaction of the Engineer at the time of acceptance of the work.

The Contractor shall be responsible for the proper performance in service, in whole or in part, of the various lighting systems and all other electrical installations furnished and installed under this Contract and shall correct, at his own expense, all difficulties with the operation which may arise prior to acceptance of the work. He shall be responsible for the cost of power until the work is accepted.

634.092 Method of Measurement. Highway lighting system will be measured by the lump sum.

Light standards will be measured by the single unit, complete in place and accepted.

The quantity of luminaires for high mast lighting will be measured by each single unit.

634.093 Basis of Payment. The accepted quantity of light standards will be paid for at the contract unit price each for the number of units of the respective types. Payment shall include the light standard and breakaway transformer base or breakaway device, bracket arm and all incidentals necessary to complete the work.

Payment for furnishing and installing luminaires for high mast lighting will be made for the accepted quantity at the contract unit price each which shall include luminaire, ballast, lamp and incidentals necessary to complete the work.

The accepted highway lighting system will be paid for at the contract lump sum price for the complete lighting system shown on the plans, except that luminaires for high mast lighting and light standards, will be paid for at the contract unit bid price each.

Lump sum payment for highway lighting system shall include furnishing, installing and erecting ballast, lamps, wiring in underground conduit, pole wiring and all other wiring except pre-wired conduit, transformer enclosures, luminaires except luminaires for high mast lighting, all identification tags, all materials, labor, equipment, tools, miscellaneous hardware and incidentals necessary to complete the work. Payment shall also include removing and resetting light standards, installing breakaway devices on existing poles, disposing of unused light standards, as noted on the plans and for furnishing portable electric power units.

Trenching for direct buried cable will be incidental to highway lighting system and shall include excavating, furnishing and placing screened sand and backfilling.

Payment will be made under:

Pay Item	Pay Unit
634.160 Highway Lighting	Lump Sum
634.164 Luminaires for High Mast Lighting	Lump Sum
634.206 Light Standard for Post Top Luminaire	Each
634.207 High Mast Light Standard	Each
634.209 Wood Ornamental Light Standard	Each
634.210 Conventional Light Standard	Each

SECTION 635 -- PREFABRICATED BIN TYPE RETAINING WALL

635.01 Description. This work shall consist of the construction of bin type retaining wall in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans or established.

MATERIALS

635.02 Materials. Materials shall meet the requirements specified in the following Subsection of Division 700 -- Materials:

Gravel Borrow	703.20
Precast Concrete Units	712.06
Metal Bin Type Retaining Wall	713.07

Bedding and backfill material shall be gravel borrow.

CONSTRUCTION REQUIREMENTS

635.03 Shop Drawings. The Contractor shall prepare shop detail erection and other working plans and shall submit 2 copies for approval. Approval of the plans shall be obtained before fabrication of the work is commenced. Changes in the approved plans shall be subjected to further approval and the Engineer shall be supplied with a record of such changes.

The Contractor will be responsible for the correctness of his plans even though plans have been approved.

635.04 Excavation and Foundation. Excavation for erection of the retaining wall shall be in accordance with Section 203 -- Excavation and Embankment, to a width sufficient to allow the proper erection of the wall and thorough compaction of the bedding and backfill material.

The foundation under the entire area of the wall shall be firm. If ledge rock is encountered, a gravel foundation of at least 12 inches in thickness shall be provided.

635.05 Erection. The retaining wall members shall be erected in accordance with the manufacturer's instructions and as shown on the plans. Members shall be handled carefully and any which are damaged shall be replaced at the Contractor's expense. All bolts for metal walls shall be placed so that heads will be exposed and the nuts tightened on the inside.

635.06 Backfill. The backfilling of the interior of the wall and behind the wall shall progress simultaneously. The material shall be placed in layers not over 8 inches in depth, loose measure and thoroughly compacted by mechanical or vibratory compactors. Puddling for compaction will not be allowed.

635.07 Method of Measurement. Bin type retaining wall will be measured by the square foot of front surface not to exceed the dimensions shown on the plans or authorized. The area of each panel shall be determined by multiplying the width of each panel, center to center distance of the columns, by the total height of the panel. Foundation and backfill material will be measured in place by the cubic yard and computed by the most convenient recognized engineering method.

635.08 Basis of Payment. The accepted quantity of bin type retaining wall will be paid for at the contract unit price per square foot complete in place.

Excavation will be measured and paid for as provided in Section 203 -- Excavation and Embankment.

Bedding and backfill material will be measured and paid for under Item 203.26, Gravel Borrow.

Payment will be made under:

Pay Item	Pay Unit
635.10 Concrete Bin Type Retaining Wall, Closed Face	Square Foot
635.11 Concrete Bin Type Retaining Wall, Open Face	Square Foot
635.12 Galvanized Metal Bin Type Retaining Wall	Square Foot
635.13 Galvanized Metal Bin Type Retaining Wall with Asbestos Coating	Square Foot

SECTION 636 -- VACANT

SECTION 637 -- DUST CONTROL

637.01 Description. This work shall consist of furnishing and applying water or calcium chloride on the roadway or haul roads for dust control as directed. When no items for dust control are included in the contract, such work will be considered incidental to the contract.

MATERIALS

637.02 General. The water shall not be salt or brackish and shall be free from oil, acid and injurious alkali or vegetable matter.

The calcium chloride shall conform to Subsection 712.02, except that the requirements for total alkali chloride and impurities shall not apply.

CONSTRUCTION REQUIREMENTS

637.03 Sprinkling. Water shall be applied by approved methods and with equipment including a tank with a pressure pump and a nozzle-equipped spray bar.

637.04 Calcium Chloride. Calcium chloride shall be used when authorized for controlling dust on the roadway under construction and on approved haul roads from the pits to the project or in the vicinity of dwellings and where dust constitutes a hazard to traffic. Calcium chloride shall be applied by mechanical spreaders or by hand at the rate designated.

637.05 Method of Measurement. Water for sprinkling will be measured by the unit of 1,000 gallons (MG) in calibrated tanks or distributors or by accurate water meters.

Calcium chloride will be measured for payment by the number of tons satisfactorily applied.

Delivery slips as specified in Subsection 109.01 will be required except that weight for calcium chloride shall be determined from the weight stated on each bag and the number of bags used.

637.06 Basis of Payment. Water for sprinkling will be paid for at the contract unit price per M.G.

Calcium chloride will be paid for at the contract unit price per ton.

Payment will be made under:

Pay Item	Pay Unit
637.07 Sprinkling	M.G.
637.08 Calcium Chloride	Ton

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SECTION 639 -- ENGINEERING FACILITIES

639.01 Description. This work shall consist of providing, erecting, lighting, equipping and maintaining buildings to be used as field offices or testing laboratories by the Engineer. Upon completion of the work, the buildings shall remain the property of the Contractor.

MATERIALS

639.02 Materials. Materials shall be of good quality customarily used in standard frame house or mobile home construction.

The incinerating toilet shall be an odorless unit using the dry flush waterless process operated by electricity or gas, capable of reducing waste to an odorless, bacteria free ash. The inner walls of the incinerator chamber shall be a high nickel alloy, the outer walls shall be stainless steel. The outer housing of the toilet shall also be stainless steel. The seat shall be non-combustible molded fiberglass. Bowl liners, if required by the manufacturer's recommendation, shall be available. The incineration cycle shall have automatic controls which shall be started with a flush button, pedal or by raising and lowering the seat. The toilet shall be equipped with a vent to the exterior.

CONSTRUCTION REQUIREMENTS

639.03 General. The building of the type called for shall be provided when work is started and shall remain until work is completed unless earlier removal is authorized. The location shall be approved.

A fire extinguisher shall be provided in each building for electrical and chemical fires and effective on all solvents used in the building.

Walls, roof, floor, windows and doors shall be tightly constructed to the required area.

Furnishings shall be supplied as called for. Doors shall be equipped with locks, and all keys shall be in the possession of the Engineer. Windows shall be equipped with latches so they may be locked on the inside. Window screens and screen doors shall be supplied when necessary.

639.04 Field Offices. Field offices are designated as Type A, Type B or Type C. Other offices or buildings, including trailers, may be provided if they substantially equal or exceed the following requirements.

The walls, roof and floor of the building shall be completely insulated with a minimum of 2 inches of insulation. The interior walls shall be covered with suitable wall panelling. The outside walls of the building shall be matched boards, clapboards or other type of siding which shall be painted.

Testing facilities furnished under this section shall include all facilities for testing as described.

Other types of buildings and facilities may be furnished of equal or better quality.

In addition to the facilities previously specified in this subsection, each type office shall meet the following minimum requirements:

<u>Description</u>	<u>Field Office</u>		
	<u>Type A</u>	<u>Type B</u>	<u>Type C</u>
Floor Area-square feet	187	125	80
Inside Wall Height feet	7	7	7
Window Area-square feet	45	35	35
Drafting Table Surface			
Area-square feet	32	32	15
Drafting Stools-each	3	2	2
Office Desks-each	1	1	0
Straight-back chairs-each	2	2	1
Benches-each	1	1	1
Lighting Units-each	2	2	1
Electric Wall Outlets-each	2	2	2
Wall Closets-each	1	1	0
Plan Rack for minimum of 6 sets of plans	1	1	1
Toilet Facility	1	1	1

All windows shall be provided with shades or blinds.

One hundred ten volt, 60 cycle, continuous electric service shall be supplied for lighting and 15 amp duplex wall outlets. Lighting shall consist of florescent light units with rapid start bulbs located over the work areas for a minimum of 50 foot candles overall.

Drafting surfaces shall be 3 feet 4 inches above the floor and have shelves beneath. Shelves for plans and rolls shall also be furnished overhead. Drafting stools shall be approximately 28 inches high. Benches shall be 12 x 24 inches by 18 inches high.

Desks shall be single or double pedestal standard office type.

Field offices shall be furnished with one 4 drawer letter size metal filing cabinet.

A toilet shall be installed in the Field Office unless otherwise authorized. The building shall be modified as necessary to provide space for the installation. An interior partition and door shall be constructed to enclose the toilet. The toilet shall be installed according to the recommendations of the manufacturer.

The Contractor shall furnish all supplies necessary, including toilet paper, bowl liners, and shall be responsible for all maintenance and repairs necessary for the proper function of the facilities. The Contractor will not be responsible for cleaning.

Wall closets shall be 21 inches wide, 15 inches deep and at least 4 feet high.

Each office shall be furnished with a broom and with cleaning material for cleaning glass.

639.05 Testing Facilities-Soils. The building and facilities shall:

- (a) Be the minimum size and quality as Field Office Type C placed in an approved location in the vicinity of the project.
- (b) Have a bench, 5 feet long by 24 inches wide, 3 feet above the floor, suitable for supporting a sieve shaker and electric dryer.
- (c) Have 2 electric wall outlets; one to be at least 20 amp, triplex, located near the bench described in (b) above.
- (d) Have one clean 55 gallon drum installed on a suitable rack and equipped with a spigot suitable for draining off water. The drum shall be furnished with water at all times.
- (e) Have 2 stools, 28 inches high and 1 straight back office type chair.

639.06 Testing Laboratory-Bituminous Mixes. The building and facilities shall:

- (a) Have the same minimum size and quality as Field Office, Type A, placed in an approved location at the mixing plant:
- (b) Have 2 benches, 5 feet long, 30 inches wide, 3 feet above the floor, suitable for supporting equipment and 2 stools, 28 inches high.
- (c) Have 5 duplex electric outlets with ground, 4 to be at least of 20 amp capacity each, placed 2 at each bench described in (b) above. The total service shall have a capacity of at least 60 amperes, at 120 V.
- (d) Have a heavily constructed rack approximately 2 feet square and 15 inches high, suitable for supporting an asphalt extractor. A 1/2 inch inside diameter drain pipe leading outside the building for draining liquids from extractions.

- (e) Have on the outside of the building, near the inside location of the bench in the larger work area, a covered box (shelf) approximately 1 foot by 2 feet, for the pump of the vacuum extractor. A hole shall be provided thru the wall for the vacuum line. A waterproof outdoor duplex receptacle with ground shall be provided with an inside on-off switch over the bench.
- (f) Have a desk with desk chair, or a writing table 4 feet by 2.5 feet, 30 inches above the floor, with an adequate filing cabinet.
- (g) Have suitable forced ventilation, sufficient to remove vapors from the building. Ventilating provisions shall be separate from the doors and windows.
- (h) Have, when required, a rack outside the building suitable for supporting one 55 gallon drum.
- (i) Be reserved for the exclusive use of the Engineer during the paving season.
- (j) Have a telephone, when required, in accordance with the provisions of Subsection 639.09.

639.07 Vacant

639.08 Heat. When required, heat shall be supplied by the Contractor to maintain an acceptable room temperature during occupancy.

639.09 Telephone. The Contractor shall provide a telephone in all field offices for the exclusive use of the State personnel. This telephone shall be on a private line, if available, and shall be listed under "State of Maine, Maine Department of Transportation". The Contractor shall be responsible for the initial telephone installation charges and any reinstallation charges following suspended periods. Except during periods of seasonal suspension of work, monthly service charges, including toll calls costs, shall be billed by the telephone company directly to the Maine Department of Transportation in care of the Resident Engineer. During seasonal suspension periods, the telephone company shall be notified to discontinue or suspend the services and the Contractor shall assume any service charges. Upon resumption of work, the telephone service shall be reinstated.

639.10 Method of Measurement. Field office and testing facilities will be measured by the unit for each building provided, equipped and maintained satisfactorily.

639.11 Basis of Payment. The accepted quantity of field office or testing facilities will be paid for at the contract unit price each or lump sum which shall be full compensation for furnishing, erecting, equipping, maintaining, furnishing electricity, heating, installing and maintaining toilet facilities and if necessary removing the buildings. Payment for testing facilities shall include furnishing all buildings and facilities as described in these specifications for the testing of materials by the State.

Payment for these items will be made in 3 parts, the first payment, of 1/3 to be made after the Contractor has supplied the building and it has been approved. The remaining payments shall be made at intervals as follows:

A second payment of 1/3 shall be made when one-half of the anticipated work has been completed.

The final payment of the remaining 1/3 shall be made upon completion of the work.

Testing facilities, bituminous liquids and cement, will not be paid for directly but all costs will be considered incidental to the various contract items.

Payment will be made under:

Pay Item	Pay Unit
639.18 Field Office Type A	Each
639.19 Field Office Type B	Each
639.20 Field Office Type C	Each
639.21 Testing Facilities Soils	Lump Sum
639.22 Testing Facilities Bituminous Mixes	Lump Sum

SECTION 640 -- VACANT

SECTION 641 -- REST AREA FACILITIES

Reserved

SECTION 642 -- STEPS

642.01 Description. This work shall consist of the construction of wooden steps, precast concrete steps or structural concrete steps in accordance with these specifications and in reasonably close conformity with dimensions and designs shown on the plans.

MATERIALS

642.02 Materials. Materials for the steps shall meet the requirements as specified in the following Subsections of Division 700 -- Materials:

Exterior Ready Mixed Paint	708.01
Timber Preservative	708.05
Precast Concrete Units	712.06

Wood shall be well seasoned spruce or pine, Number 1 dimension lumber. Nails and hardware shall be galvanized.

Precast concrete steps shall conform to the specifications precast units except as modified herein and shall be of the dimensions detailed on the plans or as otherwise approved. Exposed surfaces shall have a rubbed finish as specified in Subsection 502.14(d).

Structural concrete steps, shall conform to the requirements of Section 502 -- Structural Concrete, Class A.

CONSTRUCTION REQUIREMENTS

642.03 Wooden Steps. Wooden steps shall be fabricated and fastened in accordance with standard commercial building practices.

After members have been cut to size, the ends shall be soaked in pentachlorophenol. Prior to assembling the steps, all contact surfaces shall be painted 2 coats of paint, color to be designated. The first coat of paint shall be thinned.

642.04 Precast Portland Cement Concrete Steps. Precast portland cement concrete steps shall be placed on a compacted gravel bed with horizontal joints level and vertical joints plumb. The foundation shall be prepared in advance of setting the steps by grading and compacting the aggregate subbase to the proper elevation. The steps shall be set with a uniform tread width to match the finish grade of the slope. Any remaining excavated areas surrounding the steps shall be filled to the required grade with approved materials and thoroughly tamped.

642.05 Cast-in-place Concrete Steps. Cast-in-place concrete steps shall conform to the applicable requirements of Section 502 -- Structural Concrete.

642.06 Method of Measurement. Wooden Steps will be measured by the lump sum or by the square foot of exposed stair tread as designated by the pay item in the schedule of items.

Precast portland cement concrete steps will be measured for payment by the actual total length in linear feet, measured from one end of each step to the opposite end for each step in place.

Cast-in-place Concrete Steps will be measured for payment by the cubic yard in place.

642.07 Basis of Payment. The accepted wooden steps will be paid for at the contract lump sum price or by the contract unit price per square foot of tread complete and accepted in place which price shall include furnishing all materials, labor and other incidentals necessary to complete the work.

The accepted quantity of precast concrete steps will be paid for at the contract unit price per linear foot complete in place, which price shall be full compensation for furnishing and placing all materials including reinforcing steel.

Excavation and backfill will be measured and paid for as provided in Section 206 -- Structural Excavation.

The accepted quantity for cast-in-place concrete steps will be paid for at the unit contract price per cubic yard.

Payment will be made under:

Pay Item	Pay Unit
642.10 Wooden Steps	Lump Sum
642.11 Wooden Steps	Square Foot
642.16 Precast Concrete Steps	Linear Foot
642.17 Cast-in-place Concrete Steps	Cubic Yard

SECTION 643 -- TRAFFIC SIGNALS

643.01 Description. This work shall consist of furnishing and installing all equipment necessary for the erection and operation of a traffic signal, flashing beacon, temporary traffic signal or modification of a traffic signal all in reasonably close conformity with the plans.

MATERIALS

643.02 General. All equipment shall be new unless otherwise specified. Substitutes for specified material will be accepted if approved by the Engineer. Functionally, any substitute shall give equal or better service. Existing signal equipment to be used shall be cleaned, repainted and reconditioned as noted on the plans. All equipment, installation of equipment and other incidental work shall conform to the latest applicable provisions of the NEC, MUTCD, NESC, NEMA and the ITE, Standards for traffic control equipment shall be done to the satisfaction of the Engineer. The meaning of specific terms shall be as defined in the MUTCD, NESC and the ITE Standards for traffic control equipment.

643.021 Materials. Material shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Steel Conduit	715.02
Non-metallic Conduit	715.03
Prewired Conduit	715.04
Metallic Junction and Fuse Box	715.05
Bituminized Fiber Junction Box	715.06
Secondary Wiring	715.07
Vehicular Signal Indications	718.01
Pedestrian Signal Indications	718.02
Signal Mounting	718.03
Loop Vehicular Detectors	718.04
Magnetometer Vehicle Detectors	718.05
Pedestrian Detectors	718.06
Controllers	718.07
Controller Cabinet	718.08
Flasher	718.09
Program Selection	718.10
Contacts and Relays	718.11
Conductors	718.12
Aluminum Supports	720.01
Aluminum Mast Arm and Bracket Arm	720.02
Steel Supports	720.03
Steel Mast Arm and Bracket Arm	720.04
Anchor Bolts	720.07
Wood Utility Pole	720.10

643.022 Paint. Aluminum paint shall conform to AASHTO M 69, Type II. Green enamel paint shall meet or exceed the latest Federal Specification TT-E-489. The color shall match Federal Color Standard Number 14062.

643.023 Design and Fabrication. The design and fabrication of traffic signal support structures shall meet the requirements of the current edition of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" and interims thereto, except as otherwise indicated within these specifications or on the contract plans. All poles and mast arms shall be designed to withstand the maximum forces generated on the design configuration by the loads as specified in Section 2 of the "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals", using the 50 year mean recurrence interval for wind speeds.

After execution of the contract and before any shop work is commenced, the Contractor shall submit 2 sets of the manufacturer's drawings of all poles he proposes to furnish and erect under this Contract. The drawings shall be of sufficient detail to indicate material and dimensional conformance with these specifications and the contract drawings. Each drawing shall contain a reference to the design criteria and a certification that the design criteria have been met by the poles, mast arms and associated hardware and fittings as submitted. The certification shall be signed by a Registered Professional Engineer under his official seal.

It is the intent of these specifications that the Contractor shall be fully responsible for the adequacy of the sizes, wall thicknesses, materials and connections of the poles, mast arms and associated hardware and fittings. Approval of the drawings by the Engineer will signify only approval of the materials, mounting height(s) and mast arm length(s). Approval of deviations from the contract drawings and/or specifications shall be requested in writing and approved by the Engineer before being incorporated in the manufacturer's drawings.

The Contractor shall furnish and install all electrical fittings, pipe, switches, fuses and such other material necessary to install the equipment properly and securely. All equipment shall conform to the applicable code and be of first class workmanship. All electrical fittings shall be complete with weatherproof gaskets.

643.024 Miscellaneous Materials. Span wire shall be minimum 5/16 inch, 7 strand, extra high strength, galvanized steel wire. Anchors shall be power installed and sized according to strain and soil conditions. All hardware such as strandwise feed-thru dead ends, preforming guy grip dead ends and angle thimble-eye bolts shall be standard pole line hardware.

Guying of poles shall meet the requirements of Grade "B" Construction as defined in the NESC. Guys shall be installed in line with the direction of pull. Anchors shall be power installed so that the centerline of the anchor rod will be within 10° of the line of the guy wire. The holding capacity of the anchor shall be 1.25 times the calculated load on the guy wire. Guy wires shall be utility grade and the maximum working stress shall not exceed 1/2 of the maximum ultimate tensile strength of utility grade guy strand. Where bed rock is encountered, rock anchors shall be used.

Pipe stand-offs for sidewalk anchors shall be galvanized steel pipe sized according to the offset distance from anchor to pole and shall be fitted with standard guying hardware.

Messenger wire shall be 1/4 inch, 7 strand, extra high strength galvanized steel wire, unless otherwise specified.

CONSTRUCTION REQUIREMENTS

643.03 General. Installation details will be shown on the plans. The location shown for all equipment and loop detectors is approximate; final locations will be determined in the field.

During installation, all heads installed but not operating shall be covered or otherwise concealed from view.

The requirements of certain subsections of this specification may be waived for temporary traffic signals and traffic signal modifications if so noted on the plans.

643.04 Poles. Wood poles shall be placed in the ground to a depth of 20 percent of their overall length, with a maximum deviation from the vertical of 1/4 inch in 5 feet.

After each wood pole has been set in the ground and plumbed, the space around the pole shall be backfilled with selected earth or sand, free of rocks and other deleterious material, placed in layers approximately 4 inches thick. Each layer shall be moistened and thoroughly compacted.

Strain poles, pedestal poles and mast arm poles shall be erected in a vertical position, with a maximum deviation from the vertical of 1/4 inch in 5 feet using the leveling nuts provided with the anchor bolts. Once the poles have been plumbed, the top nuts shall be tightened by bringing the nut to a snug-tight condition using the full effort of a worker using a spud wrench or compatible tool. After all nuts have been brought to a snug-tight condition each nut shall be tightened an additional 1/3 turn, using an impact wrench, torque wrench or large crescent wrench. A minimum of two full threads shall project beyond the outside face of the nut. Nuts and bolts other than anchor bolts also shall be tightened by the above procedure.

When foundation and anchor bolts have been installed by others, the Contractor shall verify the anchor bolt dimensions at each location so that bases will be furnished with properly located and sized bolt holes.

Wires in poles shall be supported with a Kellum type braided strain relief grip attached to a "J" hook mounted inside the pole near the top.

643.05 Loop Detector Installation. The detector unit shall be located in the controller. No more than 4 loops shall be connected to a single detector amplifier.

Detectors shall be installed according to the manufacturer's recommendation, subject to approval. Each detector shall be supplied complete with comprehensive installation instructions.

The pavement slot for wire shall be 2 to 3 inches below the finished surface and not closer than 18 inches from the edge of pavement or the curb. The right angle corners of the pavement slot shall be chamfered to eliminate sharp bends in the loop wires.

All debris and moisture shall be removed from the loop pavement slot before installation of loop wires. The pavement slot shall be filled to the road surface with an approved sealing compound, to form a waterproof bond with the pavement after installing the wire loop.

Detector conductors shall not be housed in the same jacket as the signal conductors. Splices in the lead-in-cable shall be made only in junction boxes.

643.06 Magnetometer Installation. The magnetometer and sensing element shall be installed in accordance with the manufacturer's recommendations. The cable from the sensing element to the control unit shall conform to the detector manufacturer's recommendations. Holes for the sensing elements shall be cut to a depth recommended by the detector manufacturer and as approved.

643.07 Span Wire, Messenger Wire and Guy Wire. All span wire, messenger wire, and guy wire installations shall be in conformance with the requirements of the utility companies, when installed on utility poles.

All span wires, messenger wires, guy wires, terminal boxes, controller cabinets, or any other metallic surface that might be contacted by people shall be bonded to ground.

All sidewalk guy wires and slant guy wires installed in a sidewalk area shall be equipped with full round or half round guy guards.

643.08 Conduit. The type of conduit will be noted on the plans. The size shall be as determined by percentage fill in a single conduit as specified in the latest revision of the NEC, unless the size is otherwise noted on the plans. The use of liquid-tight flexible metal conduit will not be permitted. Installation of conduit shall conform to the requirements of Section 626 -- Foundations, Conduit and Junction Boxes for Electrical Facilities.

643.09 Service Connection. The Contractor shall furnish and install the necessary electrical service as directed by the utility company. The Contractor shall make all arrangements for the service connection and be responsible for all charges incurred thereby.

Under no condition shall any equipment, except that shown on the plans, be installed on any utility pole.

Whenever a service connection is to be made, the Contractor shall contact the utility involved and inform them of the location, pole number and time proposed for the service connection.

The Contractor shall be responsible for all outstanding bills for preliminary work done by the utility company during the installation of the traffic signal system, to facilitate the service connection.

A service ground rod shall be installed if the service meter trim is not grounded.

643.10 Wiring. The Contractor shall furnish and install sufficient cable and wire to operate the system properly as shown on the plans and as directed.

The following color code shall be used where possible:

Red Wire	Red, artery
Orange Wire	Yellow, artery
Green Wire	Green, artery
Red with Tracer	Red, side street
Orange with Tracer	Yellow, side street
Green with Tracer	Green, side street
White and white with tracer	Common for all signals and bond
Blue	All steady burning arrows
Blue with Tracer	Intermittent arrows
Remaining	Detectors and pedestrian signals

The white wire and white wire with tracer shall be used for all common connections and it shall be continuously connected to ground at the controller.

There shall be no wire splices. Connections shall be made on a terminal board inside a weathertight galvanized steel or aluminum junction box or in an aerial terminal enclosure with protective cover rated for 600 volts.

Spade type copper terminal ends shall be used to attach all conductors to terminals. All exposed metal parts, including service conduit and the controller cabinet shall be bonded and grounded.

Not more than 3 conductors shall be brought to any one terminal. Terminals shall be mounted to face the cabinet door.

Solderless pressure connectors may be used.

The number and size of conductors required in each cable will be indicated on the plans.

643.11 Vertical Clearance. Vertical clearances for vehicular and pedestrian heads shall be in conformity with the MUTCD. All clearances shall be uniform among each type of head or mounting scheme. Clearance for mast arm pole and span wire mounted vehicular heads shall be 16 feet; clearance for pole mounted vehicular heads shall be 10 feet; clearance for pedestrian heads shall be 8 feet unless otherwise specified. Clearance for span wire mounted flashing beacon heads shall be a minimum of 17 feet and a maximum of 18 feet.

643.12 Painting. All exterior parts of the following equipment shall be delivered to the project finished with green enamel:

Vehicular Signal Heads
Pedestrian Signal Heads
Pedestrian Push Button Detectors

The outside of the controller cabinet shall be painted aluminum paint.

The Contractor shall apply 1 coat of green enamel to all existing equipment designated on the plans to be painted. The Contractor shall touch up all scratches on exposed surfaces of new equipment with matching enamel after the equipment has been installed.

Any exposed signal parts to be painted shall be cleaned and shall be dry when the paint is applied. No painting shall be done in damp weather nor when the air temperature is below 40°F, unless otherwise permitted.

The Contractor shall identify recently painted equipment with "Wet Paint" signs, and shall be responsible for all claims for damages resulting from contact with wet paint surfaces.

643.13 Power Factor. In the event that the equipment is of such design that the power factor is reduced below the requirement of the utility company, the Contractor shall furnish and install, without further charge, all equipment necessary to restore the power factor to a satisfactory percentage. Such equipment shall be accessible and shall not be mounted on the utility company poles.

643.14 Field Tests. Prior to acceptance of the work, and in the presence of the Engineer the Contractor shall conduct the following tests on all traffic signal equipment and circuits.

- (a) Continuity. Each circuit shall be tested for continuity.
- (b) Ground. Each circuit shall be tested for grounds.
- (c) Megger. Megger tests at 500 volts DC shall be made on each circuit between the circuit and a ground. The insulation resistance shall not be less than 10 megohms on all circuits, except for inductive loop detector circuits which shall have an insulation resistance value of not less than 100 megohms.
- (d) Loop Inductance. A loop test meter shall be used to determine that the inductance of the installed loop and lead-in are within the tuning range recommended by the loop detector manufacturer.

- (e) **Functional.** A functional test shall be made in which it is demonstrated that each part of the system functions as specified.

The functional test for each new or modified traffic signal and flashing beacon shall consist of not less than 10 days of continuous satisfactory operation. If unsatisfactory performance of the system develops, the condition shall be corrected and the test shall be repeated until the 10 days of continuous satisfactory operation is obtained.

The initial operation shall be made between 9:00 A.M. and 2:00 P.M. unless specified otherwise. Prior to initial operation, all equipment shown on the plans shall be installed and operable.

Initial operation of new or modified traffic signal systems shall be made only after all traffic signal circuits have been thoroughly tested as specified above.

During the test period all costs except electrical energy shall be the Contractor's responsibility.

Functional tests shall start on any working day except Friday or the day preceding a legal holiday.

Shutdown caused by a power interruption shall not constitute discontinuity of the functional test, however, the test shall continue after power is restored.

643.15 Timing. The controller shall be timed as noted on the plans. The Contractor shall notify the Engineer, at least 1 week in advance, of his intention to initially operate the signals.

At the time of initial operation of the new signals, the Contractor shall provide police protection from the local police department at the Contractor's expense until the Contractor demonstrates to the Engineer that the signal operates in conformance with the specification.

643.16 Final Cleaning Up. After all work has been completed, the Contractor shall remove all barriers, "Wet Paint" signs, equipment and all debris which has accumulated during the work.

The Contractor shall remove and deliver all unused signal equipment and wiring to the Engineer.

