STANDARD SPECIFICATIONS FOR CONSTRUCTION

CITY OF WACO

JANUARY 2013

CITY OF WACO

STANDARD SPECIFICATIONS FOR CONSTRUCTION

GENERAL PROVISIONS

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Table of Contents

SECTION 1 DEFINITIONS 5
1.1 DEFINITIONS 5
SECTION 2 SCOPE AND CONTROL OF THE WORK 11
2.1 PROPOSAL REQUIREMENTS 11
2.2 AWARD AND EXECUTION OF CONTRACT 14
2.3 ASSIGNMENTS 15
2.4 SUBCONTRACTS 15
2.5 CONTRACT BONDS 17
2.6 PLANS AND SPECIFICATIONS 17
2.7 SUBSURFACE DATA 19
2.8 RIGHT-OF-WAY 19
2.9 SURVEYING 20
2.10 EXISTING STRUCTURES 21
2.11 AUTHORITY OF OWNER AND ENGINEER 21
2.12 INSPECTION NOTIFICATION 21
2.13 INSPECTION ACCESS 22
SECTION 3 CONTRACT ADMINISTRATION 23
3.1 GENERAL 23
3.2 SUBMITTALS 24
3.3 COMPLETION OF THE WORK 24
3.4 CHANGE MANAGEMENT – CITY PROJECTS 24
3.5 CHANGE MANAGEMENT - DEVELOPMENT PROJECTS 25
3.6 ENVIRONMENTAL AND SAFETY PLANS 25
SECTION 4 CHANGES IN WORK 33
4.1 CHANGES REQUESTED BY THE CONTRACTOR 33
4.2 CHANGES INITIATED BY THE OWNER 33
4.3 EXTRA WORK 34
4.4 CHANGED CONDITIONS 35
4.5 DISPUTED WORK 36
SECTION 5 CONTROL OF MATERIALS 39
5.1 MATERIALS AND WORKMANSHIP 39
SECTION 6 UTILITIES 43
6.1 LOCATION 43
6.2 PROTECTION 43
6.3 REMOVAL 43
6.4 RELOCATION 44
6.5 DELAYS 45
6.6 COOPERATION 45
SECTION 7 PROSECUTION, PROGRESS, AND ACCEPTANCE OF THE WORK 47
7.1 CONSTRUCTION SCHEDULE AND COMMENCEMENT OF WORK 47
7.2 PROSECUTION OF WORK 47

7.3 Suspension of Work 48
7.4 Contractor Default 48
7.5 Delays and Extensions of Time 50
7.6 Time of Completion 51
7.7 Completion and Acceptance 51
7.8 Liquidated Damages 52
7.9 Use of Improvements During Construction 52
Section 8 Responsibilities of the Contractor 53
8.1 Contractor's Equipment and Facilities 53
8.2 Supervision and Superintendence 53
8.3 Labor 53
8.4 Insurance 54
8.5 Workers' Compensation Insurance 55
8.6 Permits 58
8.7 The Contractor's Representative 58
8.8 Cooperation and Collateral Work 59
8.9 Project Site Maintenance 59
8.10 Protection and Restoration of Existing Improvements 61
8.11 Public Convenience and Safety 62
8.12 Patent Fees or Royalties 64
8.13 Laws to be Observed 64
8.14 Indemnification 65
8.15 Equal Opportunity Employment 65
8.16 State and Local Sales and Use Taxes 66
8.17 Tax Certification 67
8.18 Offsets or Other Debts Against City 67
8.19 Time of Filing Claims 67
8.20 Force Majeure 67
8.21 Waiver 68
8.22 Modification 68
8.23 Right to Assurance 68
8.24 Venue 68
Section 9 Measurement and Payment 69
9.1 Measurement for Quantities of Unit Price Work 69
9.2 Lump Sum Work 69
9.3 Payment 69
Section 10 Abbreviations and Terms 75
10.1 Abbreviations 75
10.2 Institutions 80

SECTION 1
DEFINITIONS

1.1 DEFINITIONS

Whenever used in these General Conditions or in the other Contract Documents the following terms have the meanings indicated which are applicable to both the singular and plural thereof:

1. **Addendum -** Written instruments issued by the Contract Awarding Authority which clarify, correct or change the bidding requirements or the Contract Documents prior to the Due Date. “Addenda” is the **plural form of Addendum.**
2. **Advertisement for Bids –** a Solicitation requesting pricing for a specified Good or Service which has been advertised for bid in a newspaper and/or the internet.
3. **Agreement –** See Contract.
4. **Alternative Dispute Resolution -** The process by which a disputed Claim may be settled if the OWNER and the CONTRACTOR cannot reach an agreement between themselves, as an alternative to litigation.
5. **Base -** A layer of specified material of planned thickness placed immediately below the pavement or surfacing.
6. **Bid -** A complete, properly signed response to an Invitation for Bid or Request for Proposal that, if accepted, would bind the Bidder to perform the resultant Contract.
7. **Bid Guaranty -** The certified check or Bidder's surety bond accompanying the Bid as a guarantee that the Bidder will enter into a Contract with the City for the performance of the Work.
8. **Bidder -** A person, firm, or entity that submits a Bid or Proposal in response to a Solicitation. Any Bidder may be represented by an agent after submitting evidence demonstrating the agent’s authority. The agent cannot certify as to his own agency status.
9. **Bid Documents -** The advertisement or Invitation for Bids or Request for Proposals, instructions to Bidders, the Bid form, the Contract Documents and Addenda.
10. **Bond -** Bid, performance and payment bond or other instrument of security.
11. **Calendar Day -** Any day of the week; no days being excepted. Work on Saturdays, Sundays, and/or Legal Holidays shall be coordinated with and approved by the City. See definition of Working Day.
12. **Change Directive -** A written directive to CONTRACTOR, signed by OWNER, ordering a change in the Work and stating a proposed basis for adjustment, if any, in the Contract Amount or Contract Time, or both. A Change Directive may be used in the absence of total agreement on the terms of a Change Order. A Change Directive does not change the Contract Amount or Contract Time, but is evidence that the parties expect that the change directed or documented by a Change Directive will be incorporated in a subsequently issued Change Order.

13. **Change Orders -** Written agreements entered into between CONTRACTOR and the City authorizing an addition, deletion, or revision to the Contract, issued on or after the Execution Date of the Agreement. A Change Order is not effective until executed by both the CONTRACTOR and City.
14. **City –** The City of Waco acting through authorized representatives.
15. **City's Representative -** The City shall designate a duly authorized representative which may include the Engineer, other duly authorized assistant, agent, engineer, inspector or superintendent acting within the scope of the particular duties instructed to him. The City's Representative shall be the primary point of contact for the contractor.
16. **Claim -** A written demand seeking, as a matter of right, adjustment or interpretation of Contract terms, payment of money, extension of time or other relief with respect to the terms of the Contract.
17. **Code -** City of Waco adopted Building, Electrical, Mechanical, Plumbing Codes and any other local, state, or federal codes as applicable.
18. **Construction Engineer of Record –** The engineer responsible for direct daily supervision of the work; in accordance with Section 1001.407 (2) of the Texas Engineering Practice Act.
19. **Contract -** The binding legal agreement between the OWNER and the CONTRACTOR. The Contract represents the entire and integrated agreement between OWNER and CONTRACTOR for performance of the Work, as evidenced by the Contract Documents.
20. **Contract Amount -** The moneys payable by OWNER to CONTRACTOR for completion of the Work in accordance with the Contract Documents.
21. **Contract Awarding Authority –** The Waco City Council, the City Manager, or a City department authorized to enter into Contracts on behalf of the City under state law and/or city policy.
22. **Contract Documents -** Includes but is not limited to: Contract Addenda (which pertain to the contract documents); solicitation, advertisement or Invitation for Bids or Request for Proposals ; instruction to bidders; submitted Bid/Proposal including documentation accompanying the Bid/Proposal and any post-bid documentation when attached as an exhibit to the Contract; Bonds; general and supplemental conditions; permits from other agencies; Special Provisions; Plans; Standard Plans; Standard Specifications; Reference Specifications; Change Directives and Change Orders; and all Modifications issued after the execution of the Contract.
23. **Contract Time -** The number of days allowed for completion of the Work as defined by the Contract. When any period is referred to in days, it will be computed to exclude the first and include the last day of such period. A period of twenty-four hours measured from midnight to the next midnight will constitute a day.
24. **CONTRACTOR -** The individual, partnership, corporation, joint venture, or other legal entity having a Contract with the Owner to perform the Work. In the case of work being done under permit issued by the Owner, the permittee shall be construed to be the Contractor. The term "prime contractor" shall mean Contractor.

25. **Contract Price -** The total amount of money for which the Contract is awarded.
26. **Contract Unit Price -** The amount stated in the Bid for a single unit of an item of work.
27. **Critical Path -** The longest series of tasks that runs consecutively from the beginning to the end of the project, as determined by duration and workflow sequence. This longest path sets the managerial standard for how quickly a project can be completed, given appropriate resources.
28. **Days -** Days are Calendar Days or Working Days, as specified in the Contract Documents.
29. **Design Engineer of Record –** Responsible for the specifications, materials, drawings, design and bid documents for specific components of the project; usually based upon engineer disciplines; in accordance with Section 1001.407 (1) of the Texas Engineering Practice Act.
30. **Drawings -** Those portions of the Contract Documents which are graphic representations of the scope, extent and character of the Work to be furnished and performed by CONTRACTOR and which have been approved by OWNER. Drawings may include plans, elevations, sections, details, schedules and diagrams. Shop Drawings are not Drawings as so defined.
31. **Due Date -** The date and time specified for receipt of Bids.
32. **Engineer -** The Engineer of Record or his duly authorized representative.
33. **Equal -** The terms "equal" or "approved equal" shall have the same meaning.
34. **Execution Date -** Date of last signature of the parties to the Agreement.
35. **Extended Hours** – Any work to be done outside the hours of 7:00 a.m. and 6:00 p.m. on Monday through Friday (which are not holidays).
36. **Field Order -** A written order issued by Owner's Representative which orders minor changes in the Work and which does not involve a change in the Contract Amount or the Contract Time.
37. **Final Completion –** Final Completion of a contract is when all work has been completed and accepted (including any punch lists or corrections or repairs finished after substantial completion) and the final payment (including any retainage amounts) has been paid to CONTRACTOR.
38. **Inspector -** The authorized representative of any regulatory agency that has jurisdiction over any portion of the Work.
39. **Invitation for Bid (IFB) or Request for Bid (RFB)-** a Solicitation requesting pricing for a specified Good or Service which has been advertised for Bid in a newspaper and/or the Internet or as otherwise required by state law and/or City policy.
40. **Legal Holidays -** A list of observed holiday by the OWNER can be found on the OWNER'S website. If a Legal Holiday falls on Saturday, it will be observed on the preceding Friday. If a Legal Holiday falls on Sunday, it will be observed on the following Monday.
41. **Major Bid Item -** A single Contract item constituting 10 percent or more of the original Contract Price.

42. **Milestones -** A significant event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.
43. **Modification -** Includes Change Orders and Supplemental Agreements. A Modification may only be issued after the effective date of the Contract.
44. **Notice of Award -** The written notice by the Owner to the successful Bidder stating that upon compliance by it with the required conditions, the Owner will execute the Contract.
45. **Notice to Proceed -** A Written Notice given by OWNER to CONTRACTOR fixing the date on which the Contract Times will commence to run and on which CONTRACTOR shall start to perform CONTRACTOR's obligations under the Contract Documents.
46. **OWNER -** The City of Waco, Texas or its authorized representative, unless otherwise specified.
47. **Partial Occupancy or Use -** Use by OWNER of a substantially completed part of the Work for the purpose for which it is intended (or a related purpose) prior to Substantial Completion of all the Work, provided OWNER and CONTRACTOR have accepted in writing the responsibilities assigned to each of them for payments, retainage if any, security, maintenance, utilities, corrective work, insurance and warranties.
48. **Permittee –** The person requesting a construction permit or other permits from the City in order to perform construction in the right-of-way, and such term includes any agent, employee, or other representative designated by the person requesting a construction or other such permit.
49. **Plans -** The drawings, profiles, cross sections, working drawings, and supplemental drawings, or reproductions thereof, approved by the Engineer, which show the location, character, dimensions or details of the Work.
50. **Private or Development Projects -** Work subject to the Owner's inspection, control, and approval, involving private funds, not administered by the Owner. These projects generally involves work that will be dedicated to the City once the work is inspected, approved, and accepted.
51. **Project Manual -** That portion of the Contract Documents which may include the following: introductory information; bidding requirements, Contract forms and General and Supplemental General Conditions; General Requirements; and Specifications.
52. **Proposal -** A complete, properly signed response to a Request for Proposal that, if accepted, would bind the Bidder/Propser to perform the resultant Contract. This term may be used interchangeably with “Bid.”
53. **Proposer -** A person, firm, or entity that submits a Proposal in response to a Solicitation. Any Proposer may be represented by an agent after submitting evidence demonstrating the agent’s authority. The agent cannot certify as to his own agency status. The term may be used interchangeably with “:Bidder.”
54. **Reference Specifications -** Those bulletins, standards, rules, methods of analysis or test, codes, and specifications of other agencies, engineering societies, or industrial associations referred to in the Contract Documents. These refer to the latest edition, including amendments in effect and published at the time of advertising

the project or issuing the permit, unless specifically referred to by edition, volume, or date.

55. **Right of Way –** The area on, below or above a public roadway, highway street, public sidewalk, alley, waterway or utility easement in which the City has an legal interest through dedication, easement, fee title, or adverse possession. The term does not include the airwaves above a right-of-way with regard to wireless telecommunications.
56. **Roadway -** The portion of a street reserved for vehicular use. This will generally be an improved surface.
57. **Service Connection -** Service connections are all or any portion of the conduit, cable or duct, including meter, between a utility distribution line and an individual consumer's line.
58. **Shop Drawings -** All drawings, diagrams, illustrations, schedules and other data or information which are specifically prepared or assembled by or for CONTRACTOR and submitted by CONTRACTOR as required by the Contract Documents.
59. **Solicitation –** The documents (initial documents and any addenda) through which the City seeks bids or proposals for certain specified goods or services.
60. **Special Project Provisions –** Written requirements that are unique to the respective job. These are issued as part of the bid documents.
61. **Specifications –** Standard Specifications, Reference Specifications, Special Provisions, and specifications in Supplemental Agreements between the Contractor and the Owner.
62. **Standard Plans -** Details of standard structures, devices, or instructions referred to on the Plans or in Specifications by title or number.
63. **Standard Specifications -** The Standard Specifications for Public Works Construction (SSPWC) for the City of Waco, Texas. These specifications are intended to be written so that only first class workmanship and finish of the best grade and quality will result. Barely meeting the very minimum requirements will not be considered as satisfactory. The fact that these specifications may fail to be so complete as to cover all details will not relieve the Contractor of full responsibility for providing a completed project of high quality, first class finish and appearance and satisfactory for operation.
64. **State -** The State of Texas.
65. **Storm Drain -** Any conduit and appurtenances intended for the reception and transfer of storm water.
66. **Street –** The entire width between the boundary lines of the Right of Way publicly maintained which is open to use of the public for purposes of vehicular and pedestrian travel and provides for primary public access to lots.
67. **Subbase -** A layer of specified material of planned thickness between a base and the subgrade.
68. **Subcontractor -** An individual, firm or corporation having a direct contract with the Contractor or with any other Subcontractor for the performance of a part of the Work.

69. **Subgrade -** For roadways, that portion of the roadbed on which pavement, surfacing, base, subbase, or a layer of other material is placed. For structures, the soil prepared to support a structure.
70. **Substantial Completion -** The stage in the progress of the Work when the Work, or designated portion thereof, is sufficiently complete in accordance with the Contract Documents so OWNER can occupy or utilize the Work for its intended use, as evidenced by a Certificate of Substantial Completion approved by OWNER. For the purposes of Texas Government Code Section 2253.078, "substantial completion" shall not constitute final completion.
71. **Superintendent -** The representative of CONTRACTOR authorized in writing to receive and fulfill instructions from the Owner's Representative, and who shall supervise and direct the Work.
72. **Supervision -** Supervision, where used to indicate supervision by the Engineer, shall mean the performance of obligations, and the exercise of rights, specifically imposed upon and granted to the Owner in becoming a party to the Contract. Except as specifically stated herein, supervision by the Owner shall not mean active and direct superintendence of details of the Work.
73. **Supplemental Agreement -** A written amendment of the Contract Documents signed by both parties.
74. **Supplier -** An individual or entity having a direct contract with CONTRACTOR or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by CONTRACTOR or any Subcontractor.
75. **Surety -** Any corporation, bound with and for the Contractor for the acceptable performance, execution, and completion of the Work, and for the satisfaction of all obligations incurred.
76. **Time Extension Request -** An approved request for time extension on a form acceptable to OWNER.
77. **Unit Price -** See Contract Unit Price.
78. **Utility -** Tracks, overhead or underground wires, pipeline, conduits, ducts, or structures, sewers, or storm drains owned, operated, or maintained in or across a public right of way or private easement.
79. **Work -** The entire completed construction, or the various separately identifiable parts thereof, required to be furnished under the Contract Documents.
80. **Work Order -** See Notice to Proceed.
81. **Working Day -** Any day of the week, not including Saturdays, Sundays, or Legal Holidays in which conditions under the CONTRACTOR's control will permit work for a continuous period of not less than seven (7) hours between 7:00 a.m. and 6:00 p.m. Upon agreement with Owner's Representative, work on Saturdays, Sundays and/or Legal Holidays may be allowed and will be considered a Working Day.
82. **Working Hours** - All Work shall be done between 7:00 a.m. and 6:00 p.m. unless authorized by Owner's Representative in accordance with the City of Waco ordinance.

SECTION 2
SCOPE AND CONTROL OF THE WORK

2.1 BID/PROPOSAL REQUIREMENTS

A. Bid/Proposal Form - The Owner shall furnish bidders with forms which shall state the general location and description of the contemplated work and which shall contain an itemized list of the items of work to be done or materials to be furnished, and upon which prices are asked.

B. Quantities in Bid/Proposal Form - The quantities of the work and materials set forth in the forms or on the plans approximately represent the work to be performed and materials to be furnished; and are for the purpose of comparing the bids on a uniform basis. Payment shall be made to the Contractor only for the actual quantities of work performed or materials furnished in accordance with the plans and specifications; and it is understood that the quantities may be increased or decreased as hereinafter provided, without in any way invalidating the bid prices.

C. Examination of Plans, Specifications and Site of the Work - The intent of the contract documents is to include all information necessary for the proper execution and timely completion of the Work by the Contractor. The Contractor will execute the Work described in and reasonably inferable from the Contract Documents as necessary to produce the results indicated by the Contract Documents.

Bidders are advised that the plans, specifications and other documents on file as stated in the Advertisement for Bids shall constitute all the information, which the Owner shall furnish. Bidders are required, prior to submitting any proposal, to review the plans and read the specifications, proposal, contract and bond forms carefully; to visit the site of the work; to examine carefully local conditions; to inform themselves by their independent research, tests and investigations of the difficulties to be encountered and judge for themselves the accessibility of the work and all attending circumstances affecting the cost of doing the work or time required for its completion; and to obtain all information required to make an intelligent proposal.

No information given by the Owner or any official thereof, other than that shown on the plans and contained in the specifications, proposals and other contract documents, shall be binding upon the Owner. Bidders shall rely exclusively upon their own estimates, investigations, tests and other data, which are necessary for full and complete information upon which the proposal may be based. Any bidder, by submitting his bid, represents and warrants: that he has prepared his bid in accordance with the specifications, with full knowledge and understanding of the terms and provisions thereof; that he has reviewed, studied and examined the bid prior to the signing and submission of same; and that he

was cognizant of the terms of his proposal, verified his calculations and found them to be correct and agrees to be bound thereby.

D. Preparation of Bid/Proposal - The bidder shall submit his bid/proposal on the forms furnished by the Owner. All blank spaces in the form shall be correctly filled in and the bidder shall state the prices in numerals, for which he proposes to do the work contemplated or furnish the material required. Such prices shall be written in ink or typed distinctly and legibly. Bidders may submit an original computer printout sheet bearing certification by and signature for the bidding firm. If the bid/proposal is submitted by an individual, his name must be signed by him or his duly authorized agent. If the bid/proposal is submitted by an association or partnership, the name and address must be given and the proposal signed by a duly authorized member of the association or partnership. If the bid/proposal is submitted by a corporation, the corporate name and business address must be given and the proposal signed by a duly authorized corporate officer or agent. Powers of attorney authorizing agents to sign the bid/proposal must be properly certified and must be in writing and submitted with the proposal. The bid/proposal shall be executed in ink. It is understood and agreed that the bid/proposal may not be withdrawn once the City begins the opening process.

E. Bid/Proposal Guaranty - No bid/proposal shall be considered unless it is accompanied by cashier's check on any state or national bank, or acceptable bidder's bond payable unconditionally to the Owner. The cashier's check or bidder's bond shall be in the amount of not less than five percent of the total amount of the bid. The proposal guaranty is required by the Owner as evidence of good faith and as a guarantee that if awarded the contract, the bidder shall execute the contract and furnish the required bonds and evidence of insurance within 10 days after the award of said contract or pay the damages as set forth below. The said bidder's bond shall be conditioned that, if the proposal is withdrawn after the bids have been opened or the Contractor refuses to execute the contract in accordance with his proposal and provide the required surety bonds, the Contractor and the surety shall become liable to the Owner for the amount of the bidder's bond. If a bidder's bond is used, the surety thereon shall designate an agent in the Owner's county to whom required notices may be delivered and upon whom service of process may be had.