643.17 Documents. The Contractor shall furnish 2 operation and maintenance manuals for all controller units, auxiliary equipment, vehicle detector sensor units, control units and amplifiers. Each manual must include, but need not be limited to the following:

- (a) An explanation of the theory of operation, including a functional description and a detailed circuit description.
- (b) A schematic diagram of each unit including voltage measurement charts and wave forms. A cabinet wiring diagram including all field wiring and pin locations and designations for all plug type connectors.

If any circuit changes are made in the field, corresponding changes shall be made to the schematic diagrams.
- (c) A trouble shooting and preventive maintenance procedure including both field and bench trouble shooting analysis.
- (d) A parts list including a pictorial diagram showing the location and identification of each component on the chassis or circuit board.
- (e) A drawing of the controller cabinet interior showing the location of all shelves, terminal blocks, relays, timers, loop amplifiers.

In addition, manufacturer's warranties and guarantees for materials shall be delivered to the Engineer prior to acceptance of the project.

643.18 Method of Measurement. Traffic signals, traffic signal modifications, interconnect wire and flashing beacons will each be measured for payment by the lump sum in place. Temporary traffic signals will be measured for payment by the lump sum, satisfactorily installed, operated, and removed.

643.19 Basis of Payment. Traffic signal modifications, traffic signals, interconnect wire and flashing beacons will be paid for at the contract lump sum price, which payment will be full compensation for furnishing and installing all materials, both new and re-used, including, but not limited to wood poles, strain poles, mast arm poles, pedestal poles, span wire, guys, controllers, vehicular heads, pedestrian heads, flashing beacons, wiring, cable and all appurtenances and incidentals required for a complete functioning installation and for furnishing all tools and labor necessary for completing said installation. Conduits, junction boxes, and foundations will be paid for under Section 626 -- Foundations, Conduit and Junction Boxes for Highway Signing, Lighting and Signals.

Payment for temporary traffic signals shall include compensation for the removal of the system upon completion of the work. All materials used for temporary traffic signals will remain the property of the Contractor. Operating the controller by hand will be paid for under Section 629 -- Hand Labor.

Payment will be made under:

Pay Item	Pay Unit
643.60 Flashing Beacon at _____	Lump Sum
643.71 Traffic Signal Modification _____	Lump Sum
643.72 Temporary Traffic Signal _____	Lump Sum
643.80 Traffic Signals at _____	Lump Sum
643.90 Interconnect Wire Between _____	Lump Sum

SECTION 644 -- VACANT

SECTION 645 -- HIGHWAY SIGNING

645.01 Description. This work shall consist of furnishing and installing new signs, sign supports, delineators, and breakaway devices and removing, relocating or modifying existing signs and sign supports, in accordance with these specifications and in reasonably close conformity with the plans.

MATERIALS

645.02 General. All equipment shall be new unless otherwise specified. Substitutes for specified material will be accepted if approved. Substitutes shall give equal or better service. Where an existing system is to be modified, the existing material shall be removed, upgraded or disposed of as shown on the plans or as directed.

645.021 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Reflective Sheeting	719.01
Demountable Acrylic Plastic Reflectorized Letters, Numerals, Symbols and Borders	719.02
Aluminum Extrusions	719.03
Aluminum Sheets	719.04
Plywood	719.05
Demountable Reflectorized Delineators	719.06
Assembly Hardware	719.07
Aluminum Supports	720.01
Steel Supports	720.03
Steel H-beam Poles	720.06
Anchor Bolts	720.07
U-Channel Posts	720.08
Wood Sign Posts	720.12

Paint for the edge and back of plywood and field coat paint for wood sign posts shall be an exterior grade dark green enamel conforming to Federal Specifications TT-P-71b.

645.022 Sign Layout Drawings. The Contractor shall submit 2 sets of sign face layout detail scale drawings. Fabrication of the signs shall not begin until the Contractor has received approval of these drawings. The drawings shall contain complete detailed information and dimensions. One set of drawings will be returned to the Contractor, who will make corrected drawings if required.

645.023 Support Structures. The design, materials and fabrication of sign support structures shall meet the requirements of the current edition of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals" and interims thereto, except as otherwise indicated within these specifications or on the contract plans. Bridge and pole mounted signs and their supports shall be designed using wind speeds as determined from the 25 year mean recurrence interval Isotach map. Bridge type, cantilever type and butterfly type sign supports and associated signs and hardware shall be designed using the wind speeds as determine from the 50 year mean recurrence interval Isotach map, as contained in the above referenced AASHTO Specifications. For sign supports mounted on structures and approaches to structures the mounting height shall be measured from the following:

For bridges over bodies of water: above the prevailing water level or, in the case of tidal waters, above mean high tide.

For overpass structures: above the lower roadway level.

For approach ramps: above the average adjacent ground level, if said ground level is more than 10 feet below the base of the light standard.

Before any shop work is commenced, the Contractor shall submit 2 sets of drawings of all sign supports he proposes to furnish and erect under this contract. The drawings shall be of sufficient detail to indicate material and/or dimensional conformance with these specification and the contract drawings and in the case of bridge, cantilever and butterfly type sign supports, shall be sufficient detail to show all structurally significant details. Approval for deviations from the contract drawings and/or specifications shall be requested in writing and shall be approved before being incorporated in the manufacturer's drawings.

- (a) Pole mounted signs. The poles for pole mounted signs shall be of the size, material and shape as designated on the design drawings. The Contractor shall be fully responsible for the adequacy and design of any structural details not shown on the design drawings and each drawing shall contain a reference to the de-

sign criteria and a certification by a Registered Professional Engineer, over his official stamp, that said design criteria have been met by all parts of the structure designed and/or detailed by the Contractor. Approval of the drawings will signify only approval of the size, material and length of the pole.

- (b) Bridge, Cantilever and butterfly type sign supports. The Contractor shall be responsible for the design of the support structure including its foundation(s). In addition to the required detail drawings he shall submit 3 copies of the design computations for the entire structure including its foundation(s). The computations shall be sufficiently detailed to allow the Engineer to check and approve said computations, computer printouts will not be accepted unless they meet the above criteria. All drawings and computations shall be signed by a Registered Professional Engineer. Approval will be on the basis of the applicable provisions of Section 105.02 of these specifications.
- (c) Overpass mounted sign supports. Overpass mounted sign supports shall be constructed to the configuration and sizes and of the material shown on the contract plans. Approval will be on the basis of the applicable provisions of Section 105.02 of the specifications.

Breakaway supports for sign supports will be required only for those locations indicated on the contract plans. Breakaway supports using load concentrating couplings shall be supplied for use at all locations designated as breakaway, except that, for steel sign supports, slip bases may be used as an alternate. Breakaway devices other than the above may be used subject to the approval of the Engineer and subject to the applicable provisions of Section 721 -- Breakaway Devices. Multi-pole sign supports, designated as breakaway, shall be supplied with slip bases and each pole shall be equipped with breakaway hinges immediately below the lower edge of the sign. Hinges relying on the friction between the hinge and the pole face for transmitting the design moment will not be accepted for use.

645.03 Classification of Signs. Sign sizes, color and legend designs shall conform to these specifications, the plans and the MUTCD. The signs are classed according to the intended use as follows:

- (a) Type I guide signs shall consist of high intensity reflectorized sheeting or reflectorized demountable letters, numerals, symbols and border mounted on an engineering grade reflective sheeting background adhered to a sign panel constructed of extruded aluminum planks.

- (b) Type I regulatory, warning and route marker assembly signs shall consist of engineering grade reflective sheeting letters, numerals, symbols and border on an engineering grade reflective sheeting background adhered to a sign panel constructed of sheet aluminum.
- (c) Type II guide signs shall consist of engineering grade reflective sheeting letters, numerals, symbols and border on an engineering grade reflective sheeting background attached to a sign panel constructed of plywood.
- (d) Type II regulatory, warning and route marker assembly signs shall consist of engineering grade reflective sheeting letters, numerals, symbols and border on an engineering grade reflective sheeting background adhered to a sign panel constructed of sheet aluminum or plywood.

CONSTRUCTION REQUIREMENTS

645.04 Fabrication of Type I Guide Signs.

- (a) Panels. This sign panels shall be shop fabricated from aluminum planks to the sizes designated on the approved shop drawings. Cut edges shall be true and smooth and free from burrs or ragged breaks. Flame-cutting will not be permitted. Bolt holes may be drilled to finished size or punched to finished size, provided the diameter of the punched hole is at least twice the thickness of the metal being punched.

Fabrication of extruded aluminum sign planks, including punching or drilling holes and cutting to length, shall be completed prior to the metal degreasing and the application of the reflective sheeting. The bolts required to fasten the extruded aluminum planks together shall conform to the designs used in standard commercial processes for the type of extruded aluminum panels to be used as approved.

All route shields shall be on an overlay aluminum sheet of 0.080 inch minimum thickness and shall be in full color with reflective background; they shall not have demountable numerals and borders.

- (b) Reflective Sheeting. The engineering grade reflective sheeting shall be applied to the extruded aluminum plank in accordance with the current recommendations of the sheeting manufacturer.

The reflective sheeting shall cover the complete panel and shall not be trimmed to conform with the border. The reflective sheeting shall overlap into the side recess of the individual planks. There shall be no paint applied to the sign panels. The surface of all completed sign panels shall be flat and free of defects. Extruded aluminum molding shall be placed on the edges of the extruded panels as shown on the plans.

- (c) Text. The design of upper and lower case letters and of numerals and symbols and the arrangement and spacing of texts shall be as provided on the plans and in conformance with the MUTCD.

Text for Guide Signs shall be composed of demountable letters, numerals, symbols and borders and shall be acrylic plastic reflectors in embossed aluminum frames, except that high intensity reflective sheeting may be used for text if noted on the plans. The demountable text shall be applied to the panels by use of aluminum pop rivets, in accordance with standard commercial processes as approved. All demountable letters, numerals, symbols and borders shall be the same manufacturer's make for the entire project. Cut-out high intensity reflective sheeting text shall be applied to the sign panel with a precoated adhesive backing.

645.041 Fabrication of Type I Regulatory, Warning and Route Marker Assembly Signs and Type II Sheet Aluminum Regulatory, Warning and Route Marker Assembly Signs.

- (a) Panels. Sheet aluminum sign panels shall be shop-fabricated to the size shown on the plans. The corners shall be rounded to the indicated radius where shown.

Bolt holes may be drilled or punched to finished size, provided the diameter of the punched hole is at least twice the thickness of the metal being punched. Cut edges shall be true and smooth and free from burrs or ragged breaks. Flame-cutting will not be permitted. Punching or drilling of holes and cutting to size shall be completed prior to metal degreasing and the application of reflective sheeting.

- (b) Reflective Sheeting. The engineering grade reflective sheeting shall be applied to the sheet aluminum sign panels in accordance with the current recommendations of the sheeting manufacturer. The reflective sheeting colors shall conform to the MUTCD standard highway sign colors for each type sign. Surface of all panels shall be flat and free from defects.

- (c) Text. The text for regulatory, warning, confirmation and route marker assembly signs shall be composed of cut-out engineering grade reflective sheeting letters, numerals, symbols and borders or the silver letters may be formed by applying transparent ink to the reflective sheeting background where the silk screen process is used or other methods to form the text may be used when approved in advance.

645.042 Fabrication of Type II Guide Signs and Type II Plywood, Regulatory, Warning and Route Marker Assembly Signs.

- (a) Panels. Fabrication of all sign panels from high-density overlaid plywood shall be in a uniform manner. All fabrication, including cutting, drilling, and edge routing, shall be completed prior to painting and application of reflective sheeting to the high-density overlaid plywood. Panels shall be cut to size and shall be free of warping, open checks, open splits, open joints, open cracks, loose knots and other defects resulting from fabrication. Corners shall be left square. The surface of all sign panels shall be flat.

The edge and back of the plywood shall be painted with an exterior grade dark green paint.

- (b) Sign blanks shall be cut to shape using a saw blade that does not tear plywood grain. Holes shall be clean cut and uniform. All cracks, open checks, open splits and other defects occurring on the edge surfaces shall be filled with a synthetic wood filler and sanded smooth prior to sealing and painting. The sign blank edges shall be sealed using an approved sealer/primer. The edges shall then be painted with an exterior grade dark green paint.

The surface shall not be painted prior to application of reflective sheeting. Before applying reflective sheeting, dirt or wax shall be removed by one of the following methods:

1. The surface shall be buffed lightly with solvent-soaked steel wool, fine or medium, using organic solvents such as lacquer thinner, xylol, heptane, benzene or naphtha and wiped dry with clean cloths.
2. The panel shall be sanded lightly with fine grade paper, cleaned with solvent and wiped dry using clean cloths.

(c) Reflective Sheeting. The engineering grade reflective sheeting shall be applied directly to the cleaned high-density surface in accordance with the recommendations of the reflective sheeting manufacturer.

(d) Text. The text for regulatory, warning, confirmation and route marker assembly signs shall be composed of cut-out engineering grade reflective sheeting letters, numerals, symbols and borders or the silver letters may be formed by applying transparent ink to the reflective sheeting background where the silk screen process is used. Other methods to form the text may be used when approved in advance.

The design of the letters, numerals, and symbols, the spacing of the text and the size and spacing of the border shall conform to the MUTCD Standard Highway Signs.

645.05 Preparation of Wood Posts. All sign post surfaces to be painted shall be cleaned and shall be dry when the paint is applied. Each coat shall be thoroughly brushed out and allowed to dry before the succeeding coat is applied.

No painting shall be done in damp weather nor when the air temperature is below 40°F. The wood posts shall be painted on all surfaces with 2 coats of dark green enamel prior to the setting of the posts or mounting of the sign panel.

645.06 Installation of Type I Signs. The sign locations shown on the plans are approximate, exact locations will be determined in the field by the Engineer. Signs stockpiled prior to erection, shall be stored in a vertical position and completely covered to avoid staining, weathering and dirt accumulation.

(a) Sign Supports. Poles for single and multiple support roadside signs shall be erected plumb, using the leveling nuts supplied with the anchor bolts. When signs are supported by more than 1 pole, all poles shall be carefully aligned to avoid warping of the sign panel.

Bridge, butterfly and cantilever type sign supports and their foundations shall be constructed, assembled and erected in accordance with the manufacturer's details as approved. All horizontal supports spanning the roadway shall be level and shall be cambered to be so under full dead load. If at any time, after their erection, bridge, butterfly or cantilever type sign supports are to remain without the sign(s) for which they were designed being in place, for a period in excess of 48 hours, suitable vibration damping devices approved by the Engineer shall be installed until such time as the sign(s) can be erected.

Bridge mounted sign supports shall be fabricated and assembled in accordance with the details as shown on the contract drawings and with Section 504 -- Structural Steel and, if required to be painted, they shall be painted in accordance with Section 506 -- Painting Structural Steel.

Where aluminum surfaces are in contact with concrete or dissimilar metals, the contacting surface shall be thoroughly coated with an approved, aluminum impregnated, caulking compound or the surfaces shall be separated by another approved material. Before signs are attached, aluminum sign supports shall be cleaned of all dirt and discoloration, using methods recommended by the manufacturer.

- (b) Sign Panels. Extruded aluminum planks for sign panels shall be bolted together, as indicated on the plans. Extruded aluminum molding shall be placed on the edges of the extruded panels. Sign panels shall be attached to the posts to provide the vertical and horizontal clearances from the roadway indicated on the plans. Sign panels on overhead structures shall provide a minimum clearance of 17.0 feet to the roadway surface. Sign panels on bridge mounted sign supports shall be installed with the bottom edge of the sign 1 inch above the bottom of the bridge beam.

Sign panels mounted over the roadway shall tilt in the direction of the approaching traffic in such a manner that the angle between the sign face and the roadway grade at the sign location shall be 85 degrees, plus or minus 3 degrees.

Ground mounted signs located 4 feet to 30 feet from the edge of shoulder shall form an angle of 93 degrees between the approach roadway and the sign.

Signs located more than 30 feet from the edge of the shoulder shall form an angle between the approach roadway and the sign face equal to 87 degrees minus 1 degree for each additional 10 feet beyond 30 feet.

Unless otherwise shown on the plans, or designated by the Engineer, a minimum lateral clearance of 4 feet shall be provided between the edge of the shoulder and the edge of any sign panel.

The elevation of the bottom edge of guide sign panels shall be 7 feet above the elevation of the edge of the traveled way at the sign location, or in case of a curb section, 7 feet above the elevation of the outer edge of the roadway, unless authorized otherwise.

In the event that a second sign is to be placed under the main sign, the elevation of the bottom edge of the principal sign shall be a minimum of 8 feet above the outer edge of the traveled way or a minimum of 8 feet above the edge of the traveled way in curbed sections, and the bottom edge of the second sign must be at least 5 feet above the edge of the travelled way.

The elevation of the bottom edge of the regulatory, warning and route marker sign panels shall be 6 feet above the elevation of the edge of the pavement, or edge of roadway in curbed sections, at the sign location. The elevation of the bottom edge of these sign panels on all crossing or connecting roadways shall be 5 feet in rural areas or 7 feet in urban areas above the elevation of the edge of the pavement. Field conditions may require some variation in elevations as directed.

Each sign shall have at least 2 fasteners connecting it to the sign poles, except signs of 1 foot or less in height may have 1 fastener.

645.061 Installation of Type II Signs. The sign locations shown on the plans are approximate, exact locations will be determined in the field. Signs stockpiled prior to erection shall be stored in a vertical position and completely covered to avoid staining, weathering and dirt accumulation.

- (a) Sign Supports. Support posts for Type II signs shall be U-channel posts weighing 2 1/2 pounds per foot for signs of less than 4 square feet in area, 4 inch by 4 inch wood posts for signs of area 4.00 square feet to 8.99 square feet, 4 inch by 6 inch wood posts for signs of area 9.00 square feet to 15.99 square feet, and 6 inch by 6 inch wood posts for signs of area over 16.00 square feet.

All wood posts shall be set to a depth of 4 feet and the U-channel posts shall be set to a minimum depth of 30 inches. When it is necessary to set sign posts in bed rock, holes shall be excavated to the required depth and size at the locations indicated on the plans. The excavated material will be satisfactorily disposed of as directed, and the posts set to the required depth.

Backfilling around the posts shall be with excavated material unless the excavated material is considered unsatisfactory, in which case the backfill shall be granular material conforming to the requirements of Subsection 703.19 -- Material for Embankment Construction. Backfill shall be thoroughly tamped in layers not exceeding 8 inches in depth.

When directed, the area around the posts shall be loamed and seeded in accordance with the applicable provisions of Section 615 -- Loam and Section 618 -- Seeding Method No. 1.

The Contractor shall be responsible for and shall repair all damage to underground drainage structures, utilities or lighting conduits encountered during placing the posts.

- (b) Mounting. Type II signs shall be mounted using assembly hardware specified in Subsection 719.07.

645.062 Installation of Delineators. Posts for delineators shall be so erected that posts and assemblies will be plumb. All posts bent or otherwise damaged shall be removed and properly replaced. Posts shall be driven 4 feet from the outside edge of shoulder, 4 feet from the face of curb; and 4 feet from the normal edge of shoulder in guard rail sections. Delineators shall be mounted 4 feet above the elevation of the edge of the traveled way.

A suitable driving cap shall be used and after driving, the top of the post shall have substantially the same cross sectional dimensions as the body of the post. Delineator assemblies shall be attached after the posts are driven.

When bed rock is encountered in erecting posts, the depth to be drilled into the rock shall be determined by the Engineer.

In the event that a delineator is required to be installed on a bridge structure, it shall be installed by use of a bracket as shown on the plans.

645.063 Installation of Breakaway Devices. Breakaway devices shall be installed at locations indicated on the plans by an approved method. Each sign and pole shall be carefully demounted for reinstallation at the same or at a new location.

If required, poles shall be cut in such a manner that no rough edges will be left. No flame cutting will be permitted. Cut edges on steel poles shall be painted in accordance with Subsection 645.07.

Existing foundations shall be modified for attachment of the breakaway device as shown on the plans or approved.

Breakaway devices shall be attached to new foundations in accordance with the recommendations of the breakaway device manufacturer and as approved.

645.07 Demounting and Reinstalling Existing Signs and Poles. Signs and poles designated to be demounted and not designated to be reinstalled, except those designated to be demounted by others, shall be delivered to the Engineer.

Existing sign panels, poles, foundations and sign hardware, damaged as a result of the Contractor's operations shall be replaced or repaired by the Contractor to the satisfaction of the Engineer.

New or relocated regulatory, warning, confirmation or route marker assembly signs shall be installed the same working day as the corresponding existing signs are demounted. All new or relocated guide signs shall be installed within 2 working days of the time the corresponding existing sign is demounted. Before the Contractor demounts any regulatory or warning sign he shall erect a similar easel mounted sign at a designated location. The Contractor shall maintain this temporary sign in place until the permanent sign is installed.

Existing signs and poles shall be reinstalled in accordance with the applicable requirements for installing new signs and poles.

Relocated steel posts and clamps shall be field painted 2 coats after the posts have been erected. The first coat shall be a zinc dust primer paint meeting Federal Specification TT-P-641B Type II and the second coat shall be bright aluminum paint, aluminum dust Type II, Class 3 brightness, meeting Federal Specification TT-A-468 with a minimum of 2 pounds per gallon, with vehicle meeting or exceeding Federal Specification TT-V-109. Scratches shall be touched up after the erection of the sign panels. The touch-up shall be with both primer and finish coat. Sign pole surfaces to be painted shall be cleaned and shall be dry when the paint is applied. No painting shall be done in damp weather nor when the air temperature is below 40°F.

645.08 Method of Measurement. Demount signs, demount poles, re-install signs and reinstall poles will be measured by each unit.

Bridge, cantilever and butterfly type sign supports, including the foundations, support structures and sign panels, complete in place as called for on the plans, will be measured by each unit.

Guide signs-overpass mounted, including supports, will be measured by each unit in place.

Breakaway devices, one per pole, shall be measured by the unit complete in place and accepted.

The area of roadside guide signs, regulatory, warning, confirmation and route marker assembly signs of the respective types, will be measured by the area in square feet, computed to nearest hundredth of a square foot, as determined by the overall height multiplied by the overall width.

Aluminum poles for roadside guide signs Type I will be measured by the number of units of each diameter, complete in place. Steel H-beam poles will be measured for payment by the pound, determined from the nominal weight per linear foot for each size and the lengths as indicated on the plans.

Demountable reflectorized delineators will be measured by the number of units of each type in place.

645.09 Basis of Payment. The accepted demounted signs and demounted poles will be paid for at the contract unit price each for the respective item specified. Such price will include delivery of signs and poles not to be reinstalled to a site designated by the Engineer and all incidentals necessary to complete the work.

The accepted reinstalled signs or reinstalled poles will be paid for at the contract unit price each. Such price will include furnishing new hardware when required and incidentals necessary to complete the installations. Any signs or poles designated to be reinstalled that are damaged by the Contractor shall be replaced by him with new signs or poles conforming to the applicable Specifications at no additional cost to the State.

The accepted bridge, cantilever and butterfly type sign supports will be paid for at the contract lump sum price for the respective items which price will be full compensation for the signs, support structure, foundations and incidentals necessary to complete the work.

The accepted guide signs-overpass mounted, will be paid for at the contract lump sum price for the respective items, which price will be full compensation for the signs, supports and incidentals necessary to complete the work.

The accepted roadside guide signs and regulatory, warning, confirmation, and route marker assembly signs will be paid for at the contract unit price per square foot. Such payment will be full compensation for furnishing and installing signs, assembly hardware and all incidentals necessary to complete the work.

The accepted aluminum poles will be paid for at the contract unit price per each for the specified diameter complete in place.

The accepted demountable reflectorized delineators will be paid for at the contract unit price per each for the type specified. Such payment will be full compensation for delineator and post or bridge rail mounting complete in place.

Payment for breakaway devices shall be full compensation for the device, required pole cutting, adapting the pole to the breakaway device, adapting the concrete base to the breakaway device and all incidentals necessary to satisfactorily complete the work. Separate payment will be made at the respective contract unit prices for demounting and reinstalling the signs and the poles at multi-pole installations. At single pole installations, separate payment will be made at the respective contract unit prices for demounting and reinstalling the poles only.

The accepted quantity of steel H-beam poles will be paid for at the contract unit price per pound, complete in place as shown on the plans or as designated.

Furnishing and installing posts for Type II signs including earth excavation and backfilling, furnishing and placing assembly hardware, backfill material, loam, seed and incidentals will not be paid for directly but will be considered incidental to the cost of the signs they support.

Excavating rock will be paid for as provided in Section 206 -- Structural Excavation.

Payment will be made under:

Pay Item	Pay Unit
645.103 Demount Guide Sign	Each
645.106 Demount Regulatory, Warning, Confirmation and Route Marker Assembly Sign	Each
645.108 Demount Pole	Each
645.113 Reinstall Guide Sign	Each
645.116 Reinstall Regulatory, Warning, Confirmation and Route Marker Assembly Sign	Each
645.118 Reinstall Pole	Each
645.12 Overhead Guide Sign	Lump Sum
645.13 Guide Sign-Overpass Mounted	Lump Sum
645.15 Cantilever Guide Sign	Lump Sum
645.161 Breakaway Devices Single Pole	Each
645.162 Breakaway Devices Multi Pole	Each
645.251 Roadside Guide Signs	Square Foot
645.261 Bridge Guide Signs	Square Foot
645.271 Regulatory, Warning, Confirmation and Route Marker Assembly Sign	Square Foot
645.281 5 Inch Aluminum Pole	Each
645.282 6 Inch Aluminum Pole	Each
645.283 7 Inch Aluminum Pole	Each
645.284 8 Inch Aluminum Pole	Each
645.285 10 Inch Aluminum Pole	Each
645.286 12 Inch Aluminum Pole	Each
645.289 Steel H-Beam Poles	Pounds
645.291 Roadside Guide Signs Type II	Square Foot
645.292 Regulatory, Warning, Confirmation and Route Marker Assembly Signs Type II	Square Foot
645.301 Demountable Reflectorized Delineator, Single	Each
645.302 Demountable Reflectorized Delineator, Double	Each
645.303 Demountable Reflectorized Delineator, Triple	Each

SECTION 646 -- EMBANKMENT STABILITY CONTROL DEVICES

Reserved

SECTION 647 and 648 VACANT

SECTION 649 -- PIPELINE PROTECTION

Reserved

SECTION 650 -- VACANT

SECTION 651 -- VACANT

SECTION 652 -- MAINTENANCE OF TRAFFIC

652.01 Description. This work shall consist of furnishing, installing, maintaining and removing traffic control devices necessary to provide reasonable protection for motorists, pedestrians and construction workers in accordance with these Specifications, the applicable provisions of Subsection 104.04 and the plans.

Traffic control devices include signs, signals, lighting devices, markings, barricades, channelizing and hand signaling devices and flaggers.

MATERIALS

652.02 General. All traffic control devices shall conform to the requirements of Part VI of the latest edition of the MUTCD unless otherwise provided herein.

All signs, barricades, drums and vertical panel markers shall be reflectorized with construction grade reflective sheeting conforming to Subsection 719.01. Both the orange and white areas of drums, barricades and panel markers shall be reflectorized.

Material for construction signs shall be high density, overlaid Douglas Fir Plywood, conforming to Commercial Standard CS 45-60, "Douglas Fir Plywood", published by the US Department of Commerce, or an approved equal.

652.03 Signs. Only signs with symbol messages conforming to the design of the MUTCD shall be used unless the Engineer approves the substitution of word messages.

652.04 Flashing Arrow Board. The flashing arrow board shall consist of at least 15 hooded amber sealed beam lamps arranged to present four horizontal messages; left arrow, right arrow, double arrow, light bar only. In the three arrow signals, the second light from the arrow point shall not operate. The arrow shall be mounted on at least a 4 by 8 foot flat black board with the bottom of the sign approximately 7 feet above ground.

Circuitry shall be solid state. The arrow board shall be equipped with a manual control and a solid state photocell control to reduce intensity a minimum of 50 percent when ambient light falls below 5 foot candles.

Each flashing light shall use Lamp No. 4412 A, sealed beam par 46, 8800 candlepower with a flash rate not less than 25 per minute, dwell time 50 percent per cycle.

Power for the flashing arrow board shall be from a self-contained generator unit, of sufficient power to operate the lamps at their rated output or commercial power if available.

The flashing arrow board with generator and independent power drive shall be mounted on a pneumatic tired trailer vehicle or other suitable support for hauling to various locations as directed.

652.05 Other Devices. Vertical panel markers shall be orange and white striped, 8 inches wide by 24 inches high.

Cones shall be orange in color and when used at night shall be reflectorized on the conical portion with at least 174 square inches of white construction grade reflective sheeting conforming to Subsection 719.01.

Drums shall be of metal, plastic or other yielding material and shall be approximately 36 inches high and a minimum of 18 inches in diameter. There shall be 2 reflectorized orange and 2 reflectorized white stripes at least 4 inches wide on each drum.

Warning lights and battery operated flashing and steady burn lights shall conform to the requirements Subsection 712.23.

Type I barricades shall be 8 feet in length with an 8 inch wide rail mounted 3 feet above the ground. Type II barricades shall be 2 feet in length with two 8 inch wide rails. The top rail shall be mounted 3 feet above the ground.

CONSTRUCTION REQUIREMENTS

652.06 General. Prior to starting any work on any part of the project adjacent to or being used by the traveling public, the Contractor shall install the appropriate traffic control devices in accordance with the plans, specifications and the latest edition of MUTCD, Part VI. The Contractor shall continuously maintain the traffic control devices in their proper position, clean, legible and in good repair throughout the duration of the work. If notified that the traffic control devices are not in place or not properly maintained, the Contractor may be ordered to immediately suspend work until all deficiencies are corrected.

No equipment or vehicles of the Contractor, his subcontractors or employees engaged in work on this contract shall be parked or stopped on lanes carrying traffic, or on lanes or shoulders adjacent to lanes carrying traffic, at any time, except as required by ongoing work operations.

All excavation areas adjacent to the roadway shall be channelized by vertical panel markers, barricades, drums, cones, as shown on the plans or as directed. Channelization shall be continuous in both directions for the length of the project in all areas where the centerline strip is not effective.

Where the roadway is adjacent to an area being excavated, a minimum 2 foot shoulder shall be maintained and the effective slope of the excavation beyond the 2 foot shoulder shall not be steeper than a 1 horizontal to 1 vertical.

652.07 Installation of Traffic Control Devices. Easel mounted signs shall be erected so that the bottom of the sign is a minimum of 3 feet above the travelled way. Post mounted signs shall be erected so the bottom of the sign is between 5 feet and 7 feet above the travel way. Signs may be mounted lower or higher to fit the situation when authorized.

Cones shall be either weighted or nailed, but if weighted shall not be weighted with tires unless the tires have been radially sliced to a maximum of one-half their original thickness.

Vertical panel markers shall be mounted with the top at least 4 feet above the traveled way.