In the event cash or a cashier's check is submitted along with the proposal of the bidder, and the contractor does not execute the contract and provide the required surety bonds within 10 days after award of said contract, or withdraws his bid after bids have been opened, the Owner shall be entitled to the proceeds of such check.

F. Filing of Bid/Proposals - No bid/proposal shall be considered unless it is filed at the place and within the time limit for receiving proposals as stated in the Advertisement for Bids. Each bid/proposal shall be in a sealed envelope, plainly marked with the word “Bid” or "Proposal," and the name or description of the project as designated in the solicitation.

G. Withdrawing Bids/Proposals – Bids/Proposals filed with the City can be withdrawn or modified and redeposited prior to the time set for opening bids/proposals. Request for non-consideration of bids/proposals must be made in writing addressed to the Owner prior to the time set for opening bids/proposals. After other bids/proposals are opened and publicly read, the bids/proposal for which non-consideration is properly requested may be returned unopened. The bid/proposal may not be withdrawn after the opening process has commenced. The bidder/proposer, in submitting the same, warrants and represents that his bid/proposal has been carefully reviewed and checked and that it is in all things true and accurate and free of mistakes and that such bid/proposal shall not and cannot be withdrawn after opening because of any mistake committed by the bidder/propser; provided, however, that any bidder/proposer may withdraw his bid 90 days after the actual date of opening thereof, should no award have been made to such bidder/proposer. Bids/**Proposals unaccompanied by required completed forms shall be rejected.**

H. Opening Bids/Proposals - The bids/proposals filed with the Owner shall be opened at the time stated in the advertisement for bids and publicly read aloud; and shall thereafter remain on file with the City.

I. Irregular Bids/Proposals – Bids/Proposals shall be considered irregular if they show any omissions, alterations of form, additions, unbalanced values or conditions not called for, unauthorized alternate bids or other irregularities of any kind. The Owner may reject any proposal containing any such irregularity. The Owner, however, reserves the right to waive any irregularities and to make the award in the best interest of the Owner.

The Bidder/Proposer or Contractor shall not take advantage of any error in the bidding or contract documents. Anything mentioned in the specifications and not shown on the drawings, or shown on the drawings and not mentioned in the specifications, shall be of like effect as if shown on or mentioned in both. In case of any apparent difference between the drawings and specifications, or any other apparent error which the bidder or Contractor may discover, said Bidder/Proposer or Contractor shall refer the matter at once to the Owner as to which, in accordance with the intent of the contract documents, shall govern. The Owner shall have the right to correct the error discovered through an addendum to the solicitation(if the bids/proposals have not yet been opened) or through a change order to the Contract..

J. Rejection of Proposals - The Owner reserves the right to reject any or all bids/proposals; and all bids/proposals submitted are subject to this reservation. Reasons for rejection of proposals shall include, but are not limited to, the following reasons:

(1) bid/proposal received after the time limit for receiving bid/proposals as stated in the advertisement or any subsequently issued addendum;

(2) bid/proposal unaccompanied by the required bid/proposal guaranty;

(3) bid/proposal constituting a nonresponsive bid/proposal;
(4) bid/proposal containing unsolicited conditions or qualifications.

K. Disqualification of Bidders/Proposers – Bidders/Proposers may be disqualified and their bid/proposal not considered for any of the following specific reasons (as welll as other reasons not listed herein):

(1) reason for believing collusion exists among bidders/proposers;
(2) reasonable grounds for believing that any bidder/proposer is interested in more than one bid/proposal for the work contemplated;
(3) the bidder/proposer or his surety being currently in any litigation against the Owner, or where such litigation is contemplated or imminent, in the sole opinion of Owner;
(4) the bidder/proposer being in arrears on any existing contract or having defaulted on a previous contract;
(5) lack of competency, responsibility or financial capability as revealed by the bid/proposer questionnaires, financial statement, etc.;
(6) uncompleted work which in the judgment of the Owner prevents or hinders the prompt completion of additional work if awarded;
(7) unbalanced value of any bid/proposal items.
(8) and other reasons stated in the advertisement for bids/proposals.

2.2 AWARD AND EXECUTION OF CONTRACT

A. Consideration of Contract - After bids/proposals are opened, the bids/proposals shall be tabulated for comparison on the basis of the prices and quantities shown in the proposal and any other factors identified in the Solicitation. Until final award of the contract, the Owner reserves the right to reject any or all bids/proposals, to waive technicalities or irregularities at its option, to re-advertise for new bids/proposals or proceed to do the work otherwise in the best interests of the Owner. Each bidder/proposer shall be furnished a copy of the tabulation upon request.

B. Award of Contract and Commencement of Work - The award, if made, shall be to the lowest and best responsible bidder, unless a different basis for award is stated in the Solicitation. An award will normally be made within 60 days after the opening of bids/proposals. In no case shall the award be made until after investigations are made as to the responsibility of the bidder/proposer to whom the award of contract is proposed. All bids/proposals shall be good for 60 days following the opening unless a different time is stated in the Solicitation. Following award and execution of the contract and approval of the required surety bonds, the Contractor shall commence work within 10 days from the Notice to Proceed date issued by the Owner. No work shall commence prior to the issuance of such work order or before the required insurance has been obtained by the Contractor, with certificates filed with the Owner evidencing the required coverage to be in force. Should the Owner unreasonably delay the issuance of the work order through no

fault of the Contractor, the Contractor shall be entitled only to an equitable extension of contract time and the contract amount will not be unchanged.

C. Return of Proposal Guaranty - The City shall normally return the proposal guaranties accompanying all bids/proposals within 10 working days after opening, except for the three apparent low bid/proposals (or the three likeliest awardees if some other method of award if used). Those three bid/proposal guaranties shall be retained by the Owner until the required contract and surety bonds have been executed, after which they shall be returned.

D. Execution of Contract - The person or persons, partnership, company, firm, association or corporation to whom a contract is awarded shall within 10 working days after award of the contract, sign the necessary agreements entering into the required contract with the Owner. No contract shall be binding on the Owner until all authorized signatures required by law have been affixed and the executed contract delivered to the Contractor.

E. Failure to Execute Contract - The failure of the bidder/proposer to execute the contract or provide the required statutory surety bonds within 10 working days after the contract is awarded shall constitute a breach of his proposal and the Owner may annul the award and retain the proceeds of the bid guaranty. In the event the Owner should re-advertise for bids, the defaulting Contractor shall not be eligible to bid.

2.3 ASSIGNMENTS

The Contractor shall not assign, transfer, convey or otherwise dispose of this contract, or his right to execute it, or his right, title or interest in it or any part thereof without the previous written consent of the surety company and the written approval of the Owner.

The Contractor shall not assign, either legally or equitably, by power of attorney or otherwise, any of the monies due or to become due under this contract or his claim thereto without the prior written consent of the surety company and the written approval of the Owner.

The approval of the Owner of a particular assignment, transfer or conveyance shall not dispense with such approval to any further or other assignments.

The approval by the Owner of any assignment, transfer or conveyance shall not operate to release the Contractor or surety hereunder from any of the contract and bond obligations, and the Contractor shall be and remain fully responsible and liable for the defaults, negligent acts and omissions of his assignees, their agents and employees, as if they were his own.

2.4 SUBCONTRACTS

The Contractor shall not make any subcontract for performing any portion of the work included in the contract without written notice to the Owner. This contract having been made pursuant to the bid/proposal submitted by the Contractor and in reliance with

the Contractor's personal qualifications and responsibility, the Owner reserves the right to withhold approval of any subcontractor that the Owner deems not in the Owner's best interest.

SUBCONTRACT SUBMITTAL - The Contractor shall submit a written notice to the Owner of each subcontractor and/or supplier with a 1% or greater value of the work upon submitting the bid. Upon request of the Owner, the Contractor shall promptly furnish additional information tending to establish that any proposed subcontractor has the necessary facilities, skill, integrity, past experience and financial resources to perform the work in accordance with the terms and conditions of this contract. No changes are allowed of subcontractors or suppliers without prior approval by the Owner.

If the Owner determines that any proposed subcontractor is unacceptable, Owner shall so notify the Contractor, who may thereupon submit another proposed subcontractor unless the Contractor decides to do the work himself. Disapproval by the Owner of any proposed subcontractor shall not provide a basis for any claim by the Contractor.

SUBCONTRACTOR PERFORMANCE - If an approved subcontractor fails to properly perform the work undertaken, the subcontractor shall be removed from the job upon request of the Owner, following notification to the Contractor in writing of the request for removal and the reasons therefore.

SUBCONTRACT PROVISIONS - Each subcontract entered into shall provide that the provisions of this contract shall apply to such subcontractor and his officers and employees in all respects as if the subcontractor and its officers and employees were employees of the Contractor. The Owner's decision not to disapprove of any subcontract shall not relieve the Contractor of any of his responsibilities, duties and liabilities hereunder.

CONTRACTOR RESPONSIBILITIES - The Contractor shall be solely responsible for the acts, omissions, negligence or defaults of its subcontractors and of such subcontractor's officers, agents and employees, each of whom shall, for this purpose, be deemed to be the agent or employee of the Contractor to the extent of the subcontract.

The Contractor agrees to bind each subcontractor, and each subcontractor agrees to be bound by the terms of the contract documents insofar as applicable to his work. The Contractor and each subcontractor jointly and severally agree that nothing in the contract documents or otherwise shall create or be deemed to create any rights in favor of a subcontractor against the Owner; nor shall be deemed or construed to impose upon the Owner any obligation, liability or duty to a subcontractor; or to create any contractual relation whatsoever between a subcontractor and the Owner.

The provision contained herein shall likewise apply to any sub-subcontracts.

2.5 CONTRACT BONDS

Before execution of the Contract by the City, the Bidder shall file with the City surety bonds in the amounts and for the purposes noted below. Bonds shall be on forms furnished by the City and duly executed by a responsible corporate Surety, authorized to issue such bonds in the State of Texas and acceptable to the City, and secured through an authorized agent with an office in Texas. The Bidder/Proposer shall pay all bond premiums, costs, and incidentals.

Each bond shall incorporate, by reference, the contract and be signed by both the Bidder/Proposer and Surety.

The Bidder/Proposer shall provide two good and sufficient surety bonds as required by state law and the Advertisement for Bids. A "Payment Bond" (Material and Labor Bond) shall be for not less than 100 percent of the Contract Price to satisfy claims of material suppliers and of mechanics and laborers employed by it on the Work. The bond shall be maintained by the Contractor in full force and effect until the Work is accepted by the Owner, and until all claims for materials and labor are paid.

The "Performance Bond" shall be for 100 percent of the Contract Price to guarantee faithful performance of all Work, within the time prescribed, in a manner satisfactory to the Owner, and to guarantee that all materials and workmanship will be free from original or developed defects.

Should any bond become insufficient, the Contractor shall renew the bond within 10 days after receiving notice from the Owner.

Should any Surety at any time be unsatisfactory to the Owner, notice will be given the Contractor to that effect. No further payments shall be deemed due or will be made under the Contract until a new Surety shall qualify and be accepted by the Owner.

Changes in the Work, or extension of time, made pursuant to the Contract, shall in no way release the Contractor or Surety from its obligations. Notice of such changes or extensions shall be waived by the Surety.

2.6 PLANS AND SPECIFICATIONS

A. General - The Contractor shall keep at the Work site a copy of the Plans and Specifications, to which the Engineer shall have access at all times.

The Plans, Specifications and other Contract Documents will govern the Work. The Contract Documents are intended to be complementary and cooperative and to describe and provide for a complete project. Anything in the Specifications and not on the Plans, or on the Plans and not in the Specifications, shall be as though shown or mentioned in both.

While it is believed that much of the information pertaining to conditions which may affect the cost of the Work will be shown on the Plans or indicated in the Specifications, the Owner does not warrant the completeness or accuracy of such information. The Contractor shall ascertain the existence of any conditions affecting the cost of the Work, which would have been disclosed by reasonable examination of the site.

Existing improvements visible at the job site, for which no specific disposition is made on the Plans, but which could reasonably be assumed to interfere with the

satisfactory completion of the improvements contemplated by the Plans, shall be removed and disposed of by the Contractor as directed by the Engineer.

The Contractor shall, upon discovering any error or omission in the Plans and Specifications, immediately call it to the attention of the Engineer.

B. Precedence of Contract Documents - If there is a conflict between Contract Documents, the document highest in precedence shall control. The precedence shall be:

(1) The executed contract between the OWNER and CONTRACTOR along with any properly executed change orders.
(2) Permits and licenses from other agencies as may be required by law.
(3) Special Project Provisions.
(4) Plans.
(5) Standard Plans.
(6) Standard Specifications.
(7) Reference Specifications.

Change Orders, Supplemental Agreements and approved revisions to Plans and Specifications will take precedence over Items 2 through 6 above. Detailed plans shall have precedence over general plans.

C. Shop Drawings, Product Data and Samples (SUBMITTALS) - Shop drawings are drawings, diagrams, schedules and other data specially prepared for the work by the Contractor or any subcontractor, manufacturer, supplier or distributor to illustrate some portion of the work.

Product data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the Contractor to illustrate a material, product or system for some portion of the work.

Samples are physical examples, which illustrate materials, equipment or workmanship and establish standards by which the work shall be judged.

SUBMITTAL PROCESS - The Contractor shall provide, review, approve, stamp, sign and submit, all shop drawings, product data and samples required by the contract documents. By approving and submitting shop drawings, product data and samples, the Contractor represents that Contractor has determined and verified all materials, field measurements, and field construction criteria related thereto, and that Contractor has checked and coordinated the information contained within such submittals with the requirements of the work and of the contract documents.

As the Engineer's review is only for general conformance with the requirements of the contract documents, the Contractor shall not be relieved of responsibility for any deviation from the requirements of the contract documents by the Engineer's approval of shop drawings, product data or samples unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submission and the Engineer has given written approval to the specific deviation. The Contractor shall not be relieved from

responsibility for errors or omissions in the shop drawings, product data or samples by the Engineer's approval thereof. The Contractor shall direct specific attention, in writing or on resubmitted shop drawings, product data or samples, to revisions other than those requested by the Engineer on previous submittals.

No portion of the work requiring submission of a shop drawing, product data or sample shall be commenced until the submittal has been approved by the Engineer. All such portions of the work shall be in accordance with approved submittals.

SUBMITTAL CONTENT AND FORMAT – The Contractor shall provide shop drawings, product data and sample submittals in sufficient detail to ensure compliance with all contractual specifications and requirements.

The Contractor shall provide six hard copies and one electronic copy (portable document format files). The Owner will designate the appropriate representative prior to or at the pre-construction meeting.

SUBMITTAL SCHEDULE - The Contractor shall provide submittals with reasonable promptness and in such sequence as to cause no delay in the work. The Contractor shall be responsible for delays caused by rejection of the submittal of inadequate or incorrect shop drawings, product data or samples.

SUBMITTAL DOCUMENTATION - The Contractor shall be responsible for the distribution of "approved" copies of the submittals, bearing the approval of the Engineer, for the Owner's designated representative and as otherwise necessary for the construction operation.

The Contractor shall keep adequate records of submittals, approvals, and submittal schedules so that an accurate up-to-date record file is maintained at the job site at all times.

2.7 SUBSURFACE DATA

All soil and test hole data, water table elevations, and soil analyses shown on the drawings or included in the Specifications apply only at the location of the test holes and to the depths indicated. Soil test reports for test, which have been drilled, are available for inspection at the office of the Engineer. Any additional subsurface exploration shall be done by Bidders/Proposers or the Contractor at their own expense.

The indicated elevation of the water table is that existing at the date the test hole data was determined. It is the Contractor's responsibility to determine and allow for the elevation of groundwater at the date of project construction. A difference in elevation between groundwater shown in soil boring logs and groundwater actually encountered during construction will not be considered as a basis for extra work.

2.8 RIGHT-OF-WAY

Rights-of-way, easements or rights of entry for the Work will be provided by the Owner. Unless otherwise provided, the Contractor shall make arrangements with property

owners; pay for, and assume all responsibility for acquiring, using, and disposing of additional work areas and facilities temporarily required, prior to using said work areas. The Contractor shall indemnify and hold the Owner harmless from all claims for damages caused by such actions.

2.9 SURVEYING

A. Permanent Survey Markers - The Contractor shall notify the Owner's representative at least 7 days before starting Work in order that they may take necessary measures to ensure the preservation of survey monuments and benchmarks. The Contractor shall not disturb permanent survey monuments or benchmarks without the consent of the Engineer and the Owner, and shall bear the expense of replacing any that may be disturbed without permission. Replacement shall be done only by the Owner.

B. Lot Stakes - The Contractor shall preserve property line and corner survey markers, except where their destruction is unavoidable, and the Contractor is proceeding with authority of the owner of the affected property. Markers that are lost or disturbed by the Contractor's operations shall be replaced at the Contractor's expense by a Public Land Surveyor registered by the State of Texas.

C. Survey Service – It is anticipated for most City managed projects, the City will provide and be responsible for the accuracy of the base line surveying adequate for construction. The Contractor will be for responsible any additional survey services necessary to complete the Work. The Contractor shall preserve construction survey stakes and marks for the duration of their usefulness. If any construction survey stakes are lost or disturbed and need to be replaced, such replacement shall be made by the City at the expense of the Contractor.

The Contractor shall notify the City's representative in writing at least two (2) working days before survey services will be required in connection with the laying out of any portion of the Work. The Contractor shall dig all holes necessary for line and grade stakes, and shall set bluetops for grade control as required to complete the Work.

Unless otherwise specified, stakes will be set and stationed by the Engineer for curbs, headers, sewers, storm drains, structures, and rough grade and a corresponding cut or fill to finished grade (or flowline) indicated on a grade sheet.

In some cases, a consulting Engineer or the Contractor will be responsible for providing the necessary surveying services. It is anticipated that this will occur on private (developer and utility company) projects and may occur on some City managed projects (when noted in the Contract Documents).

D. Private Engineers, Contractors - Surveying by private engineers or contractors on the Work shall conform to the quality and practice required by state law and the Engineer.

E. Line and Grade - All work shall conform to the lines, elevations, and grades shown on the Plans.

Three consecutive points set on the same slope shall be used together so that any variation from a straight grade can be detected. Any such variation shall be reported to the Engineer. In the absence of such report, the Contractor shall be responsible for any error in the grade of the finished work.

Grades for underground conduits will be set at the surface of the ground. The Contractor shall transfer them to the bottom of the trench in a manner approved by the Engineer.

2.10 EXISTING STRUCTURES

The plans show the general locations of all known surface and subsurface structures. The locations of many gas mains, water mains, conduits, sewers, other utilities, etc., however, are unknown, and the Owner assumes no responsibility for failure to show any or all these structures on the plans or the show them in their exact locations. It is mutually agreed that such failure shall not be considered sufficient basis for claims for additional compensation for extra work or for increasing the pay quantities in any manner whatsoever, unless the obstruction encountered is such as to necessitate changes in the lines or grades; or requires the building of special work, provisions for which are not made in the plans and proposal; in which case the provisions in these specifications for extra work shall apply.

2.11 AUTHORITY OF OWNER AND ENGINEER

The Owner has the final authority in all matters affecting the Work. Within the scope of the Contract, the Engineer has the authority to ensure compliance with the Plans and Specifications. The Contractor shall promptly comply with instructions from the Engineer or an authorized representative.

On all questions relating to quantities, the acceptability of material, equipment, or work, the execution, progress or sequence of work and the interpretation of Specifications or drawings, the decision of the Engineer is final and binding, and shall be precedent to any payment under the Contract, unless otherwise ordered by the Owner.

2.12 INSPECTION NOTIFICATION

The Work is subject to inspection and approval by the Engineer and the Owner or their designated representatives. The Contractor shall comply with current City of Waco ordinance notification requirements[1], unless otherwise specified in the executed contract documents.

Unless otherwise superseded by city ordinance, the Contractor shall notify the designated representatives before noon of the working day before inspection is required. Unless otherwise authorized, all critical work shall be done only in the presence of the

[1] See the Waco Code of Ordinances Chapter 23 – Right of Way management in Article II – Construction

Engineer or an authorized representative. Any work done without proper inspection will be subject to rejection.

2.13 INSPECTION ACCESS

The designated representatives shall at all times have access to the Work during its construction at shops and yards as well as the project site. The Contractor shall provide every reasonable facility for ascertaining that the materials and workmanship are in accordance with these specifications. Inspection of the Work shall not relieve the Contractor of the obligation to fulfill all conditions of the Contract.

SECTION 3
PROJECT ADMINISTRATION

3.1 GENERAL

A. CITY PROJECTS – These Standard Specifications for Construction General Provisions are part of the contract by which the Contractor has committed to complete a specific scope of Work, in compliance with the drawings, specifications, schedule, and all applicable laws, rules and regulations. Compensation for said Work shall be made as described in the agreed upon Proposal.

CONSTRUCTION STANDARDS - ALL WORK must comply with the City of Waco Standard Specifications for Construction and the Manual of Standard Details.

Any request for change to the design for this portion of private projects must be approved by the design Engineer of record, and approved prior to implementation.

Submittals for this portion of the Work shall be forwarded to, and approved by, the design Engineer of Record, and forwarded to the City of Waco. The City of Waco reserves the right to approve any items submitted as an "or equal".

Direct oversight of the construction (inspection) may be provided by the City of Waco Engineering Department, the project consulting engineer, or other City of Waco representatives.

Any request for change to the design, schedule, or project cost must be made in writing, and approved prior to implementation.

B. PRIVATE OR DEVELOPMENT PROJECTS - Private or development projects must be approved by City of Waco development review.

DEVELOPER'S DESIGNATED REPRESENTATIVE - As part of the development review process, each developer must identify a designated representative for the project, along with all necessary contact information. The designated representative will serve as the single point of contact for all communication and issue resolution.