Drums shall not be weighted on the top. Drain holes shall be provided to prevent water from accumulating in the drums. Drums may be weighted with loose dry sand.

The Contractor shall operate and maintain the flashing arrow board unit and trailer and shall continuously supply fuel and lubrication for dependable service during the life of the contract. The units shall remain in continuous night and day service at locations designated until such time as the Engineer designates a new location or discontinuance of service.

The Contractor shall maintain the devices in proper position and clean them as necessary.

The Contractor shall replace damaged traffic control devices with devices of equal quality, as directed.

652.08 Traffic Control. The Contractor shall provide a roadway width as specified or as directed. Vertical panel markers, drums, cones or striping shall be used to clearly delineate the roadway through the construction area as directed.

The traffic control devices shall be moved or removed as the work progresses to assure compatibility between the use of the traffic control devices and the traffic flow. Traffic control devices which become unnecessary shall be immediately removed from use.

Pavement markings shall be altered as required to conform to the existing traffic flow pattern. Repainting of lines, under temporary 4 inch pavement marking line, if required to maintain the effectiveness of the line, shall be considered to be maintenance of traffic control devices, no separate payment will be made.

Inappropriate existing pavement markings shall be removed whenever traffic is rerouted and temporary construction pavement markings shall be placed which clearly define the intended vehicle path. Traffic changes shall not be made unless there is sufficient time, equipment, materials and personnel available to complete the change properly before the end of the workday. This provision will not be required when traffic is rerouted for brief periods during daylight hours and the route can be clearly defined by channelizing devices or flaggers or both.

652.09 Flaggers. As called for on the traffic control plans, the Contractor shall furnish flaggers to control traffic through or around work areas.

Orange clothing, such as a vest, shirt or jacket and hard hats shall be furnished for and worn by flaggers. For nighttime conditions similar outside garments shall be reflectorized and lighted hand signal devices shall be used.

Only signals which conform to the latest revision of the MUTCD, Part VI, may be used.

While flagging, the flagger should stand either on the shoulder adjacent to the traffic being controlled or in the barricaded lane. At a spot obstruction, the flagger may stand on the shoulder opposite the barricaded sections to operate effectively. Under no circumstances shall the flagger stand in the lane being used by moving traffic. The flagger should be clearly visible to approaching traffic at all times and should stand alone.

652.10 Warning Lights. Warning lights shall be installed at locations designated prior to any work being done on the sections of roadway being used by traffic. Upon installation, all warning lights shall remain in continuous operation during the life of the project unless otherwise authorized.

When a suitable 120 volt AC power source is available within 500 feet of the designated warning light location, power operated flashing lights shall be installed. Two alternately flashing lamps, shall be mounted approximately 24 inches above the sign spaced approximately 24 inches apart.

When a suitable 120 volt AC power source is not available, battery operated flashing lights may be erected. Four flashing lamps shall be mounted approximately 6 inches above the sign spaced approximately 12 inches apart.

The service connections shall be installed to the satisfaction of both the power company and the Engineer. The Contractor shall make all necessary arrangements for the service connections and be responsible for all charges incurred thereby, including power charges. The Contractor shall also be responsible for all outstanding bills from the electric power company for preliminary work done by the electric company for the service connection.

When batteries are required for battery operated flashing lights, they shall be provided by the Contractor as necessary.

652.11 through 652.14 Vacant

652.15 Method of Measurement. Signs and panel markers will be measured by the square foot for all signs authorized and installed on the project.

Flashing arrow boards, Type I barricades, Type II barricades, flashing and steady burn lights, drums and cones will be measured by each unit authorized and installed on the project.

Flaggers will be measured for payment by the number of man hours to the nearest 1/4 hour as specified.

Maintenance of traffic control devices will be measured by the calendar day for all authorized and installed traffic control devices.

Warning lights will be measured by the group of lights furnished.

652.16 Basis of Payment. The accepted quantity of signs and panel markers will be paid for at the contract unit price per square foot. Such payment will be full compensation for furnishing and installing all signs, sign supports and all incidentals necessary to complete the installation of the signs.

The accepted quantity of flashing arrow boards, Type I barricades, Type II barricades, battery operated flashing and steady burn lights, drums and cones will be paid for at the contract unit price each for the actual number of devices authorized, furnished and installed. Such payment shall be full compensation for all incidentals necessary to install the respective devices.

Maintenance of traffic control devices will be paid for at the contract unit price per calendar day for each calendar day that the Contractor maintains traffic as specified herein. Such payment will be full compensation for moving, for replacing devices damaged, lost or stolen, and for cleaning, maintaining and removing all devices used for traffic control, including replacing temporary pavement marking lines.

The accepted quantities of flaggers will be paid for at the contract unit price per man hour. Payment for overtime will be made in compliance with the labor requirements of the contract.

The contract unit price shall be full compensation for hiring, transporting, supervising and payment of workers and all overhead and incidentals necessary to complete the work.

The accepted quantities of warning lights will be paid for at the contract unit price per group complete in place including the necessary power and remaining in operation during active work of the project or as otherwise directed. Upon completion of the work, the lamps, fixtures and the framework required to properly mount the lamps shall remain the property of the Contractor.

Payment for temporary construction pavement marking lines and pavement marking removal will be made under the respective pay item in Section 627 -- Pavement Markings.

Payment for temporary traffic signals will be made under Section 643 -- Traffic Signals.

There will be no payment made under the pay items in Section 652 for devices furnished or maintenance work required after the expiration of the adjusted total contract time.

Payment will be made under:

Pay Item	Pay Unit
652.30 Flashing Arrow Board	Each
652.31 Type I Barricades	Each
652.311 Type II Barricades	Each
652.32 Battery Operated Lights	Each
652.33 Drums	Each
652.34 Cones	Each
652.35 Construction Signs	Square Foot
652.36 Maintenance of Traffic Control Devices	Calendar Day
652.37 Warning Lights	Group
652.38 Flaggers	Man Hours

SECTIONS 653 -- POLYSTYRENE PLASTIC INSULATION

653.01 Description. This work shall consist of furnishing and installing a polystyrene plastic insulating layer at locations designated on the plans in accordance with these specifications.

MATERIALS

653.02 General. Insulating material shall be extruded expanded polystyrene insulating board conforming to the requirements of AASHTO M 230.

Pegs shall be hard wood, approximately 6 inches by 1/4 inch round, pointed on one end.

CONSTRUCTION REQUIREMENTS

653.03 Preparation of Foundation. The insulating boards shall be placed on a compacted layer of granular material graded to a tolerance of 1/2 inch above or below the required grade and cross section. The surface shall be free of rocks which would cause damage to the insulating boards. The type and thickness of the granular material will be as shown on the plans.

653.04 Placing Insulating Boards. The insulating boards shall be secured to the ground with pegs placed at each corner or where directed by the Engineer, and driven flush with the surface of the insulating board. Joints between the insulating boards shall be staggered. The opening in any joint shall be kept to a minimum.

653.05 Placing Backfill. After the insulating boards have been placed, granular material shall be placed using care to avoid pushing or puncturing the boards. The depth of the first layer of aggregate subbase sand shall not be less than 6 inches loose measure. The aggregate subbase sand shall be spread with a crawler type bulldozer of not more than 80 pounds per square foot ground contact pressure or with other approved equipment but not supported directly on the insulating boards. Trucks and other heavy construction equipment shall not be operated directly on the insulating boards. The type and thickness of granular material will be shown on the plans.

653.06 Compaction. Compaction of the first layer of aggregate subbase sand shall be by vibratory methods to the satisfaction of the Engineer. After the first layer has been compacted, normal construction practices may be followed providing no loads are placed on the area which produce more than 80 pound per square foot ground contact pressure.

653.07 Protection of Polystyrene. Since gasoline, oil, heat and sunlight will damage polystyrene, all precautions shall be taken to prevent them from damaging the insulating board. The insulating boards shall not be stored in sunlight for more than 1 day.

653.08 Method of Measurement. Polystyrene plastic insulation will be measured by the square yard in place.

653.09 Basis of Payment. The accepted quantities of polystyrene plastic insulation will be paid for at the contract unit price per square yard complete in place. Payment shall be full compensation for furnishing the pegs and for furnishing and placing the insulating boards.

Payment will be made under:

Pay Item	Pay Unit
653.20 1 inch Polystyrene Plastic Insulation	Square Yard
653.21 1 1/2 inch Polystyrene Plastic Insulation	Square Yard
653.22 2 inch Polystyrene Plastic Insulation	Square Yard
653.23 3 inch Polystyrene Plastic Insulation	Square Yard

SECTION 654 -- VACANT

SECTION 655 -- ELECTRICAL WORK

Reserved

SECTION 656 -- TEMPORARY EROSION CONTROL

656.01 Description. This work shall consist of providing temporary erosion control during construction in accordance with these specifications, with the standard details as modified by the Engineer to fit local conditions.

MATERIALS

656.02 Materials. Baled hay shall be bales at approximately 14 by 18 by 30 inches, or equivalent, securely tied to form a firm bale.

Sandbags shall consist of heavy cloth or woven plastic bags, approximately 1 cubic foot capacity, filled with sand or gravel.

Dumped stone shall be a graded mixture of large and small stones with approximately 50 percent of the stones larger than 6 inches.

Flexible drainage shall consist of collapsible neoprene pipe a minimum of 8 inches in diameter or equal.

CONSTRUCTION REQUIREMENTS

656.03 Temporary Erosion Checks. Temporary erosion checks shall be constructed in ditches and at other locations designated. Checks shall be in accordance with the Standard Detail except that the Engineer may modify the arrangement of bales and bags to fit local conditions.

Baled hay or sandbags or both, may be used in other areas as necessary to inhibit soil erosion.

656.04 Temporary Berms. When designated, temporary barriers shall be constructed along the edge of the embankment. The barriers shall be of embankment earth material, gravel or sand as available, shaped approximately as shown on the Standard Detail plans. The barriers shall be compacted with the wheels of construction equipment.

At designated intervals, temporary slope drains shall be constructed with a crescent shaped barrier placed at each slope drain to direct the water into the inlet pipe.

656.05 Temporary Slope Drains. Collapsible pipe with corrugated metal pipe inlet shall be placed down the embankment slopes at designated locations and in accordance with the Standard Detail plans.

At the outlet end of the drain, dumped stone shall be placed, when necessary to prevent scouring.

656.06 Dumped Stone. Dumped stone shall be placed at designated locations and shaped to the extent necessary to spread the stone over the area and in sufficient depth to prevent soil erosion.

656.07 Removing and Disposing. When no longer needed, material and devices for temporary erosion control shall be removed or may be left in place and dispersed over the adjacent area, as directed.

When removed, such devices may be reused in other locations provided they are in good condition and suitable to perform the erosion control for which they are intended.

When dispersed over adjacent areas, the material shall be scattered to the extent that it causes no unsightly conditions nor creates future maintenance problems. Dumped stone shall be dispersed or covered in such a manner that it will not interfere with future mowing operations.

656.08 Method of Measurement. Baled hay and sandbags will be measured for payment by the number of bales or bags satisfactorily placed. Dumped stone will be measured for payment by the cubic yard, in vehicles in accordance with the requirements of Section 109 -- Measurement and Payment.

Temporary berms and temporary slope drains will be measured for payment by the linear foot measured parallel with the flow line. Measurement for temporary slope drains shall include the section of pipe inlet.

656.09 Basis of Payment. The accepted quantity of baled hay or sandbags will be paid for at the contract unit price each for each bale or bag which price shall be full compensation for furnishing and placing the bales or sandbags, for furnishing and driving the stakes for baled hay and for the removing and disposing of the bales, stakes and sandbags when no longer needed.

The accepted quantity of temporary berms will be paid for at the contract unit price per linear foot of berm which price shall be full compensation for furnishing, placing and compacting material, for maintaining as necessary and for removing the berm when no longer needed.

The accepted quantity of temporary slope drains will be paid for at the contract unit price per linear foot of pipe, including inlet pipe, which price shall be full compensation for furnishing and placing the pipe, for maintaining and repairing when necessary and for removing when no longer needed. There will be no separate payment for excavation done in the construction of temporary erosion control items under this section and all necessary excavation shall be considered incidental to the work.

The accepted quantity of dumped stone will be paid for at the contract unit price per cubic yard which price shall be full compensation for furnishing the stone, transporting, placing and shaping. Payment for removal or for covering will be made under Hand Labor and the appropriate equipment rental item.

Payment will be made under:

Pay Item	Pay Unit
656.50 Baled Hay, in place	Each
656.51 Sandbags, in place	Each
656.55 Dumped Stone	Cubic Yard
656.60 Temporary Berms	Linear Foot
656.62 Temporary Slope Drains	Linear Foot

SECTION 657 -- REHABILITATION OF PITS

657.01 Description. This work shall consist of grading and treating the surface of pit areas in accordance with these specifications and as directed.

MATERIALS

657.02 Materials. Materials shall meet the requirements specified in the following Subsections of Division 700 -- Materials:

Fertilizer	717.01
Agricultural Ground Limestone	717.02
Seed	717.03

Seed shall be in accordance with the provisions seed for Method No. 2. When used for the rehabilitation of areas except loam and sod fields, the following seed shall be added to each 100 pounds of the seed mixture: 5 pounds of Orchard Grass, 5 pounds of Reed Canary Grass, 5 pounds of Ladino Clover and 10 pounds of Sweet Clover.

CONSTRUCTION REQUIREMENTS

657.03 Grading. Upon the completion of excavating the pit, the Contractor shall grade the pit area compatible with the surroundings. Strippings shall be redistributed over the pit area as directed.

The area where granular material is exposed shall be graded to a slope of 1 horizontal to 1 vertical or flatter. The areas of all non-granular slopes shall be graded to a slope of 2 horizontal to 1 vertical or flatter. Tree stumps, roots and other debris shall be covered. The areas of pits of solid or broken ledge rock shall be trimmed of loose rock and the bottom of the pit graded to be compatible with the surroundings.

Wherever ponds are left within the pit, a slope of 4 horizontal to 1 vertical or flatter, shall extend into the water at least 16 feet to assure that the pond will not be a hazard to the public.

657.04 Surface Treatment. After completion of the grading and distribution of the strippings, the ground surface shall be fertilized and seeded as directed.

Fertilizing and seeding shall be done in accordance with the procedures of Section 618, Method Number 2 except for the added seed mixture to be used when required. The seed shall be applied at the rate of 3 pounds of seed mixture per 1,000 square foot unit.

Mulching shall be applied in accordance with Section 619 -- Mulch.

657.05 Method of Measurement. Seeding pits will be measured by the 1,000 square foot unit of land seeded, measured along the slope of the ground from the extremities of seeded area, except as noted in Subsection 657.06.

657.06 Basis of Payment. The accepted quantity of seeding pits will be paid for at the contract price per unit which price shall be full compensation for furnishing and applying agricultural ground limestone, fertilizer and the designated type seed at the specified rate, and for tilling the soil to implant the seed.

Cost of grading of slopes and bottoms of pits, grading of stripping piles over the pit and grading of all other pit areas distributed by the Contractor under this project shall be considered incidental to the various contract items and no additional payment will be made.

Mulching, when called for, will be paid for under Section 619 -- Mulch.

When the bid schedule does not contain an estimated quantity for Seeding Pits, the work, equipment and materials required to meet the requirements of Section 657 -- Rehabilitation of Pits and Section 619 -- Mulch will not be paid for directly but will be considered incidental to the other contract items.

Payment will be made under:

Pay Item	Pay Unit
657.24 Seeding Pits	Unit

SECTION 658 -- VACANT

SECTION 659 -- MOBILIZATION

659.01 Description. When this item is listed as a Pay Item in the Proposal, it shall consist of preparatory work and operations including, but not limited to those necessary to the movement of personnel, equipment, supplies and incidentals to the project site; and for all other work and operations which must be performed or costs incurred prior to beginning work on the various items on the project site.

659.02 Basis of Payment. Partial Payments will be made as follows:

- (a) When the Contract is executed, 10 percent of the amount bid for Mobilization or 1 percent of the original contract amount, whichever is lesser, will be paid.
- (b) When 5 percent of the original contract amount is earned, 30 percent of the amount bid for Mobilization or 3 percent of the original contract amount, whichever is lesser, will be paid.
- (c) When 10 percent of the original contract amount is earned, 55 percent of the amount bid for Mobilization or 5.5 percent of the original contract amount, whichever is lesser, will be paid.
- (d) When 25 percent of the original contract amount is earned, 65 percent of the amount bid for Mobilization or 6.5 percent of the original contract amount, whichever is lesser, will be paid.
- (e) When 50 percent of the original contract amount is earned, 100 percent of the amount bid for Mobilization or 10 percent of the original contract amount, whichever is lesser, will be paid.
- (f) Upon completion of all work on the Project, payment of any amount bid for Mobilization in excess of 10 percent of the original contract amount, will be paid.
- (g) The total sum of payments under this item shall not exceed the original contract amount bid regardless of the fact that the Contractor may shut down his work on the project or move equipment away from the project and then back again.

Payment will be made under:

Pay Item

Pay Unit

659.10 Mobilization

Lump Sum

SECTION 660 -- ON-THE-JOB TRAINING

Reserved

SECTION 661 -- VACANT

SECTION 662 -- GLARE BARRIER

Reserved

DIVISION 700 -- MATERIALS

GENERAL STATEMENT

For all materials used in the work for which there is no specified testing by the project Inspectors or the Laboratory, the Contractor shall submit a Materials Certification Letter similar to the following, prior to acceptance as specified in Subsection 105.17(b):

Company Letterhead

Mr. _____, Resident Date _____

Address _____ Project No. _____

Town _____

"This is to certify that the below listed materials, which were incorporated into the above designated project, comply with the pertinent specified material requirements of the contract. Processing, project testing and inspection control of raw materials are in conformity with the applicable drawings and/or standards of all articles furnished." (List only those items used on this contract.)

Bridge Railing and Hardware
Castings, Grates, Frames & Traps
Concrete Blocks, Bricks & Precast Sections
Culverts, Underdrain, Metal Sluices, Str. Plate Pipe,
Arches & Arches
Electrical Conduit
Elastomeric Expansion Devices
Erosion Control Mesh
Epoxy Resin Surface Sealant
Fencing; Posts, Fabric & Hardware
Field Painting (Paint only)
Foundation Piles
Gabions
Guard Rail, including Rail, Posts, Cable, Beams, Anchor
Rods, Brackets, Bolts and Fittings
Joint Sealant
Membrane Waterproofing
Modular Expansion Devices
Preformed Elastic Joint Seal
Pressure Treated Posts
Polyvinylchloride Waterstops
Reinforced Earth Wall
Traffic Signals & Equipment

Luminaires & Supports
Reinforcing Steel
Seed
Shear Connectors
Steel Shells
Steel Pipe Railings
Structural Steel

"All records and documents pertinent to this letter and not submitted herewith will be maintained available by the undersigned for a period of not less than 3 years from the date of completion of the project."

The Materials Certification letter must be signed by a person having legal authority to bind the Contractor.

Materials listed in the above Certificate may be subject to random sampling and testing by the Department. Certified materials which fail to meet specification requirement may not be accepted.

For Bituminous Material, the Contractor shall arrange for the Supplier to furnish a CERTIFICATE OF ANALYSIS for all bituminous liquids and cements furnished for use on the project. The Certificate shall include the actual test results of the material in storage from which the shipments are being made. The Certificate shall show conformity of the material to the applicable requirements of Section 702 -- Bituminous Material. Certificates shall be supplied for each lot, batch or blend of each type and grade of each material. The original of each Certificate of Analysis shall be mailed to the Engineer of Materials and Research, Bureau of Highways, State Department of Transportation, Augusta, Maine 04333. A new certificate shall be issued for each material at least every 30 days.

The Contractor shall give the supplier sufficient advance notice of orders to permit testing. Material not represented by tests will not be accepted for use on the work.

Deliveries of bituminous liquids and cements shall be accompanied by a loading invoice, delivery ticket or slip, as required under Subsection 109.01(f). The Loading Invoice shall be referenced by date to the applicable Certificate of Analysis and shall include a printed or stamped statement such as the following:

"THIS IS TO CERTIFY THAT THE BITUMINOUS MATERIAL REPRESENTED BY THIS LOADING INVOICE CONFORMS TO THE SPECIFICATIONS OF THE PURCHASER FOR THE MATERIAL TYPE AND GRADE STATED THEREON."

In the event an intermediate hauler of the bituminous material is involved, he shall furnish a copy of his own delivery slip, as well as a copy of the supplier's loading invoice. The hauler's delivery slip and the supplier's loading invoice shall be cross-referenced by use of their respective serial numbers.

All test procedures shall conform to the requirements of AASHTO unless otherwise noted. Gradation tests shall be completed in accordance with AASHTO T 27 except that the sample may be separated on the 1/2 inch screen and that the results of the material finer than the Number 200 sieve shall be reported to the nearest 0.1 percent.

SECTION 701 -- STRUCTURAL CONCRETE RELATED MATERIAL

701.01 Portland Cement. Portland cement shall conform to the requirements of AASHTO M 85, Type II, with a moderate heat of hydration and with the following exceptions:

- (a) The autoclave expansion shall be limited to a maximum of 0.20 percent,
- (b) There will be no requirements for tensile strength.

Only one brand of cement shall be used on any one contract unless otherwise permitted, in writing, by the Engineer.

701.02 Water. Water used in mixing or curing concrete shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable or substances injurious to the finished product. If required by the Engineer, it shall be tested by comparison with water of known satisfactory quality. Comparison shall be made by means of standard cement tests for soundness, time of setting and mortar strength. Any indication of unsoundness, marked change in time of setting or a reduction of more than 10 percent in strength from results obtained with mixtures containing water of known satisfactory quality shall be sufficient cause for rejection of the water that is being tested. Water, known to be of potable quality may be used without testing. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass or other foreign materials.

701.03 Air-entraining Admixtures. Air-entraining admixtures shall be in accordance with the requirements of AASHTO M 154 except that tests for requirements of 6.1.1. and 6.1.6. will not be required.

The materials used shall comply with one of the following requirements:

- (a) A material included in an approved list maintained by the Department. The Contractor may select any brand included in this list.

- (b) A material approved by the Testing Laboratory of the Department after examination of a recognized independent testing laboratory's documented test results of that material's performance. Acceptance will be dependent on a materials conformance to all sections of AASHTO M 154 other than the above noted exceptions.

701.04 Water Reducing Admixtures. Water reducing admixtures shall conform to the requirements of AASHTO M 194, Type A.

The materials used shall comply with the requirements of Subsection 701.03(a) and (b) except that the materials conformance will be to AASHTO M 194.

701.05 Set-retarding Admixtures. Set-retarding admixtures shall conform to the requirements of AASHTO M 194, Types B or D.

The materials used shall comply with the requirements of Subsection 701.03(a) and (b) except that the materials conformance will be to AASHTO M 194.

701.06 Curing Materials. Sheet materials for curing concrete shall conform to the requirements of AASHTO M 171 (ASTM C 171). Burlap cloth shall conform to the requirements of AASHTO M 182. Liquid membrane-forming compounds shall conform to the requirements of AASHTO M 148 (ASTM C 309).

The liquid membrane-forming compound shall comply with the requirements of Subsection 701.03(a) and (b) except that the materials conformance will be to AASHTO M 148. The two types of approved liquid membrane-forming compounds are: (1) Type 1-D, clear or translucent with fugitive dye which must be readily distinguishable for at least 4 hours and must be inconspicuous in 7 days and (2) Type 2, white pigmented.

701.07 Waterstops. Waterstops shall be polyvinylchloride and conform to the requirements of US Army Corps of Engineers Specification CRD C-572.

701.08 Heavy Roofing Felt. Wherever heavy roofing is called for on the plans an approved standard brand of asphalt saturated roofing felt, weighing about 55 pounds per 100 square feet shall be used.

SECTION 702 -- BITUMINOUS MATERIAL

702.01 Asphalt Cement. Asphalt cement shall conform to the requirements of AASHTO M 226 for Viscosity Graded Asphalt Cement and to Table 2 therein, except the spot test will not be required. The loss on heating limits shall be as given in Table 2.

702.02 Tars. Road Tars shall conform to AASHTO M 52.

702.03 Cut-Back Asphalts. Cut-back asphalts shall conform to AASHTO M 82, Cut-Back Asphalt (Medium Curing Type), except the spot test will not be required.

702.04 Emulsified Asphalt. Emulsified asphalt shall conform to AASHTO M 140, Emulsified Asphalt, except the following revisions shall be applied To Table 1: (1) Storage Stability test 24 hours shall be used instead of the 5-day settlement test. (2) For high float emulsion grades HFMS-2 and 2h, the minimum viscosity shall be 30. (3) For the coating ability and water resistance test local aggregate shall be used and calcium carbonate shall be omitted except when using limestone aggregate. (4) Any grade with no maximum viscosity shall be pumpable at 160°C (60°F). (5) The penetration of the distillation residue for grades MS-2h, HFMS-2h and SS-1h shall be 60 to 90. (6) Ductibility of the distillation residue at 25°C (77°F) shall be 60+ for all grades.

The emulsion shall adhere firmly to the surface of the mineral aggregate even though the aggregate may be of hydrophilic character.

Cationic emulsified asphalt shall conform to AASHTO M 208, except the following revisions shall apply: (1) The coating ability and water resistance test shall be performed using local aggregate. The use of calcium carbonate shall be omitted except for limestone aggregates. (2) The residue from distillation for all grades shall have a ductility of 60+ at 25°C (77°F) at 5 centimeters per minute.

702.05 Application Temperatures. Bituminous materials for the several applications indicated in the specifications shall be used within the temperature ranges of the following table.

<u>Material Type and Grade</u>	<u>Temperatures (°F)</u>	
	Mixing	Spraying
Asphalt Cement-all grades	250-325	-
Cut-Back		
Asphalt - MC-30	-	85-150
MC-70	-	110-180
MC-250	135-175	140-220
MC-800	165-210	170-260
MC-3000	180-240	200-300
Emulsified		
Asphalt - RS-1, HFMS-1, MS-4, MS-5	-	70-140
RS-2, CRS-1, CRS-2	-	125-185
MS-1, MS-2, MS-2h	50-160	70-160
HFMS-2, HFMS-2h, HFMS-3	80-170	-
CMS-2, CMS-2h	50-160	70-160
SS-1, SS-1h, CSS-1, CSS-1h	50-160	70-160

702.06 to 702.08 Vacant

702.09 Asphalt Filler for Structural Plate Arches. Asphalt for filling spaces between the structural plates and the substructure metal connectors of the arch shall conform to the requirements for bituminous material of AASHTO M 190 or of AASHTO M 226, Table 2, for viscosity grade AC-20 asphalt cement.

702.10 Bituminous Coating. Bituminous coating shall meet the requirements of AASHTO M 243, Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe Arches and Arches.

702.11 Vacant

702.12 Emulsified Bituminous Sealing Compound. Emulsified bituminous sealing compound shall be an approved commercially prepared product manufactured for specific protective coating, colored as required. It shall contain fillers, pigments and sand or fibrous materials suspended in a suitable emulsified asphalt or tar. It shall be of such consistency that it can be applied at atmospheric temperatures and capable of being easily diluted with the addition of water and mixed by hand stirring at the site of application.

SECTION 703 -- AGGREGATES

703.01 Fine Aggregates for Concrete. Fine aggregate for concrete shall consist of natural sand or, when approved by the Engineer, other inert materials with similar characteristics or combinations thereof, having strong, durable particles. Fine aggregate from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction or mix without permission of the Engineer.

All fine aggregate shall be free from injurious amounts of organic impurities. Should the fine aggregate, when subjected to the colorimetric test for organic impurities, AASHTO T 21 (ASTM C 40), produce a color darker than the reference standard color solution (laboratory designation Plate III), it shall be rejected.

The fine aggregate shall be well graded from coarse to fine and shall meet the following grading requirements when tested according to AASHTO T 11 and AASHTO T 27.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves

3/8 inch	100
No. 4	95-100
No. 8	70-95
No. 16	45-80
No. 30	25-55
No. 50	10-30
No. 100	2-10
No. 200	5 maximum

Fine aggregate failing to meet the minimum requirements for material passing the No. 50 and/or No. 100 sieves may be retested and approved for use provided an approved inorganic fine material is added to correct the deficiency in grading.

The gradation requirements given above are the extreme limits to be used in determining the suitability of materials from all possible sources of supply.

The fineness modulus shall be not less than 2.3 nor more than 3.1, nor vary by more than 0.20 from the value assumed in selecting proportions of the concrete. If this value is exceeded, the fine aggregate will be rejected unless suitable adjustments are made in proportions of coarse and fine aggregate. The fineness modulus of fine aggregate shall be determined by adding the cumulative percentages of material by weight retained on US Standard sieves Nos. 4, 8, 16, 30, 50, 100 and dividing by 100.

Mortar cubes containing the fine aggregates and made according to AASHTO T 71 (ASTM C 87) using cement conforming to AASHTO M 85, Type II, shall develop compressive strength, at the age of 7 days, of not less than 90 percent of the strength developed by a mortar prepared in the same manner with the same cement and graded Ottawa sand having a fineness modulus of 2.40 plus or minus 0.10. After the initial test for each year and the fine aggregate has been accepted, the above compressive test will not be required unless the Engineer deems it necessary.

Fine aggregate, from an individual source or stockpile used for blending when tested for absorption as specified in AASHTO T 84 (ASTM C 128), shall show a percent of absorption of not more than 2.30.

Deleterious substances shall not exceed the following limits.

	Maximum permissible limits, percent by weight
Friable particles, clay lumps, AASHTO T 112 (ASTM C 142)	1.5
Other deleterious substances such as shale, alkali, mica, coated grains, soft and flaky particles, ASTM C 295	1.0

703.02 Coarse Aggregate for Concrete. Coarse aggregate for concrete shall consist of crushed stone or gravel having hard, strong, durable pieces, free from adherent coatings and contain less than 15 percent, by weight, of thin or elongated pieces. A thin or elongated piece is defined as any piece whose length is greater than 5 times its maximum thickness.

The coarse aggregate shall not contain more than 3.0 percent, by weight, of deleterious material. No individual aggregate source or stockpile used for blending shall contain more than 4.0 percent, by weight, of deleterious material.

Deleterious material is defined as those particles of aggregate which may be crumbled in the hand and those which have an absorption greater than 3.0 percent by weight determined in accordance with AASHTO T 85 modified for weight of sample. The types which are determined to be deleterious are generally highly absorptive shales, phylites, sandstones and rotten rock of various kinds.

Coarse aggregate shall conform to the requirements of the following table for the size or sizes designated and shall be well graded between the limits specified.