PUBLIC SIDE OF DEVELOPMENT PROJECTS - Any portion of a private or development project that occurs in the public right of way or easements must comply with the City of Waco Standard Specifications for Construction and the Manual of Standard Details.

Any request for change to the design for this portion of private projects must be approved by the engineer of record, submitted to City of Waco development review, and approved prior to implementation.

Submittals for this portion of the Work shall be forwarded to, and approved by, the design Engineer of Record, and forwarded to the City of Waco development review. The City of Waco reserves the right to approve any items submitted as an "or equal".

The City of Waco Engineering Department construction inspection group will provide direct oversight of this portion of the Work, unless otherwise noted.

PRIVATE SIDE OF DEVELOPMENT PROJECTS - The portion of development projects within the property lines must comply with all applicable building codes, City of Waco code enforcement, and associated permitting.

3.2 SUBMITTALS

A. CITY PROJECTS -

The Contractor shall submit within 10 days of the effective date of the Notice to Proceed:

- The name and contact information of the project superintendent as noted in *General Provisions Section 8.2 Supervision and Superintendence*;
- The name and contact information of the emergency contact;
- The name and contact information of the designated safety representative(s);, and
- The name and contact information for the designated project manager for this Contract.

B. DEVELOPMENT PROJECTS -

All information associated with the completion of the Work will be submitted to development review.

3.3 COMPLETION OF THE WORK

The Contractor shall maintain a work force adequate to accomplish the work within the contract time. The Contractor agrees to employ only orderly, competent, and knowledgeable workers, skillful in performance of the type of Work required under this contract.

3.4 CHANGE MANAGEMENT – CITY PROJECTS

A. DESIGN

Changes to any aspect of the project (materials, design, construction methods, etc.) shall be reviewed and approved by the Design Engineer of Record. A change is not effective until a change directive or change order is executed by the OWNER/City and/or Design Engineer of Record.

(1) Change of Materials – Or Equals

The Contractor may request, in writing, a change in materials specified in the Contract Documents as noted in *General Provisions Section 5.1.F, Trade Names or Equals*. It is the Contractor's responsibility to submit the necessary information in such a timely manner as to avoid any adverse impacts to the Contract Schedule.

The Contractor may request, in writing, a deviation from the specified materials using the same procedure outlined above.

(2) Request for Deviation from Design

The Contractor may request a deviation from the design of the Work. The Contractor shall submit, in writing, the necessary information in such a timely manner as to avoid any adverse impacts to the Contract Schedule.

The modification to the design may be utilized upon receipt of written approval by the Owner or Engineer.

(3) Change of Construction Methods

If a specific means, method, technique, sequence, or procedure of construction is required by the Contract Documents, the Contractor may request a substitute as noted in *General Provisions Section 4.1, Changes Requested By the Contractor.*

The Contractor shall submit, in writing, the necessary information in such a timely manner as to avoid any adverse impacts to the Contract Schedule. The substitute means or methods may be utilized upon receipt of written approval by the Owner or Engineer.

B. SCHEDULE

The Contractor may request a change to the number of specified working days as provided in the contract. The project schedule may be only changed with the approval of a Change Order. Please refer to *General Provisions Section 7.2, Prosecution of Work*.

C. COST

The Contractor may request a change to the cost as provided in the contract. The cost may be only changed with the approval of a Change Order. Please refer to *General Provisions Section 4.1, Changes Requested by the Contractor.*

3.5 CHANGE MANAGEMENT - DEVELOPMENT PROJECTS

The Contractor may request a Change of Materials, Request for Deviation from the design, or a change to specified construction methods as noted in *General Provisions Section 3.4, Change Management – City Projects*. All requests for change shall be approved by the Design Engineer of Record and City of Waco development review prior to implementation. Any changes requested to the City of Waco Standard Specifications For Construction, Standard Details or equal clause shall be submitted to the City of Waco Engineering Department for review and approval.

3.6 ENVIRONMENTAL AND SAFETY PLANS

The Contractor shall submit for approval all required environmental and safety plans for the completion of the Work. The Work will not be permitted to begin until all related plans have been reviewed and approval by the appropriate party.

A. TRAFFIC CONTROL PLAN (TCP) - When required, the Contractor is responsible to submit a Traffic Control Plan for approval. The Plan shall be based upon applicable City and State requirements and established standards.

In the event a TCP has been included with the contract documents, the Contractor shall comply with the TCP. The Contractor is responsible to monitor the Plan as the Work progresses and submit modifications for approval as needed.

The Contractor is also responsible to provide the Inspector a copy of the signed Plan prior to beginning work. The Contractor is responsible to monitor the Plan as the Work progresses and submit modifications for approval as needed. The Contractor is also responsible to provide the Inspector a copy of the signed Plan prior to beginning work. Refer to *8.11.C, Street Closures, Detours, Barricades.*

The requirements for the TCP are as follows:

(1) Must conform with current Texas MUTCD (Manual on Uniform Traffic Control Devices) standards

(2) Must clearly depict each construction stage

(3) Must be compiled by a Licensed or Certified Personnel

- **a.** Texas Licensed Professional Engineer
- **b.** IMSA Certified Work Zone Personnel
- **c.** TEEX Certified Work Zone Personnel

The TCP and associated work plan shall be submitted to the City of Waco Engineering office 15 days prior to the anticipated start date. A copy of the current certification shall be submitted as part of the request.

B. TRENCH SAFETY PLAN - When required by the Work, the Contractor shall submit a trench safety plan for review. The plan shall include the recommended safety protection measures with the appropriate loading requirements.

The Contractor shall ensure that all protective measures located on site and all procedures on the project are in compliance with all aspects of the plan.

The Contractor shall comply with all applicable rules and regulations. All related documentation will be made available to the Inspector on a daily basis. The Contractor shall provide copies of all related documentation to the Owner upon request.

(1) Trench Safety Systems

(a) Description - This item shall govern for the trench safety systems required for the construction of all trench excavation to be utilized in the project and including all additional excavation and backfill necessitated by the safety system. A trench shall be defined as a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet. Trench safety systems include, but are not limited to sloping, sheeting, trench boxes or trench shield, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage.

(b) Construction Methods - Trench safety systems shall be accomplished in accordance with the detailed specifications set out in the provisions of Federal Occupational Safety and Health Administration (OSHA) Standards setout in

29CFR, Part 1926. With regard to excavations, Subpart P of 29 CFR Part 1926, as it currently exists or is amended in the future, shall be followed. The sections that are incorporated into these specifications by reference include Sections 1926-650 through 1926-653. The provisions of Subchpater C, trench Safety, of Chapter 756 of the Texas Health and Safety Code are hereby incorporated by reference into these specifications. This section is intended to incorporate these laws and regulations as they currently exist or may be amended in the future.

(c) Safety Systems - Prior to construction, the Contractor shall submit five (5) copies of a trench safety system to the City Engineer specifically for the construction of trench excavation. The trench safety system shall be in accordance with OSHA standard governing the presence and activities of individuals working in an around trench excavation. The trench safety system must be designed and sealed by a professional engineer registered in the State of Texas with professional experience in Soil Mechanics. The Contractor is responsible for obtaining boring and soil analysis as required for plan design. After review of the trench safety system, the City Engineer will forward a copy of the reviewed plan to the project inspector, to the Contractor and keep one file copy. The review is only for general conformance with O.S.H.A. safety standards and the review does not relieve the Contractor or design professional of any or all construction means, methods, techniques and procedures. Any property damage, bodily injury or death that arises from use of the trench safety system or from the City's failure to note exceptions to the system shall remain the sole responsibility of the Contractor. No trenching in excess of 5 feet (1.52 M) below existing grade will be allowed until the plan is reviewed. Any changes in the trench safety system after the initiation of construction will not be cause for extension of time or change order and will require the same review process. On some projects, the City may elect to provide preliminary soil information to the Contractors for bid purposes only and not as a substitute for required soil data for design use. The City assumes no liability nor makes any guarantees by the inclusion of any soil data.

(d) Inspection - The Contractor shall make daily inspections of the trench safety systems to ensure that the systems meet OSHA requirements. Daily inspection is to be made by a "competent person" provided by the Contractor.

If evidence of possible cave-ins, or slides, is apparent, all work in the trench shall cease until the necessary precautions have been taken by the Contractor to safeguard personnel entering the trench. It is the sole duty, responsibility and prerogative of the Contractor, not the Owner or the Engineer, to determine the specific applicability of the designed trench safety systems to each field condition encountered on the project. The Contractor shall maintain a permanent record of daily inspections.

(e) Indemnification - The Contractor shall indemnify and hold harmless the City, its elected officials, employees, and agents, from any and all damages, costs (including, without limitation, legal fees, court costs, and the cost of investigation), judgments or claims by anyone for injury or death of persons resulting from the collapse or failure of trenches constructed under this contract.

The Contractor acknowledges and agrees that this indemnity provision provides indemnity for the City in case the City is negligent either by act or omission in providing for trench safety, including but not limited to inspections, failure to issue stop work orders, and the hiring of the Contractor.

(f) Measurement and Payment - Trench safety systems shall be measured by the linear foot along the centerline of the trench.

Payment for Trench Safety Systems shall be made at the unit price bid per linear foot for "Trench Safety Systems". Payment of all work prescribed under this item shall be full compensation for the Trench Systems including any additional excavation and backfill required, for furnishing, placing, maintaining and removing all shoring, sheeting, or bracing; for dewatering or diversion of water; for all jacking and jack removal; and for all other labor, materials, tools, equipment, acquisition of soils information and design of trench safety system, and incidentals necessary to complete the work.

C. CONFINED SPACE PLAN - When required by the Work, the Contractor shall submit a Confined Space Plan for review.

The Contractor shall ensure that all procedures employed on the project are in compliance with all aspects of the Plan.

The Contractor shall comply with all applicable rules and regulations. All related documentation will be made available to the Inspector on a daily basis. The Contractor shall provide copies of all related documentation to the Owner upon request.

D. STORM WATER POLLUTION PREVENTION PLAN (EROSION CONTROL PLAN)

The Contractor shall submit a STORM WATER POLLUTION PREVENTION PLAN (EROSION CONTROL PLAN) for approval. The Plan shall be based upon applicable City, State, and Federal requirements and established standards. For further information see *Section 1.10, Storm Water Pollution Prevention*, of the Standard Specifications, Section 1, Site Work.

3.7 PROJECT MEETINGS

A. General

(1) **Related Documents** – Documents related to this section will included are construction drawings and general provisions of the Contract, including the General Conditions and Supplemental General Conditions and any other Contract Documents.

(2) **Summary**- This section describes the preconstruction conference and other Project Related meetings throughout the duration of the project.

The Contractor, or his authorized representative(s), shall attend all Project related meetings as indicated herein. The Contractor's representative, as a minimum, shall include his Project Manger and Superintendent. Other Contractor's representatives may attend Project related meetings as is appropriate.

The Contractor Shall provide all pertinent reports, copies of reports, etc., for each meeting as may be required by this or other sections of the Contract.

B. Preconstruction Meetings

(1) Preconstruction Conference

(a) A preconstruction conference shall be held as soon after the award and execution of the Contract as possible and before any Work at the site is started. The Owner's Project Manager shall prepare and distribute the meeting agenda, preside over the conference, and may distribute meeting minutes. The conference shall be attended by:

1. Contractor's Project Manger
2. Contractor's Superintendent
3. Any Subcontractors' and/or Suppliers' representatives whom the Contractor may desire to invite or whom the Engineer or Owner may request to attend.
4. Engineer's representative
5. Owner's Project Manager
6. Owner's Representative

(b) The topics to be discussed may include, but will not be limited to, the following items:

1. Review of previous meetings' notes and update of pertinent information and Project status.
2. Introduction of persons attending the meeting.
3. General project description, including length of contract and liquidated damages.
4. Key personnel associated with the construction (may include, but is not limited to the following):
   - Contractor's Project Manager
   - Contractor's Superintendent
   - Owner's Project Manager
   - Engineer's representative
   - Owner's Sponsoring Department Representative
   - Representatives of the various utilities
5. Lines of communication and chains of command
6. Wage and personnel records and reporting requirements
7. Subcontractors and suppliers
8. Submittal review and approval procedure. Submittals may include, but are not limited to the following:
   - Letter stating the name and qualifications of the Contractor's Superintendent
   - Letter(s) from the Subcontractor(s) listing their salaried specialists
   - Schedule of Values

- If applicable, a letter designating the Safety Representative (for general project safety) and the "Competent Person" for trench safety
- Trench Safety Plan
- Schedule for submittals
- Shop drawings
- Construction schedule (The schedule shall indicate the phases of work in which subcontractors, if necessary, will be participating. Subcontractors shall be indicated by name)
- Payroll reports
- Substitution of subcontractors
- Non-use of asbestos materials affidavit

9. Job and traffic safety
10. Permits.
11. Utility coordination report.
12. Notification of property owners and other affected by the project
13. Job meetings.
14. Use of the site for construction, storage, staging, etc., and interrelationship with other contracts.
15. Equal opportunity requirements
16. Laboratory testing of material requirements.
17. Inventory of materials stored on site provisions.
18. Progress estimate and payment of procedure.
19. Posting of signs.
20. Project safety.
21. Prompt payment procedure.
22. Review of contract – addenda, supplementary general conditions, special provisions, special specifications and other unique project items.
23. Other

(2) Partnering Workshop

(a) To complete this work most beneficially for all parties, the Owner desires to form a Partnering Team among the Owner, Engineer, Contractor, and Subcontractor(s). This relationship will draw on the strength of all parties to identify and achieve mutual goals. The objectives are effective and efficient contract performance, intended to achieve completion within budget, on schedule, and in accordance with the drawings and specifications.

(b) The Owner may schedule a Partnering Workshop independent of or in conjunction with the Preconstruction Conference, to facilitate the project objectives.

The partnering relationship will be multilateral in make up and participation will be totally voluntary.

C. Construction Meetings

(1) Progress Meetings

(a) Progress meetings shall be held as deemed necessary by the Engineer/Architect or Owner or as requested by the Contractor throughout the duration of the Project. The meetings shall be held at a location selected by or approved by the Owner's Representative. The Owner's Representative or Contractor, as agreed to, shall preside over the meeting and issue meeting minutes.

(b) Progress meetings will be attended by the following:

1. Contractor's Project Manager, when requested to attend.
2. Contractor's Construction Superintendent.
3. Any subcontractors' and/or suppliers' representatives whom the Contractor may desire to invite or whom the Engineer/Architect or Owner requests to attend.
4. Owner's Representative.
5. Engineers representative(s).
6. Owner's Project Manager, if needed or required.

(c) The topics will include, but not necessarily be limited to, the following subjects:

1. Safety on the Construction site.
2. Progress of work. This will include a detailed run of a rolling 3-week schedule and any deviation from the approved critical path schedule.
3. Identification and discussion of construction related issues.
4. Submittal status.
5. Review of any applicable administrative issues (pay requests, change orders, etc.)

(2) Design Co-ordination Meetings

Design coordination and issues resolution meeting will be scheduled as needed. The Project Manager will ensure all appropriate parties attend the meeting.

D. Post-Construction Meetings

(1) Warranty Issues

In the event any issues arise in the Post-Construction period that requires a meeting, the Project Manager will schedule such a meeting with appropriate parties.

(2) Project Close-Out Meeting

(a) When necessary, the City of Waco Project Manager will schedule a mandatory project close-out meeting following final completion of the Work.

(b) The Contractor will ensure all necessary personnel attend the close-out meeting to submit and review all contract close-out documentation. Follow up mandatory meetings will be schedule as needed to complete the close-out process. Approval of the final invoice is dependant upon receipt of close-out documentation.

SECTION 4
CHANGES IN WORK

4.1 CHANGES REQUESTED BY THE CONTRACTOR

A. GENERAL - Changes in specific methods of construction may be made at the Contractor's request when approved in writing by the Engineer. The Contractor shall submit sufficient information to the Owner's representative to determine the requested change is equivalent to that identified in the drawings and specifications. This request for deviation (RFD) submittal shall be submitted with sufficient notice as to provide ample time for review without adversely impacting the project schedule.

Changes in the Plans and Specifications requested in writing by the Contractor which do not materially affect the Work and which are not detrimental to the Work or to the interests of the Owner, may be granted by the Owner to facilitate the Work, when approved in writing by the Engineer.

Changes are not effective until documented by an executed Change Directive or Change Order.

B. PAYMENT FOR CHANGES REQUESTED BY THE CONTRACTOR - If such changes are granted, they shall be made at a reduction in cost or at no additional cost to the Owner. Nothing herein shall be construed as granting a right to the Contractor to demand acceptance of such changes.

4.2 CHANGES INITIATED BY THE OWNER

A. General - The Owner may change the Plans, Specifications, character of the work, or quantity of work, provided the total arithmetic dollar value of all such changes, both additive and deductive, does not exceed the original Contract Price by more than 25%.

Change Orders shall be in writing and state the dollar value of the change or establish method of payment, any adjustment in contract time, and, when negotiated prices are involved, shall provide for the Contractor's signature indicating acceptance. Change Orders exceeding certain values will require approval of the Waco City Council.

B. Payment

(1) Contract Unit Prices – Subject to Section 4.2.A above, if a change is ordered in an item of work covered by a Contract Unit Price, and such change does not involve a substantial change in the character of the work from that shown on the Plans or included in the Specifications, then an adjustment in payment will be made based upon the increase or decrease in quantity using the Contract Unit Price.

If a change is ordered in an item of work covered by a Contract Unit Price, and such change does involve a substantial change in the character of the work from that shown on the Plans or included in the Specifications, an adjustment in payment will be made in accordance with *General Provisions Section 4.2.B(3), Agreed Prices.*

Should any Contract item be deleted in its entirety, payment will be made only for actual costs incurred prior to notification of such deletion.

(2) Stipulated Unit Prices - Stipulated unit prices are those established by the Owner in the Contract Documents, as distinguished from Contract Unit Prices submitted by the Contractor. Stipulated unit prices may be used for the adjustment of Contract changes.

(3) Agreed Prices - Adjustments in payments for changes other than those set forth in *General Provisions* Section *4.2.B(1) (Contract Unit Prices)* and *4.2.B(2) (Stipulated Unit Prices)* will be determined by agreement between Contractor and Owner. If unable to reach agreement, the Owner may direct the Contractor to proceed on the basis of Extra Work in accordance with *General Provisions Section 4*.3, *Extra Work.*

4.3 EXTRA WORK

A. General - New or unforeseen work will be classified as "extra work" when the Engineer determines that it is not covered by Contract Unit Prices or stipulated unit prices.

(1) The Owner reserves the right to add work to this contract, by change order, at locations not specified in the bid documents. The price for such extra work will be mutually agreed upon by the Owner and the Contractor. The cost for such Extra Work may not exceed the original Contract Price by more than 25%.

B. Payment - The extra work done by the Contractor as authorized and approved shall be paid for in the manner hereinafter described; and the compensation thus provided shall be accepted by the Contractor as payment in full for all labor, materials, tools, equipment and incidentals and all superintendents' and timekeepers' services, all insurance, bond and all other overhead expense incurred in the performance of the extra work.

Payment for extra work shall be made by one of the following methods:

(1) Method "A" - By unit prices agreed on in writing by the Engineer and approved by the Owner before said extra work is commenced, subject to all other conditions of the contract.

(2) Method "B" - By lump sum price agreed on in writing by the Engineer and the Contractor and approved by the Owner before said extra work is commenced, subject to all other conditions of the contract.

(3) Method "C" - By actual field cost of the work plus 25 percent as described herein below, agreed on in writing by the Engineer and the Contractor, and approved by the Owner before said extra work is commenced, subject to all other conditions of the contract.

In the event extra work is to be performed and paid for under Method "C", the actual field cost of the work shall include the wages of all workmen, foremen, timekeepers, mechanics and laborers, the cost of materials, supplies, trucks, rental on machinery and equipment, only for the time actually employed or used on such extra work, plus all power, fuel, lubricants, water and similar operating expenses and rateable proportion of premiums on construction and maintenance bonds, public liability and workers' compensation and all other insurance required by law or ordinances. The Engineer shall specify in writing the method of doing work, and the type and kind of machinery and equipment to be used. The 25 percent of the actual field cost to be paid the Contractor shall cover and compensate him for profit, overhead, general supervision and field office expense, and all other elements of cost and expense not embraced within the actual field cost as herein specified. The Contractor shall give the Engineer access to all accounts, bills and vouchers relating thereto.

Method "C" shall be used only in the event that Method "A" or "B" are not applicable or in the best of interest of the Owner.

4.4 CHANGED CONDITIONS

The Contractor shall notify the Engineer in writing of the following Work site conditions, hereinafter called changed conditions, promptly upon their discovery and before they are disturbed:

A. Subsurface or latent physical conditions differing materially from those represented in the Contract; and

B. Unknown physical conditions of an unusual nature differing materially from those ordinarily encountered and generally recognized as inherent in work of the character being performed.

The Engineer will promptly investigate conditions when notified of any conditions discovered by it, which appear to be changed conditions. If the Engineer determines that the conditions are changed conditions and that they will materially increase or decrease the costs of any portion of the Work, a Change Order will be issued adjusting the compensation for such portion of the Work in accordance with *General Provisions Section 4*.2.B, Payment. If the Engineer determines that conditions of which it has been notified by the Contractor do not justify an adjustment in compensation, the Contractor will be so advised in writing, which notice shall also advise the Contractor of its obligation to notify the Engineer, in writing, if the Contractor disagrees. Should the Contractor disagree with such determination, it may submit a written notice of potential claim to the Engineer before commencing the disputed work. The Contractor shall proceed as provided in *General Provisions Section 4.5, Disputed Work.*

If the Engineer determines that the conditions are changed conditions and that they will materially affect the performance time, the Contractor, upon submitting a

written request, may be granted an extension of time subject to the provisions of *General Provisions Section 7*.5, *Delays and Extensions of Time*.