Class Design	Percentage by Weight	Passing	Square Mesh	Sieves
Conc. Sizes	2" 1 1/2"	1" 3/4"	3/4" 1/2"	
AA 3/4		100	90-100	45-80
A 1	100	95-100	70-95	25-60
B 1 1/2	100	95-100	60-85	35-70
S 1 1/2	100	95-100	60-85	45-70
Y 3/4		100	90-100	45-80
Latex 1/2			100	90-100

Class	Design	Percentage by Weight		Passing	Square Mesh	Sieves
		3/8"	1/4"	No. 4	No. 8	No. 200
AA	3/4	20-55	-	0-10	0-5	1.5 max.
A	1	10-35	-	0-10	0-5	1.5 max.
B	1 1/2	10-30	-	0-5	-	1.5 max.
S	1 1/2S	20-35	-	0-10	-	1.5 max.
Y	3/4	20-55	5-20	0-10	0-5	1.5 max.
Latex	1/2	40-70	10-30	0-15	0-5	1.5 max.

The material passing the No. 200 sieve shall be determined in accordance with AASHTO T 11 and AASHTO T 27.

Coarse aggregate for a non-integral structural concrete wearing surface shall be hard and durable crushed ledge rock.

703.03 Aggregate for Plant Mix Bituminous Base.

- (a) Coarse Aggregate. Coarse aggregate shall be crushed stone or crushed gravel and shall conform to the quality requirements of Subsection 703.07.

- (b) Fine Aggregate. Fine aggregate shall conform to the requirements of Subsection 703.07.

The total aggregate shall be a blend of coarse and fine aggregate and shall conform to the requirements of Subsection 703.09 and as designated on the plans.

703.04 Aggregate for Road Mix Bituminous Base. Aggregate for road mix bituminous base construction shall be crushed rock, crushed or natural gravel. The total aggregate shall be well graded and shall conform to the gradation specified in Subsection 703.11. For material obtained from locations north of the Canadian Pacific Railroad track, the amount of deleterious material shall not exceed 16 percent by weight. For material obtained from locations south of the Canadian Pacific Railroad, the amount of deleterious material shall not exceed 8 percent.

703.05 Aggregate for Sand Leveling. Aggregate for sand leveling shall be sand of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation shall meet the grading requirements of the following table.

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
3/8 inch	85-100
No. 200	0-5

703.06 Aggregate for Base and Subbase.

- (a) Aggregate for base shall be screened or crushed gravel of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of the part that passes a 3 inch sieve shall meet the grading requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves		
	Type A Aggregate	Type B Aggregate	Type C Aggregate
1/2 inch	45-70	35-75	
1/4 inch	30-55	25-60	25-70
No. 40	0-20	0-25	0-30
No. 200	0-5	0-5	0-5

Type A aggregate for base shall not contain particles of rock which will not pass the 2 inch square mesh sieve.

Type B aggregate for base shall not contain particles of rock which will not pass the 4 inch square mesh sieve.

Type C aggregate for base shall not contain particles of rock which will not pass the 6 inch square mesh sieve.

- (b) Aggregate for subbase shall be sand or gravel of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of the part that passes a 3 inch sieve shall meet the grading requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves			
	Type D Aggregate	Type E Aggregate	Type F Aggregate	Type G Aggregate
1/4 inch	25-70	25-100	60-100	-
No. 40	0-30	0-50	0-50	0-70
No. 200	0-7	0-7	0-7	0-10

Aggregate for subbase shall not contain particles of rock which will not pass the 6 inch square mesh sieve.

703.07 Aggregates for Flexible Pavements. Coarse aggregate and fine aggregate for flexible pavements shall be of such gradation that when combined in proper portions, including filler if required, the resultant blend will meet the composition of mixture for the type of pavement specified.

- (a) Coarse aggregate, that material retained on the No. 8 sieve, shall be crushed stone or crushed gravel and unless otherwise stipulated shall consist of clean, tough, durable fragments free from an excess of flat, elongated, soft or disintegrated pieces and free from stone coated with dirt or other objectionable matter. In addition, the allowable amount of deleterious particles shall not exceed 16 percent by weight for material obtained north of the location of the Canadian Pacific Railroad and 8 percent for material obtained south of this location. Deleterious material is defined in Subsection 703.02.

When crushed gravel is used, not less than 50 percent of the particles retained on the No. 4 sieve shall have at least 1 fractured face. The coarse aggregate shall be of such gradation that, when combined with other required aggregate fractions in proper proportions, the resultant mixture will meet the gradations required under the composition of mixture for the type of pavement specified. Only one kind shall be used on the project except by permission of the Engineer.

- (b) Fine aggregate, that material passing the No. 8 sieve, shall consist of natural sand or sand prepared from stone or gravel or combination thereof. It shall consist of hard, tough grains, free from injurious amounts of clay, loam or other deleterious substances. In addition, the absorption of the fine aggregate, as determined by AASHTO T 84, shall not exceed 3.0 percent by weight for use in mixes exposed to traffic and weather.

The fine aggregate shall be of such gradation that when combined with other required aggregate fractions in the proper proportions, the resultant mixtures will meet the gradation requirements.

- (c) Composition of Mixture. The following requirements shall apply to the composite blend resulting when the stockpiled aggregates are combined to produce a mixture conforming to the specified tolerances to the gradation stated in the job mix formula.

The amount of natural or crushed gravel aggregates retained on the No. 8 sieve in a composite blend requiring crushed stone aggregate shall not exceed 15 percent of the total aggregate.

The gradation of the composite blend shall be such that the portion passing the No. 200 sieve shall not exceed 50 percent of the portion passing the No. 50 sieve.

Samples of the composite blend obtained immediately prior to addition of bituminous material shall be tested in accordance with AASHTO Designation T 176. The sand equivalent value found shall be in excess of 50.

703.08 Vacant

703.09 Aggregate for Plant Mix Hot Bituminous Pavement. The coarse and fine aggregate shall meet the requirements of Subsection 703.07. The several aggregate fractions for mixtures shall be sized, graded and combined in such proportions that the resulting composite blends will meet the grading requirements of the following tables or as otherwise specified.

Percentage by Weight Passing Square Mesh Sieves

Sieve Designation	A	B	Grading C	D	E
2 inch	100	-	-	-	-
1 1/2 inch	90-100	-	-	-	-
1 inch	-	100	-	-	-
3/4 inch	50-80	80-100	100	-	-
1/2 inch	-	50-85	90-100	100	100
3/8 inch	35-65	-	65-100	95-100	90-100
No. 4	25-50	28-60	40-70	60-80	70-100
No. 8	20-40	20-50	26-52	46-65	50-90
No. 16	13-33	14-39	17-40	25-55	36-78
No. 30	-	-	10-30	16-40	24-66
No. 50	6-24	6-24	7-22	10-30	15-50
No. 100	4-16	4-16	4-14	6-22	8-30
No. 200	1-8	1-8	2-7	3-8	3-8

703.10 Aggregate for Untreated Surface Course and Levelling Course. Aggregate for untreated surface course and levelling course shall be screened or crushed gravel consisting of hard durable particles which are free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of the material shall meet the grading requirements of the following table:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1 inch	95-100
3/4 inch	90-100
No. 4	40-65
No. 10	10-45
No. 200	0-7

703.11 Aggregate for Road Mix Bituminous Pavement. Aggregate for road mix bituminous pavement shall be crushed rock or crushed or natural gravel. The aggregate shall not contain more than 8 percent by weight of deleterious material. Deleterious material is defined in Subsection 703.02. At least 25 percent of the gravel retained on the Number 4 sieve shall have one crushed face if crushed material is specified. The total aggregate shall be well graded and shall conform to the following gradation requirements as specified.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Gradation A	Gradation B
	Crushed Stone or Crushed Gravel	Uncrushed Gravel
1 1/2 inch	-	100
1 inch	100	95-100
3/4 inch	90-100	70-90
No. 4	45-65	30-50
No. 8	32-52	-
No. 50	10-22	-
No. 200	2-8	0-5

703.12 Vacant

703.13 Aggregate for Cover Coat Material. Stone chip aggregate shall be crushed stone or crushed gravel that will meet the following elongation requirement: Not over 8 percent of the pieces shall have a length greater than 5 times their maximum thickness. The aggregate shall contain not more than 8 percent by weight of deleterious material. Deleterious material is defined in Subsection 703.02. Sand cover shall be granular material consisting of hard durable particles which are free from vegetable matter, lumps or balls of clay and other deleterious substances. Only one type of aggregate shall be used on the project unless alternate types are approved. The gradation of the materials shall conform to the grading requirements of the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Stone Chips	Sand Cover
1/2 inch	100	-
3/8 inch	85-100	85-100
No. 4	10-30	50-80
No. 8	0-10	-
No. 16	0-5	-
No. 200	-	0-5

When tested in accordance with AASHTO T 182, (ASTM D 1664) the stone chip aggregate shall have a retained bituminous film above 95 percent. The stripping tests may be omitted if the total quantity of stone chip aggregate is less than 50 cubic yards or if it comes from a source which has given satisfactory performance.

703.14 Blotter. Aggregate for blotter material shall consist of sharp durable particles of sand conforming to the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
3/4 inch	100	
No. 4	40-100	
No. 40	10-50	
No. 200	0-5	

The aggregate shall be free from vegetable and other deleterious material.

703.15 Filler. These materials shall conform to the following specification requirements for the designated materials.

Mineral filler shall conform to the requirements of AASHTO M 17.

Ground limestone shall meet the following gradation requirements:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
No. 8	100
No. 50	80-100
No. 200	30-70

703.16 Vacant

703.17 Aggregate for Stabilized Base. Aggregates for bituminous stabilized base course shall consist of granular material containing hard, durable particles conforming to the gradation requirements of the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1 1/2 inch	100
3/8 inch	60-100
No. 4	50-85
No. 8	38-74
No. 50	8-34
No. 200	0-10

The gradation shall be uniform within the limits specified and shall not vary from the low limit on one sieve size to the high limit on the adjacent sieve size. The material passing the No. 200 sieve shall be not more than 1/2 of the fraction passing the No. 50 sieve.

703.18 Common Borrow. Common borrow shall consist of earth, suitable for embankment construction. It shall be free from frozen material, perishable rubbish, peat and other unsuitable material.

The moisture content shall be sufficient to provide the required compaction and stable embankment. In no case shall the moisture content exceed 4 percent above optimum.

The optimum moisture content shall be determined in accordance with AASHTO T 180, Method C or D.

703.19 Granular Borrow. Granular borrow shall consist of sand or gravel of hard durable particles free from vegetable matter, lumps or balls of clay and other deleterious substances. The gradation of that portion passing a 3 inch sieve shall meet the gradation requirements of the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves	
	Material for Underwater Backfill	Material for Embankment Construction
No. 40	0-70	0-70
No. 200	0-10	0-20

Granular borrow shall contain no particles or fragments with a maximum dimension in excess of the compacted thickness of the layer being placed.

703.20 Gravel Borrow. Gravel borrow shall consist of uniformly graded granular material having no rocks with a maximum dimension of over 6 inches and that portion passing a 3 inch square mesh sieve shall contain not more than 70 percent passing a 1/4 inch mesh sieve and not more than 10 percent passing a No. 200 mesh sieve.

703.21 Rock Borrow. Rock borrow shall consist of hard durable rock broken to various sizes that will form a compact embankment with a minimum of voids. The maximum size for any rock shall be 3 feet in its greatest dimension.

703.22 Underdrain Backfill Material. Granular material for Underdrain Type B shall be free from organic matter and shall conform to the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1 inch	95-100
1/2 inch	75-100
No. 4	50-100
No. 20	15-80
No. 50	0-15
No. 200	0-5

Crushed or uncrushed material for Underdrain Type C shall conform to the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
1 inch	100
3/4 inch	90-100
3/8 inch	0-75
No. 4	0-25
No. 10	0-5

703.23 Vacant

703.24 Stone for French Drains. Stones for French drains shall consist of hard, durable rock and shall conform to the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
6 inch	90-100
1 1/2 inch	0-40
No. 4	0-5

Gradation test shall conform to AASHTO T 27 except that the total sample shall be sieved and the minimum weight of the sample will be 120 pounds.

703.25 Stone Fill. Stones for stone fill shall consist of sound durable rock which will not disintegrate by exposure to water or weather. Either field stone or rough, unhewn quarry stone may be used. Stones shall weigh from 10 pounds to a maximum of 500 pounds or larger if approved by the Engineer. Fifty percent by weight of the stones, shall be approximately 200 pounds.

703.26 Plain and Hand Laid Riprap. Stones shall consist of sound durable rock which will not disintegrate by exposure to water or weather. Either field stone or rough, unhewn quarry stone may be used. Exposed stones shall be angular and as nearly rectangular in cross-section as practicable. Rounded boulders or cobbles will not be permitted. Stones shall weigh from 10 pounds to 200 pounds except that when available suitable stones weighing more than 200 pounds may be used. Approximately 50 percent of the stones by volume, shall exceed a unit weight of 50 pounds.

703.27 Stone Blanket. Stones shall consist of sound durable rock which will not disintegrate by exposure to water or wind. Either field stone or rough, unhewn quarry stone may be used. Stones shall weigh from 300 pounds to 3,000 pounds. Approximately 50 percent of the stones, by volume, shall exceed a unit weight of 1,000 pounds.

703.28 Heavy Riprap. Stones shall consist of sound, durable rock, resistant to the action of air and water. Either field stone or rough, unhewn quarry stone may be used. The exposed stones shall be angular. Round or thin, flat stones will not be permitted. Stones shall have a minimum weight of 500 pounds each and at least 50 percent of the stones, by volume, shall exceed 1,000 pounds each.

703.29 Stone Ditch Protection. Rock used for ditch protection shall consist of sound, durable rock which will not disintegrate by exposure to water or weather. Field stone, rough quarry stone, blasted ledge rock or tailings may be used. The rock shall be graded within the following limits or as otherwise approved.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
12 inch	90-100
4 inch	0-15

The size of any stone shall not exceed 18 inches when measured along its longest axis.

703.30 Vacant

703.31 Crushed Stone. Crushed stone shall be obtained from rock of uniform quality and shall consist of clean, angular fragments of quarried rock, free from soft disintegrated pieces or other objectionable matter.

The stone, which shall be similar to railroad ballast, shall meet the following gradation requirements in the stockpile at the source.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieves
2 1/2 inch	100
2 inch	95-100
1 inch	0-30
3/4 inch	0-5

SECTION 704 -- MASONRY UNITS

704.01 Clay or Shale Brick. Except as modified below, brick shall conform to the requirements of one of the following specifications:

Type of Brick	Specification
Sewer and Manhole	AASHTO M 91, Grade MS or SM
Building	AASHTO M 114, Grade SW
Size Number 1 brick of a nominal length of 7 5/8 inches may be used.	

704.02 Vacant

704.03 Concrete Masonry Blocks. Concrete masonry blocks may be rectangular or segmented and when specified shall have ends shaped to provide interlock at vertical joints.

Hollow blocks shall conform to the requirements of ASTM C 90, Grade N-II, except paragraph 3.2(1). Aggregates shall meet the requirements of Section 703.01 and 703.02 for fine aggregates and coarse aggregates respectively except that grading requirements are hereby waived.

Solid blocks for catch basins and manholes shall conform to the requirements of ASTM C 139.

SECTION 705 -- JOINT MATERIAL

705.01 Preformed Expansion Joint Filler. Preformed expansion joint filler shall be non-extruding and resilient bituminous type and shall conform to the requirements of AASHTO M 213 (ASTM D 1751).

705.02 Joint Mortar. Joint mortar shall consist of 1 part portland cement, 2 parts sand and sufficient water to obtain the required consistency. Mortar shall be used within 30 minutes after its preparation.

The cement shall conform to the requirements of portland cement AASHTO M 85, Type II or IIA.

The sand shall meet the requirements of the following table.

Sieve Designation	Percentage by Weight Passing Square Mesh Sieve	
	Joints Thicker Than 1/2"	Joints 1/2" or Thinner
3/8 inch	100	-
1/4 inch	-	100
No. 4	95-100	-
No. 8	70-95	85-100
No. 16	45-80	60-90
No. 30	25-55	35-70
No. 50	10-30	15-45
No. 100	2-10	0-15
No. 200	5.0 max.	0-5

When necessary, material retained on the No. 4 sieve may be removed.

The sand shall be subjected to the colorimetric test for organic impurities, AASHTO T 21, (ASTM C 40) and when a color darker than the reference standard color solution (laboratory designation Plate III) is produced, the material shall be rejected.

705.03 Flexible Gaskets. Flexible gaskets, either rubber or plastic, shall conform to AASHTO M 198, Type A or Type B, respectively.

SECTION 706 -- NON-METALLIC PIPE

706.01 Nonreinforced Concrete Pipe. This pipe shall conform to the requirements of AASHTO M 86 except paragraph 5.2 for the specified diameters and strength classes. Aggregates shall meet the requirements of Subsections 703.01 and 703.02 for fine aggregates and coarse aggregates respectively, except that grading requirements are hereby waived.

706.02 Reinforced Concrete Pipe. Circular pipe shall conform to the requirements of AASHTO M 170, (ASTM C 76) except paragraph 5.2. Elliptical pipe shall conform to the requirements of AASHTO M 207, except paragraph 5.2. Unless otherwise specified, pipe wall design and use of elliptical reinforcement in circular pipe are optional. Pipe arch shall conform to the requirements of AASHTO M 206, except paragraph 5.2.

Aggregates shall meet the requirements of Subsections 703.01 and 703.02 for fine aggregates and coarse aggregates respectively, except that grading requirements are hereby waived.

Precast reinforced concrete special sections shall conform to the requirements of the cited specifications to the extent to which they apply.

706.03 Perforated Concrete Pipe. This pipe shall conform to the requirements of AASHTO M 175 for the specified diameters.

706.04 ABS Pipe. ABS (Acrylonitrile-butadiene-styrene) composite pipe and fittings shall conform to the requirements of AASHTO M 264 and AASHTO M 265.

706.05 ABS Pipe For Underdrain. ABS (Acrylonitrile-butadiene-styrene) composite pipe and fittings shall conform to the requirements of AASHTO M 264 and AASHTO M 265 and shall be perforated in accordance with the applicable perforation requirements of AASHTO M 36, Type III.

706.06 Corrugated Plastic Slot-perforated Pipe. This pipe shall conform to the requirements of AASHTO M 252 heavy duty.

706.07 and 706.09 Vacant

706.10 Asbestos Cement Pipe. Pipe for storm drain and other designated uses shall conform to the requirements of AASHTO M 217.

706.11 Asbestos Cement Perforated Pipe. This pipe shall meet the requirements of AASHTO M 189.

706.12 Bituminized Fiber Pipe. This pipe shall meet the requirements of AASHTO M 177.

706.13 Bituminized Fiber Perforated Pipe. This pipe shall meet the requirements of AASHTO M 177.

SECTION 707 -- METALLIC PIPE

707.01 Vacant

707.02 Zinc Coated (Galvanized) Corrugated Iron or Steel Pipe and Pipe Arches. These pipes and the coupling bands shall conform to the requirements of AASHTO M 36 for the specified sectional dimensions and sheet thickness. Special sections, such as elbows, tees and wyes, for these conduits shall be of the gage called for on the plans and conform to the applicable requirements of AASHTO M 36. Modification of coupling bands resulting in strength requirements which equal or exceed the requirements of AASHTO M 36 will be allowed upon approval.

707.03 Bituminous Coated Corrugated Iron or Steel Pipe and Pipe Arches. These pipes and the coupling bands shall conform to the requirements of AASHTO M 190 Type C for the specified sectional dimensions, gages and type of bituminous coating. The temperature of the bituminous material used for coating, except that material used for invert paving, shall be a minimum of 390 F, when applied to the pipe.

Special sections, such as elbows, tees and wyes, for these pipes shall be of the gage called for on the plans and shall conform to the applicable requirements of AASHTO M 190.

707.04 Vacant

707.05 Bituminous Coated Corrugated Iron or Steel Pipe for Underdrain. This pipe shall conform to the requirements of AASHTO M 36, Type III, Class II or Class III and shall be coated with bituminous material to meet the requirements of AASHTO M 190, Type A coating except that minimum coating thickness shall be 0.03 inch. Coupling bands shall be fully coated.

707.06 Corrugated Aluminum Alloy Pipe and Pipe Arches. These pipes shall conform to the requirements of AASHTO M 196. Special sections, such as elbows and metal end sections, shall be of the gage called for on the plans and shall conform to the applicable requirements of AASHTO M 196. Shop-formed elliptical pipe and shop strutted pipe shall be furnished where specified.

707.07 Vacant

707.08 Corrugated Aluminum Alloy Pipe for Underdrains. This pipe shall conform to the requirements of AASHTO M 196, Type III, Class II, Class III for the specified size and type.

707.09 Steel Structural Plates. Plates, bolts, nuts and other accessories shall conform to the requirements of AASHTO M 167.

707.10 Smoothlined Corrugated Iron or Steel Pipe. This pipe shall conform to the requirements of AASHTO M 36, Type 1A Pipe.

707.11 Smoothlined Corrugated Aluminum Alloy Pipe. This pipe shall conform to the applicable requirements of AASHTO M 196, Type 1A Pipe.

707.12 Bituminous Coated, Smoothlined Corrugated Iron or Steel Pipe. This pipe shall conform to the requirements of AASHTO M 36, Type 1A Pipe. After fabrication, the pipe shall be coated with bitumen on the exposed surfaces of the inside and outside of the pipe in accordance with AASHTO M 190, Type A.

707.13 Precoated, Smoothlined, Corrugated Iron or Steel Pipe. This pipe shall conform to the requirements of AASHTO M 245, Type 1A Pipe, with a coating of 3 mil thickness on the outside and 10 mil thickness on the exposed inside surface of the liner. After fabrication, all edges and surfaces which have become exposed to the

bare metal or galvanized surface because of cutting or any other reason shall be coated with asphaltic mastic or an approved equal. Coupling bands shall also be fabricated of the specified precoated iron or steel sheets and coated on both sides with a bitumen as hereinafter specified for the pipe culvert. The pipe shall then be coated with a bitumen on the exposed surfaces of the inside and outside of the pipe in accordance with AASHTO M 190, Type A, except that the minimum thickness of bitumen shall be 0.03 inches.

707.14 Aluminum Alloy Structural Plate for Pipe, Pipe Arches and Arches. Plates, bolts and nuts for this pipe shall conform to the requirements of AASHTO M 219.

SECTION 708 -- PAINTS AND STAINS

708.01 Exterior Ready Mixed Paint. Exterior paint for wood structures shall conform to the requirements of AASHTO M 70, Type I. When white paint is called for the paint shall be Class A. When tinting is required Class B shall be supplied.

708.02 Metal Bridge Paint. Paint for structural steel shall be a Lead Silico-Chromate Base System.

The materials listed shall conform to the requirements of the specifications shown below:

<u>Material</u>	<u>Test Specs.</u>
Organo Montmorillonite	Bentone 38 or equal
Basic Lead Silico Chromate	ASTM D 1648
Titanium Dioxide Rutile	ASTM D 476, Type II
Chromium Oxide Green	ASTM D 263
Synthetic Red Iron Oxide	ASTM D 3721
Fibrous Magnesium Silicate	ASTM D 605
Raw Linseed Oil	ASTM D 234
Alkyd Resin Solids	Federal Specification TT-R 266, Type I, II, III
Mineral Spirits	ASTM D 235
Driers	ASTM D 600
Lampblack	ASTM D 209

The paint pigments shall be thoroughly machine ground, mixed and thinned by the addition of oil and other ingredients specified in the formula for the paint mixture.

The paint, in freshly opened cans, shall show no skinning, nor excessive settling or caking of pigment. When a moderate amount of settling or caking occurs, the paint pigments shall be capable of

being broken up and mixed to a smooth uniform mixture of good brushing consistency. The paint shall have good spreading qualities and when brushed or sprayed on a clean, smooth, vertical metal surface, shall dry to a smooth uniform finish, free from roughness, unevenness, separation, running, streaking or sagging.

Paint shall be supplied ready mixed in new, strong, air-tight containers. The containers shall be five gallon containers unless otherwise approved by the Engineer. The outside of the containers shall be cleaned of all paint spilled during the filling operation and shall be plainly marked with the name and address of the manufacturer, the color of the paint, the number of gallons, the date of manufacture, the lot or batch number and other information that will provide pertinent identification. Containers shall be delivered unopened.

The Contractor or his authorized representative shall submit the batch formula for approval, prior to the application of the paint to the structure, (generic names rather than trade names and in weight proportions and total gallons per batch). After the paint has been manufactured a Certified Batch Analysis shall also be submitted to the Engineer for approval. The batch formula and Certified Batch Analysis shall be forwarded by the Engineer to the Materials and Research Engineer, Maine Department of Transportation, P.O. Box 1028, Bangor, Maine 04401. The Contractor or his authorized representative may submit the formula and certified batch analysis directly to Materials & Research for approval, providing notice is given to the Resident Engineer.

The Engineer shall have free access to the manufacturing plant for sampling the ingredients entering into the paint and for observing the weighing of the raw materials going into the batches and the process of the manufacture. Random samples at the manufacturing plant or the project site may be subjected to both chemical and physical analysis and, if found to be of unsatisfactory quality, the materials they represent will be rejected.

The methods of analysis shall be those approved by the American Society for Testing and Materials or otherwise specified in the applicable material specifications.

The composition of the various paints shall conform to the following Materials Table:

MATERIALS TABLE FOR LEAD SILICO-CHROMATE BASE SYSTEM

PIGMENT	FIRST		SECOND		THIRD		FOURTH	
	ORANGE	MAROON	GRAY	(Fed. Color) 395-24201	GREEN 595-14272	(Fed. Color)	MIN.	MAX.
Basic Lead Silico Chromate, %	57.0 % MIN.	62.0 % MIN.	56.0 % MIN.	41.0 % MIN.	41.0 % MIN.	MIN.	MIN.	MAX.
Organo Montmorillonite, %	95.2	84.0	85.6	81.0	81.0	81.0	81.0	81.0
*Prewet with 30% methyl alcohol: Water 95:5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0
Siliceous Red Iron Oxide (85% Fe ₂ O ₃), %	5.0	7.0	35.5	16.6	30.0	30.0	30.0	30.0
Titanium Dioxide Rutile, %								
Fibrous Magnesium Silicate and Tinting colors								
Lampblack and Phthalocyanine Blue (No Iron Blue permitted)								
Chromium Oxide Green, %								
Phthalocyanine Green								
Phthalocyanine Blue								
VEHICLE	43.0 % MAX.	38.0 % MAX.	44.0 % MAX.	59.0 % MAX.	59.0 % MAX.	59.0 % MAX.	59.0 % MAX.	59.0 % MAX.
Raw Linseed Oil %	26.0							
Alkyd Resin Solution (TT-R266 Type I Class A or B)		See note 1						
Alkyd Resin Solids (TT-R266 Type III), %	26.0							
Alkyd Resin Solids (TT-R266 Type I, II), %		7.6	7.5	39.5	39.5	39.5	39.5	39.5
Phthalic Anhydride		7.6	7.5					
Mineral Spirits and Driers, %	48.0	See note 2	31.0	See note 3	See note 3	See note 3	See note 3	See note 3
THE PAINT SHALL CONSIST OF:								
Non-Volatile Vehicle, %	52.0	72.0	69.0	59.0	59.0	59.0	59.0	59.0
Weight per Gallon, pounds	13.5	14.8	13.5	11.3	11.3	11.3	11.3	11.3
Water, %	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Coarse particles and Skins (Total residue of pigment retained on #325 sieve), %	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Consistency at 25°C (Stormer-Krebs Unit)	70	83	74	84	72	82	72	82
Finesness of Grind (North Standard)	4	4	4	4	5	5	5	5
Drying Time: Dry Through, hrs.	16	18	18	18	18	18	18	18

NOTE: In general, with all paint systems, small quantities of grinding, wetting aids, and anti-skimming agents may be used if desired.

NOTES: (1) Combined in the proportion, by weights of approximately 2 parts Raw Linseed Oil to 1 part Alkyd Resin.

(2) 28% maximum of Mineral Spirits and Driers. A drier combination of 0.14% Zirconium and 0.04% Manganese Metals

furnished in soluble form based on the non-volatile vehicle of the paint, shall be used.

(3) 41% maximum of Mineral Spirits, Driers and Solvents.

708.03 Pavement Marking Paint. Paint for final pavement marking shall meet the requirements of AASHTO M 248. Either Type N, regular dry traffic paint or Type F, fast dry traffic paint may be used.

Paint for temporary pavement marking shall retain the original color, adhere to the glass beads and shall be adequately durable to minimize the need for repainting.

Glass beads shall conform to the requirements of AASHTO M 247, Type I.

708.04 Tree Paint. Tree paint shall be an approved waterproof, adhesive and elastic paint, manufactured and customarily used for painting cuts on trees. It shall contain an antiseptic ingredient and be free from kerosene, creosote, coal tar or any other injurious material.

708.05 Timber Preservative. Timber preservatives shall conform to the requirements of AASHTO M 133.

SECTION 709 -- REINFORCING STEEL AND WELDED STEEL WIRE FABRIC

709.01 Reinforcing Steel. Reinforcing steel shall be deformed bars conforming to the requirements of AASHTO M 31. Bars shall be Grade 60 unless otherwise specified on the plans.

Fabricated steel bar or rod mats shall conform to the requirements of AASHTO M 54 (ASTM A 184).

709.02 Welded Steel Wire Fabric. Welded steel wire fabric shall conform to the requirements of AASHTO M 55 (ASTM A 185).

SECTION 710 -- FENCE AND GUARD RAIL

710.01 Barbed Wire. Barbed wire shall conform to the requirements of ASTM A 121, Class 1 if zinc coated or ASTM A 585, Class I if aluminum coated. The wire shall be 12 1/2 gage, 4 point round barbs wrapped around both wires, interlocked with one barb projecting through the strand and spaced 6 inches apart or less.

710.02 Woven Wire. Wire and stays shall conform to the requirements of ASTM A 116, Class 1 if zinc coated or ASTM A 584, Class I if aluminum coated.

710.03 Chain Link Fabric. Chain Link fabric shall conform to the requirements of AASHTO M 181, Type I, Class B or Type II.

710.04 Metal Beam Rail. The rails shall conform to the requirements of AASHTO M 180, Class A, Type 1 or Type 4 as designated.

When metal beam rail is to be installed on a curve having a radius of curvature of 150 feet or less, the beam sections shall be fabricated on an arc to the required radius.

710.05 Cedar Rail Fence. Rails and posts for cedar rail fence shall be of cedar, reasonably straight, machine or hand peeled and branch stubs cut flush.

710.06 Fence Posts and Braces. Wood posts shall be of cedar, white oak or tamarack, of the diameter or section and length shown on the plans.

Round wood posts shall be of seasoned stock straight and sound and shall have been cut from live growing trees with the outer and inner bark removed and all knots trimmed flush with the surface of the post. Rotted, loose or hollow knots, plugged or open holes will not be permitted. Sound knots will be permitted if the diameter of any one knot or the combined diameter of 2 or more knots occurring in the same cross section is not greater than one-third of the circumference of the post at that cross section. Posts shall be of uniform taper from top to butt not to exceed 1 1/2 inches in taper in 7 feet.