The Contractor's failure to give notice of changed conditions promptly upon their discovery and before they are disturbed shall constitute a waiver of all claims in connection therewith.

4.5 DISPUTED WORK

A. General - If the Contractor is of the opinion that (a) the work necessary or required to accomplish the result intended by this contract; or (b) any work ordered to be done as contract work by the Owner is extra work or additional work and not contract work; or (c) any determination or order of the Owner violates the terms and provisions of this contract, the Contractor shall promptly, notify the Owner in writing of his contentions with respect thereto and request a final determination thereof before proceeding with such work or complying with such order or determination.

Such determination of the Owner shall be given in writing to the Contractor. If the Owner determines that the work in question is extra work and not contract work, or the determination or order complained of requires performance by the Contractor beyond that required by the contract or violates the terms and provisions of the contract, thereupon the Owner shall cause either (a) the issuance of a written order covering the extra work as provided for in *General Provisions Section 4*.3, Extra Work, or (b) the determination or order complained of to be rescinded or so modified so as to not require performance beyond that required by the terms and provisions of the contract.

If the Owner determines that the work in question is contract work and not extra work, or that the determination or order complained of does not require performance by the Contractor beyond that required by the contract or violate the terms and provisions of the Contract, the Owner shall direct the Contractor to proceed, and the Contractor must promptly comply. In order to reserve his right to claim compensation for such work resulting from such compliance, however, the Contractor must, within 20 calendar days after receiving the Owner's determination and direction, notify the Owner in writing that the work is being performed, or that the determination and direction is being complied with, under protest.

If the Contractor fails to so appeal to the Owner for a determination or, having so appealed, should the Contractor thus fail to notify the Owner in writing of his protest, the Contractor shall be deemed to have waived any claim for extra compensation of damages thereof. No oral appeals or oral protests, no matter to whom made, shall be deemed even substantial compliance with the provisions of this item.

A delay of the Contractor due to a court order against the Owner, or due to the Owner's failure to secure right-of-way at the time required or because of a conflict of a utility with the work shall not be a cause for additional compensation for damages sustained by the Contractor, but may be a cause for extension of contract working time only.

In addition to the foregoing requirements, the Contractor shall, upon notice from the Owner, produce for examination and audit at the Contractor's office, by the

representatives of the Owner, all contractor's books and records showing all of its acts and transactions in connection with contractual performance as well as relating to or arising by reason of the matter in dispute. At such examination a duly authorized representative of the Contractor may be present.

Unless the aforesaid requirements and conditions shall have been complied with by the Contractor, the Owner shall be released from all claims arising under, relating to or by reason of this contract, except for the sums to be due under the payment provisions of this contract. It is further stipulated and agreed that no conduct on the part of the Owner or any agent or employee of the Owner shall ever be construed as a waiver of the requirements of this section, which such requirements constitute an absolute condition precedent to any approval of any claim for extra compensation, notwithstanding any other provisions of the contract documents; and in any action against the Owner to recover any sum in excess of the contract amount the Contractor must allege and prove strict compliance with the provisions of this section.

In connection with the examination provided for herein, the Owner, upon demand thereof, shall also produce for inspection by the Contractor such records as the Owner may have with respect to such disputed work or work performed under protest pursuant to order of the Owner, except those records and reports which may have been prepared for the purpose of determining the accuracy and validity of the Contractor's claim.

B. Performance of Extra or Disputed Work - While the Contractor or his subcontractor is performing extra work in accordance with the Owner's written order, the cost of which is to be determined by Method "C" set forth in *General Provisions Section 4.3.B, Payment*, or is performing disputed work or complying with a determination or order under protest in accordance with *General Provisions Section* 4*.5.A, General*, the Contractor shall daily furnish the Owner's representative at the site with three copies of verified statements showing:

(1) The name and number of each workman employed on such extra work or engaged in complying with such determination or order, the character of extra work each is doing and the wages paid to him, including the rate and amount of payroll taxes contributions for insurance and federal social security; and

(2) The nature, cost and quantity of any materials, plant or construction equipment furnished or used in connection with the performance of such extra work or in complying with such determination or order, and from whom purchased or rented.

A copy of such statements shall be signed by the Owner's representative, noting thereon any items in question, and shall be returned to the Contractor within two working days after submission. This signature shall not be construed as the Owner's agreement and acceptance of items not questioned since all items are subject to subsequent review and audit by Owner representatives.

The Contractor and his subcontractors, when required by the Owner, must also produce for inspection and audit by designated Owner representatives, any and all books, vouchers, records, daily job diaries and reports, canceled checks, etc., showing

the nature and quantity of labor, materials and equipment actually used in the performance of the extra work; the amounts expended thereof; and the costs incurred for insurance premiums and other items of expense directly chargeable to such extra work. The Contractor must permit the Owner's representatives to make extracts therefrom or copies thereof as may be desired.

Failure of the Contractor to comply strictly with these requirements shall constitute a waiver of any claim for extra compensation on account of the performance of such extra work.

4.6 UNAUTHORIZED CHANGES IN THE WORK

The Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any Work performed that is not required by the Contract Documents as amended.

SECTION 5
CONTROL OF MATERIALS

5.1 MATERIALS AND WORKMANSHIP

A. General - All materials, parts, and equipment furnished by the Contractor in the Work shall be new, high grade, and free from defects. Quality of work shall be in accord with the generally accepted standards. Materials and work quality shall be subject to the Engineer's approval.

Materials and work quality not conforming to the requirements of the Specifications shall be considered defective and will be subject to rejection. Defective work or material, whether in place or not, shall be removed immediately from the site by the Contractor, at its expense, when so directed by the Engineer.

If the Contractor fails to replace any defective or damaged work or material after reasonable notice, the Engineer may cause such work or materials to be replaced. The replacement expense shall be deducted from the amount to be paid to the Contractor.

Used or secondhand materials, parts, and equipment may be used only if permitted by the Specifications.

B. Protection of Work and Materials - The Contractor shall provide and maintain storage facilities and employ such measures as will preserve the specified quality and fitness of materials to be used in the Work. Stored materials shall be reasonably accessible for inspection. The Contractor shall also adequately protect new and existing work and all items of equipment for the duration of the Contract.

The Contractor shall not, without the Owner's consent, assign, sell, mortgage, pledge as security, or remove equipment or materials which have been installed or delivered and which may be necessary for the completion of the Contract.

C. Inspection Requirements - Unless otherwise specified, inspection is required at the source for such typical materials and fabricated items as bituminous paving mixtures, structural concrete, metal fabrication, metal casting, welding, concrete pipe manufacture, protective coating application, and similar shop or plant operations. Steel pipe in sizes less than 18 inches; vitrified clay, asbestos-cement, polyvinyl chloride, and ductile iron pipe in all sizes are acceptable upon certification as to compliance with the Specifications, subject to sampling and testing by the Owner. Standard items of equipment such as electric motors, conveyors, elevators, plumbing fixtures, etc., are subject to inspection at the job site only. Special items of equipment such as designed electrical panel boards, large pumps, sewage plant equipment, etc., are subject to inspection at the source, normally only for performance testing. The Specifications may require inspection at the source for other items not typical of those listed in this subsection. The Owner will provide all inspection and testing laboratory services.

D. Test of Materials - Before incorporation in the Work, the Contractor shall submit samples of materials as required by the Engineer at no cost to the Owner. The Contractor, at its expense, shall deliver the materials for testing to the place and at the time designated by the Engineer. All materials tested shall be representative of the materials to be used in the Work and a statement to this effect shall be submitted by the Contractor with the material sample. Unless otherwise provided, all initial testing and any required retesting shall be performed under the direction of the Engineer and at no expense to the Contractor.

The Contractor shall notify the Engineer in writing at least 15 days in advance of its intention to use materials for which tests are specified to allow sufficient time to perform the tests. The notice shall name the proposed supplier and source of material.

If the notice of intent to use is sent before the materials are available for testing or inspection, or is sent so far in advance that the materials on hand at the time will not last but will be replaced by a new lot prior to use on the Work, it will be the Contractor's responsibility to re-notify the Engineer when samples which are representative may be obtained.

E. Certification - The Engineer may waive materials testing requirements of the Specifications and accept the manufacturer's written certification that the materials to be supplied meet those requirements. Materials test data may be required as part of the certification.

Asphalt - The Contractor shall provide the Engineer with three copies of manufacturer's certified analysis on each tank car or truckload of asphalt.

F. Trade Names or Equals - The Contractor may supply any of the materials specified or offer an equivalent. The Engineer shall determine whether the material offered is equivalent to that specified. Adequate time shall be allowed for the Engineer to make this determination.

Whenever any particular material, process, or equipment is indicated by patent, proprietary of brand name, or by name of manufacturer, such wording is used for the purpose of facilitating its description and shall be followed by the words ***or approved equal***. A listing or materials is not intended to be comprehensive, or in order of preference. The Contractor may offer any material, process, or equipment considered to be equivalent to that indicated.

The Contractor shall, at its expense, furnish sufficient data concerning items offered by it as equivalent to those specified. The Contractor shall have the material tested as required by the Engineer to determine that the quality, strength, physical, chemical, or other characteristics, including durability, finish, efficiency, dimensions, service, and suitability are such that the item will fulfill its intended function.

Test methods shall be subject to the approval of the Engineer. Test results shall be reported promptly to the Engineer, who will evaluate the results and determine if the

substitute item is equivalent. The Engineer's findings shall be final. Installation and use of a substitute item shall not be made until approved by the Engineer.

If a substitute offered by the Contractor is not found to be equal to the specified material, the Contractor shall furnish and install the specified material.

The specified Contract completion time shall not be affected by any circumstance developing from the provisions of this subsection.

On Private or Development Projects, as defined in *Section 3.1*, any requests submitted for use of "or-equal" must be approved by the City of Waco before utilization.

G. Weighing Equipment - All scales used for proportioning materials shall be inspected for accuracy and certified within the past 12 months by a commercial scale company approved by the Engineer.

The accuracy of the work of a scale service agency, except as stated herein, shall meet the requirements of the latest revision of the National Bureau of Standards Handbooks 44 and 112 pertaining to weight devices. A certificate of compliance shall be presented, prior to operation, to the Engineer for approval and shall be renewed whenever required by the Engineer at no cost to the Owner.

All scales shall be so arranged that they may be read easily from the operator's platform or area. They shall indicate the true net weight without the application of any factor. The figures of the scales shall be clearly legible. Scales shall be accurate to within 1 percent when tested with the plant shut down. Weighing equipment shall be so insulated against vibration or moving of other operating equipment in the plant area that the error in weighing with the entire plant running will not exceed 2 percent for any setting nor 1½ percent for any batch.

H. Calibration of Testing Equipment - Testing equipment, such as, but not limited to pressure gages, metering devices, hydraulic systems, force (load)-measuring instruments, and strain measuring devices shall be calibrated by a testing agency acceptable to the Engineer at intervals not to exceed 12 months and following repairs, modification, or relocation of the equipment. Calibration certificates shall be provided when requested by the Engineer.

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SECTION 6
UTILITIES

6.1 LOCATION

The Plans for the project shall indicate those substructures which may affect the Work. Information regarding removal, relocation, abandonment, or installation of new utilities will be furnished to prospective bidders.

Where underground main distribution conduits such as water, gas, sewer, electric power, telephone or cable television are shown on the Plans, the Contractor, for the purpose of preparing a Bid, shall assume that every property parcel will be served by a service connection for each type of utility.

Existing utility line locations shown on the Plans are approximate only and are furnished as a guide for the Contractor. The Contractor will verify the location and elevation of all utilities before beginning excavation. The Contractor shall notify utility companies by DigTess that have utilities in the construction area at least 48 hours prior to starting construction to allow them to locate and mark their utilities and make adjustments if required.

The Contractor shall determine the location and depth of all utilities, including service connections, which have been marked by the respective owners and which may affect or be affected by its operations. If no pay item is provided in the Contract for this work, full compensation for such work shall be considered as included in the prices bid for other items of work.

6.2 PROTECTION

The Contractor shall not interrupt the service function or disturb the support of any utility, such as the base and thrust blocks, without authority from the utility owner or order from the City. All valves, switches, vaults, and meters shall be maintained readily accessible for emergency shutoff.

Upon learning of the existence and location of any utility omitted from or shown incorrectly on the Plans, or not properly marked, the Contractor shall immediately notify the Engineer in writing.

The Contractor shall immediately notify the Engineer and the utility owner if any utility is disturbed or damaged.

6.3 REMOVAL

Unless otherwise specified, the Contractor shall remove all interfering portions of utilities shown on the Plans or indicated in the Bid documents as "abandoned" or "to be abandoned in place." Before starting removal operations, the Contractor shall ascertain from the Owner whether the abandonment is complete, and the costs involved in the removal, plugging, capping, and disposal shall be included in the Bid for the items of work necessitating such removals.

All utility poles and guy wires, private sign posts, sign guy wires, and similar private obstructions which interfere with the construction of this project will be removed and replaced or moved to a new permanent location by the utility owners thereof without cost to the Contractor.

The removal and reinstallation of City of Waco street signposts and signs is the responsibility of the Contractor. The Contractor shall be responsible for all damage to street signs and sign posts whether they remain in place or are removed and replaced within the limits of his operations. In the event that street signposts and/or signs are damaged or destroyed by the Contractor's operations (including removal and reinstallation), they shall be replaced by the Contractor. No separate compensation will be paid for the work, but the costs thereof should be included in such contract pay items as are provided.

6.4 RELOCATION

The utility owners within the area affected by the Work will complete their necessary installations, relocations, repairs or replacements before commencement of work by the Contractor. When the Specifications or Plans indicate that a utility installation is to be relocated, altered or constructed by others, the Owner will conduct all negotiations with the utility owners and the work will be done at no cost to the Contractor. Utilities which are relocated in order to avoid interference with the proposed permanent work shall be protected in their relocated position and the cost of such protection shall be included in the Bid for the items of work necessitating such relocation.

After award of the Contract, portions of utilities, which are found to interfere with the Work, will be relocated, altered or reconstructed by the utility owners, or the Engineer may order changes in the Work to avoid interference. Such changes will be paid for in accordance with *General Provisions Section 4.2, Changes Initiated By the Owner.*

When the Plans or Specifications provide for the Contractor to alter, relocate, or reconstruct a utility, all costs for such work shall be included in the bid for the items of work necessitating such work. Temporary or permanent relocation or alteration of utilities requested by the Contractor for its convenience shall be its responsibility, and it shall make all arrangements and bear all costs.

The utility owner will relocate service connections as necessary within the limits of the Work or within temporary construction or slope easements unless otherwise specified. When directed by the Engineer, the Contractor shall arrange for the relocation of service connections as necessary between the meter and property line, or between a meter and the limits of temporary construction or slope easements. The relocation of such service connections will be paid for in accordance with *General Provisions Section 4.3, Extra Work*. Payment will include the restoration of all existing improvements, which may be affected thereby. The Contractor may, for convenience or to expedite the Work, agree with the owner of any utility to disconnect and reconnect interfering service connections. The Owner will not be involved in any such agreement.

6.5 DELAYS

The Contractor shall notify the Engineer of its construction schedule insofar as it affects the protection, removal or relocation of utilities. Said notification shall be in writing and shall be included as a part of the construction schedule required in *General Provisions Section 7.1, Construction Schedule and Commencement of Work*. The Contractor shall notify the Engineer in writing of any subsequent changes in the construction schedule, which will affect the time available for protection, removal, or relocation of utilities.

The Contractor will not be entitled to damages or additional payment for delays attributable to utility relocations or alterations.

The Contractor may be given an extension of time for unforeseen delays attributable to unreasonably protracted interferences by utilities in performing work correctly shown on the Plans.

6.6 COOPERATION

When necessary, the Contractor shall so conduct its operations as to permit access to the Work site and provide time for utility work to be accomplished during the progress of the Work.

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SECTION 7
PROSECUTION, PROGRESS, AND ACCEPTANCE OF THE WORK

7.1 CONSTRUCTION SCHEDULE AND COMMENCEMENT OF WORK

After notification of award and prior to start of any work, the Contractor shall submit its proposed construction schedule to the Design Engineer for approval. The construction schedule shall be in the form of a tabulation chart or graph and shall be in sufficient detail to show chronological relationship of all activities of the project. These include, but are not limited to: estimated starting and completion dates of various activities, submittal of shop drawings to the Engineer for approval, procurement of materials and scheduling of equipment. The construction schedule shall recognize the requirements of *General Provisions Section 6.5, Delays*, and reflect completion of all work under the Contract within the specified time and in accordance with the Specifications. The schedule will be prepared prior to the pre-construction conference.

Any request to work extended hours must be submitted no later than 72 hours in advance. The city reserves the right to approve or disapprove the extended work hours in consideration of factors such as impact of the public, safety and any other pertinent implications.

The graveling of pavement cut behind construction should be moistened and kept to street grade and free from blowing dust for at least two weeks until any asphalt is placed. The maintenance of these street cuts shall be at the Contractor's expense and included in bid items of the proposal.

Unless otherwise provided, the Contract time shall commence upon the date of issuance of a work order. The Notice to Proceed Date will not be issued to the Contractor until an approved schedule of construction has been reviewed by the Engineer.

If the Contractor desires to make a major change in the method of operations after commencing construction, or if the schedule fails to reflect the actual progress, the Contractor shall submit to the Engineer a revised construction schedule in advance of beginning revised operations.

7.2 PROSECUTION OF WORK

To minimize public inconvenience and possible hazard and to restore street and other work areas to their original condition and state of usefulness as soon as practicable, the Contractor shall diligently prosecute the Work to completion. If the Engineer determines that the Contractor is failing to prosecute the Work to the proper extent, the Contractor shall, upon orders from the Engineer, immediately take steps to remedy the situation. All costs of prosecuting the Work as described herein shall be included in the Contractor's Bid. Should the Contractor fail to take the necessary steps to fully accomplish said purposes, after orders of the Engineer, the Engineer may suspend the Work in whole or part, until the Contractor takes said steps.

As soon as possible under the provisions of the Specifications, the Contractor shall backfill all excavations and restore to usefulness all improvements existing prior to the start of the Work.

If Work is suspended through no fault of the Owner, all expenses and losses incurred by the Contractor during such suspensions shall be borne by the Contractor. If the Contractor fails to properly provide for public safety, traffic, and protection of the Work during periods of suspension, the Owner may elect to do so, and deduct the cost thereof from monies due the Contractor. Such actions will not relieve the Contractor from liability.

7.3 SUSPENSION OF WORK

A. General - The Work may be suspended in whole or in part when determined by the Engineer that the suspension is necessary in the interest of the Owner. The Contractor shall comply immediately with any written order of the Engineer. Such suspension shall be without liability to the Contractor on the part of the Owner except as otherwise specified in *Subsection 7.5.C, Payment for Delays to Contractor*.

B. Archaeological and Paleontological Discoveries - If discovery is made of items of archaeological or paleontological interest, the Contractor shall immediately cease excavation in the area of discovery and shall not continue until the Engineer approves resuming work with whatever restriction are deemed necessary to comply with state and federal laws and regulations.

Discoveries, which may be encountered, may include, but not be limited to, dwelling sites, stone implements or other artifacts, animal bones, human bones, and fossils.

If bone is uncovered during the construction process or observed on the ground, all work in that area shall cease until the Engineer has an opportunity to determine if the bone is human and to determine if court authorization is necessary to remove the bones.

The Contractor shall be entitled to an extension of time and compensation in accordance with *General Provisions Section 7.5, Delays and Extensions of Time*.

7.4 CONTRACTOR DEFAULT

Owner's Right to Suspend Work and Annul Contract

The work or any portion of the work under contract shall be suspended immediately on written order of the Owner declaring the Contractor to be in default. A copy of such notice shall be served on the Contractor's surety. The contract may be annulled by the Owner for any good cause or causes, among others of which special reference is made to the following:

A. Failure of the Contractor to start the work within 10 days from the date specified in the written work order issued by the Owner to begin the work;

B. Substantial evidence that the progress of the work being made by the Contractor is insufficient to complete the work within the specified working time;

C. Failure of the Contractor to provide sufficient and proper equipment, materials or construction forces for properly executing the work;

D. Substantial evidence that the Contractor has abandoned the work or discontinuance of the performance of the work or any part thereof and failure to resume performance within a reasonable time after notice to do so;

E. Substantial evidence that the Contractor has become insolvent or bankrupt, or otherwise financially unable to carry on the work;

F. Deliberate failure on the part of the Contractor to observe any requirements of these specifications or to comply with any orders given by the Engineer as provided for in these specifications;

G. Failure of the Contractor to promptly make good any defects in materials or workmanship, or any defects of any nature, the correction of which has been directed in writing by the Owner;

H. Substantial evidence of collusion for the purpose of illegally procuring a contract or perpetuating fraud on the Owner in the construction of work under contract;

I. Repeated and flagrant violations of safe working procedures;

J. The filing by the Contractor of litigation against the Owner prior to final completion of the work.

When the work is suspended for any of the causes itemized above, or for any other cause or causes, the Contractor shall discontinue the work or such part thereof as the Owner shall designate; whereupon the surety may either at its option assume the contract or that portion thereof which the Owner has ordered the Contractor to discontinue, and perform the same or, with the written consent of the Owner, subcontract the same; provided, however, that the surety shall exercise its option, within two weeks after the written notice to discontinue the work has been served upon the Contractor and upon the surety or its authorized agents. The surety in such event shall assume the Contractor's place in all respects, and shall be paid by the Owner for all work performed by it in accordance with the terms of the contract, but in no event shall such payments exceed the contract amount, regardless of the cost to the surety to complete the work.

All monies remaining due the Contractor at the time of his default shall thereupon become due and payable to the surety as the work progresses, subject to all terms of the contract. In case the surety does not within the hereinabove specified time, exercise its obligation to assume the contract or that portion thereof which the Owner has ordered the Contractor to discontinue, then the Owner shall have the power to complete by contract or otherwise, as it may determine, the work herein described or such part thereof as it may

deem necessary; and the Contractor hereto agrees that the Owner shall have the right to take possession of or use any or all of the materials, plant, tools, equipment, supplies and property of every kind provided by the Contractor for the purpose of his work and to procure other tools, equipment and materials for the completion of the same; and to charge to the account of the Contractor the expense of said contract for labor, materials, tools, equipment and expenses incident thereto. The expense so charged shall be deducted by the Owner out of such monies as may be due or may at any time thereafter become due the Contractor under and by virtue of the contract or any part thereof.

The Owner shall not be required to obtain the lowest bid for the work of completing the contract, but the expenses to be deducted shall be the actual cost of such work. In case such expense is less than the sum which would have been payable under the contract, if the same had been completed by the Contractor, then in such case the Owner may pay to the Contractor the difference in the cost, provided that the Contractor shall not be entitled to any claim for damages or for loss of anticipated profits.

In case such expense shall exceed the amount which would have been payable under the contract if the same had been completed by the Contractor, the Contractor and his surety shall pay the amount of the excess to the Owner on notice from the Owner for excess due including any costs incurred by the Owner, such as inspection, legal fees and liquidated damages. When any particular part of the work is being carried on by the Owner by contract or otherwise under the provisions of this section, the Contractor shall continue the remainder of the work in conformity with the terms of the contract; and in such manner as not to hinder or interfere with the performance of workmen employed as above provided by the Owner or surety.

7.5 DELAYS AND EXTENSIONS OF TIME

A. General - If delays are caused by unforeseen events beyond the control of the Contractor, such delays will entitle the Contractor to an extension of time as provided herein, but the Contractor will not be entitled to damages or additional payment due to such delays, except as provided in *Subsection 7.5.C, Payment for Delays to Contractor.* Such events if beyond the control of Contractor may include: war; government regulations; labor disputes; strikes; fires; floods; adverse weather or elements necessitating cessation of work; inability to obtain materials, labor or equipment; required extra work; or other specific events as may be further described in the Specifications.

No extension of time will be granted for a delay caused by the Contractor's inability to obtain materials unless the Contractor furnishes to the Engineer documentary proof. The proof must be provided in a timely manner in accordance with the sequence of the Contractor's operations and the approved construction schedule.

If delays beyond the Contractor's control are caused by events other than those mentioned above, the Engineer may deem an extension of time to be in the best interests of the Owner. The Contractor will not be entitled to damages or additional payment due to such delays, except as provided in *Subsection 7.5.C, Payment for Delays to Contractor.*

If delays beyond the Contractor's control are caused solely by action or inaction by the Owner, such delays will entitle the Contractor to an extension of time as provided in *Subsection 7.5.B, Extensions of Time.*

B. Extensions of Time - Extensions of time, when granted, will be based upon the effect of delays to the Work. They will not be granted for noncontrolling delays to minor portions of the Work unless it can be shown that such delays did or will delay the progress of the Work.

C. Payment for Delays to Contractor - The Contractor will be compensated for damages incurred due to delays for which the Owner is responsible. Such actual costs will be determined by the Engineer. The Owner will not be liable for damages that the Contractor could have avoided by any reasonable means, such as judicious handling of forces, equipment, or plant. The determination of what damages the Contractor could have avoided will be made by the Engineer.

D. Written Notice and Report - If the Contractor desires payment for a delay as specified in *Subsection 7.5.C, Payment for Delays to Contractor,* or an extension of time, it shall file with the Owner a written request and report of cause within 15 days after the beginning of the delay. Failure by the Contractor to file these items within the times specified will be considered grounds for refusal by the Owner to consider such request.

7.6 TIME OF COMPLETION

The Contractor shall complete the Work within the time set forth in the Contract. The Contractor shall complete each portion of the Work within such time as set forth in the Contract for such portion. Unless otherwise specified, the time of completion of the Contract shall be expressed in working days.

7.7 COMPLETION AND ACCEPTANCE

The Work will be inspected by the Engineer for acceptance upon receipt of the Contractor's written assertion that the Work has been completed.

If, in the Engineer's judgment, the Work has been completed and is ready for acceptance, it will issue a certificate of Substantial Completion to the City. The Engineer will, in its notification, give the date when the Work was completed. This will be the date when the Contractor is relieved from responsibility to protect the Work.

All Work shall be guaranteed by the Contractor against defective workmanship and materials furnished by the Contractor for a period of one (1) year from the date the Work was accepted. The Contractor shall replace or repair any such defective Work in a manner satisfactory to the Engineer, after notice to do so from the Engineer, and within the time specified in the notice. If the Contractor fails to make such replacement or repairs within the time specified in the notice, the Owner may perform this work and the Contractor or Contractor's sureties shall be liable for the cost thereof.

The Contractor will provide the Owner with a notarized affidavit stating that all bills for materials, labor and other obligations have been paid, discharged or waived.

7.8 LIQUIDATED DAMAGES

As stated in the Solicitation, time is of the essence to the Owner in completing the project. It is impracticable and extremely difficult to fix the actual damages, if any, that may proximately result from a failure by Contractor to perform the service within the time specified. Therefore, in the event of Contractor's failure to complete Work by the time deadlines specified in the Contract, Contractor agrees to pay and will pay to Owner liquidated damages for each day of delay or nonperformance as defined in the contract. For each day in excess of the time specified in the Contract (working or calendar depending on th Contract) for the completion of Work, as adjusted in accordance with General Provisions S*ection 7.5, Delays and Extensions of Time,* the Contractor shall pay to the Owner, or have withheld from monies due it, the sum of $250, unless otherwise provided in the contract documents.

Execution of the Contract shall constitute agreement by the Owner and Contractor that $250 per day (unless otherwise provided in the contract documents) is the minimum value of the costs and actual damage caused by the failure of the Contractor to complete the Work within the allotted time. Such sum is liquidated damages and shall not be construed as a penalty, and may be deducted from payments due the Contractor if such delay occurs.

7.9 USE OF IMPROVEMENTS DURING CONSTRUCTION

The Owner reserves the right to take over and utilize all or part of any completed facility or appurtenance. The Contractor will be notified in writing in advance of such action. Such action by the Owner will relieve the Contractor of responsibility for injury or damage to said completed portions of the improvement resulting from use by public traffic or from the action of the elements or from any other cause, except Contractor operations or negligence. The Contractor will not be required to reclean such portions of the improvement before field acceptance, except for cleanup made necessary by its operations. Nothing in this section shall be construed as relieving the Contractor from full responsibility for correcting defective work or materials.

In the event the Owner exercises its right to place into service and utilize all or part of any completed facility or appurtenance, the Owner will assume the responsibility and liability for injury to persons or property resulting from the utilization of the facility or appurtenance so placed into service, except for any such injury to persons or property caused by any willful or negligent act or omission by the Contractor, Subcontractor, their officers, employees, or agents.

SECTION 8
RESPONSIBILITIES OF THE CONTRACTOR

8.1 CONTRACTOR'S EQUIPMENT AND FACILITIES

The Contractor shall furnish and maintain in good condition all equipment and facilities as required for the proper execution and inspection of the Work. Such equipment and facilities shall meet all requirements of applicable ordinances and laws.

8.2 SUPERVISION AND SUPERINTENDENCE

The Contractor shall supervise, inspect and direct the Work competently and efficiently, applying such skills and expertise necessary to perform the Work in accordance with the Contract Documents. The contractor shall be solely responsible for the mean, methods, techniques, sequences and procedures of construction unless otherwise stated in the Contract Documents. The Contractor is responsible to see that the completed Work complies accurately with all the requirements of the Contract Documents.

The Contractor shall have an English-speaking, competent Superintendent on the Work at all times the work is in progress. The Superintendent will be the Contractor's Representative on the Work and shall have the authority to act on behalf of the Contractor. All communications given to the Superintendent shall be binding as if given to the Contractor. The Contractor shall submit the contact information for the Superintendent, including cell phone number, within 10 days of the Notice to Proceed. The Superintendent must be an employee of the Contractor, unless waived in writing by the Owner. The superintendent may not be replaced without prior written approval of the Owner.

8.3 LABOR

A. General - Only competent workers shall be employed on the Work. Any employee who in the opinion of the Owner is found to be incompetent, intemperate, troublesome, disorderly, or otherwise objectionable, or who fails or refuses to perform work properly and acceptably, shall be immediately removed from the Work by the Contractor and not be reemployed on the Work.

Under urgent circumstances, the Owner may require immediate removal of an employee for cause, to be followed by written confirmation.

B. Laws - The Contractor, its agents, and employees shall be bound by and comply with applicable provisions of Federal, State, and local laws related to labor.

The Contractor shall strictly adhere to the provisions of the Labor Standards and Prevailing Wage Requirements regarding minimum wages; the 8-hour day and 40-hour week; overtime; Saturday, Sunday, and holiday work; and nondiscrimination because of race, color, national origin, sex, or religion.

The Owner has on file a schedule of prevailing wage rates for the types of work to be done under the Contract. The Contractor shall not pay less than these rates. The prevailing wage rate will be included in the contract documents.

All Subcontractors concerning the Contract shall include this provision to be made applicable to all Subcontractors.

8.4 INSURANCE

Contractor will provide continuous enforcement of adequate insurance issued by companies authorized to conduct business in the State of Texas covering all employees employed by the Contractor. The Contractor shall keep in full force and effect during the term of this Agreement insurance in the following types and minimum amounts, **unless provided for different in other contract documents**:

Type	Amount
Comprehensive General Liability, including the following: a. Premises/Operations b. Independent Contractors c. Products/Completed Operations d. Personal Injury e. Contractual Liability d. Explosion, Collapse, Underground.	$1,000,000 per occurrence; $2,000,000 General Aggregate, or its equivalent in Umbrella or Excess Liability Coverage. (Required coverages may be higher, depending on the size and scope of the project)
Worker's Compensation	Statutory
Employer's Liability	$500,000/$500,000/$500,000
Comprehensive Automobile Liability, including owned, non-owned and hired car coverage	$1,000,000 per occurrence
Builders Risk	The minimum amount of coverage To be carried shall be determined By the City Risk Manager based Upon the hazard exposure of the Duration of the project
Note: Other insurance coverages may be required based upon the nature of the project.	

All insurance policies, except Workers' Compensation and Employer's Liability, will name the City of Waco, its elected officials, officers, and employees as

additional insureds. All insurance policies shall be subject to the examination and approval of City for their adequacies as to form, content, form of protection, and insurance company. Prior to the execution of the Contract by all parties, the Contractor shall furnish to the City's Risk Manager for the City files certificates of insurance, relevant extracts from insurance policies, endorsements, or copies of insurance policies that plainly and clearly evidence such insurance with all exclusions, exceptions or limitations. The insurance shall provide for an endorsement that the "other insurance" clause shall not apply to the City of Waco where the City is an additional insured shown on the policy. Workers' compensation and employer's liability policy will provide a waiver of subrogation in favor of the City.

All insurance policies shall bear an endorsement or shall have attached a rider whereby it is provided that in the event of expiration or proposed cancellation of such policies for any reason whatsoever, the Owner shall be notified by registered mail, return receipt requested, giving a sufficient time before the date thereof to comply with any applicable aw or statute, but in no event less than 10 days before expiration or cancellation is effective.

Subcontractors must meet the requirements and amounts as stated above.

The cost of this insurance shall be included in the Contractor's Bid.

8.5 WORKERS' COMPENSATION INSURANCE

A. Definitions:

(1) Certificate of Coverage ("Certificate") - A copy of a certificate of insurance issued by a company authorized to do business in Texas , or a certificate of authority to self-insure issued by the Workers' Compensation Division of the Texas Department of Insurance, showing statutory workers' compensation insurance coverage for the person's or entity's employees providing services on a project for the duration of the project.

(2) Duration of the Project - Includes the time from the beginning of the work on the project until the Contractor's work on the project has been completed and accepted by the governmental entity.

(3) Persons Providing Services on the Project - Includes all persons or entities performing all or part of the services the Contractor has undertaken to perform on the project, regardless of whether that person contracted directly with the Contractor and regardless of whether that person has employees. This includes, without limitation, independent contractors, subcontractors, leasing companies, motor carriers, owner-operators, employees of any such entity, or employees of any entity, which furnishes persons to provide services on the project. "Services" include without limitation, providing, hauling, or delivering equipment or materials, or providing labor,

transportation, or other service related to a project. "Services" does not include activities unrelated to the project, such as food/beverage vendors, office supply deliveries, and delivery of portable toilets.

B. The Contractor shall provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code Chapter 401, *et seq*, for all employees of the Contractor providing services on the project for the duration of the project.

C. The Contractor must provide a certificate of coverage to the City prior to or simultaneous with the execution of the contract.

D. If the coverage period shown on the Contractor's current certificate of coverage ends during the duration of the project, the Contractor must prior to the end of the coverage period file a new certificate of coverage with the City showing that coverage has been extended.

E. The Contractor shall obtain from each person providing services on a project, and provide to the City:

(1) A certificate of coverage, prior to that person beginning work on the project, so the City will have on file certificates of coverage showing coverage for all persons providing services on the project; and

(2) No later than seven (7) days after receipt by the Contractor, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project.

F. The Contractor shall retain all required certificates of coverage for the duration of the project and for one year thereafter.

G. The Contractor shall notify the City in writing by certified mail or personal delivery, within 10 days after the Contractor knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project.

H. The Contractor shall post on each project site a notice in the text, form, and manner prescribed by the Texas Department of Insurance, Workers' Compensation Division, informing all persons providing services on the project that they are required to be covered, and stating how a person may verify coverage and report lack of coverage.

I. The Contractor shall contractually require each person with whom it contracts to provide services on a project, to:

(1) Provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any documents, which meets the statutory requirements of Texas Labor Code Chapter 401, *et seq*, for all of its employees providing services on the project, for the duration of the project;

(2) Provide to the Contractor, prior to that person beginning work on the project, a certificate of coverage showing that coverage is being provided for all employees of the person providing services on the project, for the duration of the project;

(3) Provide the Contractor, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

(4) Obtain from each other person with whom it contracts, and provide to the Contractor:

(a) A certificate of coverage, prior to the other person beginning work on the project; and

(b) A new certificate of coverage showing extension of coverage, prior to the end of the coverage period, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

(5) Retain all required certificates of coverage on file for the duration of the project and for one year thereafter;

(6) Notify the City in writing by certified mail or personal delivery, within 10 days after the person knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project; and

(7) Contractually require each person with whom it contracts, to perform as required by paragraphs (1) - (7), with the certificates of coverage to be provided to the person for whom they are providing services.

J. A Contractor entering into a building or construction contract with a governmental entity, such as the City of Waco, must certify in writing that the Contractor provides workers' compensation insurance coverage for each employee of the Contractor employed on the public project. Each subcontractor on the public project shall provide such a certificate relating to coverage of the subcontractor's employees to the Contractor, who shall provide the subcontractor's certificate to the City. By signing a contract or providing or causing to be provided a certificate of coverage, the Contractor

is representing to the City that all employees of the Contractor who will provide services on the project will be covered by workers' compensation coverage for the duration of the project, that the coverage will be based on proper reporting of classification codes and payroll amounts, and that all coverage agreements will be filed with the appropriate insurance carrier or, in the case of a self-insured, with the Workers' Compensation Division of the Texas Department of Insurance. Providing false or misleading information may subject the Contractor to administrative penalties, criminal penalties, civil penalties, or other civil actions.

K. The Contractor's failure to comply with any of these provisions is a breach of contract by the Contractor which entitles the City to declare the contract void if the Contractor does not remedy the breach within ten days after receipt of notice of breach from the City.

8.6 PERMITS

The Owner will obtain, at no cost to the Contractor, all encroachment and building permits necessary to perform Contract work in streets, highways, railways or other rights-of-way. The Contractor shall obtain and pay for all costs incurred for permits necessitated by its operations such as, but not limited to, those permits required for night work, overload, blasting, and demolition. For Private or Development Projects, the Contractor shall obtain all permits incidental to the Work or made necessary by its operations, and pay all costs incurred by the permit requirements.

The Contractor shall pay all business taxes or license fees that are required for the work.

8.7 THE CONTRACTOR'S REPRESENTATIVE

Before starting work, the Contractor shall designate in writing a representative who shall have complete authority to act for it. An alternate representative may be designated as well. The representative or alternate shall be present at the Work site whenever work is in progress or whenever actions of the elements necessitate the Contractor's presence to take measures necessary to protect the Work, persons, or property. Any order or communication given to this representative shall be deemed delivered to the Contractor. A joint venture shall designate only one representative and alternate. In the absence of the Contractor or its representative, instructions or directions may be given by the Engineer to the superintendent or person in charge of the specific work to which the order applies. Such order shall be complied with promptly and referred to the Contractor or its representative.

In order to communicate with the Owner, the Contractor's representative, superintendent, or person in charge of specific work shall be able to speak, read, and write the English language.

8.8 Cooperation and Collateral Work

The Contractor shall be responsible for ascertaining the nature and extent of any simultaneous, collateral, and essential work by others. The Owner, its workers and contractors and others, shall have the right to operate within or adjacent to the Work site during the performance of such work.

The Owner, the Contractor, and each of such workers, contractors and others, shall coordinate their operations and cooperate to minimize interference.

The Contractor shall include in its Bid all costs involved as a result of coordinating its work with others. The Contractor will not be entitled to additional compensation from the Owner for damages resulting from such simultaneous, collateral, and essential work. If necessary to avoid or minimize such damage or delay, the Contractor shall re-deploy its work force to other parts of the Work.

Should the Contractor be delayed by the Owner, and such delay could not have been reasonably foreseen or prevented by the Contractor, the Engineer will determine the extent of the delay, the effect on the project, and any extension of time.

8.9 Emergency Communication

Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with laws or regulations.

In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, the Contractor is obligated to act to prevent threatened damage, injury, or loss. The Contractor shall give the Engineer/Owner prompt written notice if the Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer/Owner determines that a change in the Contract Documents is required because of action taken by the Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

8.10 Project Site Maintenance

A. Cleanup and Dust Control - Throughout all phases of construction, including suspension of work, and until the final acceptance, the Contractor shall keep the site clean and free from rubbish and debris. The Contractor shall also abate dust nuisance by cleaning, sweeping and sprinkling with water, or other means as necessary. The use of water resulting in mud on public streets will not be permitted as a substitute for sweeping or other methods.

When required by the Plans or Specifications, the Contractor shall furnish and operate a self-loading motor sweeper with spray nozzles at least once each working day for the purpose of keeping paved areas acceptably clean wherever construction, including restoration, is incomplete.

Materials and equipment shall be removed from the site as soon as they are no longer necessary. Before the final inspection, the site shall be cleared of equipment,

unused materials, and rubbish so as to present a satisfactory clean and neat appearance. All cleanup costs shall be included in the Contractor's Bid.

Care shall be taken to prevent spillage on haul routes. Any such spillage shall be removed immediately and the area cleaned.

Excess excavated material from catch basins or similar structures shall be removed from the site immediately. Sufficient material may remain for use as backfill if permitted by the Specifications. Forms and form lumber shall be removed from the site as soon as practicable after stripping.

Failure of the Contractor to comply with the Engineer's cleanup orders may result in an order to suspend work until the condition is corrected. No additional compensation will be allowed as a result of such suspension.

The Owner may elect to perform clean up, if the Contractor fails to comply with the Engineer's orders, and deduct the cost thereof from monies due the Contractor.

B. Air Pollution Control - The Contractor shall not discharge smoke, dust, or any other air contaminants into the atmosphere in such quantity as will violate any local, state, or federal laws or regulations.

C. Vermin Control - At the time of acceptance, structures entirely constructed under the Contract shall be free of rodents, insects, vermin, and pests. Necessary extermination work shall be arranged and paid for by the Contractor as part of the Work within the Contract time, and shall be performed by a licensed exterminator in accordance with local, state, or federal laws or regulations. The Contractor shall be liable for injury to persons or property and responsible for the elimination of offensive odors resulting from extermination operations.

D. Sanitation - The Contractor shall provide and maintain enclosed toilets for the use of employees engaged in the Work at each project location. These accommodations shall be maintained in a neat and sanitary condition. They shall also comply with all applicable laws, ordinances, and regulations pertaining to public health and sanitation.

Wastewater shall not be interrupted. Should the Contractor disrupt existing sewer facilities, sewage shall be conveyed in closed conduits and disposed of in a sanitary sewer system. Sewage shall not be permitted to flow in trenches or be covered by backfill.

E. Temporary Light, Power, and Water - The Contractor shall furnish, install, maintain, and remove all temporary light, power, and water at its own expense. These include piping, wiring, lamps, and other equipment necessary for the Work. The Contractor shall not draw water from any fire hydrant (except to extinguish a fire), without obtaining permission from the City water office.

F. Water Pollution Control - The Contractor shall exercise every reasonable precaution to protect channels, storm drains, and bodies of water from pollution. It shall conduct and schedule operations so as to minimize or avoid muddying and silting of said channels, drains, and waters. The Contractor will comply with EPA National Pollutant Discharge Elimination System (NPDES) and Texas Pollutant Discharge Elimination System requirements. Water pollution control work shall consist of constructing those facilities, which may be required to provide prevention, control, and abatement of water pollution.