The minimum diameter of heartwood in line posts at their small end shall be no less than 3 inches. The minimum diameter of line posts at the small end shall be no less than 3 inches. The maximum diameter of line posts at the small end shall be 6 inches. The minimum diameter of heartwood in end, corner, gate and barway posts shall be 4 1/2 inches at the small end. The minimum diameter of end, corner, gate and barway posts at the small end shall be 4 1/2 inches. The maximum diameter of end, corner, gate and barway posts shall be 8 inches.

That portion of wood posts to be set below ground shall be immersed to a depth of 4 feet in a tank or barrel containing 5 percent pentachlorophenol solution for a minimum of 60 minutes. All wood posts so treated, unless otherwise specified by the Engineer, shall have been peeled and air seasoned to permit thorough drying for at least 3 months prior to treatment. After being treated, the posts shall be piled to permit thorough drying before being set in the ground.

Braces shall be of spruce, eastern hemlock, Norway pine, pitch pine or tamarack timbers or spruce, cedar or tamarack round posts of sufficient length to make a diagonal brace between adjacent posts. If other than cedar, white oak or tamarack, braces shall be treated as described above for posts except that they shall be immersed full length.

Metal posts and braces for woven wire fence shall be of new billet steel conforming to the requirements of ASTM A 615 or Commercial Standard 184-51, or shall be rail steel conforming to the requirements of ASTM A 616, or ASTM A 499. Posts shall be galvanized according to the requirements of AASHTO M 111. Steel pipe used for woven wire fence corner posts, for rails and for bracing shall conform to the requirements of ASTM A 53, galvanized.

Metal posts, rails and bracing for chain link fence shall be as specified in AASHTO M 181. Expansion sleeves, turnbuckles and other fittings and hardware shall be galvanized in accordance with the applicable requirements of ASTM A 153.

710.07 Guard Rail Posts. Posts shall be of wood or steel.

- (a) Wood posts shall be of cedar, tamarack, white oak, Norway pine, southern yellow pine, pitch pine, Douglas fir, maple, beech, birch or red oak. They shall be of well seasoned, straight and sound timber cut from live growing trees, free from loose knots or other structurally weakening defects, including shake, holes and heart rot over 1 inch in diameter. The posts shall be free from season checks that exceed 1/4 inch in width. A tolerance of 1 inch in length and 1/4 inch in width or thickness is permitted in the dimensions of rectangular posts. They shall be well sawn and have square edges except that wane not more than 1 1/2 inches wide and extending not more than 1/2 the length of the piece will be allowed on that portion of the post to be placed below ground. Sound, tight, well spaced knots to 2 1/2 inches diameter will be permitted.

The posts shall be pressure treated with creosote oil or 50-50 creosote petroleum solution for a minimum retention of 6 pounds per cubic foot using the empty cell process. All line posts and offset brackets shall be bored and trimmed prior to preservative treatment. The standards of the AASHTO M 133 shall be followed for treatment of all wood posts.

- (b) Galvanized steel posts shall conform to the requirements of AASHTO M 183 and shall be galvanized and shall be in accordance with AASHTO M 111.
- (c) Steel corrosion resistant steel posts shall conform to the requirements of ASTM A 588.

710.08 Guard Rail Hardware. Guard rail hardware shall conform to the applicable standards contained in the latest ARTBA Bulletin No. 268B, "A Guide to Standardized Highway Barrier Rail Hardware", approved by the AASHTO-ARTBA-AGC Joint Cooperative Committee, Technical Bulletin Number 268-B.

All galvanized fittings, bolts, washers, twisted end section anchors and other accessories shall be in accordance with the requirements of AASHTO M 111 or AASHTO M 232, whichever applies. All galvanizing shall be done after fabrication.

Hardware for corrosion resistant guard rail shall be in accordance with ASTM A 325, Type 3, except the 16 inch bolts and nuts for attaching the metal beam rail to the posts which may be galvanized as specified above.

SECTION 711 -- MISCELLANEOUS BRIDGE MATERIAL

711.01 Steel Pipe Piles. Steel pipe piles shall conform to the requirements of ASTM A 252, Grade 2 with chemical requirements meeting ASTM A 53, Grade B. Pile points shall conform to the requirements of ASTM A 36.

711.02 Gabions. Tensile strength of all wire used for manufacturing the gabions and lacing wire shall range from 60,000 to 80,000 pounds per square inch when tested in accordance with ASTM A 370.

Mesh openings shall be hexagonal shape, measuring approximately 3 1/4 by 4 1/2 inches and uniform in size. Mesh joints shall be flexible and triple twisted with steel wire to prevent unraveling. Steel wire shall be galvanized with a minimum amount of zinc coating of 0.80 ounces per square foot of wire when tested in accordance with ASTM A 90.

- (a) Galvanized Gabions without Polyvinylchloride Coating. The diameter of the steel wire mesh shall be 0.1181 inches after galvanizing. The diameter of the selvedge wire, running through all the edges (perimeter wire), shall be 0.1535 inches after galvanizing. The above wire sizes shall be to a tolerance of ± 2.50 percent.
- (b) Polyvinylchloride (PVC) Coated Gabions. When specified on the plans, all galvanized steel wire shall be coated with a minimum of 0.015 inches of black PVC, which shall be suitable to resist destructive effects of immersion in acidic, salt, or polluted water, exposure to ultra violet light and abrasion and retain these characteristics after a period of not less than 3,000 hours under test in accordance with ASTM G 23. The diameter of the steel wire mesh shall be 0.1063 inches after galvanization and an overall diameter of 0.1463 inches, core wire plus PVC coating.

The diameter of the selvedge wire running through all the edges (perimeter wire) shall be 0.1339 inches after galvanizing and an overall diameter of 0.1739 inches, core wire plus PVC coating. The diameter of the wire for assembling and lacing the gabion units shall be 0.0866 inches after galvanizing and an overall diameter of 0.1266 inches, core wire plus PVC coating. All wire gages shall be to a tolerance of ± 2.50 percent, the thickness of the PVC excluded.

An uncut section of the mesh not less than 6 feet long and 3 feet wide shall withstand a load test of 6,000 pounds applied to an area of 1 square foot located approximately in the center of the section under test. The details of this test are as follows: An uncut section of mesh 6 feet long and of a minimum width of 3 feet, including all selvedge bindings, shall have the ends securely clamped for 3 feet along the width of the sample. When the width of the section under test exceeds 3 feet, the clamps shall be placed in the middle portion of the width and the excess width shall be allowed to fall free on each side of the clamped section. The sample shall then be subjected to sufficient tension to cause 10 percent elongation of the sample section between clamps. After elongation and while clamped as described above (and otherwise unsupported), the section shall be subjected to a load applied to an area of 1 square foot located approximately in the center of the sample section between the clamps and in a direction perpendicular to the direction of the tensile force. The sample shall withstand without rupture of any wire or opening of any mesh fastening, an actual load, so applied, equaling or exceeding 6,000 pounds. The ram head used in the test shall be circular with its edges beveled or rounded to prevent cutting of the wires.

Each shipment of gabions to a job site shall be accompanied by a certificate which states that the material conforms to the requirements of this specification. The certificate shall be on manufacturer's letterhead and shall be signed by an officer of the company having legal authority to bind the company.

711.03 Stones for Gabions. Stones to fill gabions shall be of clean, hard and durable rock with a minimum dimension of 4 inches in all directions and a maximum dimension of 12 inches.

711.04 Bridge Drains. The pipe for Bridge Drains shall conform to the requirements of ASTM A 53, black, Grade B, Type E or S. All bars and plates shall conform to the requirements of ASTM A 36, except if angles are used to attach the pipe to the structural steel, the angles shall be the same type as the structural steel.

711.05 Protective Coating for Concrete Surfaces. The coating shall be a blend of 50 percent by volume boiled linseed oil and 50 percent petroleum spirits. The linseed oil shall comply with the requirements of ASTM D 260. Petroleum spirits shall be kerosene, diesel fuel or shall be mineral spirits complying to the requirements of ASTM D 235. CAUTION: This blend is flammable.

711.06 Stud Shear Connectors. Steel studs shall conform to AASHTO M 169, cold drawn bars, grade 1015 thru 1020, either semi-killed or fully-killed. If flux retaining caps are used, the steel for the caps shall be of a low carbon grade, suitable for welding and shall comply with ASTM A 109.

Stud shead connectors may be welded in the shop or in the field.

Only studs qualified in accordance with the requirements of AASHTO Standard Specifications for Highway Bridges shall be used. The arc shield used in production shall be the same as used in the qualification test.

Before ordering studs, the Contractor shall submit to the Engineer for approval the following information:

The name of the manufacturer.

A detailed description of the stud and arc shield to be furnished.

Reference to the qualification test covering the material to be furnished.

If the studs to be used are listed on the Department's approved list of manufacturers, the requirements of 2 and 3 above may be waived.

Finished studs shall be of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends or other injurious defects. Finish shall be as produced by cold drawing, cold rolling or machining.

Tensile properties shall be determined by tests of bar stock after drawing or by full diameter finished studs and shall conform to the following requirements:

Tensile strength (minimum)	60,000 psi
Yield Strength (minimum)	50,000 psi*
Elongation (minimum)	20 percent in 2 inches
Reduction of area (minimum)	50 percent

*As determined by a 0.2 percent offset method.

Testing shall be performed in accordance with the applicable sections of ASTM A 370. Tensile test of finished studs shall be made as described in AASHTO Standard Specifications for Highway Bridges, 2.10.3(11)(6).

If fracture occurs outside the middle half of the gage length, the test shall be repeated.

An arc shield (ferrule) of heat-resistant ceramic or other suitable material shall be furnished with each stud. The material shall not be detrimental to the welds or cause excessive slag and shall have sufficient strength so as not to crumble or break due to thermal or structural shock before the weld is completed.

Flux for welding shall be furnished with each stud, either attached to the end of the stud or combined with the arc shield, for automatic application in the welding operation.

SECTION 712 -- MISCELLANEOUS HIGHWAY MATERIAL

712.01 Vacant

712.02 Calcium Chloride. Calcium chloride shall conform to the requirements of AASHTO M 144 (ASTM D 98).

712.03 Vacant

712.04 Stone Curbing and Edging. Stone for curbing and edging shall be approved granite from acceptable sources. The stone shall be hard and durable, predominantly gray in color, free from seams which impair its structural integrity and of smooth splitting character. Natural grain size and color variations characteristic of the source deposit will be permitted. Such natural variations may include bands or clusters of mineral or both of mineral crystallization that do not impair the structural integrity of the curb stone. The dimensions, shape and other details shall be as shown on the plans.

The exposed face of stone curb shall be free from indications of drill holes. Half drill holes not larger than 3/4 inch diameter will be permitted in the arris line in the plane of the back.

- (a) Vertical Curb, Type 1 shall have a top surface sawed or dressed to an approximate true plane with no depression or projection on that surface of over 1/8 inch. The top front arris line shall be pitched straight and true with no variations from a straight line greater than

1/4 inch. The top back arris line shall meet the same requirement except that indentations of a maximum of 3/8 inch will be allowed. There shall be no projection or depression on the back face which would exceed a batter of 1 horizontal on 3 vertical for a distance from the top of 3 inches.

The front face shall be at right angles to the top and shall be smooth split and have no projections greater than 1 inch or depressions greater than 1/2 inch, measured from the vertical plane of the face through the top arris line, for a distance down from the top of 8 inches. The remainder of the face shall have no projections or depressions greater than 1 inch from the plane of the face.

The ends of the curb shall be approximately square with the planes of the top, back and face and so finished that when the sections are placed end to end with the required minimum spacing of 1/4 inch no more than 5/8 inch space shall show in the joint for the full width of the top surface and for the entire exposed front face. The remainder of the end may extend back no more than 8 inches from the plane of the joint.

Drill holes through the curb will be allowed providing they are at least 9 inches below the top and are mortared full with portland cement mortar before placing the stone.

- (b) Miscellaneous Stone Curb. When a depressed or modified section of curb is called for on the plans or ordered by the Engineer, for driveways, crossings, closures, transitions or for other reasons, the Contractor shall furnish curbing with the required modifications.
- (c) Curb Inlets. Inlets used at catch basins shall conform to the applicable requirements of Vertical Curb, Type 1 and to the shape, dimensions and details as shown on the Standard Detail plans.
- (d) Vacant
- (e) Vertical Bridge Curb, Type 1 shall conform to the requirements above, except as indicated on the plans and as follows:

1. The back face of the curb stones shall have no projections or depressions greater than 1 inch, measured from the vertical plane of the back face through the arris or pitch line down to the bottom of the stone. The front face shall be finished as required for Vertical Curb, Type 1, except that it shall be finished the full distance down on the face. Bottoms of curb stones shall be approximately parallel to the top and sawed or dressed to lay with a bedding of approximately 1 inch for the full length of the stone.
2. Anchor holes shall be provided in the back of the stones pitched down as shown on the plan, a maximum of 12 inches from each end of the stone and spaced horizontally at approximately 2 feet apart. A minimum of 2 anchor holes shall be provided in each stone.
3. The ends of stones at expansion joints between spans and at ends of bridge shall be cut to present a vertical face when set in position, bevelled to the skew angle, if any and the entire end finished in the same manner as the top.
4. The exposed edges of the stones at intermediate joints shall be trimmed square with the planes of the top and front face so that a neat, parallel joint, free from drill holes is formed between the stones. Length of stones shall be so scheduled that joints will be uniform in width along any run of curb. Joints shall be 1/2 inch, plus or minus 1/8 inch. A joint shall be provided at each curb and sidewalk contraction joint of the bridge.
5. Stones set transversely at ends of bridge, when the grade exceeds 2 percent, shall have the top bevelled to fit the grade of the bridge.
6. Mortar for bedding shall be composed of 1 part portland cement and 2 parts sand with sufficient water to form a workable mix. Cement, sand and water shall conform to Section 502 -- Structural Concrete.
7. Mortar for pointing shall be composed of equal parts sand and portland cement with sufficient water to form a workable mix and shall conform to Section 502 -- Structural Concrete.

8. Portland cement grout shall be made the same as mortar for pointing, except that consistency shall be such that it will flow readily.

- (f) Curb Type 5. The exposed face shall be smooth split to an approximate true plane having no projections or depressions which will allow over 1 inch to show between a 2 foot straightedge and the face when the straightedge is placed as closely as possible on any part of the face. Half drill holes not more than 3 inches in length and 3/4 inch in diameter will be permitted along the bottom. The arris line, top front shall be straight and true with no variation from a straight line greater than 1/8 inch. The arris lines at the bottom of the face shall be straight and true so that not over 1 inch shall show between the stone and a straightedge for the full length of the stone. The ends shall be square to the length at the face and so finished that when the stones are placed end to end, no space more than 1 1/2 inches will show in the joint for the width of the face.

When Curbing Type 5 is required on a curve, the pieces shall be shaped as described in the table on the Standard Detail plans.

712.05 Reflectorized Plastic Pavement Markings. The reflectorized plastic final pavement marking material shall conform to AASHTO standards and shall be a retro-reflective, prefabricated, conformable polymer thermoplastic consisting of polymeric materials, pigments, reflective glass spheres uniformly distributed throughout the entire cross section with a reflective layer of glass spheres bonded to the top surface and shall be capable of being affixed to bituminous pavement and concrete pavement by a pressure sensitive precoated adhesive or a liquid contact cement. The reflectorized marking material shall be plastic of the cold applied preformed type as compared to the hot applied extruded or sprayed thermoplastic.

The reflectorized plastic final pavement marking material shall be capable of conforming to pavement contours, breaks and faults and shall have resealing characteristics. The top surface of the plastic shall have maximum glass sphere retention qualities, shall have a matte finish and shall be a minimum of 60 mils thick without adhesive.

The reflectorized plastic final pavement marking material shall have the following initial minimum reflectance values at 0.2° observation angle and 86.0° entrance angle as measured in accordance with the testing procedures of Federal Test Method Standard 370. The photometric quantity to be measured shall be specific luminance (SL) and shall be expressed as millicandelas per square foot per foot-candle (mcd ft⁻² fc⁻¹). The test distance shall be 50 ft. and the sample size shall be a 2.0 x 2.5 ft. rectangle.

The angular aperture of both the photoreceptor and light projector shall be 6 minutes of arc. The reference center shall be the geometric center of the sample and the reference axis shall be taken perpendicular to the test sample.

	White		Yellow	
Observation Angle	0.2°	0.5°	0.2°	0.5°
SL (mcd·ft-2·fc-1)	550	380	410	250

Temporary plastic pavement markings material shall be pliant polymer material designed for short term pavement marking, shall be removable without requiring grinding or burning and shall possess the following initial minimum reflective values when tested as above:

Color	White	Yellow
Observation angle	0.2°	0.2°
SL (mcd·ft-2·fc-1)	1770	1310

712.06 Precast Concrete Units. Precast concrete units shall conform to the plan dimensions and shall meet the requirements of ASTM C 478 except as modified below.

Cement shall conform to Subsection 701. An approved air entraining admixture shall be added if needed to obtain the required entrained air content.

Aggregates shall meet the quality requirements of Subsection 703.01 and Subsection 703.02 except that limitations on grading and the fineness modulus may be omitted. The concrete mix design shall be approved by the Laboratory. Concrete shall contain 6 percent entrained air, plus or minus 1 1/2 percent.

712.07 Tops, Traps and Ladder Rungs. These metal units shall conform to the plan dimensions and to the following specification requirements for the designated materials.

Gray iron castings shall conform to the requirements of AASHTO M 105, Class 30, unless otherwise designated.

Carbon steel castings shall conform to the requirements of AASHTO M 103. Grade shall be 65-35 unless otherwise designated.

Structural steel shall conform to the requirements of AASHTO M 183 or ASTM A 283, Grade B or better. Galvanizing, where specified for these units, shall conform to the requirements of AASHTO M 111.

Aluminum steps for manholes and catch basins shall conform to ASTM B 221, Alloy 6061-T6 or 6005-T5.

712.08 Corrugated Metal Units. The units shall conform to plan dimensions and the metal to AASHTO M 36. Bituminous coating, when specified, shall conform to AASHTO M 190 Type A.

712.09 to 712.22 Vacant

712.23 Flashing Lights. Flashing Lights shall be power operated or battery operated as specified.

- (a) Power operated flashing lights shall consist of housing, adapters, lamps, sockets, reflectors, lens, hoods and other necessary equipment designed to give clearly visible signal indications within an angle of at least 45 degrees and from 10 to 300 feet under all light and atmospheric conditions. Two circuit flasher controllers with a two-circuit filter capable of providing alternate flashing operations at the rate of not less than 50 nor more than 60 flashes per minute shall be provided.

The lamps shall be 650 lumens, 120 volt traffic signal lamps with sockets constructed to properly focus and hold the lamp firmly in position.

The housing shall have a rotatable sun visor not less than 7 inches in length designed to shield the lens.

Reflectors shall be of such design that light from a properly focused lamp will reflect the light rays parallel. Reflectors shall have a maximum diameter at the point of contact with the lens of approximately 8 inches.

The lens shall consist of a round one-piece convex amber material which, when mounted, shall have a visible diameter of approximately 8 inches. They shall distribute light and not diffuse it. The distribution of the light shall be asymmetrical in a downward direction. The light distribution of the lens shall not be uniform, but shall consist of a small high-intensity portion with narrow distribution for long distance throw and a larger low-intensity portion with wide distribution for short distance throw. Lenses shall be marked to indicate the top and bottom of the lens.

- (b) Battery operated flashing lights shall be self-illuminated by an electric lamp behind the lens. These lights shall also be externally illuminated by reflex-reflective elements built into the lens to enable it to be seen by reflex-reflection of the light from the headlights of oncoming traffic. The batteries must be entirely enclosed in a case. The case must be secured by a locking device. The light shall have a flash rate of not less than 50 nor more than 60 flashes per minute from minus 20°F to plus 150°F. The light shall have an on-time of not less than 10 percent of the flash cycle. The light beam projected upon a surface perpendicular to the axis of the light beam shall produce a lighted rectangular projection whose minimum horizontal dimension shall be 5 degrees each side of the horizontal axis. The effective intensity shall not have an initial value greater than 15.0 candelas or drop below 4.0 candelas during the first 336 hours of continuous flashing. The illuminated lense shall appear to be uniformly bright over its entire illuminated surface when viewed from any point within an angle of 9 degrees each side of the vertical axis and 5 degrees each side of the horizontal axis. The lens shall not be less than 7 inches in diameter including a reflex-reflector ring of 1/2 inch minimum width around the periphery. The lens shall be yellow in color and have a minimum relative luminous transmittance of 0.440 with a luminance of 2854° Kelvin. The lens shall be one piece construction. The lens material shall be plastic and meet the luminous transmission requirements of this specification. The case containing the batteries and circuitry shall be constructed of a material capable of withstanding abuse equal to or greater than No. 18 U.S. Standard Gage Steel. The housing and the lens frame, if of metal shall be properly cleaned, degreased and pretreated to promote adhesion. It shall be given one or more coats of enamel which, when dry shall completely obscure the metal. The enamel coating shall be of such quality that when the coated case is struck a light blow with a sharp tool, the paint will not chip or crack and if scratched with a knife will not powder. The case shall be so constructed and closed as to exclude moisture that would affect the proper operation of light. The case shall have a weep hole to allow the escape of moisture from condensation. Photoelectric controls, if provided, shall keep the light operating whenever the ambient light falls below 20 foot candles. Each light shall be plainly marked as to the manufacturer's name and model number.

If required by the Engineer, certification as to conformance to these specifications shall be furnished based on results of tests made by an independent testing laboratory. All lights are subject to random inspection and testing. All necessary random samples shall be provided to the Engineer upon request without cost to the Department. All such samples shall be returned to the Contractor upon completion of the tests.

712.24 through 712.31 Vacant

712.32 Copper Tubing. Copper tubing and fittings shall conform to the requirements of ASTM B 88, Type K or better.

712.33 Non-metallic Pipe, Flexible. Non-metallic pipe and pipe fittings shall be acceptable flexible pipe manufactured from virgin polyethylene polymer suitable for transmitting liquids intended for human or animal consumption.

712.34 Non-metallic Pipe, Rigid. Non-metallic pipe shall be a rigid plastic pipe of an extrudable synthetic thermoplastic of styrene copolymer, polyethylene or polyvinylchloride or approved equivalent. The pipe shall be corrosion resistant, uniform wall thickness, smooth circular bore, standard wall IPS dimensions with inside walls smooth enough and hard surfaced to permit the insertion of water supply lines. Fittings shall be of the same material of the weld socket type, screw type or plug type with clamping bands.

712.341 Metallic Pipe. Metallic pipe shall be ANSI Schedule 80 steel pipe conforming to the requirements of ASTM A 53 Types E and S, Grade B. End plates shall be steel conforming to ASTM A 36.

Both the sleeve and end plates shall be hot dip galvanized. Pipe sleeve splices shall be welded splices with full penetration weld before galvanizing.

712.35 Epoxy Resin. Epoxy resin for grouting or sealing shall consist of a mineral filled thixotropic, flexible epoxy resin having a pot life of approximately one hour at 50°F. The grout shall be an approved product suitable for cementing steel dowels into the preformed holes of curb inlets and adjacent curbing. The sealant shall be an approved product, light gray in color and suitable for coating the surface of portland cement concrete curbing.

712.36 Bituminous Curb. Bituminous curb shall be in reasonable conformity to the dimensions shown on the plans and of a shape acceptable to the Engineer. The asphalt cement shall be of the grade required for the wearing course, or shall be Viscosity Grade AC-20 meeting the current requirements of Subsection 702.01 Asphalt Cement. The aggregate shall conform to the requirements of Subsection 703.07. The coarse aggregate portion (retained on the No. 8 sieve) may be either crushed rock or crushed gravel.

The mineral constituents of the bituminous mixture shall be sized and graded and combined in a composite blend that will produce a stable durable curbing with an acceptable texture.

Bituminous material for curb shall meet the requirements of Section 403 -- Hot Bituminous Pavement.

712.37 Precast Concrete Slab. Portland cement concrete for precast slabs shall meet the requirements of Section 502 -- Structural Concrete, Class A.

The slabs shall be precast to the dimension shown on the plans and cross section and in accordance with the Standard Detail plans for Concrete Sidewalk Slab. The surface shall be finished with a float finish in accordance with Subsection 502.14(c). Lift devices of sufficient strength to hold the slab while suspended from cables shall be cast into the top or back of the slab.

712.38 Stone Slab. Stone slabs shall be of granite from an acceptable source, hard, durable, predominantly gray in color, free from seams which impair the structural integrity and be of smooth splitting character. Natural color variations characteristic of the deposit will be permitted. Exposed surfaces shall be free from drill holes or indications of drill holes. The granite slabs in any one section of backslope must be all the same finish.

The granite slabs shall be scabble dressed or sawed to an approximately true plane having no projections or depressions over 1/2 inch under a 2 foot straightedge or over 1 inch under a 4 foot straightedge. The arris at the intersection of the top surface and exposed front face shall be pitched so that the arris line is uniform throughout the length of the installed slabs. The sides shall be square to the exposed face unless the slabs are to be set on a radius or other special condition which requires that the joints be cut to fit, but in any case shall be so finished that when the stones are placed side by side no space more than 3/4 of an inch shall show in the joint for the full exposed height.

Liftpin holes in all sides except the exposed face will be allowed.

SECTION 713 -- STRUCTURAL STEEL AND RELATED MATERIAL

713.01 Structural Steel.

(a) Structural Steel shall conform to one or more of the following ASTM Specifications as designated on the plans:

1. A 36 Structural Steel.
2. A 242 High-Strength Low-Alloy Structural Steel.

3. A 514 High Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
 4. A 570 Hot-rolled Carbon Steel Sheet and Strip, Structural Quality.
 5. A 572 High Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality (Grade 50 only).
 6. A 588 High Strength Low-Alloy Structural Steel with 50,000 psi. Minimum Yield Point, to 4 inches thick.
- (b) In addition to the requirements of the applicable ASTM Specifications, Notch Toughness Requirements, as specified in Table A, are mandatory for main load-carrying members except as otherwise indicated on the plans. For purposes of this specification main load-carrying members shall be those parts of a structure carrying calculated stresses, including webs and flanges of welded plate girders, rolled shapes used as girders, floorbeams and stringers and all splice material other than filler plates for such members.
- (c) High Strength, Low-Alloy corrosion resistant steel conforming to ASTM A 588 shall be of Grade A, B, F or G. Other grades will be acceptable, provided satisfactory weldability data are submitted to and approved by the Engineer before the order is placed and provided the grade is not otherwise prohibited under this contract.

High Strength Bolts for use with unpainted ASTM A 588 steel shall conform to ASTM A 325 Type 3. All other bolts or fasteners which will remain in the finished structure shall be of material having the same weathering characteristics as ASTM A 588 steel.

Steel conforming to ASTM A 242 may be used as an alternate ASTM A 588 steel, for members other than main stress carrying members that do not require welding.

TABLE A -- NOTCH TOUGHNESS REQUIREMENTS

Steel Designation	Thickness-Inches	Charpy V-notch Impact Test
ASTM A 36	: Up to 4"	: Min. 15 ft. lb. @ 40°F
ASTM A 514	: Up to 4" mechanical fasteners	: Min. 25 ft. lb. @ 0°F
	: Up to 2 1/2"	: Min. 25 ft. lb. @ 0°F
	: welded Over 2 1/2"	
	: to 4" welded	: Min. 35 ft. lb. @ 0°F
ASTM A 572	: Up to 4" mechanical fasteners	: Min. 15 ft. lb. @ 40°F
	: Up to 2" welded	: Min. 15 ft. lb. @ 40°F
ASTM A 588	: Up to 4" mechanical fasteners	: Min. 15 ft. lb. @ 40°F
	: Up to 2" welded	: Min. 15 ft. lb. @ 40°F
	: Over 2" to 4"	
	: welded	: Min. 20 ft. lb. @ 40°F

If the yield point for the material exceeds 65 ksi., the temperature for the CVN value for acceptability shall be reduced by 15°F for each increment of 10 ksi. or fraction thereof above 65 ksi.

- (d) Impact test sampling and testing procedures shall be in accordance with ASTM A 673. Frequency (H) shall be used.
- (e) Submission of test reports for all tests required under the applicable ASTM Specifications and this specification is mandatory.

713.02 High Strength Bolts. Bolts, nuts and washers shall conform to the requirements of ASTM A 325.

Unless otherwise shown on the design drawings or approved by the Engineer, Type 1 bolts shall be supplied for all structures, except for those structures utilizing ASTM A 588 steel in the unpainted condition.

For all structures utilizing ASTM A 588 steel in the unpainted condition, Type 3 bolts shall be supplied.

When galvanized high strength bolts are specified, Type 1 bolts, Type 2H or DH nuts and quenched and tempered washers shall be supplied. Bolts, nuts and washers may be galvanized using either the hot-dip coating process or the mechanically deposited coating process conforming respectively to ASTM A 153, Class C or ASTM B 454, Class 50. In the case of hot-dip galvanized nuts the nuts shall be retapped oversized by an amount compatible with the size of the nut.

Bolt and nut dimensions shall conform to the requirements of ANSI B18.2.1 for heavy hex structural bolts and B18.2.2 for heavy hex nuts respectively and said dimensions are summarized in Table 1 of this specification.

Threads for bolts and nuts 1 inch in diameter and smaller shall be UNC, Class 2A and 2B respectively and for bolts 1 1/8 inch in diameter and larger shall be 8UN, Class 2A and 2B respectively as defined in ANSI B 1.1.

Dimensions of washers shall conform to those shown in the latest issue of the "Specifications for Structural Joints Using ASTM A 325 Bolts", as issued by the Research Council on Riveted and Bolted joints of the Engineering Foundation and said dimensions are summarized in Table 2 of this specification.

TABLE 1 - BOLT AND NUT DIMENSIONS (inches)

Bolt					Nut		
Nominal bolt size	Width across Flats	Height of head	Thread length	Add to grip for bolt length ¹	Width across Flats	Height	
1/2	7/8	5/16	1	13/16	7/8	31/64	
5/8	1 1/16	25/64	1 1/4	1 1/16	1 1/16	39/64	
3/4	1 1/4	15/32	1 3/8	1 3/16	1 1/4	47/64	
7/8	1 7/16	35/64	1 1/2	1 5/16	1 7/16	55/64	
1	1 5/8	39/64	1 3/4	1 7/16	1 5/8	63/64	
1 1/8	1 13/16	11/16	2	1 11/16	1 13/16	1 7/64	
1 1/4	2	25/32	2	1 13/16	2	1 7/32	
1 3/8	2 3/16	27/32	2 1/4	1 15/16	2 3/16	1 11/32	
1 1/2	2 3/8	15/16	2 1/4	2 1/16	2 3/8	1 15/32	

¹allowance for one circular washer is included.