G. Drainage Control - The Contractor shall maintain drainage within and through the work areas. Earth dams will not be permitted in paved areas. Temporary dams of sandbags, asphaltic concrete, or other acceptable material will be permitted when necessary. Such dams shall be removed from the site as soon as their use is no longer necessary.

The Contractor shall provide at his own cost and expense all methods of adequately draining the Work. No separate measurement or compensation will be paid for subdrains or other methods of draining, but the cost thereof shall be included in such contract pay items as are provided in the proposal and contract.

The Contractor shall be entirely responsible for adequate draining and pumping of water from the excavation. In the event of failure to provide adequate draining and pumping, which results in unstable subgrade conditions requiring the use of foundations or concrete cradles, they shall be placed at the entire cost and expense of the Contractor.

8.11 PROTECTION AND RESTORATION OF EXISTING IMPROVEMENTS

The Contractor shall be responsible for the protection of public and private property adjacent to the Work and shall exercise due caution to avoid damage to such property.

The Contractor shall repair or replace all existing improvements within the right-of-way that are not designated for removal (e.g., curbs, sidewalks, driveways, fences, walls, signs, utility installations, pavement, structures, etc.) and that are damaged or removed as a result of its operations. When a portion of a sprinkler system within the right-of-way must be removed, the remaining lines shall be capped. Repairs and replacements shall be at least equal to existing improvements and shall match them in finish and dimension.

Trees, lawns, and shrubbery that are not to be removed shall be protected from damage or injury. If damaged or removed due to Contractor's operations, they shall be restored or replaced in as nearly the original condition and location as is reasonably possible. Lawns shall be reseeded, sodded, sprigged and covered with suitable mulch.

The Contractor shall give at least a one-week notice in writing to occupants or owners of adjacent property to permit them to salvage or relocate plants, trees, fences, sprinklers, and other improvements, within the right-of-way that are designated for removal and would be destroyed because of the Work.

The removal of trees and shrubbery shall be approved by the Engineer in all cases where the necessity of such removal is open to question.

All costs to the Contractor for protecting, removing, and restoring existing improvements shall be included in the Bid.

8.12 PUBLIC CONVENIENCE AND SAFETY

A. Traffic and Access - The Contractor's operations shall cause no unnecessary inconvenience. The access rights of the public shall be considered at all times. Unless otherwise authorized, traffic shall be permitted to pass through the Work, or an approved detour shall be provided.

Safe and adequate pedestrian and vehicular access shall be provided and maintained to: fire hydrants; commercial and industrial establishments; churches, schools and parking lots; service stations and motels; hospitals; police and fire stations; and establishments of similar nature. Access to these facilities shall be continuous and unobstructed unless otherwise approved by the Engineer.

Vehicular access to residential driveways shall be maintained to the property line except when necessary construction precludes such access for reasonable periods of time. If backfill has been completed to the extent that safe access may be provided, and the street is opened to local traffic, the Contractor shall immediately clear the street and driveways and provide and maintain access.

The Contractor shall cooperate with the various parties involved in the delivery of mail and the collection and removal of trash and garbage to maintain existing schedules for these services.

Grading operations, roadway excavation and fill construction shall be conducted by the Contractor in a manner to provide a reasonably satisfactory surface for traffic. When rough grading is completed, the roadbed surface shall be brought to a smooth, even condition satisfactory for traffic.

The Contractor shall include in its Bid all costs for the above requirements.

B. Storage of Equipment and Materials in Public Streets - Construction materials shall not be stored in streets, roads, or highways for more than 14 days after unloading. All materials or equipment not installed or used in construction within 14 days after unloading shall be stored elsewhere by the Contractor at its expense unless authorized additional storage time by the Engineer.

Construction equipment shall not be stored at the Work site before its actual use on the Work nor for more than 5 days after it is no longer needed. Time necessary for repair or assembly of equipment may be authorized by the Engineer.

Excavated material, except that which is to be used as backfill in the adjacent trench, shall not be stored in public streets unless otherwise permitted. After placing backfill, all excess material shall be removed immediately from the site.

C. Street Closures, Detours, Barricades - The Contractor shall comply with all applicable State, County and City requirements for closure of streets. The Contractor

shall provide barriers, guards, lights, signs, temporary bridges, flag persons, and watchpersons. The Contractor shall be responsible for compliance with additional public safety requirements, which may arise. The Contractor shall furnish and install signs and warning devices and promptly remove them upon completion of the Work. The "Texas Manual on Uniform Traffic Control Devices for Streets and Highways" requirements shall apply to the above. Please refer to *Section 3.6.E, Traffic Control Plans (TCP)*.

At least 48 hours in advance of closing, partially closing or reopening, any street, alley, or other public thoroughfare, the Contractor shall notify the Engineering Department, and comply with their requirements. Deviations must first be approved in writing by the Engineer.

Prior to beginning construction, the Contractor shall submit a proposed plan of the streets which Contractor plans to barricade to the City Traffic Operations Manager for his approval and assistance.

The Contractor shall secure approval in advance from authorities concerned for the use of any bridges proposed by it for public use.

All costs involved shall be included in the Bid.

D. Public Safety

(1) Safety Orders - The Contractor shall have at the Work site, copies or suitable extracts of any Safety Orders that would apply to the construction project. The Contractor shall comply with provisions of these and all other applicable laws, ordinances, and regulations.

Before excavating any trench 5 feet or more in depth, the Contractor shall submit a detailed plan to the Owner showing the design of shoring, bracing, sloping, or other provisions to be made for the worker's protection from the hazard of caving ground during the excavation of such trench. The plan shall be prepared by a registered Civil Engineer. No excavation shall start until the Engineer has accepted the plan. Refer to *Section 3.6.B, Trench Safety Plans* for further information.

Payment for performing all work necessary to provide trench safety shall be included in the bid items for trench safety.

(2) Use of Explosives - Explosives may be used only when authorized in writing by the Engineer, or as otherwise stated in the Specifications. Explosives shall be handled, used, and stored in accordance with all applicable regulations.

The Engineer's approval of the use of explosives shall not relieve the Contractor from liability for claims caused by blasting operations.

(3) Special Hazardous Substances and Processes - Materials that contain hazardous substances or mixtures may be required on the Work. A Material Safety Data Sheet shall be requested by the Contractor from the manufacturer of any hazardous products used.

Material usage shall be accomplished with strict adherence to Occupational Safety and Health Administration (OSHA) and Texas Hazard Communication Act

requirements and all manufacturer warnings and application instructions listed on the Material Safety Data Sheet and on the product container label.

The Contractor shall notify the Engineer if a specified product cannot be used under safe conditions.

(4) Hazardous Environmental Conditions

The Contractor shall not be responsible for any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in the drawings or specifications or identified in the Contract Documents to be within the scope of the Work. Contractor shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by the Contractor, subcontractor, Supplier or anyone else for whom the Contractor is responsible.

If the Contractor encounters a Hazardous Environmental Condition or if the Contractor or anyone for who the Contractor is responsible creates a Hazardous Environmental Condition, the Contractor shall immediately:

(a) secure or otherwise isolate such condition
(b) stop all Work in connection with such condition and in any area affected thereby (except as defined in Section 8.8 “Emergencies”)
(c) Notify Owner and Engineer (and promptly thereafter confirm such notice in writing.)

Owner shall promptly consult with the Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any.

The Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits.

8.13 PATENT FEES OR ROYALTIES

The price included by Contractor in its Bid/Proposal shall include any patent fees or royalties on any patented article or process furnished or used in the Work. The Contractor shall indemnify and hold the Owner harmless from any legal action that may be brought for infringement of patents.

8.14 LAWS TO BE OBSERVED

The Contractor shall keep fully informed of State and Federal laws and County and Municipal ordinances, codes, and regulations which in any manner affect those employed in the Work or the materials used in the Work or in any way affect the conduct of the Work. The Contractor shall at all times observe and comply with such laws, ordinances, codes, and regulations.

If, during the performance of the Work, the Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents or between the Contract Documents and any provision of any law or regulation applicable to the performance of the Work or of any standard, specification, manual or code, or of any instruction of any supplier, Contractor shall report it to the Engineer in writing at once. Contractor shall

not proceed with the Work affected thereby until an amendment or supplement to the Contract Documents has been issued.

8.15 INDEMNIFICATION

If Contractor fails to provide the insurance required in General Provisions Section 8.4 naming the City, its elected official, officers, and employees as an Additional Insureds, then Contractor agrees to assume full responsibility and liability for the services rendered under this agreement and hereby agrees to indemnify, protect and hold harmless the City, its elected officials, officers, employees, agents, and servants, of and from all claims, demands, and causes of actions of every kind and character, including the cost of defense thereof, for any injury to or of persons and any losses for damages to property caused by or alleged to be caused, arising out of, or alleged to arise out of, either directly or indirectly or in connection with the services to be rendered hereunder, whether or not said claims, demands, causes of actions are caused by the sole negligence of the City, its elected officials, officers employees, agents, or servants, or whether it was caused by concurrent negligence of the City, its elected officials, officers employees, agents, or servants, and a party to this agreement or some other third party. If contractor provides the required insurance naming the City, its elected officials, officers, and employees as an additional insured, then this section shall not apply.

8.16 EQUAL OPPORTUNITY EMPLOYMENT

During the performance of this Contract, the Contractor agrees as follows:

(a) The Contractor shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, age or national origin. The Contractor shall take affirmative action to insure that applicants are employed, and that employees are treated during employment without regard to their race, color, sex, religion, age or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination, rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees or applicants for employment, notices setting forth the provisions of this nondiscrimination clause.

(b) The Contractor shall, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants shall receive consideration for employment without regard to race, color, religion, sex, national origin or age.

(c) The Contractor shall send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice to be provided, advising the said labor union or workers' representatives of the Contractor's commitments under this

section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(d) The Contractor shall include the provisions of this section in all Subcontracts pertaining to the Work.

During the course of the Work, the Contractor shall submit to the Engineer on a monthly basis a breakdown by minority group of all employees at the site of the Work.

8.17 State and Local Sales and Use Taxes

Under section 151.309 of the Texas Tax Code, the City of Waco is exempt in the payment of sales tax. In addition, when the City contracts with a third party to make certain improvements to real property, purchases of materials/consumable items that are physically incorporated into that real property are also exempt from sales tax. In other words, materials and supplies that are entirely consumed or used up on a construction job for the City of Waco can be purchased without paying state and local sales tax. Items qualifying for this exemption must be used up entirely on a job for the City of Waco.

To claim this exemption, a contractor purchasing materials and supplies (as the buyer of the materials and supplies) will complete a Texas Sales and Use Tax Exemption Certification form (established by the Texas Comptroller) to submit to the seller at the of the purchase, rental or lease of:

(a) All materials, supplies, equipment and other tangible personal property incorporated into the real property being improved; and

(b) All materials, supplies, equipment and other tangible personal property used or consumed by the Contractor in performing the Contract with the Owner.

Materials and supplies "used in the performance of a contract" include only those materials actually incorporated into the property being improved and those supplies directly used to incorporate such materials into the property being improved. Overhead supplies and supplies used indirectly or only incidental to the performance of the contract with the Owner are not included in the exemption. The purchase of tangible personal property, other than machinery or equipment and its accessories and repair and replacement parts, for use in the performance of a contract for an improvement to realty for the City is exempt if the tangible personal property is: (1) necessary and essential for the performance of the contract and (2) completely consumed at the job site. Tangible personal property is completely consumed if after being used once for its intended purpose it is used up or destroyed. Tangible personal property that is rented or leased for use in the performance of the contract cannot be completely consumed.

Under "reasons said purchaser is claiming this exemption" in the exemption certificate, the Contractor must name the City of Waco and the project name and number for which the equipment, material and supplies are being purchased, leased or rented.

8.18 TAX CERTIFICATION

Contractor hereby certifies that it is not delinquent in the payment of any taxes owed to the City and will pay any taxes owed to the City so that such taxes will not become delinquent. If the previous certification is determined to be false, such false certification shall constitute grounds for termination of the Contract at the option of the City.

This Contract is subject to Article VIII, Section 8 of the Home Rule Charter of the City of Waco, Texas, as amended, and as follows:

> The City shall be entitled to counterclaim and offset against any debt, claim, demand or account owed by the City to any person, firm or corporation who is in arrears to the City of Waco for taxes, in the amount of taxes so in arrears, and no assignment or transfer of such debt, claim, demand or account after the said taxes are due, shall affect the right of the City to so offset the said taxes against the same.

8.19 OFFSETS OR OTHER DEBTS AGAINST CITY

Contractor agrees that the City is entitled to counterclaim and offset against any debt, claim, demand, or account owed by the City to Contractor pursuant to this Contract, for any debt owed to the City by Contractor, other than for arrearage of taxes which are governed *General Provisions Section 8.17, Tax Certification*. The City may withhold, from payment under this Contract, an amount equal to the total amount of debts owed to the City by Contractor. The City may apply the amount withheld to the debts owed to the City by Contractor until said debts are paid in full

8.20 TIME OF FILING CLAIMS

It shall be agreed by both parties hereto that all questions of disputes or adjustments presented by the Contractor shall be in writing and filed with the Engineer within thirty (30) days after the Engineer has given any directions, orders, or instructions to which the Contractor desires to take exception. The Engineer shall reply to such written exceptions by the Contractor and render his final decisions in writing. In case the Contractor should disagree with the Engineer's decisions, any demand for arbitration should be filed with the Engineer in writing within ten (10) days after the date of delivery to the Contractor of the Engineer's final decision. The Contractor further agrees that final acceptance of the work by the City and the acceptance by the Contractor of the final payment shall be a bar to any claims by either party.

8.21 FORCE MAJEURE

Neither party shall be held responsible for losses resulting if the fulfillment of any terms or provisions of this contract are delayed or prevented by any cause not within the control of the party whose performance is interfered with, which by the exercise of reasonable diligence said party is unable to prevent.

8.22 WAIVER

No claim or right arising out of a breach of this contract can be discharged in whole or in part by a waiver or renunciation of the claim or right unless the waiver or renunciation is supported by consideration and is in writing signed by the aggrieved party.

8.23 MODIFICATION

This contract can be modified or rescinded only by a written statement signed by both parties or their duly authorized agents.

8.24 RIGHT TO ASSURANCE

Whenever one party to this contract in good faith has reason to question the other party's intent to perform he may demand that the other party give written assurance of his intent to perform he may demand that the other party give written assurance of his intent to perform. In the event that a demand is made and no assurance is given within five (5) days, the demanding party may treat this failure as an anticipatory repudiation of the contract.

8.25 VENUE

Waco, McLennan County, Texas

SECTION 9
MEASUREMENT AND PAYMENT

9.1 MEASUREMENT FOR QUANTITIES OF UNIT PRICE WORK

A. General - Unless otherwise specified, quantities of work shall be determined from measurement or dimensions in horizontal planes. However, linear quantities of pipe, piling, fencing and timber shall be considered as being the true length measured along longitudinal axis.

Unless otherwise provided in Specifications, volumetric quantities shall be the product of the mean area of vertical or horizontal sections and the intervening horizontal or vertical dimension.

B. Methods of Measurement - Materials and items of work, which are to be paid for on basis of measurement, shall be measured in accordance with methods stipulated in the particular sections involved.

C. Certified Weights - When payment is to be made on the basis of weight, the weighing shall be done on certified platform scales or, when approved by the Engineer, on a completely automated weighing and recording system. The Contractor shall furnish the Owner's representative with duplicate licensed weighmaster's certificates showing actual net weights. The Owner will accept the certificates as evidence of weights delivered.

D. Units of Measurement - Measurements shall be in accordance with U.S. Standard Measures. A pound is an avoirdupois pound. A ton is 2,000 pounds avoirdupois. The unit of liquid measure is the U.S. gallon.

9.2 LUMP SUM WORK

Items for which quantities are indicated "Lump Sum" or "L.S." shall be paid for at the price indicated in the Bid. Such payment shall be full compensation for the items of work and all work appurtenant thereto.

When required by the Specifications or requested by the Engineer, the Contractor shall submit to the Engineer within 15 days after award of Contract, a detailed schedule to be used only as a basis for determining progress payments on a lump sum contract or designated lump sum bid item. This schedule shall equal the lump sum bid and shall be in such form and sufficiently detailed as to satisfy the Engineer that it correctly represents a reasonable apportionment of the lump sum.

9.3 PAYMENT

A. General - The quantities listed in the Bid schedule will not govern final payment. Payment to the Contractor will be made only for actual quantities of Contract items constructed in accordance with the Plans and Specifications. Upon completion of construction, if the actual quantities show either an increase or decrease from the

quantities given in the Bid schedule, the Contract Unit Prices will prevail subject to the *General Provisions Subsection 4.2.B(1), Contract Unit Prices.*

The unit and lump sum prices to be paid shall be full compensation for the items of work and all appurtenant work, including furnishing all materials, labor, equipment, tools, and incidentals.

Payment will not be made for materials wasted or disposed of in a manner not called for under the Contract. This includes rejected material not unloaded from vehicles, material rejected after it has been placed, and material placed outside of the Plan lines. No compensation will be allowed for disposing of rejected or excess material.

Whenever any portion of the Work is performed by the Owner at the Contractor's request, the cost thereof shall be charged against the Contractor, and may be deducted from any amount due or becoming due from the Owner.

Whenever immediate action is required to prevent injury, death, or property damage, and precautions which are the Contractor's responsibility have not been taken and are not reasonably expected to be taken, the Owner may, after reasonable attempt to notify the Contractor, cause such precautions to be taken and shall charge the cost thereof against the Contractor, or may deduct such cost from any amount due or becoming due from the Owner. Owner action or inaction under such circumstances shall not be construed as relieving the Contractor or its Surety from liability.

Payment shall not relieve the Contractor from its obligations under the Contract; nor shall such payment be construed to be acceptance of any of the Work. Payment shall not be construed as the transfer of ownership of any equipment or materials to the Owner. Responsibility of ownership shall remain with the Contractor who shall be obligated to store any fully or partially completed work or structure for which payment has been made; or replace any materials or equipment required to be provided under the Contract which may be damaged, lost, stolen or otherwise degraded in any way prior to acceptance of Work, except as provided in *General Provisions Section 7.9, Use of Improvements During Construction*.

Guarantee periods shall not be affected by any payment, but shall commence on the date of final completion and acceptance of all work covered by the project.

The City's Engineering Inspector compiles progress payment based on quantities on or around the 25th of each month with the contractor superintendent. To insure the proper performance of this Contract, the Owner shall retain a percentage of the amount of each estimate until final completion and acceptance of all work covered by the contract: Provided, that the Contractor shall submit his estimate not later than the first day of the month: Provided, further that the Owner at any time after fifty percent of the work has been completed, if it finds that satisfactory progress is being made, may make any of the remaining progress payments in full: Provided, further, that on completion and acceptance of each separate building, public work, or other division of the Contract on which the price is stated separately in the Contract, payment may be made in full, including retaining percentages thereon, less authorized deductions.

B. Partial Payment - The Owner shall make an approximate estimate of the value of the work done during the month under the Specifications. The estimate may include acceptable nonperishable materials and equipment delivered to the Work.

The Contractor shall furnish to the Owner such detailed information as he may request to assist him in the preparation of monthly estimates. It is understood that the monthly estimates shall be approximate only, and all monthly estimates and partial payments shall be subject to correction in the estimate rendered following the discovery of an error in any previous estimate, and such estimate shall not in any respect be taken as an admission of the Owner of the amount of work done or of its quality or sufficiency nor as an acceptance of the work or the release of the Contractor of any of his responsibility under the Contract.

No partial payment made to the Contractor or its sureties will consummate a waiver of the liquidated damages under *General Provisions Section 7.8, Liquidated Damages*.

On contracts for which no surety bonds are required, payment to the Contractor will be made when all work to be performed under the contract is complete and accepted by the City. The City shall retain ten percent (10%) of the total contract price for sixty (60) days after completion and acceptance of the work by the Owner.

C. Retainage - As security for the faithful completion of the Work by the Contractor, the Owner shall retain ten percent (10%) of the total dollar amount of work done on all contracts less than $400,000; five percent (5%) of the total dollar amount of work done on all contracts of $400,000 or more.

D. Final Inspection and Acceptance - Whenever the improvements provided for by the Contract shall have been completely performed on the part of the Contractor; the Contractor shall notify the Engineer that the improvement is ready for final inspection. The Engineer shall then make such final inspection, and if the work is satisfactory and in accordance with the specifications and contract documents, the Contractor shall be issued a certificate of acceptance.

E. Final Payment - Whenever the improvements provided for by the Contract shall have been completely performed on the part of the Contractor, as evidenced in the certificate of acceptance, and all required submissions provided to the Owner, a final estimate showing the value of the work shall be prepared by the Engineer as soon as the necessary measurements and computations can be made. All prior estimates upon which payments have been made are subject to necessary corrections or revisions in the final payment. The amount of this final estimate, less any sums that have been previously paid, deducted or retained under the provisions of the Contract, shall be paid the Contractor, **provided** the Contractor has furnished to the Owner a one (1) year guarantee and an affidavit or other satisfactory evidence that all indebtedness connected with the work and all sums of money due for any labor, materials, apparatus, fixtures or machinery furnished for and used in the performance of the Work have been paid or otherwise

satisfied, or that the person or persons to whom the same may respectively be due have consented to such final payment.

The acceptance of the Contractor of the final payment as aforesaid shall operate as and shall be a release to the Owner from all claims or liabilities under the Contract, including all Subcontractor claims, for anything done or furnished or relating to the Work under the Contract or for any act or neglect of said Owner relating to or connected with the Contract.