Table 1 Notes:

Grip is the total thickness of material to be connected, exclusive of washers.
Bolt lengths shall be determined by adding the values given in the 5th column of Table 1 to the grip and if necessary, adjusting upwards to next 1/4 inch increment.

When using bevelled washers 1/8 inch shall be added to the grip for one washer and 7/16 inch for two. Dimensions listed in the table shall be governed by tolerances as specified in ANSI Standards B18.2.1. and B18.2.2.

TABLE 2 - WASHER DIMENSIONS (inches)

Circular Washers										:Square or Rectangular Beveled :Washers for American Beams :and Channels		
Bolt Size	:Nominal	:Nominal	:Thickness	:Minimum	:	:	:	:Slope or	:	:		
	:Outside	:Diameter:	:	:side	:	:Mean	:	:taper in	:	:		
D	:Diameter ¹	: of Hole:	Min.	Max.	:dimension:	thickness:	thickness:	:	:	:		
1/2	: 1	1/16	: 17/32	: .097	.177	: 1 3/4	: 5/16	: 1:6	:	:		
5/8	: 1	5/16	: 21/32	: .122	.177	: 1 3/4	: 5/16	: 1:6	:	:		
3/4	: 1	15/32	: 13/16	: .122	.177	: 1 3/4	: 5/16	: 1:6	:	:		
7/8	: 1	3/4	: 15/16	: .136	.177	: 1 3/4	: 5/16	: 1:6	:	:		
1	: 2		: 1 1/16	: .136	.177	: 1 3/4	: 5/16	: 1:6	:	:		
1 1/8	: 2	1/4	: 1 1/4	: .136	.177	: 2 1/4	: 5/16	: 1:6	:	:		
1 1/4	: 2	1/2	: 1 3/8	: .136	.177	: 2 1/4	: 5/16	: 1:6	:	:		
1 3/8	: 2	3/4	: 1 1/2	: .136	.177	: 2 1/4	: 5/16	: 1:6	:	:		
1 1/2	: 3		: 1 5/8	: .136	.177	: 2 1/4	: 5/15	: 1:6	:	:		

¹May be exceeded by 1/4 inch.

713.03 Preformed Pads. Preformed pads shall be made with new unvulcanized rubber and unused fabric fibres and shall be approximately 1/8 inch thick after compression and vulcanizing with a proportion of fibre content sufficient to maintain strength and stability. The surface hardness shall be 85 to 95 Shore A Durometer. The ultimate breakdown limit of the pad under compressive loading shall be no less than 10,000 pounds per square inch.

713.04 Bronze or Copper-Alloy Bearing and Expansion Plates. Bronze bearing and expansion plates shall conform to the requirements of AASHTO M 107 (ASTM B 22), Alloy No. 911 and copper-alloy bearing and expansion plates shall conform to the requirements of AASHTO M 108, (ASTM B 100) Alloy No. 510 or 511, unless otherwise specified. The bearing surface(s) subject to sliding action shall be provided with trepanned recesses (not grooves) filled with a lubricating compound. The lubricating compound shall consist of graphite and metallic substances with a lubricating binder capable of withstanding the atmospheric elements. The compound shall be pressed into the recesses so as to form dense, non-plastic lubricating inserts. The lubricating area shall comprise between 25 and 35 percent of the total area of the plate subject to sliding action. The sliding surface(s) shall be planed parallel to the prevailing direction of movement of the structure and subsequently polished, unless detailed otherwise.

713.05 Cold-finished Carbon Steel Shafting. Cold-finished carbon steel shafting shall conform to the requirements of AASHTO M 169 (ASTM A 108). Grade Designation 1021-1030 inclusive, cold drawn, either semi-killed or fully-killed shall be furnished unless otherwise specified.

713.06 Castings. Gray iron castings shall conform to the requirements of AASHTO M 105. Class Number 30 shall be furnished unless otherwise specified.

Malleable iron castings shall conform to the requirements of ASTM M 47. Grade Number 35018 shall be furnished unless otherwise specified.

Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting their strength and value for the service intended.

Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect.

All castings must be sand blasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean and uniform surface.

713.07 Metal Bin Type Retaining Wall. The base metal for bin type retaining wall members shall conform to the applicable requirements of AASHTO M 36.

When asbestos coating is specified, the galvanized metal sheets used to form the retaining wall, except the base plates and connecting channels, shall be coated on both sides with a layer of asbestos fibers applied in sheet form by pressing it into the molten spelter. Immediately after the metallic bond has solidified the asbestos fibers shall be thoroughly saturated with a bituminous saturant conforming to the following requirements:

Penetration at 25°C, 100g., 5 sec.	35-45
Loss on heating at 163°C, (325°F) 50g., 5hrs.	Not more than 1.5%
Flash point (open cup)	Not less than 440°F
Penetration at 25°C, 100g., 5 sec., of residue after heating at 163°C, (325°F) as compared with penetration of asphalt before heating	Not less than 70%
Insoluble in carbon disulfide	Not more than 2%

Testing shall be in accordance with methods specified in AASHTO M 20.

Whenever possible in the manufacture of the units, a minimum forming radius of 1 inch is to be maintained. All units that are formed with less than 1 inch radius shall be hot-dipped galvanized after forming.

Bolts shall conform to the requirements of AASHTO M 164 (ASTM A 325) and galvanized in accordance with ASTM Designation A 153.

SECTION 714 -- JOINT SEALS

714.01 Elastomer for Seal Elements. The elastomer for seal elements, both compression and gland type, shall be poly-chloroprene rubber (Neoprene) conforming to the requirements of ASTM D 2628, except that for gland type seal elements the low temperature and high temperature recovery tests may be omitted, the hardness shall be Durometer A, 60 ± 5 and the compression set test, ASTM D 395 shall be modified to be conducted for 22 hours at 158°F (70°C) with a maximum set of 25 percent.

Ethylene Polypropylene Diene Monomer (EPDM) may be supplied as an alternate material for gland type seal elements. Its hardness shall be Durometer A, 80 ± 5 and the oven aging test, ASTM D 573 shall be revised to allow 25 percent maximum loss of elongation. All other requirements shall be as above described for Neoprene.

714.02 Fabric for Seal Elements. Fabric used for reinforcement in a seal element shall be a non wicking fabric conforming to the requirement of ASTM D 578.

714.03 Lubricant Adhesive. The lubricant-adhesive shall be a 1 part, moisture curing, polyurethane and aromatic hydrocarbon solvent mixture and shall have the following physical properties:

Solids content	60-80 percent by weight
Service Range	5°F to 120°F minimum
Film Strength (ASTM D 412)	1200 psi minimum
Elongation at Break	250 percent minimum

Each lot of lubricant-adhesive shall be delivered in sealed containers plainly marked with the manufacturer's name or trademark and the date of manufacture.

714.04 Sealant. The sealant shall be a one part, moisture curing, polyurethane base elastomeric product, conforming to the requirements of Federal Specification TT-S-00230C, Type II, Class A.

Each lot of sealant shall be delivered in sealed containers plainly marked with the manufacturer's name or trademark and the date of manufacture.

714.05 Compression Seals. Compression seals shall be multi-channel extruded shapes made of polychloroprene rubber (Neoprene). At the time of manufacture, the seals shall be clearly marked, on

the top surface, at 1 foot + 1/16 inch intervals and shall show the manufacturer's name or trademark, the lot number and the size designation at intervals of 5 feet or less.

Each type and size of seal shall be prequalified. Such prequalification shall be valid for use on any project for a period of 5 years. In order to be prequalified a 2 foot length of seal shall be submitted to the Engineer. The Engineer will have pressure-deflection tests made and will establish a movement rating based upon the results of said tests.

The minimum depth of the seal, measured at the contact surface shall be at least 65 percent of the nominal uncompressed width of the seal.

For each type and size of seal on a project, a notarized statement from the manufacturer, attesting conformance with the provision of Subsection 714.01, shall be submitted, accompanied by notarized copies of the results of all required tests, specified under Section 714.01 and as modified thereby.

714.06 Gland Type Seals. Gland type seals shall be single membrane extruded or molded shapes, made of material conforming to the requirements of Subsection 714.01 and of a configuration as determined by each manufacturer and as shown on the plans. The seals shall be marked on the top surface with the manufacturer's name or trademark, the lot number and the size designation at intervals of 5 feet or less. If fabric is used to reinforce the seal, it shall conform to the requirements of Subsection 714.02.

For each type and size of seal on a project a notarized statement from the manufacturer, attesting conformance with the provisions of Subsection 714.01 shall be submitted, accompanied by notarized copies of the results of all required tests, specified under Subsection 714.01 and as modified thereby.

714.07 Stud Bolts. Stud bolts shall be pitch diameter base, solid fluxed studs. Material for stud bolts shall conform to ASTM A 108 (AASHTO M 169), Grade 1020, either semi-killed or fully-killed. Nuts for stud bolts shall conform to ASTM A 307, Grade B. Thread shall be UNC2A.

714.08 Steel Extrusions. Material for steel extrusions for expansion devices shall be ASTM A 36, A 588 or A 242, except that ASTM A 242 shall not be used for extrusions that are to be welded.

SECTION 715 -- LIGHTING MATERIAL

715.01 Vacant

715.02 Steel Conduit. Galvanized steel conduit shall be of uniform thickness with scale-free, smooth circular bore to permit cutting of clean, true threads.

Steel conduit and couplings shall be Schedule 40 galvanized steel pipe conforming to the requirements of ASTM A 53. Threaded couplings shall be conduit type permitting the end of conduits to fully abut each other squarely within the coupling. Other fittings for metal conduit, exclusive of bushings shall be threaded malleable iron conforming to the requirements of ASTM A 338 and shall be galvanized in accordance with the requirements of ASTM A 153.

All bushings shall be threaded, insulated grounding type.

715.03 Non-Metallic Conduit. Non-metallic conduit shall be rigid unplasticized polyvinylchloride conduit, suitable for Type II or Type III installations, whichever is required and shall conform to the standards of the NEMA or the UL.

715.04 Prewired Conduit. The prewired conduit shall be a unit assembly consisting of the required insulated conductors and neutrals enclosed in a medium or high density polyethylene duct. The conduit shall be flexible enough for easy coiling or uncoiling at -10°C. The duct shall be extruded directly over the paralleled conductors at the factory.

The percent of conduit fill shall be in accordance with the NEC and the UL.

(a) Scope: Polyethylene plastic pipe in either medium density or high density grade, in sizes 3/4 through 2 1/2 inches for direct earth burial.

(b) Materials:

1. Medium density polyethylene shall meet the applicable requirements as defined in ASTM D 1248-70a, Type II, Class C, Category 5 Grade P23.
2. High density polyethylene shall meet the applicable requirements as defined in ASTM D 1248-70a, Type III, Class C, Category 5 Grade P34.
3. In addition, the above materials shall meet the requirements as shown below:

<u>Property</u>	<u>Medium Density</u>	<u>High Density</u>	<u>Test Method</u>
Tensile Strength, Minimum psi	2500	2800	ASTM D 638
Elongation, Minimum Percent	400	400	ASTM D 638
Melt Index, Maximum	0.4	0.4	ASTM D 1238
Brittle Temperature 80% Non-failure	-76°C	-76°C	ASTM D 746
Environmental Stress Cracks Resistance, Maximum Failures Per 10 Specimens After 48 Hrs.	2	2	ASTM D 1693

The duct shall have dimensions consistent with iron pipe size Schedule 40 conduit. The prewired conduit shall be shipped in continuous lengths on suitable reels.

The wires shall be stranded soft drawn coated copper conductors individually insulated with class THW insulation rated at 75°C, wet or dry. Insulation thickness shall be 600 volt rated. Phase identification shall be accomplished by numerical coding. Duct size and wire size shall be as indicated on the plans. The wire shall be UL approved.

Terminal connections, splices and test data requirements shall be as specified in Subsection 715.07.

715.05 Metallic Junction and Fuse Box. Surface-mounted junction boxes and fuse boxes shall be of either hot-dipped galvanized cast iron or cast aluminum with hinged screw down covers.

Cast iron boxes shall conform to the requirements of Gray and Malleable Iron Castings, Subsection 713.06. Cast aluminum boxes shall conform to ASTM B 108 or ASTM B 26, alloy 356.0.

All boxes shall be furnished with mounting lugs of adequate sizes and threaded bosses properly located and of sufficient thickness to provide a minimum of five full threads for all sizes of conduit used.

Fuse boxes shall be furnished with 5-ampere, cartridge type midget fuses, 13/32 inch in diameter and 1 1/2 inches long with 600 volt fuse holder, unless indicated otherwise on the plans. Fuse boxes shall be bossed for fuse holder mounting.

715.06 Bituminized Fiber Junction Box. Bituminized fiber junction or pull box shall be a bituminized compound, reinforced with a multi-ply laminated spiral fibrous structure, bonded with a water resistant adhesive. The fibrous material shall be thoroughly impregnated with the bituminous compound.

The box shall meet the chemical and physical requirements of Sections 3.1, 4.2, 4.3, 4.4, 4.5, 4.6 of ASTM D 2418 when tested in accordance with ASTM D 2315. It shall be 18 inches long, 18 inches nominal inside diameter with a wall thickness of 0.375 inches. The dry crushing strength, with a load applied parallel to the axis of the pipe shall be a minimum of 600 pounds per linear foot. Axial compressive crushing strength shall be a minimum of 40,000 pounds.

TABLE I

Nominal Inside Diameter	:	Nominal Length	:	Min. Wall Thickness	:	Min. Crush	:	Strength
	:		:		:		:	
Inches	:	Inches	:	Inches	:	lbs/l.f.	:	lbs.
18	:	18	:	0.375	:	600	:	40,000
	:		:		:		:	

The box cover shall be cast iron and marked with the word "ELECTRIC" and secured to the pull box with two stainless steel 3/8 inch-16 NC captive bolt clevises which will enable the lid to be removed without separating bolt from clevis. The clevis shall be fastened to the wall of the pull box with a 1/4 inch stainless steel bolt.

715.07 Secondary Wiring. Secondary wiring cables, including neutrals and grounding conductors, shall be 600 volt cables and shall consist of single conductor, stranded, soft-drawn or annealed copper wire, insulated with flame retardant, moisture and heat resistant thermoplastic material. The cable shall be UL approved and listed as THW.

Wire shall be of sufficient size to allow a maximum voltage drop of 5 percent from source of power to the most remote luminaire. Phase identification shall be made by factory-applied color coding.

Terminal lugs shall be cast copper alloy, solderless, mechanical type.

All conduit connections in above ground junction boxes and light standards shall be made by connector kits, fused or non-fused, as indicated on the plans. Splices for the roadway lighting shall be made by straight through or wye connector kits as required. Where these connector kits cannot be used as verified by the Engineer, connections on cables in junction boxes shall be made by splicing as described elsewhere. The connector kits shall be a quick disconnect type.

Fused "we" connectors shall be composed of a "we" line side housing assembled with a load side and fuse terminal housing. The housing shall be formed from water-resistant synthetic rubber. Each housing shall provide a water seal around the cables and when fully assembled shall form a water-tight connector.

The interior shall be arranged to receive and retain line side wiring and the fuse contacts. The fuse contacts shall be spring-loaded copper designated for 30 amperes, 600 volts, shall have 90 percent minimum conductivity and shall be suitable for gripping a 5 amp or as designated on the plans, 600 volt cartridge type midget fuse approximately 13/32 inch in diameter and 1 1/2 inches long. The contacts shall be fully annealed. The load side conductors shall be connected by crimping and the line side conductors shall be connected with screws. The connector shall be of the non-locking type that will break off under extreme tensile stress leaving no exposed metal contacts on the line side of the connector.

The cable diameter used will determine the size of each housing. The load side housing shall retain the fuse when disconnected.

Non-fused connectors shall be similar to the fused "we" connectors. The cable diameter will determine the size of each housing of each connector.

Fuses for connectors shall be rated at 5 amperes or as indicated on the plans.

Underground splices shall be made with cast epoxy splice kits.

715.08 Luminaire, Lamp and Ballast. The luminaire shall be designed for the wattage rating and voltage indicated on the plans and for operation on a multiple circuit, using the type of lamps indicated on the plans. All luminaires shall be the product of the same manufacturer.

The luminaire shall be constructed of an aluminum housing and refractor-holder, a refractor-holder latch on the street side and hinge with safety catch on the house side of the luminaire, a detachable reflector with heat resisting gasketing between the reflector and the socket entry. Luminaire shall mount by a slipfitter, which shall clamp onto at least 7 inches of a 1 1/4 to 2 inch bracket.

The prismatic refractor shall be constructed of clear heat and shock resistant material or of a material which will give similar light and transmission qualities with superior shock resistance.

The luminaire shall be able to produce by socket adjustment IES distributions indicated on the plans.

The luminaire shall have a high power factor integral ballast, of the regulator or constant-wattage type capable of operating from a multiple circuit indicated on the plan. The ballast shall be prewired to the lamp socket and terminal board, requiring only connection of the power-supply leads to the ballast primary terminals. The ballast shall be capable of starting the lamp at -20°F. The minimum efficiency of the ballast shall not be less than 80 percent; the power factor not less than 96 percent.

The regulator ballast shall provide regulation within 2 percent variation in lamp watts.

Each luminaire shall be provided with an internal ground stud to accommodate a Number 12 AWG stranded ground wire and so labeled.

The Contractor shall submit shop drawings of the luminaire, a sample luminaire for inspection and the following information:

- Isofootcandle curves
- Utilization curves
- Temperature and mounting height correction factors
- Candle power distribution or isocandela diagrams.

Lamps shall be of the type and wattage rating indicated on the plans. Lamps used shall conform to the lamp designations as listed in the latest edition of the IES Lighting Handbook. The lumen output rating shall conform to the handbook listing.

Underpass or underdeck luminaires shall be constructed such that the refractor is hinged and can be opened for maintenance without the use of tools. The beam angles shall be field adjustable for, but not limited to, 60° and 70° settings. The ballast shall be integrally mounted, regulator or constant wattage type and designed to operate from a 3 wire 240/480 volt circuit or voltage indicated on the plans.

The ballast shall maintain lumen output within 5 percent for as much as 10 percent primary voltage variation. Ballast shall provide satisfactory lamp starting and operation to -20°F. The prismatic refractor shall be constructed of clear heat and shock resistant glass or a material which will give similar light transmission qualities.

Pole top luminaires shall be of colonial or traditional design and shall consist of a cast aluminum base and slipfitter for 3 inch outside diameter pole top, aluminum side posts which are gasketed to the translucent white acrylic lens panels and cast aluminum top housing. The canopy shall be hinged to the lower housing, held closed with two captive screws and gasketed to the lens. In addition, the internal reflector/refractor assembly shall be gasketed. The ballast shall be prewired to the terminal socket. The luminaire shall be factory painted black.

715.09 Luminaire, Lamp and Ballast for High Mast Lighting. The luminaire and ballast shall be designed for the wattage rating and type of lamp shown on the plans.

The maximum weight of the luminaire shall be 105 pounds and its projected area shall not exceed 3.1 square feet.

The luminaire shall be open ventilated design with an optical system consisting of an aluminum reflector. The reflector shall have a smooth, non-porous inner surface and shall be readily attached to the ballast assembly by means of a captive stainless steel nut and machine screw.

The reflector with its aluminum cover shall be firmly attached to a cast ring. This ring shall have keyhole slots in its upper surface such that the reflector/refractor assembly may be readily attached to or detached from the luminaire bracket entry and lamp support assembly without completely removing the support bolts.

The luminaire ballast shall be enclosed within a Number 356 alloy cast aluminum housing which integrally attaches to the luminaire bracket entry and lamp support assembly. It shall be readily removable without removing the luminaire from the bracket arm.

The luminaire shall be attached to the bracket arm by a bracket entry and lamp support assembly. The base for this assembly shall be cast aluminum. The assembly shall include a side entry slipfit-ter designed for 2 inch pipe with provision for $\pm 3^\circ$ adjustment for levelling the luminaire. The lamp shall be vertical burning and prevented from undue vibration and backing out by means of a stainless steel lamp clamp attached to the assembly but separate from the socket. An enclosed terminal block shall be included such that all electrical connections shall be removed from exposure to weather. A stainless steel or aluminum rolled rain shield shall be attached to the outside of this assembly.

All cast aluminum parts of the luminaire shall conform to ASTM B 26 or ASTM B 108, Alloy 356.0.

The luminaire shall provide ANSI-IES Type I, Type IV or Type V distributions:

715.10 Photo Electric Control. The control shall meet the following minimum requirements:

Unit Design. The photo electric unit shall consist of a light sensitive element connected directly to a control relay without intermediate amplifications. The unit shall be zenith sensing type.

Housing. The photo electric control shall be housed in a weather-proof housing.

Operating Levels. The operating levels shall be factory set to turn on at approximately 2.0 footcandles and off at approximately 6.0 footcandles.

Supply Voltage. The control shall be capable of operation on a supply voltage of 105 to 285 volts.

Base. The base of the unit shall be provided with a 3-prong, EET-NEMA standard twist lock plug mounting.

Directional Design. The control shall be oriented in a northerly direction according to the manufacturer's recommendation.

Surge Protection. The unit shall have a built-in surge protective device for protection from induced high voltage and follow-through currents.

715.11 Service Equipment. The service pole or service rack and other entrance equipment shall be as detailed on the plans.

The control cabinet shall be fabricated from cast aluminum, sheet aluminum, galvanized steel or stainless steel. The following are required.

Hinged cover with weather protected hasp for padlocking. The lock will be provided by others.

Mounting brackets.

Suitable bossed and threaded holes in the case wall for conduit installation.

Independent single pole magnetic trip circuit breakers.

Manual control switch.

Lightning arresters in load and line side - rated 650 Volts RMS, indoor type.

Contactor - One double pole, single throw contactor with contacts rated at the voltage and amperes shown on the plans. The coil shall be capable of operating at the voltage shown on the plans, 60 hertz. The Contactor shall have contacts normally open unless otherwise specified. The contacts shall be fine silver, silver alloy or other material with similar contact resistance.

Ground rods shall be copperclad steel, 5/8 inch diameter, 8 feet long, complete with ground clamp and square head bolt.

Dry-Type transformers shall be designed for indoor and outdoor installation.

The following are required:

25 KVA rating, 120/240 volt primary, 240/480 volt secondary, single phase 3 wire system, if single phase service is supplied.

Frequency - 60 hertz.

Key-hole mounting slots and lifting groove.

Insulation system for 115°C rise at 40°C ambient.

Wiring compartment located on bottom front of unit. Access through a single cover.

Heat barrier to protect connecting cables.

Connecting leads to extend 6 inches from box and identified with metal tags.

Core and coils to be contained within a non-ventilated weather-proof enclosure.

Conduit knockouts to be located on bottom, back and sides of wiring compartment.

Maximum sound level to be 40 decibels.

Rack-mounted circuit breakers shall be enclosed in NEMA 3R enclosures with raintight hubs. The breakers shall be rated for 3 pole, 125 amperes, 600 volt, 4 wire service. Lugs for padlocking shall be supplied.

The service entrance rack shall be constructed as shown on the plan. Minor modifications will be permitted, if approved by the Engineer to accommodate variations in equipment dimensions. Lumber shall be as shown on the plan. Bolts and hardware shall be hot-dipped galvanized steel.

715.12 Lowering System for High Mast Lighting. Each pole shall be furnished with a mechanical lowering system operated by cables and an electrically operated winch which will permit servicing of the luminaires and associated electrical and mechanical apparatus from the ground. Lowering systems shall permit lowering of the complete assembly, including luminaires, ballasts, fuses and other apparatus which may require periodic inspection or servicing, to a height of 5 feet or less above the pole base plate.

At the top of the pole shaft there shall be mounted a detachable head assembly which remains fixed in position during the raising and lowering operation. The head assembly shall consist of 3 or more symmetrically located fixed support arms which will carry the weight of the lowering assembly. The fixed head assembly shall incorporate no moving parts except for the necessary pulleys, rollers or sheaves which guide the lowering cables and electrical cable during the lowering operation of the assembly. The fixed head assembly and luminaire lowering ring shall be ASTM A 588 weathering steel. All required pulley rollers or sheaves and associated bearings, bushings and shafts shall be constructed of highly corrosion resistant materials not relying upon plating of the parent material for corrosion protection. All pulleys and rollers attached to the head assembly shall have permanently lubricated bearings or bushings.

All parts of the head assembly shall be protected with covers, screens, shields, as necessary, to prevent entrance of dirt, moisture, ice accumulation, nesting of insects or birds or other contaminants harmful to the operation of the lowering device.

All miscellaneous fittings, fasteners or hardware shall be fabricated from corrosion resistant materials not relying on plating for their corrosion protection.

A lightning rod of approved design shall be attached to the top of each pole and shall be firmly attached to the pole shaft or head assembly to provide good electric bonding to the pole shaft.

The entire luminaire lowering ring assembly shall be raised and lowered by three or more symmetrically placed stainless steel aircraft type cables located inside the pole shaft and extending through the head assembly support arms and attached to the lowering ring. Electrical cable supplying energy from the base of the pole to the luminaire ring shall be rough service mining type cable consisting of 3-600 volt conductors assembled into a single cable. No electrical disconnect shall be permitted at the top of the pole. In addition, a stainless steel guide cable or equivalent shall be attached to the inside of the pole shaft to prevent the twisting of the lowering and electrical cables during the raise-lower operation. Each of the stainless steel lowering cables shall be capable of supporting the entire lowering assembly.

When the luminaire ring assembly is in the fully raised position, a mechanism for securing the luminaire ring to the head assembly shall be provided. Such mechanism shall provide support for the lowering ring and shall latch the ring to the head assembly thus permitting the removal of all tension on the cables. All mechanisms shall be designed to provide the operator with a positive means of ascertaining when the raising operation is complete and the ring assembly is in the proper resting position.

The inner portion of the lowering ring shall be equipped with a protective bumper or roller system which will prevent damage to the pole shaft surface and preclude excessive swing during the lowering-raising operation.

Winches shall be operated by an appropriately geared 120 volt electric drive motor with adjustable torque limiter which can be easily hand-transported. One drive motor assembly shall be furnished for this contract which will operate all units furnished. The drive motor shall be designed to be readily attached to the pole and/or winch unit and capable of being controlled remotely from at least 20 feet from the pole. The drive motor unit shall be equipped with a 480 to 120 volt weatherproof step-down transformer either attached to the drive motor assembly or supplied in a separate enclosure. Transformer to be of a size compatible with the drive motor and be adequately grounded to prevent electric shock. A rubber covered heavy duty type "SO" rated 600 volt cable with connectors shall be provided to test the luminaires when they are in a fully lowered position.

An approved junction box shall be installed in the handhole of each pole which will accommodate the terminations of the underground cable with the cable in the pole serving the luminaires and to include a 480 volt grounded receptacle.

Secondary lightning arresters shall be rated for 650 volts RMS and shall be designed for outdoor use. The arresters shall be installed in each phase conductor to ground and shall be attached in or on the luminaire lowering device in a location accessible for inspection and servicing when the device is lowered.

715.13 Astronomical Time Switch. The time switch shall be installed in a welded steel case suitably protected with a zinc rich primer and epoxy tar finish, an aluminum weatherproof case or a stainless steel case. External fitting shall be corrosion-resisting steel and provision shall be made for padlock mounting.

The time switch shall meet the following requirements:

Energize lighting system at sunset and de-energize at sunrise.

Be designed to operate on the designed circuit voltage.

Be operated by a synchronous motor with mainspring reserve with 10 hour carryover during power failure.

On-off switching scheduled to be controlled by an astronomical dial which will energize the magnetic Contactor.

SECTION 716 -- STRUCTURAL ALUMINUM AND RELATED MATERIAL

716.01 Aluminum Railings.

- (a) Aluminum Extrusions. Traffic rails, hand rails, splice bars and pales brackets shall conform to the requirements of ASTM B 221, Alloy 6061-T6 or 6351-T5. Post and post bases shall conform to the requirements of ASTM B 221, Alloy 6061-T6. Pales shall conform to the requirements of ASTM B 429, Alloy 6063-T5. Washers shall conform to the requirements of ASTM B 209, Alloy Alclad 2024-T4.
- (b) Aluminum Rivets. Rivets shall conform to the requirements of ASTM B 316, Alloy 6061-T6 (cold heading). Rivets shall have a button-type manufactured head. Self-plugging, aluminum blind fasteners for pale panels shall meet the following requirements: 1) Sleeve-ASTM B 211, Alloy 5056 (Stabilized), 2) Pin-ASTM B 211, Alloy 2017 (Naturally Aged). The driven fastener shall meet the requirements for ultimate shear and tensile strength of Military Specification MIL-R-7885.
- (c) Miscellaneous Aluminum Parts. Rail caps shall be either sand cast or permanent-mold cast and shall conform to the requirements of ASTM B 26 or ASTM B 108, Alloy S5A-F or SG70A-F (Aluminum Association Alloy B 443-F or 356-F). All aluminum bars and plates shall conform to the requirements of ASTM B 211 or B 221, Alloy 6061-T6.
- (d) Steel Anchor Assembly. Steel spacers for post anchors shall conform to the requirements of ASTM A 36. Nuts embedded in concrete shall conform to the requirements of ASTM A 307.

Anchor bolts, exposed nuts and washers shall conform to the requirements of ASTM A 449 and shall be hot dipped galvanized in accordance with ASTM A 153.
- (e) Stainless Steel Parts. Cap screws, for fastening clamp bars and for fastening bases to posts and set screws for pale-panel brackets shall conform to the requirements of ASTM A 276, Type 304, Condition "A", cold finished.

SECTION 717 -- ROADSIDE IMPROVEMENT MATERIAL

717.01 Fertilizer. Fertilizer shall be commercial fertilizer having available elements in conformity with the standards of the Association of Official Agricultural Chemists. The fertilizer shall be furnished in unopened bags with the weight, contents and guarantee analysis shown thereon or on a securely attached tag.

- (a) Granular Fertilizer shall be a commercial grade fertilizer containing the following percentages of available nutrients by weight:

Nitrogen	10 percent
Phosphoric Acid	10 percent
Potash	10 percent

- (b) Water soluble fertilizer shall be completely soluble in water and contain the following percentages of available nutrients by weight. It shall contain a coloring agent.

Nitrogen	16 percent
Phosphoric Acid	32 percent
Potash	16 percent

- (c) Slow release fertilizer packets shall be slow release fertilizer contained in a polyethylene perforated bag with micropore holes. Each bag shall contain 4 ounces of minimum water soluble fertilizer to be effective for 8 years. Packets shall contain the following percentage of available elements by weight:

Nitrogen	20 percent
Phosphoric Acid	10 percent
Potash	5 percent

The Engineer may approve the use of other fertilizers providing they contain an equivalent amount of nutrients in an acceptable form.