All warranties and guarantees shall commence from the date of the certificate of acceptance. No interest shall be due the Contractor on any partial or final payment, or on the retainage.

F. Payment Withheld - In addition to express provisions elsewhere contained in the contract, the Owner may withhold from any payment otherwise due the Contractor such amount as determined necessary to protect the Owner's interest, or, if it so elects, may withhold or retain all or a portion of any progress payment or refund payment on account of:

(1) Unsatisfactory progress of the work caused by conditions within the Contractor's control;

(2) Defective work not corrected;

(3) Contractor's failure to carry out instructions or orders of the Owner or his representative;

(4) A reasonable doubt that the contract can be completed for the balance then unpaid;

(5) Work or execution thereof not in accordance with the contract documents;

(6) Claim filed by or against the Contractor or reasonable evidence indicating probable filing of claims;

(7) Failure of the Contractor to make payments to subcontractor or for material or labor;

(8) Damage to another contractor;

(9) Unsafe working conditions allowed to persist by the Contractor;

(10) Failure of the Contractor to provide work schedules as required by the Owner; or

(11) Use of subcontractors without the Engineer's approval;

(12) Liquidated Damages.

When the above grounds are removed (except for liquidated damages), payment shall be made for amounts withheld because of them, and Owner shall never be liable for interest on any delayed or late payment.

G. Mobilization - When a bid item is included in the Proposal form for mobilization and subject to the conditions and limitations in the Specifications, the costs of work in advance of construction operations and not directly attributable to any specific bid

item will be included in the progress estimate, in accordance with *Section 6.4, Mobilization*. When no such bid item is provided, payment for such costs will be considered to be included in the other items of work.

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SECTION 10
ABBREVIATIONS AND TERMS

10.1 ABBREVIATIONS

A. General - The abbreviations herein, together with others in general use, are applicable to these Standard Specifications and to project Plans or other Contract Documents.

All abbreviations and symbols used on Plans for structural steel construction shall conform to those given by the "Manual of Steel Construction" published by the American Institute of Steel Construction, Inc.

ABS	Acrylonitrile - butadiene - styrene
AC	Asphaltic Concrete
ACP	Asbestos cement pipe
Alt	Alternate
Amer Std	American Standard
AWG	American Wire Gage (nonferrous wire)
AT&T	American Telephone and Telegraph Co.
BC	Beginning of curve
BHP	Brake horse power
Bdry	Boundary
BL	Base line
BM	Bench mark
BR	Beginning of return
BVC	Beginning of vertical curve
B/W	Back of wall
CAB	Crushed aggregate base
CAP	Corrugated aluminum pipe
CB	Catch Basin
Cb	Curb
CBR	California Bearing Ratio
c-c	Center to center
C&G	Curb and gutter
CIP	Cast iron pipe
CIPP	Cast-in place pipe
CL	Center line
CLF	Chain link fence
CMB	Crushed miscellaneous base
CMC	Cement mortar-coated
CML	Cement mortar-lined

CO	Cleanout (Sewer)
Col	Column
Conc	Concrete
Const	Construct, construction
Conn	Connection
Coord	Coordinate
CSP	Corrugated steel pipe
CTB	Cement treated base
CV	Check valve
db	Decibels
DF	Douglas fir
Dia	Diameter
DIP	Ductile iron pipe
DT	Drain tile
Dwg	Drawing
Dwy	Driveway
Dwy Appr	Driveway Approach
DL	Dead load
EC	End of curve
EF	Each face
EG	Edge of gutter
EGL	Energy grade line
El	Elevation
ELC	Electrolier lighting conduit
Eng	Engineer, Engineering
EP	Edge of pavement
ER	End of return
Esmt	Easement
ETB	Emulsion treated base
EVC	End of vertical curve
Ex	Existing
Exc	Excavation
Exp Jt	Expansion joint
□F	Degree on Fahrenheit temperature scale
Fab	Fabricate
FC	Face of curb
F&C	Frame and cover
FD	Floor drain
Fdn	Foundation
Fed Spec	Federal Specification
FG	Finished grade
FH	Fire hydrant

F&I	Furnish and install
FIC	Fiber optic cable
FL	Flow line
FS	Finished surface or flexural strength
ftg	Footing
ft-lb	Foot-pound
F/W	Face of wall
Ga	Gauge
Galv	Galvanized
GIP	Galvanized iron pipe
GL	Ground, grade, gas, or gutter line
GM	Gas meter
GP	Guy pole
Gr	Grade
Grtg	Grating
GSP	Galvanized steel pipe
GV	Gate valve
HB	Hose bib
HC	House connection
Hdwl	Headwall
HGL	Hydraulic grade line
HMAC	Hot Mix Asphaltic Concrete
Hor	Horizontal
Hp	Horsepower
HPG	High pressure gas
HPS	High pressure sodium (Light)
Hyd	Hydraulic
ID	Inside diameter
Insp	Inspection
Inv	Invert
IP	Iron pipe or iron pin
JC	Junction chamber
Jct	Junction
JS	Junction structure
Jt	Joint
L	Length
Lab	Laboratory
LD	Local depression
LH	Lamp hole
LL	Live load or liquid limit
Long	Longitudinal
LP	Lamp post

LPS	Low pressure sodium (Light)
LTS	Lime treated soil
Maint	Maintenance
Max	Maximum
Meas	Measure
MH	Manhole
Mil Spec	Military specification
Misc	Miscellaneous
Mon	Monument
Mult	Multiple
MVL	Mercury vapor light
Obs	Obsolete
oc	On center
OD	Outside diameter
OE	Outer edge
Opp	Opposite
Orig	Original
PB	Pull box
PC	Point of curvature
PCC	Portland cement concrete or point of compound curvature
PCVC	Point of compound vertical curve
PE	Polyethylene
PI	Point of intersection or plasticity index
PL	Property line or plastic limit
PMB	Processed miscellaneous base
POC	Point on curve
POT	Point on tangent
PP	Power pole
PRC	Point of reverse curve
PRVC	Point of reverse vertical curve
PSI	Pounds per square inch
PT	Point of tangency
PVC	Polyvinyl chloride
Pvmt	Pavement
Pvt R/W	Private Right-of-way
Q	Rate of flow in cubic feet per second
Quad	Quadrangle, Quadrant
R	Radius
R&O	Rock and oil
RA	Recycling agent
RAC	Recycled asphalt concrete

RAP	Reclaimed asphalt pavement
RC	Reinforced concrete
RCB	Reinforced concrete box
RCCP	Reinforced concrete cylinder pipe
RCP	Reinforced concrete pipe
RCV	Remote control valve
Ref	Reference
Reinf	Reinforced or reinforcement
Res	Reservoir
ROW	Right-of-way
RR	Railroad
SD	Storm drain
SDR	Standard thermoplastic pipe dimension ratio (ratio of pipe OD to minimum wall thickness)
SI	International System of Units (Metric)
Spec	Specifications
SR	Shrinkage ratio
SS	Sanitary sewer
St	Street
Sta	Station
Stab	Stability
Std	Standard
St Hwy	State highway
Str	Straight
Str Gr	Straight grade
Struc	Structural/Structure
S/W	Sidewalk
SWBT	Southwestern Bell Telephone Co.
Tan	Tangent
TC	Top of curb
Tel	Telephone
TxDOT	Texas Department of Transportation
Topo	Topography
TP	Top of pavement
Tr	Tract
Trans	Transition
TS	Traffic signal or transition structure
TSC	Traffic signal conduit
TSS	Traffic signal standard
TU	TU Electric Co.
T/W	Top of wall
Typ	Typical

UC	Underground cable
USA	Underground Service Alert
Var	Varies, variable
VB	Valve box
VC	Vertical cover
VCP	Vitrified clay pipe
Vert	Vertical
Vol	Volume
WCR	Water cement ratio
WI	Wrought iron
WM	Water meter
WPJ	Weakened plane joint
WV	Water valve
X Conn	Cross connection
X-Sec	Cross section

10.2 INSTITUTIONS

AASHTO	American Assoc. of State Hwy. and Transportation Officials
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
API	American Petroleum Institute
AREA	American Railway Engineering Association
ASTM	American Society for Testing and Materials
AWPA	American Wood Protection Association
AWS	American Welding Society
AWWA	American Water Works Association
FAA	Federal Aviation Administration
NEMA	National Electrical Manufacturers Assn.
NOAA	National Oceanic and Atmospheric Administration (Dept. of Commerce)
OSHA	Occupational Safety and Health Administration
UL	Underwriters' Laboratories, Inc.
USGS	United States Geological Survey

CITY OF WACO

STANDARD SPECIFICATIONS FOR CONSTRUCTION

Materials and Construction Methods

TABLE OF CONTENTS

SECTION 1: SITE WORK **1-1**

SECTION 1.1:	PREPARING RIGHT-OF-WAY	1 – 3	6/1/10
SECTION 1.2:	CLEARING AND GRUBBING	1 – 5	6/1/10
SECTION 1.3:	UNCLASSIFIED EXCAVATION	1 – 7	6/1/10
SECTION 1.4:	GRADING IN RIGHT-OF-WAY BEHIND CURB	1 – 11	6/1/10
SECTION 1.5:	FILL	1 – 13	6/1/10
SECTION 1.6:	TOPSOIL	1 – 17	6/1/10
SECTION 1.7:	SODDING	1 – 19	6/1/10
SECTION 1.8:	SEEDING	1 – 23	6/1/10
SECTION 1.9:	FERTILIZER	1 – 27	6/1/10
SECTION 1.10:	STORM WATER POLLUTION PREVENTION	1 – 29	6/1/10
SECTION 1.11:	SPRINKLING FOR DUST CONTROL	1 – 41	6/1/10
SECTION 1.12:	FENCING	1 – 43	6/1/10

SECTION 2: SUBGRADE AND BASE COURSES **2-1**

SECTION 2.1:	ROLLING	2 – 3	6/1/10
SECTION 2.2:	SUBGRADE COURSES	2 – 5	6/1/10
SECTION 2.3.A:	SUBGRADE PREPARATION	2 – 5	6/1/10
SECTION 2.4.B:	PORTLAND CEMENT MODIFICATION OF SUBGRADE SOILS	2 – 7	6/1/10
SECTION 2.3:	BASE COURSES	2 – 11	6/1/10
SECTION 2.3.A:	GRAVEL BASE COURSE	2 – 11	6/1/10
SECTION 2.3.B:	FLEXIBLE BASE (CRUSHED STONE)	2 – 15	6/1/10
SECTION 2.3.C:	PORTLAND CEMENT TREATMENT (PUG BASE)	2 – 19	6/1/10
SECTION 2.3.D:	REHABILITATION OF EXISTING BASE AND PAVEMENT	2 – 25	6/1/10
SECTION 2.4:	LIME TREATMENT	2 – 27	6/1/10
SECTION 2.5:	PRIME COAT	2 – 35	6/1/10
SECTION 2.6:	MATERIALS TESTING	2 – 37	6/1/10

SECTION 3: PAVEMENT AND SURFACE COURSES **3-1**

SECTION 3.1:	ASPHALTS, OILS AND EMULSIONS	3 – 3	6/1/10
SECTION 3.2:	TACK COAT	3 – 15	6/1/10
SECTION 3.3:	HOT-MIX ASPHALT CONCRETE PAVEMENT	3 – 17	6/1/10
SECTION 3.4:	WARM-MIS ASPHALT CONCRETE PAVEMENT	3 – 27	6/1/10
SECTION 3.5:	SLURRY SEAL	3 – 29	6/1/10
SECTION 3.6:	PORTLAND CEMENT CONCRETE PAVEMENT	3 – 39	6/1/10
SECTION 3.7:	MATERIALS TESTING	3 – 47	6/1/10

SECTION 4: WATER, WASTEWATER, AND STORM WATER UTILITY CONSTRUCTION **4-1**

SECTION 4.1:	GENERAL	4 – 3	6/1/10
SECTION 4.2:	EXCAVATION AND BACKFILL	4 – 7	6/1/10
SECTION 4.3:	STREET CUT EXCAVATION AND REPAIR STANDARDS	4 – 23	6/1/10
SECTION 4.4:	JACKING, BORING, OR TUNNELING	4 – 25	6/1/10
SECTION 4.5:	STREET, HIGHWAY AND RAILROAD CROSSING	4 – 31	6/1/10
SECTION 4.6:	UNDERGROUND PIPE INSTALLATION	4 – 33	6/1/10
SECTION 4.7:	PIPING MATERIALS	4 – 37	6/1/10
SECTION 4.8:	SANITARY SEWER	4 – 71	6/1/10
SECTION 4.9:	WATER PIPE	4 – 89	6/1/10
SECTION 4.10:	STORM SEWER	4 – 103	6/1/10
SECTION 4.11:	PIPE BURSTING	4 – 107	6/1/10
SECTION 4.12:	BACKFLOW PREVENTION	4 – 113	6/1/10
SECTION 4.13:	LIFT STATIONS	4 – 115	6/1/10
SECTION 4.14:	PACKAGE LIFT STATION SPECIFICATIONS ADDENDUM	4 – 129	6/1/10

SECTION 5: CONCRETE **5 -1**

SECTION 5.1:	CONCRETE AND REINFORCEMENT	5 – 3	6/1/10
SECTION 5.2:	LIGHTWEIGHT CONCRETE	5 – 37	6/1/10
SECTION 5.3:	CONCRETE CURB AND GUTTER	5 – 41	6/1/10
SECTION 5.4:	CONCRETE SIDEWALKS AND DRIVEWAY APPROACHES	5 – 45	6/1/10
SECTION 5.5:	DRILLED SHAFT FOUNDATIONS	5 – 49	6/1/10
SECTION 5.6:	MATERIALS TESTING	5 – 55	6/1/10

SECTION 6: MISCELLANEOUS CONSTRUCTION **6 -1**

SECTION 6.1:	BARRIERS AND WARNING AND/OR DETOUR SIGNS	6 – 3	6/1/10
SECTION 6.2:	PAVEMENT MARKINGS	6 – 5	6/1/10
SECTION 6.3:	ROADWAY ILLUMINATION ASSEMBLIES	6 – 9	6/1/10
SECTION 6.4:	MOBILIZATION	6 – 11	6/1/10
SECTION 6.5:	METAL BEAM GUARDRAIL	6 – 13	6/1/10
SECTION 6.6:	RAILING	6 – 15	6/1/10
SECTION 6.7:	SAWING	6 – 17	6/1/10
SECTION 6.8:	PAINTING	6 – 19	6/1/10
SECTION 6.9:	ELECTRICAL CONDUIT	6 – 39	6/1/10
SECTION 6.10:	RIPRAP	6 – 43	6/1/10
SECTION 6.11:	GABION STRUCTURE	6 – 49	6/1/10
SECTION 6.12:	GEOTEXTILES FOR USE WITH UNDERGROUND PIPES	6 – 53	6/1/10
SECTION 6.13:	WOOD PRODUCTS	6 – 55	6/1/10

SECTION 7: STRUCTURES **7 -1**

SECTION 7.1:	GENERAL	7 – 3	6/1/10
SECTION 7.1.A	STRUCTURAL EXCAVATION	7 – 3	6/1/10
SECTION 7.1:B	DRIVING PILING	7 – 7	6/1/10
SECTION 7.2:	CONCRETE	7 – 23	6/1/10
SECTION 7.2.A	DRILLED SHAFT FOUNDATIONS	7 – 23	6/1/10
SECTION 7.2:B	CONCRETE STRUCTURES	7 – 29	6/1/10
SECTION 7.2:C	PRESTRESSED CONCRETE FOR STRUCTURES	7 – 35	6/1/10
SECTION 7.2:D	PRESTRESSING	7 – 45	6/1/10
SECTION 7.2:E	PRECAST CONCRETE UNITS	7 – 53	6/1/10
SECTION 7.3:	STEEL	7 – 57	6/1/10
SECTION 7.3:A	STEEL STRUCTURES	7 – 57	6/1/10
SECTION 7.3:B	STRUCTURAL BOLTING	7 – 73	6/1/10

SECTION 8: TRAFFIC **8 -1**

SECTION 8.1:	ANTIQUE/SHOEBOX LIGHT AND ASSOCIATED ITEMS	8 – 3	6/1/10
SECTION 8.2:	TRAFFIC SIGNAL MAST-ARM POLES	8 – 7	6/1/10
SECTION 8.3:	STREET LIGHTING POLES	8 – 13	6/1/10
SECTION 8.4:	POWDER COATING OVER GALVANIZED STEEL SURFACES	8 – 17	6/1/10
SECTION 8.5:	TRAFFIC SIGNAL INSTALLATION SPECIFICATIONS	8 – 19	6/1/10
SECTION 8.6:	TRAFFIC SIGNAL DESIGN CRITERIA CABINET & CABINET ACCESSORIES	8 – 25	6/1/10
SECTION 8.7:	PAVEMENT MARKINGS & ROADWAY SIGNAGE	8 – 27	6/1/10

SECTION 9: WATER AND WASTEWATER ELECTRICAL **9 -1**

SECTION 9.1:	ELECTRICAL GENERAL INFORMATION	9 – 3	6/1/10
SECTION 9.2:	INCOMING LINE PROTECTION	9 – 13	6/1/10
SECTION 9.3:	CONDUIT SYSTEMS	9 – 17	6/1/10
SECTION 9.4:	WIRE AND CABLE	9 – 23	6/1/10
SECTION 9.5:	BOXES AND FITTINGS	9 – 27	6/1/10
SECTION 9.6:	PANELBAORDS	9 – 31	6/1/10
SECTION 9.7:	CIRCUIT BREAKERS	9 – 35	6/1/10
SECTION 9.8:	SAFETY SWITCHES	9 – 37	6/1/10
SECTION 9.9:	GROUNDING	9 – 41	6/1/10
SECTION 9.10:	EXTERIOR LIGHTING	9 – 45	6/1/10
SECTION 9.11:	CONTROL PANELS	9 – 49	6/1/10
SECTION 9.12:	REMOTE TELEMETRY UNITS	9 – 59	6/1/10
SECTION 9.13:	CALIBRATION AND TESTING	9 – 67	6/1/10
SECTION 9.14:	TESTING INSTRUMENTATION AND CONTROLS	9 – 71	6/1/10

SECTION 1
SITE WORK

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SECTION 1.1: PREPARING RIGHT-OF-WAY

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of preparing the right-of-way for construction within work areas defined in the contract documents.

This item includes the removal and proper disposal of all obstructions from the right-of-way and from designated easements, where removal of such obstructions is not otherwise provided for in the plans and specifications.

Such obstructions shall include, but are not limited to, remains of houses not completely removed by others, foundations, floor slabs, concrete, brick, lumber, plaster, septic tanks, basements, abandoned utility pipes or conduits, equipment, or other foundations, fences, retaining walls, shacks and other debris.

Removal of any potentially hazardous infrastructure, such as underground storage tanks, will be performed by qualified personnel in accordance with all applicable rules and regulations.

This item shall also include the removal of curb and gutter, driveways, paved parking areas, miscellaneous stone, brick, concrete sidewalks, drainage structures, manholes, inlets, abandoned railroad tracks, scrap iron, all rubbish and debris, whether above or below ground except live utility facilities.

Please refer to *Section 1.2, Clearing and Grubbing,* for the removal of trees, stumps, bushes, vegetation, roots, and shrubs.

It is the intent of this specification to provide for the removal and disposal of all obstructions and objectionable materials within the designated work areas not specifically provided for elsewhere in the plans and specifications.

B. SUBMITTALS

The contractor shall provide a copy of all documentation related to material disposal to the Owner's representative.

PART 2: PRODUCT

A. MATERIALS

Not applicable.

B. EQUIPMENT

Not applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

All work areas designated for this project including the right of way, and such additional areas, including public or corporate areas and public or corporate lands, as made available for construction of this project, shall be cleared of all structures and obstructions.

Unless otherwise indicated on plans, all foundations and underground obstructions shall be removed to the following depths:

1. In areas to receive embankment, one foot below natural ground.
2. In areas to be excavated, one foot below the lower elevation of the excavation.
3. All other areas, one foot below natural ground.

All basement walls and floors, septic tanks and storage tanks within the designated work areas shall be removed and the resulting holes backfilled as directed by the Owner. Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc., shall be backfilled. The Contractor shall complete the operation of preparing right-of-way so that the prepared right-of-way shall be free of holes, ditches and other abrupt changes in elevations and irregularities to contour.

The remaining ends of all abandoned storm sewers, culverts, sanitary sewers, conduits and water or gas pipes shall be plugged with an adequate quantity of concrete to form a tight closure. All materials and debris removed shall become the property of the Contractor unless otherwise provided for on the plans or in the specifications; and shall be removed from the right-of-way. Gravel, brick, stone or broken concrete, when permitted by special conditions may be used in the roadway embankment.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

All work performed and measured as prescribed by this item may be paid for as a unit rate (acres) or by lump sum, in accordance with the contract.

For contracts that utilize unit rate payment, measurement shall be made only on areas indicated and classified on plans as preparing right of way. The contract unit price shall be the total compensation for furnishing all material, labor, equipment, tools and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

When not listed as a separate contract pay item, preparing the right of way shall be considered as incidental work, and the cost thereof shall be included in such contract pay items as are provided for in the proposal contract.

SECTION 1.2: CLEARING AND GRUBBING

PART 1: GENERAL

A. DESCRIPTION

Clearing and grubbing shall consist of the removal and disposal of trees, stumps, brush, roots, vegetation, logs, rubbish and other objectionable matter from the designated work areas.

B. SUBMITTALS

The contractor shall provide a copy of all documentation related to material disposal to the Owner' representative.

PART 2: PRODUCT

A. MATERIALS

Not applicable.