717.02 Agricultural Ground Limestone. Agricultural ground limestone shall have the following mechanical analysis: At least 50 percent shall pass the Number 100 mesh sieve, 90 percent shall pass the Number 20 mesh sieve and 100 percent shall pass the No. 10 mesh sieve. The total carbonates shall not be less than 90 percent.

Agricultural ground limestone may be shipped in containers or in bulk. Packaged material shall be delivered in the manufacturer's standard containers. The containers shall be new and so constructed to assure safe arrival at the site. The net weight of the contents, shall not exceed 100 pounds per container. The manufacturer's name and a guarantee analysis and the net weight shall appear on each container. Bulk shipments shall be accompanied by certificates stating manufacturer's name, weight and guarantee analysis.

717.03 Seed. All seed shall be certified as to mixture, germination and purity. Each variety of seed shall have a percentage of germination of not less than 80, a percentage of purity of not less than 85 and shall have not more than one percent of weed content. All seed shall be from the same or previous year's crop unless recent tests by an approved testing agency demonstrate that older seed meets the above requirements.

Seed Mixtures. The seed mixtures shall consist of seeds proportioned percent by weight as follows:

Method Number 1
Park Mixture

Creeping Red Fesque 50%
Kentucky Bluegrass 30%
Annual Ryegrass 20%

Method Number 2
Roadside Mixture

Creeping Red Fesque 40%
Kentucky Bluegrass 25%
Kentucky 31 Fesque 25%
White Clover 5%
Crown Vetch 5%

Crown Vetch seed (*Caronille varia*) shall be hulled and re-cleaned Penngift, Chemung or other approved Crown Vetch seed of the previous year's crop. Inoculating bacteria for crown vetch shall be furnished. The Crown Vetch seed shall be treated with inoculating bacteria immediately prior to sowing the seed, in accordance with the directions of the supplier. Inoculant shall be kept refrigerated at all times until used. When a hydraulic method of seeding is used, 3 times the normal recommended rate of inoculant shall be used.

717.04 Mulch.

- (a) Hay or straw mulch shall consist of long fibred hay or straw, reasonably free from noxious weeds and other undesirable material. No material shall be used which is so wet, decayed or compacted as to inhibit even and uniform spreading. No chopped hay, grass clippings or other short fibred material shall be used unless directed.
- (b) Cellulose fiber mulch shall consist of natural wood, recycled paper or humus cellulose fiber containing no materials which will inhibit seed germination or plant growth. Sufficient non-toxic water soluble green dye shall be added to provide a definite color contrast to the ground surface to aid in even distribution. Cellulose fiber mulch shall be supplied in uniform packages not exceeding 100 pounds each marked to show the air dry weight.

(c) Wood chips for mulch shall be obtained from green wood and shall average 1/8 inch in thickness with 50 percent having an area of not less than 1 square inch nor more than 8 square inches. Not more than a total of 2 percent by volume shall consist of sawdust, shavings and leaves. The mulch shall contain no foreign material injurious to plant growth. Wood chips made from badly weathered or decayed material will not be accepted. Wood chips which have been stored long enough to become decayed will not be accepted unless approved by the Engineer.

(d) Bark mulch shall consist of soft wood bark fragments of such size and texture as to successfully resist washing or blowing under normal conditions but capable of being easily and uniformly spread around the plants. No large peel strips and decayed material will be permitted.

(e) Stone mulch shall be clean native stone, except limestone, consisting of stone particles passing a 3/4 inch screen, but retained on a 1/4 inch screen. This material shall be free from dust, dirt or other foreign matter.

Stone mulch will normally be used around individual trees or on plant beds that are in traffic islands or in other areas requiring frequent mowing. Wood Chip or bark mulch will normally be used on all other plant pits and beds.

(f) Plastic membrane shall be an approved black plastic blanket of at least 6 mil. thickness.

717.05 Mulch Binder. Material for mulch binder may be emulsified asphalt of a type acceptable to the Engineer and may be diluted with water to assure even distribution. Other types of approved mulch binders may be used when authorized.

717.06 Erosion Control Mesh.

(a) Jute erosion control mesh shall be of uniform plain weave single jute yarn averaging approximately 130 pounds per spindle of 14,400 yards. The yarn shall be loosely twisted having an average twist of not less than 1.6 turns per inch and shall not vary in thickness more than 1/2 its normal diameter. The mesh shall be woven 48 inches in width, plus or minus 1 inch, 78 warp ends per width of cloth; 41 weft ends per yard and shall be furnished in lengths of not less than 100 feet. The weight shall be approximately 1.22 pounds per linear yard with a tolerance of plus or minus 8 percent. All materials shall be new and unused.

The Engineer may approve mesh with minor variations in material or weave provided that weight requirements per unit of area are met. He may also approve mesh of a different width.

- (b) Excelsior blanket erosion control mesh shall consist of a machine produced mat of curled wood excelsior of 80 percent 6 inches or longer fiber length. The fiber shall be of consistent thickness and evenly distributed over the entire area of the blanket. The top side of each blanket shall be covered with either a 3 by 1 inch weave of twisted kraft paper having a high wet strength or a 2 by 1 inch biodegradable extruded plastic mesh. The blanket shall be made smolder-resistant without the use of chemical additives.

Width, in inches	Type I	36	$\pm$ 1 inch
	Type II	48	$\pm$ 1 inch
Length, in inches	Type I	150	average
	Type II	180	average
Weight per roll, pounds	Type I	40	$\pm$ 10%
	Type II	64	$\pm$ 10%
Weight pounds per sq. yard		00.8 lbs.	$\pm$ 10%
Fiber dimensions		.021 x .042	$\pm$ 25%

- (c) Staples for fastening erosion control mesh shall be U shaped made from 11 gage or heavier steel wire stiff enough to be forced vertically into the ground without bending. Staples shall be 1 to 2 inches across, approximately 6 inches long except that in loose soil, the Engineer may require the use of staples up to 12 inches in length.

717.07 Herbicide. The herbicide shall be an approved chemical registered in this state for stump or basal bark treatment.

717.08 Manure. Manure shall be well-rotted manure approved by the Engineer and free of weeds, grass or harmful chemicals. Dehydrated cow manure may be used if approved by the Engineer.

717.09 Peat Humus. Peat Humus shall be a natural peat approved by the Engineer consisting of sedge, sphagnum or reed peat of such physical condition as will pass through a 1 inch screen and will be readily incorporated with the topsoil. The peat humus shall be free from sticks, stones, roots and other objectionable matter.

The peat humus shall come from a freshwater saturated area and be conditioned in stockpiles for at least 6 months after excavation, including one freezing and thawing period.

717.10 Aluminum Sulphate. Aluminum Sulphate shall be unadulterated and delivered in containers with the name of material, name of manufacture, net weight of contents and analysis appearing on each container.

717.11 Plant Supporting Material. Posts for supporting plants shall be straight sound cedar posts free of bark or an approved equal. They shall have a minimum diameter of 1 3/4 inches and a maximum diameter of 3 inches. Posts will be provided in 2 sizes, 6 feet tall and 8 feet tall. Where shorter posts are necessary to protect trees from injury, the 6 foot size shall be used and cut to the required height.

Support ties shall be approved plastic chain-lock material, 7/16 inch minimum size.

Anchor stakes for guying trees shall be of sound hard pine or approved equal, 2 or 3 inches in diameter and 2 to 2 1/2 feet long, notched near the top to hold wire.

Guy wire shall be pliable, 10 to 20 gage galvanized steel wire or approved equal. Woven wire of approximately equal strength may be used if approved by the Engineer.

Hose for protecting the bark from guy wires shall be good quality reinforced rubber hose of 1/2 inch inside diameter or approved equal, in sound condition. Old, cracked material and light weight plastic is not permitted.

717.12 Wrapping Material. Wrapping material for tree trunks shall be furnished in strips approximately 4 to 6 inches wide consisting of first quality, 8 ounce per square yard burlap, approved waterproof paper or plastic.

Twine for tying wrapping material to trees shall be approved good quality jute twine, not less than 3 ply or approved heavy duty weather resistant tape.

SECTION 718 -- TRAFFIC SIGNALS MATERIAL

718.01 Vehicular Signal Indications.

- (a) Vehicular signal heads for traffic signals and flashing beacons shall conform to the ITE "Standard for Adjustable Face Vehicle Traffic Control Signal Heads", 1970 Edition. Each housing section shall be complete with a one-piece, hinged door mounting for the lens and other parts of the optical system, water-tight gaskets and simple door-locking device. The optical system shall be mounted so that the various parts may be swung open for ready access or removal. The sections shall be interchangeable and constructed so that sections can be removed or added.

There shall be a round opening in the top and bottom of each head to receive 1 1/2 inch supporting pipe frame. All parts of the housing, including the doors and end plates shall be of die cast aluminum free from flaws, cracks, blow holes or other imperfections.

All exposed bolts, screws, hinge pins and door-locking devices shall be stainless steel. All interior screws and fittings shall be stainless steel or approved non-ferrous, corrosion-resistant material.

All gaskets, including door, lens and reflector gaskets, exclusive of lampholder gaskets, shall be of neoprene. Lampholder gaskets shall be of a material unaffected by heat. The lampholder gasket will not be required when the lampholder is not in direct contact with the reflector.

All lampholders shall be wired so that a white wire will be connected to the shell of the lampholder and black or colored wire to the bottom or end terminal of the lampholder. The wires shall in turn be connected to the terminal block mounted inside at the back of the housing. The terminal block shall have sufficient screw type terminals to terminate all field wires and lamp wires with separate screws. The terminals to which field wires are attached shall be permanently identified or the wiring shall be color coded to facilitate field work. Each lens shall be provided with a removable visor hood unless tunnel hoods or louvered hoods are specified on the plans. Hoods for 8 inch sections shall be 7 inches long, hoods for 12 inch sections shall be 9 1/2 inches long.

When 2 or more vehicular signal heads or a combination of vehicular signal heads and pedestrian signal heads are installed on 1 pole, only 1 conduit riser shall be used. The signal heads shall not be connected together by the use of liquid tight flexible metal conduit and terminal fittings.

All new vehicular signal faces installed at any one intersection shall be of the same make and type.

Lamps for the 8 inch units shall be 650-lumen minimum initial output, 120 volt, 6000 hour rated life, clear traffic signal lamps. Lamps for the 12 inch units shall be 1900-lumen minimum initial output, 120 volt, 6000 hour rated life, clear, traffic signal lamps.

The intensity and distribution of light from each illuminated signal lens shall conform to the ITE "Standard for Adjustable Face Vehicle Traffic Control Signal Heads", Revised 1970 and the "Standard for Traffic Signal Lamps", December 1967.

- (b) Programmed Visibility Vehicular Indications. The programmed visibility traffic signal vehicular indication shall optically determine the visibility zone of indication without the use of hoods or louvers. The projected signal may be visible or selectively veiled anywhere within 15 degrees of the optical axis. The signal head shall be adjustable to various angles between 9 degrees above and below horizontal. No indication shall result from external illumination and each indication shall be illuminated separately. The visibility of the signal indication shall be adjustable within the signal head to fit the lane or lanes in which traffic is to be controlled.

The illumination lamp shall be a nominal 150 watt, 115 volt AC, 3 prong, sealed beamed type, having an integral reflector and an average rated life of 6,000 hours. A dimming device shall be provided to reduce the candle power at each signal head for nighttime operation to approximately 15 percent of the candlepower for daytime operation.

A circular reflector with a specular inner surface shall mate the lamp to a diffusing element.

An internal imaging surface shall be provided to permit an effective veiling system to be applied as determined by the desired visibility zone. The Contractor shall notify the Engineer 48 hours prior to the application of the veiling system. The optical limited-diffuser shall be provided with positive indexing means and shall be composed of heat resistant glass.

The objective lens shall be a high resolution planar incremental lens thermetically sealed within a flat laminate of weather resistant acrylic. The lens outline shall be symmetrical. Lens colors shall conform to the latest ITE transmittance and chromaticity standards.

The signal shall be housed in cast aluminum, conforming to the latest ITE alloy and tensile requirements. Each section shall have a sun visor. The cast aluminum shall have a chromate preparatory treatment prior to the application of green baked enamel prime and finish. The lens cover and the interior of the case shall be flat black. Hinge and latch pins shall be stainless steel. All access openings shall be sealed with weather resistant rubber gaskets.

The lamp fixture housing shall be readily accessible and lamp replacement shall not require special tools nor necessitate major disassembly.

Electrical connections between the case and lamp-holder shall be an interlock assembly which disconnects the lampholder when open. Number 16 wire shall be used to connect the lamp receptacle to the signal head terminal.

The signal head shall be capable of being mounted to standard 1 1/2 inch fittings as a signal head section, as a multiple section face or in combination with other signal heads.

The signal section shall be provided with a rigid connection that permits tilting from at least 9 degrees above or below the horizontal while maintaining a common vertical line through couplers and conduit. No special tools should be needed for servicing or mounting.

718.02 Pedestrian Signal Indications. The pedestrian traffic control signal heads shall conform to the ITE, "Standard for Adjustable Face Pedestrian Signal Heads", latest Edition. The housing shall be dust and moisture proof and corrosion resistant and shall provide easy access to all components. All pedestrian signal heads shall have a sun visor.

All pedestrian traffic control signal heads of the incandescent type shall be as outlined in the above Standard. All new pedestrian signal faces installed at any one intersection shall be of the same make and type.

The "Don't Walk" and "Walk" indications shall be separate heads and the "Don't Walk" indication shall appear directly over the "Walk" indication. The "Walk" message shall be lunar white and the "Don't Walk" message shall be Portland orange.

Head sizes shall be standard nominal 9 inches in minimum dimension unless otherwise specified.

Lamps for 9 inch units shall be 650-lumen minimum initial output, 120-volt, 6,000 hour rated life, clear traffic signal lamps.

Lamps for 12 inch units shall be 1,900-lumen minimum initial output, 120-volt, 6,000 hour rated life, clear traffic signal lamps.

When 2 or more pedestrian signal heads are installed on 1 wood pole, only 1 conduit riser shall be used. The pedestrian signal heads shall not be connected by the use of liquid tight flexible metal conduit.

Pedestrian signal heads which use fiber optic bundles to form the message shall achieve the color of the messages by filters between the light source and the optical bundles. The legends shall be 5 inch minimum in height with a 5/8 inch stroke. The housing materials shall conform to the requirements for conventional pedestrian signal housings. The message shall be illuminated by a light source designed to operate on a 120-volt source and shall be rated for 8,000 hour average life. The flashing message may be accomplished by use of a mechanical flasher in place of the solid state flasher required for conventional pedestrian signal indications.

718.03 Signal Mounting. All trunnions, brackets and suspensions used for assembling and mounting signal control faces shall be entirely weather tight. The inside area of the cross section of the tubular arms shall not be less than the inside area of 1 1/2 inch IPS pipe to permit the signal control wires or cable to be inserted through them.

All vehicular and pedestrian signal heads, regardless of mounting arrangement, after final adjustment shall be fastened by a positive locking device acceptable to the Engineer. This device shall prevent any deviation from the position set, but shall allow for readjustment of the signal head at a later date in the same installation or in another installation without the necessity of damaging any part of the signal head.

718.04 Loop Vehicular Detectors. Vehicle detectors shall consist of wire loops and self-contained detection equipment capable of registering independently the presence or passage of any vehicle passing over the loop at any speed up to 70 miles per hour and at any temperature between -35°F and 165°F. Each loop detector shall contain its own integral power supply and shall operate between 95 VAC and 135 VAC. The input power shall be protected by fuse or resettable circuit breaker.

The detector amplifiers shall be self-tuning, solid state construction except for the output relay. Printed circuit design shall allow the components to be removed and replaced without permanent damage to the printed circuit boards or tracks.

Detector amplifiers installed in a common cabinet shall have a frequency difference and shall not interfere with the operation of other detector amplifiers installed in the same cabinet.

All input and output circuits for each amplifier shall enter by a single connector provided with a threaded shell. All controls, indicator lights, meters, fuseholders, circuit breakers and connectors shall be mounted on the front panel of the detector amplifier. All controls shall be adjustable without the use of tools and the controls shall be clearly and permanently identified.

The detector unit shall show a visible indication of vehicle calls. After a power interruption, the units shall return to normal operation within 30 seconds. If any vehicle stops over a portion of the loop registering a call, the detector shall be capable of detecting additional vehicles traversing the loop after approximately 15 seconds.

Detectors shall detect vehicles by lanes of traffic and shall not detect traffic moving away from the intersection when properly positioned in normal travel lanes. Detection must be positive and not erratic under all actual operating conditions with the exception of storm damage to the detector.

All detectors shall be capable of detecting all four-wheeled vehicles for all lengths of lead-in up to 750 feet for single detection loops and for a combined lead-in length of 750 feet in the case of multiple loops.

Detector loop wire shall be number 14 THWN stranded wire, moisture and heat resistant. Lead-in cable shall conform to the detector manufacturer's recommendations.

No damage shall occur in the detector if the pavement loop or lead-in becomes short-circuited.

718.05 Magnetometer Vehicle Detectors. Magnetometer vehicle detectors shall operate on the principle of increased density of magnetic flux. Each magnetic vehicle detector amplifier shall be self-contained with its own integral power supply for operation on 120-volt, 60 hertz. The magnetometer vehicle detectors shall be capable of providing 2 operational modes, either pulse detection or presence detection. All controls shall be located on the front panel of the amplifier unit and shall include pulse-presence mode selection switch, detection indicator light, fuse, connectors and the necessary calibration adjustment controls. All controls shall be adjustable without the use of tools and the controls shall be clearly and permanently identified.

The magnetometer vehicle detectors shall be capable of detecting any vehicle from speeds of 0 to 100 miles per hour and at any temperature between -30°F and +150°F. The magnetometer vehicle detectors shall detect any vehicle properly positioned in the normal travel lane and detection shall not be affected by adverse roadway surface conditions such as accumulations of snow, dirt, rain or ice control chemicals.

718.06 Pedestrian Detectors. Pedestrian push button detectors shall be weatherproof and constructed to eliminate the possibility of electrical shock in all weather conditions.

The pedestrian push button switch shall be a phenolic enclosed precision snap-acting type, switching unit, single-pole, double-throw, with screw type terminals, rated 15 amperes at 125 volts, AC and shall have the following characteristics:

- (a) The switching unit shall have a stainless steel plunger actuator and shall be provided with U-frame to permit recessed mounting in push button housing.

- (b) Where a pedestrian push button is attached to a pole, the housing shall be shaped to fit the curvature of the pole and secured to provide a rigid installation. When required, saddles shall be provided to make a neat fit.

718.07 Controllers. A controller shall consist of a complete electrical mechanism for controlling the operation of the traffic control signals, including the timing mechanism and all necessary auxiliary equipment mounted in a cabinet. The controller supplied shall conform to the type as noted on the plans.

All equipment inputs, outputs and terminals shall be identified by the phase designations shown on the plans.

The reliability of the equipment shall be demonstrated by test performance which will confirm that the controller unit, fully wired cabinet and auxiliary equipment meet the operational and functional requirements of the plans and specifications.

The Contractor shall be responsible for providing all information describing the operation of the equipment necessary to facilitate the completion of the tests. All schematic wiring diagrams of the controllers and auxiliary equipment, all cabinet diagrams and all operation manuals shall be submitted to the Engineer at the time the controllers are delivered for testing. These diagrams shall show in detail all circuits and parts. Such parts shown thereon shall be identified by name or number and in such a manner as to be readily interpreted.

The controller shall be delivered to the Maine Facility, US Route 2, Palmyra, Maine, mailing address RFD Box 421, Pittsfield, Maine, 04967, with all internal connections made and ready for testing. The test will be performed under simulated field loads or manufacturer's design loads, whichever are greater. Testing will be performed by the Department.

The Contractor shall allow 21 days for the testing of each controller, commencing on the day the controller is delivered to the test site, exclusive of the number of days necessary for the Contractor to respond to defect notices and the number of days the Contractor requires to correct the defective equipment.

The test shall consist of not less than 5 days of continuous, satisfactory operation. If unsatisfactory performance of the controller develops during the test, the Contractor shall remove the defective equipment for repair within 5 working days after notification, correct the deficiency and the controller shall be re-tested, until the 5 days of continuous satisfactory operation are obtained. If repeated failures occur, the entire controller may be rejected, requiring the Contractor to submit a new controller for testing. Delays to the contract resulting from unsatisfactory test performance due to continued equipment failure will not be considered as a valid reason to justify extension of the contract time.

The Contractor will be notified when testing of the traffic signal equipment has been completed. It shall be his responsibility to transport the equipment to the work site.

Each traffic controller unit, flasher and all other current interrupting devices shall be equipped with a suitable radio interference suppressor installed at the input power point. Interference suppressors shall be designed to minimize interference in both broadcast and aircraft frequencies. Suppressors shall be designed for 125 percent of the total connected load and shall meet standards of the UL and the EIA.

The type of controller, auxiliary equipment and other operational features shall be as noted on the plans.

All equipment, except pedestrian push buttons, shall be designed to operate on 120 volt, 60 hertz. Operation shall be satisfactory at voltages from 105 to 130. The voltage for pedestrian push buttons shall not exceed 18 volts.

- (a) Auxiliary Functions. All controllers shall be capable of providing flashing operation of the signal lights, as indicated on the plans. Transfer from flashing operation or to flashing operation shall conform to the MUTCD.

If noted on the plans, preempt circuits shall be provided for emergency vehicles and/or railroad crossings. The clearance and preempt indications shall be as noted on the plans. Preempt circuits shall function during stop and go and flashing operation unless otherwise noted. The duration of clearance and preempt intervals shall be adjustable over the range noted on the plans and shall be labeled according to function. The railroad preempt circuit shall be designed to operate as a fail-safe loop through a normally made contact on the railroad's control relay in the railroad's control cabinet. Railroad preemption shall have precedence over all preemption intervals for other purposes.

- (b) Pre-timed Controllers. Electro-mechanical controllers shall have 3 dial units, a switch for manual selection of dials and all circuits necessary to operate as shown on the plans. The dial motors shall be self-starting, synchronous motors developing sufficient torque for proper operation of the dial unit. Intervals shall be adjustable from the face of the dial unit by self-retaining timing keys in one percent increments. The dial unit shall be mounted on an assembly panel with the motor, dial with slots for timing keys, contact block, motor switch and connector for plug-in mounting. A set of timing gears for each controller shall be mounted in the cabinet. The set shall include gears in 10 second increments from 50 seconds to 120 seconds.

Cycle lengths shall be established by brass timing gears changeable from the back of the dial unit, with a cycle length indicator on the face of the dial unit. The 3 dial units, cam and related equipment shall be mounted on a self-contained, readily interchangeable housing, designed to swing out of the controller cabinet for inspection while in operation. The housing for the dial unit and cam shall have all back panel and field terminal board circuits terminated in a multiple-contact "MS" connector. The conductors shall be cabled and the back panel or terminal board end shall be fitted with spade terminal ends.

The cam contacts shall be of silver or silver alloy, not less than 5/16 inch in diameter, minimum 15 ampere capacity, designed for 1 million operations and shall be easily removed and replaced. Cams shall provide 12 intervals minimum and shall be wired for the number of circuits indicated on the plans.

Actuated vehicle phases and actuated pedestrian phases shall be served in that interval of the cycle indicated on the plans. Time for an actuated interval shall be taken from the non-actuated phase(s) as noted on the plans.

Solid state pre-timed controllers shall provide 3 cycle lengths of up to 120 seconds. The intervals shall be adjustable in 1 second increments from 0 to 99 seconds. The controller shall be designed to provide the number of intervals shown on the plans without any auxiliary equipment. Intervals with a zero time setting shall be skipped. Sufficient signal circuits shall be provided to effect the operation as shown on the plans. Dial transfer shall occur at the end of the green interval in effect at the time of the transfer command signal. Dial transfer shall not cause irregular interval timing or out of step operation. The controller shall be designed to allow adjustment of cycle lengths and interval lengths from the front of the controller without requiring the use of any tools, auxiliary equipment or removal of the controller from the cabinet. The front panel of the controller shall have a switch to select cycles; a switch for power on-off; displays to indicate interval and cycle durations; all necessary switches to program the intervals and cycle lengths; an indicator lamp for dial in operation and a removable fuse to protect the controller. Solid state pre-timed controllers shall be supplied with conflict monitors as specified in Subsection 718.11.

Automatic transfer to or from flashing operation shall conform to the MUTCD. Manual advance of the intervals by use of hand cord control shall cause the controller to advance to the next programmed interval only upon pulse signal from the hand cord circuit, interval timing shall hold the interval for the minimum programmed amber and red clearance intervals.

Pre-timed electro-mechanical controllers designated on the plans to be interconnected shall provide 3 resets on each dial. The master controller shall have system selection switches in addition to those required for local functions. There shall be a switch to select the dial and reset for the system and system flash. The reset shall be established by the use of self-retaining keys accessible from the front of the dial unit, adjustable in one percent increments. The master controller shall provide automatic synchronization and supervise cycle and reset selection of all interconnected controllers. The local controller shall be supplied with a switch to manually select dials and resets. Loss of supervisory information from the master controller shall cause the local controller to operate on dial one, no reset.

- (c) Actuated Solid State Controllers. The controller unit shall be enclosed in a sheet metal case with protective painted finish, designed to permit easy access to the interior and removal of printed circuit boards and modules without the use of special tools. All program controls, fuses and indicator lights shall be mounted on the front panel and shall be clearly and permanently labeled. Modules of unlike function shall be mechanically keyed or electrically interlocked to prevent placement in the wrong location. Each phase module shall be identified with the symbol shown on the plans with an embossed, color contrasting, plastic label. All components shall be marked for identification compatible with the maintenance manual for the controller unit, including components mounted on printed circuit boards.

When on manual operation, all phases shall be called regardless of vehicle detection and the controller shall be advanced upon pulse from the hand cord circuit except yellow and red clearance intervals shall be timed for the duration programmed.

An exclusive pedestrian phase shall not extend or recycle until a vehicle phase has been serviced. When on manual operation, all phases shall be called regardless of vehicle detection and the controller shall be advanced upon pulse from the hand cord circuit except yellow and red clearance intervals shall be timed for the duration programmed. Automatic transfer from or to flashing operation shall conform to the MUTCD.

Pedestrian phases shall not be extended by actuations, during the walk or clearance interval. Actuations during the clearance intervals shall be placed in memory.

718.08 Controller Cabinet. The traffic signal control equipment shall be enclosed within a dust and moistureproof aluminum or stainless steel housing with an auxiliary door in door feature. The door hinge pins shall be made of stainless steel. The cabinet shall be installed with the back toward the nearest line of traffic unless otherwise directed by the Engineer.

The controller cabinet shall be of sufficient size to accommodate all control equipment including temperature control equipment. It shall be designed to be attached to the type of pole indicated in the contract plans. If attached to a traffic signal post, it shall be integral with the post giving the appearance of the signal post passing directly through the cabinet. If the controller cabinet is to be ground mounted, details of the installation will be shown on the plans. Piano type hinges on controller cabinet doors shall be fabricated of stainless steel with a stainless steel hinge pin.

All manual control switches, push button control, flashing switch, signal switch and any other specified switches shall be located so as to be accessible within the outside door, without exposing the controller mechanism.

The flashing mechanism for flashing beacon installations must be enclosed within a dust and moistureproof aluminum cabinet with a hinged door.

The flasher cabinet shall be of sufficient size to accommodate a 2 circuit solid state flashing mechanism and other necessary equipment. It shall be designed to attach to the type of pole indicated in the contract plans. The flasher cabinet shall be vented to prevent excessive heat build-up.

The locks for the door of the flasher cabinet shall be the type shown on the plans. Two keys shall be furnished with each control lock.

All cabinets housing solid state traffic signal control equipment shall be provided with a thermostatically controlled ventilating fan and throw-away glass fiber air filters. The electric fan shall have ball or roller bearings and shall have a capacity of 100 cubic feet per minute. The ventilating system shall be designed to prevent the entrance of rain, snow, dust and insects. The fan and vents shall be arranged in such a manner that the air intake is at the cabinet bottom and the exhaust is at the cabinet top. The filter shall be firmly held in place such that cracks and openings are eliminated to ensure that all air is filtered. The fan shall be thermostatically controlled with an adjustable upper limit of 100°F to 140°F and a differential of not more than 10°F.

The locks for the switch compartment door of the controller cabinet shall be the type shown on the plans. The main door shall be a lock of the tumbler type. Two keys shall be furnished with each control lock.

All traffic signal controller cabinets shall be supplied with a convenience outlet, a standard 3-wire grounding duplex receptacle, 20 amp capacity and a lamp socket and 1900 lumen lamp.

A police panel shall be provided behind the auxiliary door and shall contain a switch to select "flash-automatic" function, "automatic-manual" function, "signals on-off" function and a manual control cord. Switch terminals on the rear of the main cabinet door shall be insulated so that no live posts are exposed. The "signal on-off" switch shall allow the signal indications to be de-energized, but power to all other control circuits shall not be disrupted. Switches shall be labeled and rated for load current. Traffic signal controller cabinet main doors over 6 square feet in area shall be provided with a stop to limit door opening to both 90 and 180 degrees, ± 10 degrees. The stop shall be provided with a catch which can be operated when the door reaches these 2 positions and will hold the door open securely until released. Controller cabinets designated on the plans to be ground mounted shall have a pliable seal composed of caulking compound or mastic placed between the cabinet base and the concrete foundation to prevent dust and dirt from entering the cabinet. The bottom of the controller cabinet shall be mounted on an aluminum non breakaway transformer base as shown on the plans.

The cabinet shall be supplied with sufficient shelf space for all control units. Receptacles for relays, shelf spaces below all removable control equipment, contactors, switches, fuses, circuit breakers and terminal blocks shall be identified with plastic labels embossed with the symbol used on the plans to indicate the related function.

718.09 Flasher. The flasher shall be a two circuit solid-state device with no contact points or moving parts, producing between 50 and 60 flashes per minute with a 50 to 67 percent duty cycle. The flasher mechanism shall be mounted on a plug-in base with a plug-in mounting. The flasher relay shall energize the flasher and transfer signal light circuits from the controller unit to the flasher. The flasher shall be capable of breaking and carrying 10 amps on each circuit at 125 volts. All amber indications shall be on one circuit and all red indications shall be on the other circuit. The flasher shall be protected from lightning damage by a device intended for use with solid state equipment. The flashing mechanism shall be independent of the controller unit and shall remain in operation upon shutdown of the controller or removal of the controller unit from the cabinet. The pedestrian indications shall be flashed with a separate solid-state flasher.

718.10 Program Selection. Time switches used for flash, dial, reset selection or other specified controller functions shall be synchronous motor driven; shall be equipped with an electrically wound spring, 10 hour minimum reserve; shall provide for at least 3 openings and 3 closings per 24 hour period; and shall be equipped with an omitting device. Time setting adjustments shall be made without requiring the use of tools.

The weekly program selection unit shall be capable of automatically supervising the operation of dial 1, dial 2, dial 3, split 1, split 2, split 3, reset 1, reset 2, reset 3 and flashing operation. The weekly program selection unit shall allow selection and/or omission of these functions to be varied on a daily basis. The weekly program selection unit shall enable function transfers to be made as often as 15 minutes.

If the weekly program selection unit depends upon the use of break-out type keys to establish the program, 2 complete groups of keys shall be furnished, 1 group for initial programming and 1 group for future programming. The weekly program selection unit shall be constructed so that re-programming can be accomplished easily without requiring the use of any special tools or any dismantling of the unit.

Solid state devices used to automatically select dial, reset and flashing modes shall meet the applicable functional requirements of mechanical devices. They shall maintain the preset program during power interruption and shall continue timing functions using a reserve power source.

718.11 Contacts and Relays. All contacts used in connection with interval indications shall be of pure coin silver or its equivalent and shall be capable of breaking and carrying at least 15 amperes at 120 volts AC. The Contractor is directed to arrange the internal wiring and number of circuits so that the contact rating is not exceeded.

All actuated controllers shall be equipped with external type signal light relays.

Relays shall not be used in connection with any automatic non-flashing red, yellow or green indication in installations having pre-timed electro-mechanical equipment without the approval of the Engineer.

Relays shall be designed for continuous duty. Relays shall be designed to operate at ambient temperatures from -30°F to +160°F. Each relay shall be mounted on a plug-in base with a plug-in mounting. Coils shall have a power consumption of 10 volt-amperes maximum and shall be designed for continuous duty on 120 volts, AC.

A leakage resistor, which shall permit current to pass through the relay coil if the contacts should remain closed after the coil circuit is opened, shall be installed with each external signal light relay to overcome residual magnetism effects.

All relays shall be of a rating sufficient to carry the electrical loads imposed upon them. A sufficient number shall be provided so that the total load is distributed among the various circuits in such a manner that the rating of each relay is 150 percent of the load.

Relays may be either the electro-mechanical or solid state type, unless a particular type is specifically called for in another section of this contract.

Electro-mechanical signal light relays shall be wired to eliminate conflicting indications. Electro-mechanical relays not provided with interlock circuitry, electro-mechanical relays which will display a red indication in the absence of green or amber and all solid state signal light relays shall be provided with a monitor unit to prevent the illumination of conflicting indications.

The monitor unit shall be connected to the field terminals of the signal light circuit to provide protection against conflicting green, yellow or walk indications being simultaneously energized as a result of controller failure, relay or solid state switch failure, short circuited field wiring or other failures.

When a conflict is detected, the monitor unit shall cause the signal system to commence flashing operation; energize the stop-timing circuit of the controller while controller power shall remain on; lock-in flashing operation until manual actuation of the momentary contact reset push button; remove power from the signal light circuit; disable all functions of the "Flash-Automatic" and "Automatic Manual" switches in the police panel.

Each circuit of the solid state switching devices shall have a minimum rating of 1,000 watts for tungsten lamp load at 120 volts, AC. The solid state switching devices shall be plug-in mounted to a base. Solid state switching devices shall be protected from transient voltages and lightning by components especially designed for use with solid state devices.

Circuit breakers shall be approved and listed by the UL. The operating mechanism shall be enclosed and shall be trip-free from operating handle under load and shall be trip-indicating. All circuit breakers shall be quick-make, quick-break on either automatic or manual operation. Contacts shall be silver alloy enclosed in an arc quenching chamber. Overload tripping of breakers shall not be influenced by an ambient temperature range of from 0 to +160°F.

718.12 Conductors. The number and size of conductors required in each cable is indicated on the plans. All conductors shall be stranded copper conductors. Multiconductor cables shall conform to the latest revisions of IMSA Specification Number 20-1. The service ground rod shall be an 8 foot by 5/8 inch copperclad rod.

The service wiring shall be single conductor number 6 AWG THW stranded copper black insulated and number 6 AWG THW stranded copper white insulated rated 600 volts.

The Contractor shall furnish samples of materials as may be required by the Engineer for testing. Both the plain insulated wire and the finished cable shall be capable of withstanding all the electrical tests required in the IPCEA Specifications.

All circuits for the timer and each auxiliary control unit shall terminate in a multiple contact connector. Conductors shall be attached to all pins of the connector and cabled. Conductors of the cable, except spares, shall be fitted with terminal ends compatible with the terminal block and shall have identifying bands. The ends of all spare conductors shall be taped.

SECTION 719 -- SIGNING MATERIAL

719.01 Reflective Sheeting. The reflective sheeting shall consist of a retroreflective lens system having smooth outer surface. The sheeting shall have a pre-coated adhesive on the backside protected by an easily removable liner.

The reflective sheeting and its components shall conform with all the requirements of FHWA "Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects" 1979, FP-79, Sections 633.06, 633.07 and 718.01. Engineering grade reflective sheeting shall meet the reflective intensity requirements for Type II sheeting as shown in Table IV Section 633.06, FP-79. High intensity reflective sheeting shall meet the reflective requirements for Type III sheeting as shown in Table V Section 633.06, FP-79. Construction grade reflective sheeting shall meet the reflective intensity requirements for Type I sheeting as shown in Table III, Section 633.06, FP-79.

719.02 Demountable Acrylic Plastic Reflectorized Letters, Numerals, Symbols and Borders. Demountable reflectorized letters, numerals, symbols and borders shall consist of circular acrylic plastic prismatic reflectors supported by embossed white-enameled aluminum frames, conforming to FHWA, "Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects", 1979, FP-79, Section 633.07.

719.03 Aluminum Extrusions. The extruded aluminum planks shall be bolted type with dimensions, holes, lengths, and cross sections as detailed on the plans. The extruded aluminum molding for edging of the extruded aluminum sign panels shall be of the cross section as detailed on the plans. Extruded aluminum planks shall conform to ASTM B 221, 6063-T6, 6005-T5 or 6061-T6. The extruded aluminum planks and molding shall be free from all corrosion and dirt and the face and edges shall be true and smooth and free from burrs and breaks.

719.04 Aluminum Sheets. Flat aluminum sheets shall conform to ASTM B 209, 6061-T6, 6005-T5 or 6063-T6. The minimum sheet thickness shall be 0.080 inch for signs of an area of 4.00 square feet or less and shall be 0.135 inch for all signs over 4.00 square feet, unless otherwise specified.

719.05 Plywood. The plywood shall conform to the requirements as set forth in "Commercial Standards CS 45-60 for Douglas Fir Plywood", published by the US Department of Commerce, for the following paragraphs:

- (a) Face stock-Face veneers shall be Grade A, paragraph 4.4.4.1.
- (b) Core and Cross Veneers-Core and crossband veneers shall be Grade B or better and shall be solid jointed.
- (c) Glue-The entire area of each contacting veneer surface shall be bonded with a waterproof adhesive that meets the test requirements for exterior type, as set forth in paragraphs 5.3, 5.4.2 and 5.4.3.
- (d) Overlay-The overlay shall be of the high-density type as described in paragraph 4.4.5.1. It shall have a minimum weight of 60 pounds per 1,000 square feet surface, shall be at least 0.009 inch thick and have a minimum resin content of 40 percent based on the dry weight of the impregnated fiber. It shall consist of at least 2 sheets of resin-impregnated fiber of sufficient resin content to bond itself to the plywood. Manufacturing precautions shall be taken to prevent overlay surfaces from coming into contact with any substance which would inhibit adhesion of paint or reflective sheeting. The overlay shall be natural color.
- (e) Thickness-The thickness of plywood shall be 5/8 inch.
- (f) Testing-The plastic overlay shall not delaminate from the plywood after being subjected to the exterior boiling test for glue-line durability as outlined in Commercial Standard CS 45-60.

719.06 Demountable Reflectorized Delineators. Delineators shall be demountable round acrylic plastic reflectors approximately 3 inches in diameter with aluminum housings or shall be rectangular, adhesive coated reflective sheeting permanently adhered to a sheet aluminum backing. All delineators on a project shall be the same type. Single delineators shall be clear or silver-white; double and triple delineators shall be amber.

- (a) Delineators using acrylic plastic reflectors shall conform to FHWA "Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects", 1979, FP-79, Section 712.14(a), Type I reflectors. Single delineators shall have one 1/4" square hole for center mounting. Double and triple delineators shall have two 1/4" square mounting holes on the vertical centerline.
- (b) Delineators using adhesive coated high intensity reflective sheeting.

The silver-white and amber delineators shall be of adhesive coated high intensity reflective sheeting permanently adhered to a sheet aluminum backing. The high intensity reflective sheeting shall conform to the requirements of Subsection 719.01. Single delineators shall be 4 by 4 inch diamonds with 3/4 inch radius corners and two 1/4 inch square mounting holes, 3 inches on center. Double delineators shall be 4 x 8 inch rectangles with 3/4 inch radius corners and two 1/4 inch square mounting holes 6 inches on center. Triple delineators shall be 4 by 12 inch rectangles with 3/4 inch radius corners and two 1/4 inch square mounting holes, 10 inches on center.

The aluminum shall be 6061-T6, ASTM B 209 or 6063-T6 or 6005-T5 0.063" thick sheet properly degreased and etched or treated with a light, tight amorphous chromate type coating.

The reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified by the sheeting manufacturer.

- (c) General Requirements and Packaging. The finished delineators shall show careful workmanship, be free of burrs, scratches or damaged reflective surface.

Delineators shall be packaged in such a manner as to insure their arrival at destination in undamaged condition. Delineators shall not become wet in storage or shipment.

719.07 Assembly Hardware. The bolts required to attach the extruded aluminum planks together shall conform to the designs used in standard commercial processes for the type of extruded aluminum panels to be used, as approved by the Engineer. Aluminum Zee Bars, where shown on the plans, shall be of 6061-T6 or 6063-T6 or 6005-T5 aluminum conforming to ASTM B 221. Post Clips shall be 356-T7 aluminum conforming to ASTM B 108. Panel Bolts, Clip Bolts and all washers shall be 2024-T4 aluminum, Hex Nuts shall be 6262-T9 aluminum, both conforming to ASTM B 211.

Nuts, bolts, and washers for assembling metal sign components shall be stainless steel, ASTM F 593, alloy group 1. All nuts shall be of the self-locking type. Aluminum signs mounted on U-channel posts shall be attached with stainless steel ASTM F 593, alloy group 1, 3/8 by 3 inch bolts and washers, and an approved nylon or fiber washer will be used on the face of signs. Signs mounted on wood posts shall be attached with 3/8 by 3 1/2 inch cadmium plated lag screws. Fiber washers or approved nylon washers shall be used to protect the sign face from the fastener head. The fiber washers shall be vulcanized fiber 1/8 inch thick by 1 inch outside diameter by 7/16 inches inside diameter. The nylon washer shall be of a minimum of 1/16 inch thick by 1 inch outside diameter by 7/16 inch inside diameter.

Plywood signs mounted on U-channel posts shall be attached with 3/8 by 2 1/2 inch cap screws and standard hex nuts conforming to ASTM A 307, galvanized in accordance with ASTM A 153. A galvanized steel washer shall be used under the nut and an approved nylon or fiber washer shall be used between the head of the bolt and the face of the sign. Signs mounted on wood posts shall be attached with 3/8 by 3 1/2 inch cadmium plated lag screws. Fiber washers or approved nylon washers shall be used to protect the sign face from the fastener head. The fiber washers shall be vulcanized fiber 1/8 inch thick by 1 inch outside diameter by 3/8 inch inside diameter. Nylon washers shall be a minimum 1/16 inch thick by 1 inch outside diameter by 3/8 inch inside diameter.

Signs mounted on steel H-beam posts shall be attached using a method recommended by the extruded plank manufacturer or as shown on the plans.

Delineator assembly hardware shall consist of 10 gage 24 UNC thread, 2 1/4 inch aluminum carriage bolts, and self-locking nuts fabricated of 3003-H-14 aluminum.

SECTION 720 -- STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS

720.01 Aluminum Supports. Extrusions for aluminum supports shall conform to ASTM B221 or B429, Alloy 6061-T6 or 6063-T6. Castings for use with aluminum supports shall conform to ASTM B26 or B108, Alloy 356.0-T6, except that castings for parts having a non-structural application, such as pole caps or bolt covers may be temper F. The T6 tempers specified for Alloys 6063 and 356.0 shall be obtained by the proper heat treatment of the assemblies after all welding for the base and if required, for the handhole reinforcement has been completed. No welding will be allowed on the shaft other than as required for the attachment of the shoe base, handhole reinforcement and bracket arm.

The exterior of all parts shall have a satin brushed or satin etched finish. The assemblies shall be free of bulges, dents, cracks and on external surfaces, discoloration and scratches. The presence of any of these defects or any other imperfection detrimental to strength or appearance may be cause for rejection by the Engineer. All assemblies shall be tire wrapped for protection during shipment, storage and handling.

All nuts, washers and bolts, other than anchor bolts and associated washers and nuts, shall be made from stainless steel conforming to ASTM F 593, alloy group 1.

All ends of shafts open to the weather shall be fitted with a cast-aluminum or formed aluminum cap secured in place with set screws.

All assemblies shall be permanently marked on the edge of the base or flange, showing alloy and temper, diameter and wall thickness of the shaft.

- (a) Light Standards, Mast arm Poles, Strain Poles and Dual Purpose Poles. Shafts shall be round, tapered and seamless and shall be fabricated as a single continuous unit without splices, except that shafts with a length of over 40 feet may be fabricated with one splice at approximately mid-height and dual purpose poles may be fabricated with a splice immediately above the mast arm attachment. The minimum wall thickness of the shaft shall be 0.188 inches. A hand-hole of approximately 25 square inches in area, reinforced to maintain the full design strength of the shaft, shall be provided approximately 18 inches above the base. Provisions for internal grounding shall be incorporated in the handhole reinforcement. A hole, fitted with a rubber grommet, shall be provided in the shaft to match the wire-way of the bracket arm or mast arm, except that strain poles shall be provided with a wire inlet as shown on the standard details. Bases shall be shoe type and shall be supplied with suitable covers for the anchor bolts. Anchor bolt covers shall be securely fastened to the base by means of one or more stainless steel phillips or hex head screws with a minimum size of 1/4 inch. Bases shall be welded to the shaft with both an internal and external continuous fillet weld. The use of sleeve type bases or other bases not requiring welding of the shaft to the base and the use of reinforcing sleeves will not be allowed.

Dual purpose poles shall be provided with a pull wire for the luminaire.

- (b) Colonial Light Standards. Shafts shall be round, tapered and seamless and shall be fabricated as a single continuous unit without splices. The minimum wall thickness shall be 0.125 inches and the minimum diameter at the base shall be 5 inches. The length of the shaft plus the base shall be 14 feet and 3 inches, with a 4 inch long by 3 inch OD straight section at the top to accept the pole top luminaire. The entire assembly of pole and base shall be black anodized. Bases shall be handhole type with a handhole of approximately 25 square inches in area and equipped with an approved locking device on the handhole cover. The bases shall have internal flanges capable of accepting four 3/4 inch anchor bolts, equally spaced on a 10 inch diameter bolt circle. The bases shall be welded to the shaft with both an internal and an external continuous fillet weld.
- (c) Pedestal Poles. Shafts shall be round, tapered and seamless and shall be fabricated as a single continuous unit without splices. The minimum outside diameter at the base shall be 6 inches and the minimum wall thickness shall be 0.125 inches. The length of the pole plus the base shall be 10 feet, except that the length of poles supporting only pedestrian heads shall be 8 feet. Bases shall be transformer type with suitable covers for the anchor bolts. The bases shall be welded to the shaft with an external and an internal fillet weld.
- (d) Sign Supports. Shafts shall be round, seamless and of uniform cross section and shall be fabricated as a single continuous unit without splices. The minimum wall thickness shall be 0.125 inches. Bases shall be shoe type as specified under Subsection 720.01(a).
- (e) Sign Bridges, Cantilever Type and Butterfly Type Sign Supports. The configuration of the foundation(s), base(s), shaft(s), arm(s) or truss shall be of the Contractor's design as approved by the Engineer and shall use only material as specified above. Sleeve type bases or other bases not requiring welding to the shaft and the use of reinforcing sleeves will not be allowed.

720.02 Aluminum Mast Arm and Bracket Arm. Mast arms and bracket arms shall be of the same materials as the matching pole and have a similar finish. Member cross sections shall be either round or elliptical and have a minimum wall thickness of 0.125 inches. Internal diameters, bends, joints and attachments shall permit internal

wiring in the upper member of the arms. Fixtures for attaching the arms to the poles shall be either castings or extrusions, sized to meet the design requirements and shall be designed to prevent rotation of the arms about the poles. Any mechanical means used to prevent rotation shall completely penetrate both the fixture and the shaft and the use of set screws will not be allowed.

- (a) Mast Arms. Mast arms shall be of the tapered tube truss type design, consisting of an upper and a lower member with vertical struts, welded to form an integral unit. Mast arms shall be equipped with sturdy signal hangers and/or appropriate tenons for mounting the signal heads and shall have weatherproof wire inlets located close to the suspended signal heads.
- (b) Bracket Arms. Bracket arms shall be of the single member or truss type. Single member type bracket arms shall be of the tapered upsweep design. Truss type bracket arms shall be of a tapered tube design, consisting of an upper and a lower member and a single vertical strut, welded to form an integral unit. Arms shall be equipped with an appropriate tenon for the attachment of the luminaire.

720.03 Steel Supports. Tapered shafts for steel supports shall conform to ASTM A 595, Grade A or approved equal. Straight shafts for steel supports shall conform to ASTM A 53, Grade B; A 500, Grade A or approved equal. Flanges shall be fabricated of steel plate conforming to ASTM A 36 or A 572, Grade 50 and shall be sized to transmit the full design load of the shaft. The flanges shall be welded to the shafts with either a continuous internal and external fillet weld or with a full penetration groove weld.

The interior and exterior of all parts shall be hot dip galvanized in conformance with AASHTO M 111 (ASTM A 123), after all welding and/or other fabrication processes have been completed. The finished assemblies shall be free of bulges, dents, cracks and scratches on external surfaces. The presence of any of these defects or any other imperfection detrimental to strength or appearance may be cause for rejection. All assemblies shall be tire wrapped for protection during shipment, storage and handling.

All nuts, bolts and washers, other than anchor bolts and their associated washers and nuts, shall conform to AASHTO M 164, Type I ASTM A 325 or ASTM A 449 and shall be hot dip galvanized in conformance with AASHTO M 232 (ASTM A 153). After galvanizing, nuts shall be retapped oversize by an amount appropriate to the nut size.

All ends of shafts open to the weather shall be fitted with an appropriate cast aluminum or galvanized cast iron cap secured in place with set screws.

All assemblies shall be permanently marked on the edge of the base or flange showing steel type and grade, diameter and wall thickness of the shaft.

- (a) Light Standards, Mast Arm Poles, Strain Poles and Dual Purpose Poles. Shafts shall be round and either tapered or of uniform cross section and shall be fabricated as a single continuous unit without splices, except that shafts with a length over 40 feet may be fabricated with one splice at approximately mid-height and dual purpose poles may be fabricated with a splice immediately above the mast arm attachment. The minimum wall thickness of shafts shall be 0.188 inches. A handhole of approximately 25 square inches in area, reinforced to maintain the full design strength of the shaft, shall be provided approximately 18 inches above the base. Provisions for internal grounding shall be provided in a location accessible through the handhole. A hole, fitted with a rubber grommet, shall be provided in the shaft to match the wire-way of the bracket arm or mast arm, except that strain poles shall be provided with a wire inlet as shown on the standard details.

On dual purpose poles a pull wire shall be provided for the luminaire.

Step-tapered shafts and shafts utilizing swaged joints and/or reinforcing sleeves will not be allowed.

- (b) Pedestal Poles. Shafts shall be 4 inches nominal ID, schedule 40 pipe without splices. The length of the pole plus the base shall be 10 feet, except that the length of poles supporting only pedestrian heads shall be 8 feet.
- (c) Sign Supports. Shafts shall be round, seamless and of uniform cross section and shall be fabricated as a single continuous unit without splices. The minimum wall thickness shall be 0.125 inches.
- (d) Sign Bridges, Cantilever Type and Butterfly Type Sign Supports. The configuration of the foundation(s), base(s), shaft(s), arm(s) or truss shall be of the Contractor's design as approved by the Engineer and shall use only material as specified above.

720.04 Steel Mast Arm and Bracket Arm. Material for mast arms and bracket arms shall be ASTM A 595, Grade A. Steel for flanges and attachments shall conform to AASHTO M 183 (ASTM A 36) or AASHTO M 223 Grade 50 (ASTM A 572, Grade 50). Internal diameters, bents, joints and attachments shall permit internal wiring in the upper member of the arms. Arms shall be hot dipped galvanized, both inside and outside, in conformance with AASHTO M 111 (ASTM A 123).

- (a) Mast arms. Mast arms may be of the single member or the truss type. Single member type mast arms shall be a single, straight, tapered, round member and may incorporate a maximum of 2 telescopic splices. Truss type mast arms shall be of a tapered design consisting of an upper and a lower member connected by vertical struts welded to form an integral unit. Mast arms shall be equipped with sturdy signal hangers and/or appropriate tenons for mounting the signal heads and shall have weatherproof wire inlets located close to the suspended signal heads.
- (b) Bracket Arms. Bracket arms may be of the single member or the truss type. Single member type bracket arms shall be of the tapered upsweep design. Truss type bracket arms shall be of a tapered design consisting of an upper and lower member connected by a single vertical strut, welded to form an integral unit. Bracket arms shall be equipped with an appropriate tenon for the attachment of the luminaire.

720.05 High Mast Light Standard. High mast light standards shall be either round or 12 sided in cross section and shall have a uniform taper from the base to the top, except that an expanded base section may be used, if required, to accommodate the electrical and mechanical equipment. The shaft shall be fabricated with welded shop splices not less than 25 feet apart and a field splice not less than 50 feet above the base plate and not less than 50 feet between field splices. The top section of a shaft may be less than 25 feet in length to obtain the specified shaft length. Sections may be fabricated with a maximum of two longitudinal welded seams. The welded shop splices shall be AWS prequalified, full penetration, butt welds. The welded longitudinal seams shall have 100 percent penetration for 1 foot on either side of a shop splice and 3 feet at the field splice end of a shaft section and the remainder shall be welded with a process capable of developing a minimum effective weld throat of 60 percent of the wall thickness. The Contractor shall submit prequalification tests for all welds that are not AWS prequalified. Field splices shall be of the telescopic type and designed to maintain the strength and rigidity of the shaft. The minimum length of a field splice shall be 2 feet. The base shall be welded to the shaft with an AWS prequalified, full penetration weld, welded from one side of the joint. All welding shall conform to the provisions of Section 504 -- Structural Steel.

100 percent of all circumferential welds and the full penetration sections of the longitudinal seam welds shall be inspected either radiographically or ultrasonically. Ten percent of the partial penetration sections of the longitudinal seam welds shall be inspected by the magnetic particle method.

Material for the shaft, base and attachments shall conform to the requirements of AASHTO M 222 (ASTM A 588) or ASTM A 595, Grade C. The Contractor shall submit two copies of the mill test reports covering the material used. All section shall have walls consisting of one plate thickness. Walls consisting of more than one layer of metal will not be allowed. The walls of dodecagonal shafts shall have an inside corner radius to wall thickness ratio not less than 2.

Prior to erection, the completely assembled shaft shall not exhibit a sweep in excess of 0.2 percent of the nominal pole height as measured with the shaft in a horizontal position on a flat and approximately level surface.

The shaft shall be provided with an equipment access opening approximately 2 square feet in area and located approximately 2 feet above the base. The access opening shall be reinforced to maintain the full design strength of the shaft and shall be provided with a hinged, removable, access door equipped with a vandalproof means of being locked in place. All welds for the access opening reinforcement shall be full penetration welds. A positive means of internal grounding shall be provided inside the access door.

720.06 Steel H-beam Poles. Steel H-beam Poles shall conform to AASHTO M 183 (ASTM A 36), shall be fabricated in accordance with the provisions of Section 504 -- Structural Steel and shall be hot dipped galvanized in accordance with AASHTO M 111 (ASTM A 123). All steel hardware for use with H-beam poles shall be hot dipped galvanized in accordance with AASHTO M 232.

720.07 Anchor Bolts. Anchor bolts and nuts supplied for aluminum and/or steel supports shall conform to ASTM A576, Grades 1021 through 1046, with a minimum yield strength of 50,000 psi. Nuts for anchor bolts shall conform to ASTM A573, Grade C and shall be heavy hex nuts. Anchor bolts shall be supplied with 2 nuts and 2 hardened washers and shall have a 90° bend with a 6 inch minimum leg length at the lower end. The anchor bolts, the nuts and the hardened washers shall be hot dipped galvanized. After galvanizing the nuts shall be retapped oversize by an amount appropriate to the nut size. If the anchor bolts are to be used with breakaway devices incorporating the function of a nut, for example, longitudinally grooved breakaway couplings, nuts or washers will not be required.

Alternate materials and designs may be used for the anchor bolts subject to approval.

720.08 U-Channel Posts. Except as otherwise authorized, U-Channel posts for secondary road regulatory, warning, confirmation and route marker assembly signs and for supporting demountable reflectorized delineators shall be fabricated of steel of the size shown on the plans. Aluminum U-channel posts having the same strength characteristics as steel U-channel posts may be used, subject to the approval of the Engineer. The steel U-channel posts shall be galvanized in accordance with AASHTO M 111 (ASTM A 123).

720.09 Wood Ornamental Light Standard. Material for wood light standards shall be Western Red Cedar (*Rhuja Plicata*) or other species with equal or better decay resistance, approved by the Engineer.

The wood cross section shall be 10 by 10 inches minimum. The mounting height and depth of burial shall be as shown on the plans.

The following items shall be supplied, a 2 inch slip-fitter of corrosion resistant material of adequate length to support the luminaire, a sideplowed wire-way covered by a suitable flush filler strip to accommodate three, number 12 conductors, a pair of two-piece plinths for conduit entrance and splice box.

All bolts shall be hot dipped galvanized in accordance with AASHTO M 232 (ASTM A 153).

All parts of the wood light standard shall be prefitted and predrilled, holes shall be counterbored to conceal bolts and filled with mastic compound.

The wood light standard surface finish shall be as indicated on the plans.

720.10 Wood Utility Pole. Wood poles shall be Douglas Fir or Southern Yellow Pine, conforming to ANSI Standard Specification 0 5.1 and of the class and length as indicated on the plans.

Poles shall not have more than 180 degrees twist in grain over the full length. Sweep shall be no more than 4 inches. Tops of poles shall be beveled.

Wood poles shall be pressure treated, after fabrication, with creosote, pentachlorophenol (oil borne), pentachlorophenol-liquified petroleum gas solution or copper naphthenate (oil borne), in accordance with the latest AWPA Specification C4 for pressure treated wood poles.

720.11 Mast Arms for Wood Utility Poles. All mast arms for wood utility pole attachment shall be standard 2 inch nominal diameter pipe of specified length and shall include a mast arm head, universal joint, insulated wire inlet, tie rods, cross arm and mounting brackets. The vertical distance between the mast arm and point of attachment of the cross arm shall not be less than 40 percent of the mast arm length. All attachments for mast arm assemblies shall be designed to withstand stresses due to the mast arm and signal weights and wind loads generated by a 90 mile per hour wind.

720.12 Wood Sign Posts. Wood sign posts shall be rectangular, straight and sound timber, cut from live growing native spruce, hemlock, cedar or Douglas Fir trees, free from loose knots or other structurally weakening defects of importance, such as shake or holes and heart rot. A tolerance of 1 inch in length and 1/4 inch in width or thickness is permitted in the dimensions of rectangular posts. They shall be sawn true and planed 4 sides. Nominal dimensions of rectangular posts shall be as given on the plans. The top shall be cut on a 22 degree bevel plus or minus 2 degrees.

Wood sign posts with 25 square inches or more of cross sectional area shall have an adequate quantity of material removed by drilling holes as shown on the plans to reduce the cross sectional area of the solid post to 25 square inches.

SECTION 721 -- BREAKAWAY DEVICES

721.01 Breakaway Devices. Breakaway devices shall be capable of supporting all design loads and shall conform in all respects to the requirements of the current AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals". No breakaway devices will be accepted for use unless accompanied by a notarized copy of the test method used, and the results obtained in testing the breakaway characteristics of said breakaway device. The description of the test method shall include but not be limited to the following:

Name of Testing Agency
Date tested
Description of test vehicle
Speed of Impact

Cast aluminum sleeve type bases, steel breakaway poles or any breakaway supports that require the use of tools, other than simple mechanic's tools, for the replacement of parts after having been struck or require the replacement of all or part of the light standard or sign support itself in order to be restored to service after having been struck, will not be allowed.

- (a) Aluminum Breakaway Couplings. Aluminum breakaway couplings shall be fluted aluminum castings or extrusions designed to be mounted on the anchor bolts supplied for light standards. The coupling shall incorporate in its upper end a suitable threaded stud and be equipped with a matching heavy hex nut and hardened washer. The stud, nut and washer shall be hot dipped galvanized or shall be of corrosion resistant steel.

The aluminum breakaway coupling shall be designed to sustain all axially applied design loads and to fracture under the application of transverse impact loads.

- (b) Aluminum Breakaway Transformer Bases. Aluminum breakaway transformer bases shall be standard aluminum transformer bases modified either metalurgically or structurally to conform to the requirements of the above AASHTO Specification. They shall be clearly and permanently identified as "Breakaway Base" in two conspicuous places, one of which must be on an outside exposed surface.
- (c) Steel Slip Bases. Steel slip bases shall incorporate three bolts arranged in an equilateral triangular pattern, set in "Vee" slots in two approximately triangular flanges and restrained from vibrating or "walking" out of said slots by a 28 gage steel keeper plate or equivalent. The bolts shall be equipped with washers of sufficient strength to

prevent their cupping into the "Vee" slots. The total slip face clamping force shall not exceed 45 kips, but shall preferably be between 10 kips and 15 kips. A positive self limiting means of controlling the clamping force, shall be incorporated in the design. The parts that will remain attached to the foundation after an impact shall have a stub height of 4 inches or less.

- (d) Breakaway Bases using Load-Concentrating Couplings. The load-concentrating couplings and their supports shall be designed to carry all loads, other than impact loads, in such a way that the couplings are stressed axially and no moments, sufficient to fracture the couplings, are induced in the couplings. The load-concentrating couplings shall also be designed and supported in such a way that forces induced in them by vehicular impact shall cause them to fail in bending and to cause a complete separation between the foundation and the supported structure.
- (e) Hinges. Hinge plates shall be dimensioned to transmit the full design moment of the support with a safety factor of not less than 1.00 nor more than 1.20, as determined by using the ultimate tensile stress range of hinge material.

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