B. EQUIPMENT

Not applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

The designated work areas shall be cleared of all trees, brush, shrubbery, plants, etc., not designated by the Owner or indicated on the plans to be preserved. **Prior to removal of any growth, the Contractor shall verify with the Owner all vegetation to be cleared**.

Unless otherwise indicated on the plans, trees and stumps shall be cut off or otherwise removed as close to the natural ground as practicable on areas, which are to be covered by at least three feet of embankment. On areas required for borrow sites and materials sources, stumps, roots, etc., shall be removed to the complete extent necessary to prevent such objectionable matter becoming mixed with the material to be used in construction.

All cleared and grubbed material shall be properly disposed of by the Contractor. The contractor shall provide a copy of all disposal related documentation to the Construction Inspector.

Unless otherwise provided, all merchantable timber removed as previously specified shall become the property of the Contractor. It is the intent of this specification to provide for the removal and disposal of all obstructions and objectionable materials not specifically provided for elsewhere by the plans and specifications.

B. REMOVAL AND REPLACEMENT OF SOD, SHRUBBERY, PLANTS, ETC

Where sod, shrubbery, plants, etc., are removed in making the excavation, such areas shall have the same sod, shrubbery, plants, etc., of the same kind and in good condition, replaced in their prior positions. Trees that are to be removed and subsequently replaced shall be designated on the plans. Sod shall be removed in squares cut out with a

sharp spade, and of such sizes that they may be handled conveniently without breaking. They shall be carefully stored and given proper attention. During hot, dry weather, the stored sod shall be protected by covering with canvas or burlap. Shrubbery, plants, etc., shall be removed with a ball of dirt about their roots and shall be carefully stored and given proper attention. Contractor may, at his option, replace sod, plants, shrubbery, etc., with new materials. When backfilling is completed, the sod, shrubbery, plants, etc., shall be carefully replaced in their original location; and the area thoroughly wet down. The cost of such removal and replacement shall be paid for as a separate contract pay item if a separate pay item is provided; otherwise, the costs thereof shall be included in such pay items as are provided in the proposal and contract.

C. Protection of Trees and Shrubs

Trees and brush, designated to be left in place, shall be carefully trimmed as directed and shall be protected from scarring, barking or other injuries during construction operations. Pruned limbs over two inches in diameter shall be treated by painting the exposed ends with an approved asphaltic material.

No trees shall be removed unless so noted on the plans or upon the specific approval of the Owner. Where trees, plants, shrubbery, etc., are adjacent to the line of the work and are not to be removed or removed and replaced, the Contractor shall protect such trees, plants, shrubbery, etc., by substantial wooden boxes and guards and shall not permit machinery or employees to scrape, tear limbs from, damage or attach guy cables to them; and if, in the opinion of the Owner, such trees, plants, shrubbery, etc., would be damaged by machinery, etc., hand excavation may be required. The Contractor shall be responsible for all damages to adjacent trees, plants, shrubbery, etc., and any such damage shall be remedied to the satisfaction of the Owner. The cost of such protection shall not be paid for as a separate contract pay item, and the costs thereof shall be included in such pay items as are provided for in the proposal and contract.

PART 4: MEASUREMENT AND PAYMENT

A. Measurement and Payment

All work performed and measured as prescribed by this item may be paid for as a unit rate (acres) or by lump sum, in accordance with the contract.

For contracts that utilize unit rate payment, measurement shall be made only on areas indicated and classified on plans as clearing and grubbing. The contract unit price shall be the total compensation for furnishing all material, labor, equipment, tools and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

When not listed as a separate contract pay item clearing and grubbing shall be considered as incidental work, and the cost thereof shall be included in such contract pay items as are provided for in the proposal contract.

SECTION 1.3: UNCLASSIFIED EXCAVATION

PART 1: GENERAL

A. DESCRIPTION

It is the intent of this specification to provide for all required excavation within the designated work areas not specifically provided for elsewhere in the plans and specifications.

Unclassified excavation shall consist of all the required excavation within the limits of the right-of-way and areas adjacent thereto; the removal, proper utilization or disposal of all excavated material; and the shaping and finishing of all earthwork in conformity with the lines and grades as shown on the plans or as established by the Owner all in accordance with the specification requirements contained herein.

B. CLASSIFICATION

Without regard to the nature of materials encountered, all excavations shall be unclassified and shall be designated as "Unclassified Excavation" which shall include all materials excavated. It is to be distinctly understood that any reference to rock, or any other material on the plans, and/or in this specifications is solely for the Owner's and Contractor's information, and is not to be taken as an indication of classification of excavation.

C. SUBMITTALS

The contractor shall provide a copy of all documentation related to material disposal.

PART 2: PRODUCT

A. MATERIALS

Not applicable.

B. EQUIPMENT

Not applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Excavation of Streets - All excavation shall be in accordance with the lines, grades and typical sections as shown on the plans or as established by the Owner. Unless otherwise shown on the plans or established by the Owner, the street excavation shall be made to the subgrade of the roadway and finished grade of parkways. Where excavation to grades established in the field by the Owner would terminate in unstable soil, the Contractor shall remove the unstable soil and backfill to the required grade.

Where excavation to grade established in the field by the Owner terminates in loose or solid rock, the Contractor may be required to extend the depth of excavation six inches; and to backfill with select material compacted as required.

Dragging, pushing or scraping of material along or across the surface of the completed concrete improvements or pavements shall not be permitted.

The Contractor shall conduct his operation in such a manner that adequate measurements may be taken before any backfill, as required above, is placed.

2. Excavation of Channels - All suitable materials removed from the excavation shall be used, insofar as practicable, in the formation of embankments or shall be otherwise utilized or satisfactorily disposed of as indicated on the plans, or as directed; and completed work shall conform to the established alignment, grades and cross sections. During construction, the channel shall be kept drained, insofar as practicable; and the work shall be executed in a neat workmanlike manner.

B. Provisions for Drainage

If it is necessary in the execution of the work to interrupt the natural drainage of the surface, or the flow of artificial drains, the Contractor shall provide temporary drainage facilities that shall prevent damage to public or private interest; and shall restore the original drains as soon as the work shall permit.

The Contractor shall be held liable for all damages, which may result from neglect to provide for either natural or artificial drainage, which his work may have interrupted.

C. Excess Excavation

Excavation in excess of that needed for construction shall be properly disposed of by the Contractor. In general, suitable excess street excavation shall be used in construction of parkways, widening of embankments, flattening of slopes, etc.; but, if it becomes necessary to waste any material, it shall be disposed of in such a manner as to present a neat appearance and to not obstruct proper drainage or cause injury to any street improvements or abutting property. If necessary to haul off excess or unsuitable material, the Contractor shall notify the Owner's representative as to disposition site and method, and shall provide a copy of all disposal related documentation.

PART 4: MEASUREMENT AND PAYMENT

A. Measurement and Payment

All work performed and measured as prescribed by this item may be paid for as a unit rate (area or volume), in accordance with the contract.

For contracts that utilize unit rate payment, measurement shall be made only on areas indicated and classified on plans as clearing and grubbing.

All authorized excavation shall be measured in its original position, the volume in cubic yards determined by the average end area method. Changes to contract quantities must be based upon changes in design.

The contract unit price shall be the total compensation for furnishing all material, labor, equipment, tools and incidentals necessary to complete the work, all in accordance with the plans and these specifications. The contract bid price for

unclassified excavation shall include all costs related to excavation, placing excavated material in embankment, loading and hauling and for satisfactory disposal of unsuitable and excess materials; finishing slopes, ditches and parkways; for all maintenance blading or scarifying the ground surface; and for furnishing all labor, tools, materials, equipment, and incidentals necessary to complete the work.

When not listed as a separate contract pay item, unclassified classification shall be considered as incidental work, and the cost thereof shall be included in such contract pay items as are provided for in the proposal contract.

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SECTION 1.4: GRADING IN RIGHT-OF-WAY BEHIND CURB

PART 1: GENERAL

A. DESCRIPTION

The area in the Right-of-Way behind the Curb shall be finished as shown on the plans.

B. SUBMITTALS

Not applicable.

PART 2: PRODUCT

A. MATERIALS

Not applicable.

B. EQUIPMENT

Not applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Whenever the adjacent property is lower than the design curb grade and drains away from the street, the Right-of-Way behind the curb may be set level with the top of the curb, if approved by the Owner. The Owner may approve variations from these standards in special cases.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

All work performed as prescribed by this item is considered to be subsidiary to the completion of the project.

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SECTION 1.5: FILL

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of the placement and compaction of all suitable materials in accordance with the design.

B. SUBMITTALS

Not applicable.

PART 2: PRODUCT

A. MATERIALS

Materials shall be selected based upon the design, in compliance with all applicable rules and regulations, consistent with good engineering practice.

C. MATERIAL TESTING

Construction Operation	Applicable Testing	Frequency of Testing
Embankment	Standard Proctor & field densities	Proctor for each material to be used. Densities to be project specific.

* Frequencies are minimums unless otherwise specified.

B. EQUIPMENT

Not applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Prior to the placing of any embankment, all site preparation and clearing and grubbing of the site shall have been completed. Stump holes or other small excavations within the limits of the embankment shall have been backfilled before commencing the embankment construction. The surface of the ground, including plowed or loosened ground or small ditches or washes, shall be restored to approximately its original slope.

The surface of hillsides shall be loosened by the scarifying or plowing to a depth of not less than four inches, or cut into steps before embankment materials are placed. The embankment shall then be placed in layers as hereinafter specified, beginning at the low side in part widths as the embankment is raised. The material, which has been loosened, shall be recompacted simultaneously with embankment material placed at the same elevation. Where embankment is to be placed over or adjacent to the existing roadbeds, the slopes shall be plowed or scarified to a depth not less than four inches and the embankment built up in successive layers, as hereinafter specified, to the level of the old roadbed before its height is increased. Then the old roadbed shall be

scarified and recompacted with the next layer of embankment. The total depth of the scarified and added materials shall not exceed the permissible depth of the layer.

All fill for roadbeds shall be constructed in layers approximately parallel to the finished grade of the street and shall be so constructed as nearly as possible to conform to the cross section of the subgrade section.

Fill shall be constructed to the established grade and to the shape of the typical section shown on the plans, and each section shall conform to the detailed sections of slopes. After completion of the embankment, it shall be continuously maintained to its finished section and grade until the project is accepted.

B. EARTHEN FILL

Earthen fill shall be constructed in successive layers, for the full width of specified depth or cross sections; and in such length as are suitable for the sprinkling and compaction methods to be used. Each layer of earth embankment shall be uniform as to material, density, and moisture content before beginning compaction. Prior to compaction, the layers shall not exceed six inches in depth for pneumatic tire rolling or eight inches in depth for rolling with other types of rollers.

Earth fill placed adjacent to and over pipes, culverts, arches and bridges shall be suitable material and shall be placed in successive layers approximately horizontal. Layers of embankment shall be brought up uniformly on each side of the structure, and special care shall be taken to prevent any wedging action against the structure. For such distances along fill adjacent to structures where it is impracticable to obtain compaction by rolling, the embankment material shall be placed in layers not exceeding six inches in depth of loose material wetted uniformly to the moisture content directed; and shall then be compacted by methods approved by the Owner, maintaining the required moisture content by additional sprinkling, if necessary, supplemented by such hand work as is necessary to secure a uniform and thoroughly compacted fill, until each layer has been uniformly compacted to the satisfaction of the Owner.

All earth cuts, full or part width in the side of a hill, which are not required to be excavated below subgrade elevation for base or backfill, shall be scarified to a uniform depth of not less than six inches below grade shown on the plans; and the materials shall be mixed and reshaped by blading and then sprinkled and rolled in accordance with the hereinabove outlined requirements for any earthen fill.

C. ROCK FILL

Rock fill shall be composed principally of rock; and shall be constructed in successive layers for the full width of the specified depths or cross sections, and each layer shall be eighteen inches or less in depth. Each layer shall be constructed by starting at one end, dumping the rock on top of the layer being constructed, and then pushing the dumped material ahead in such a manner that the larger rock shall be placed on the ground or preceding rock embankment layer; and the interstices between the larger stones shall be filled with smaller stones and spalls both by this operation and from the placing of succeeding loads of rock materials. The upper or final layer of rock embankment shall contain no stones larger than four inches in their maximum

dimension; and insofar as such is available by selection of the excavation, this layer shall be composed of materials so graded that the maximum density and uniformity of the surface layer may be secured. Each rock layer shall be rolled as directed by the Owner. In addition to the foregoing selection of materials and utilization of the materials in the embankment, the fill shall be placed in the proper sequence to receive select materials as specified or as shown on the plans, with any modifications as may be directed by the Owner. The layer of fill immediately preceding the upper layer of select material shall be constructed to the required cross section and the proper elevation within a tolerance of not more than one-tenth of a foot from the established cross section or elevation after proper compaction; and shall be finished as necessary to receive the select material.

D. DENSITY

For each layer of earth fill and selection material, the relative compaction of the embankment shall be 95% standard proctor density unless otherwise noted. After each section of earthen fill or select material is completed, such tests as are necessary shall be made as specified by the Owner, unless otherwise specified in the special provision or in the plans.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

All work performed and measured as prescribed by this item will be paid for as a unit rate (volume), in accordance with the contract.

Measurements shall be in its final, compacted condition, computed in cubic yards by the method of average end areas; or as specified otherwise. The unit price bid shall be full compensation for furnishing all labor, for all royalties, materials, tools, equipment, hauling and incidentals necessary to complete the work.

All work performed as prescribed by this item shall be paid for at the contract unit price per cubic yard for unclassified excavation. The prices bid shall be full compensation for furnishing all labor, materials, tools, equipment, hauling and incidentals necessary to complete the work. Payment for unauthorized work shall not be made.

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SECTION 1.6: TOPSOIL

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of furnishing and placing topsoil, free from rock and foreign material, as indicated on the plans, to the lines and grades as established by the Owner.

B. SUBMITTALS

Not applicable.

PART 2: PRODUCT

A. MATERIALS

Not applicable.

B. EQUIPMENT

Not applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Topsoil shall be imported as required to supplement material available from excavation. All excavated material, which is suitable for topsoil, shall be used before any topsoil is imported. Imported topsoil shall be stockpiled at locations approved in advance by the Owner.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Imported topsoil shall be measured by the square yard in place on the project site. Measurement for payment shall be made only on imported topsoil.

All work performed as ordered and measured as provided under this item shall be paid for at the unit price bid for topsoil. The price shall be full compensation for excavating (except as noted below), loading, hauling, placing and furnishing all labor, equipment, tools, supplies and incidentals necessary to complete the work.

Salvage Topsoil - all labor, equipment, tools and incidentals necessary to place salvage topsoil as specified shall be included in the price as bid for in Unclassified Excavation.

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SECTION 1.7: SODDING

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of furnishing, hauling, and placing approved live sod on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the Engineer.

B. SUBMITTALS

Not applicable.

PART 2: PRODUCT

A. MATERIALS

1. General - Sod furnished by the Contractor shall have a good cover of living or growing grass. This shall be interpreted to include grass that is seasonally dormant during the cold or dry seasons and capable of renewing growth after the dormant period. All sod shall be obtained from areas where the soil is reasonably fertile and contains a high percentage of loamy topsoil. Sod shall be cut or stripped from living, thickly matted turf, relatively free of weeds or other undesirable foreign plants, large stones, roots, or other materials, which might be detrimental to the development of the sod or to future maintenance. At least 70% of the plants in the cut sod shall be composed of the species stated in the special provisions, and any vegetation more than 6" in height shall be mowed before sod is lifted. Sod, including the soil containing the roots and the plant growth showing above, shall be cut uniformly to a thickness not less than that stated in the special provisions.

2. Sod - Turf grass and sod shall be "Cynodon dactylon" (Common Bermuda grass)/"Stenotaphrum secundatum" (St. Augustine grass). Sod shall consist of stolons, leaf blades, rhizomes, and roots with a healthy, virile system of dense, thickly matted roots throughout the soil of the sod for a thickness not less than 0.75 inches. Sod shall be alive, healthy, vigorous, free of insects, disease, stones, and undesirable foreign materials and grasses. The grass shall have been mowed prior to sod cutting. Sod shall have been produced on growing beds of clay or clay loam topsoil. Sod shall not be harvested or planted when its moisture condition is so excessively wet or dry that its survival shall be affected. All sod is to be harvested, delivered and planted within a 36-hour period of time. Sod shall be protected from exposure to wind, sun and freezing. If sod is stacked, it shall be kept moist and shall be stacked roots to roots and grass to grass.

Dimensions - All sod shall have been machine cut to uniform soil thickness of 1" plus or minus ¼". All sod shall be of the same thickness.

Rectangular sections of sod may vary in length; but all shall be of equal width and of a size that permits the sod to be lifted, handled and rolled without breaking. Broken pads and torn, uneven ends shall be rejected.

3. Water - The water shall be sufficiently free from oil, acid, alkali, salt, or other harmful materials that would inhibit the growth of grass. It shall be subject to the approval of the Engineer prior to use.

C. EQUIPMENT

Suitable equipment necessary for proper preparation of the ground surface and for the handling and placing of all required materials shall be on hand, in good condition, and shall be approved by the Engineer before the various operations are started..

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. General - Areas to be solid, strip, or spot sodded shall be shown on the plans. Areas requiring special ground surface preparation such as tilling and those areas in a satisfactory condition, which are to remain undisturbed, shall also be shown on the plans.

The Contractor shall demonstrate to the Engineer before starting the various operations that the application of required materials will be made at the specified rates.

2. Preparing the Ground Surface - After grading of areas has been completed and before applying fertilizer, areas to be sodded shall be raked or otherwise cleared of stones larger than 2" in any diameter, sticks, stumps, and other debris which might interfere with sodding, growth of grasses, or subsequent maintenance of grass covered areas. If any damage of erosion or other causes occurs after grading of areas and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage. This may include filling gullies, smoothing irregularities, and repairing other incidental damage.

3. Obtaining and Delivering Sod - After inspection and approval of the source of sod by the Engineer, the sod shall be cut with approved sod cutters to such a thickness that after it has been transported and placed on the prepared bed, but before it has been compacted, it shall have a uniform thickness of not less than 2". Sod sections or strips shall be cut in uniform widths, not less than 10 inches, and in lengths of not less than 18", but of such length as may be readily lifted without breaking, tearing, or loss of soil. Where strips are required, the sod must be rolled without damage with the grass folded inside. The Contractor may be required to mow high grass before cutting sod.

The sod shall be transplanted within 36 hours from the time it is stripped, unless circumstances beyond the Contractor's control make storing necessary. In such cases, sod shall be stacked, kept moist, and protected from exposure to the air and sun and shall be kept from freezing. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected. Where the soil is too dry, permission to cut sod may be granted only after it has been watered sufficiently to moisten the soil to the depth the sod is to be cut.

4. Laying Sod - Sodding shall be performed only during the seasons when satisfactory results can be expected. Frozen sod shall not be used and sod shall not be placed upon frozen soil. Sod may be transplanted during periods of drought with the approval of the Engineer, provided the sod bed is watered to moisten the soil to a depth of at least 4 inches immediately prior to laying sod.

The sod shall be moist and shall be placed on a moist earth bed. Pitchforks shall not be used to handle sod, and dumping from vehicles shall not be permitted. The sod shall be carefully placed by hand, edge to edge and with staggered joints, in rows at right angles to the slopes, commencing at the base of the area to be sodded and working upward. The sod shall immediately be pressed firmly into contact with the sod bed by tamping or rolling with approved equipment to provide a true and even surface, and insure knitting without displacement of the sod or deformation of the surfaces of sodded areas. Where the sod may be displaced during sodding operations, the workmen when replacing it shall work from ladders or treated planks to prevent further displacement. Screened soil of good quality shall be used to fill all cracks between sods. The quantity of the fill soil shall not cause smothering of the grass. Where the grades are such that the flow of water will be from paved surfaces across sodded areas, the surface of the soil in the sod after compaction shall be set approximately one inch below the pavement edge. Where the flow will be over the sodded areas and onto the paved surfaces around manholes and inlets, the surface of the soil in the sod after compaction shall be placed flush with pavement edges. On slopes steeper than one vertical to 2½ horizontal and in V-shaped or flat-bottom ditches or gutters, the sod shall be pegged with wooden pegs not less than 12 inches in length and have a cross-sectional area of not less than ¾ square inch. The pegs shall be driven flush with the surface of the sod.

5. Watering - Adequate water and watering equipment must be on hand before sodding begins, and sod shall be kept moist until it has become established and its continued growth assured. In all cases, watering shall be done in a manner, which will avoid erosion from the application of excessive quantities and will avoid damage to the finished surface.

6. Establishing Turf

a. General - The Contractor shall provide general care for the sodded areas as soon as the sod has been laid and shall continue until final inspection and acceptance of the work.

b. Protection - All sodded areas shall be protected against traffic or other use by warning signs or barricades approved by the Engineer.

c. Mowing - The Contractor shall mow the sodded areas with approved mowing equipment, depending upon climatic and growth conditions and the needs for mowing specific areas. In the event that weeds or other undesirable vegetation are permitted to grow to such an extent that, either cut or uncut, they shall be mowed and the clippings raked and removed from the area.

7. Repairing - When the surface has become gullied or otherwise damaged during the period covered by this contract, the affected areas shall be repaired to re-establish the grade and the condition of the soil, as directed by the Engineer, and shall then be resodded as specified.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

All work performed and measured as prescribed by this item will be paid for as a unit rate (area), in accordance with the contract.

Spot, strip, or solid sodding, shall be measured by the square yards of sodded area completed in accordance with the plans and specifications. Spot, strip, or solid sodding, as the case may be, shall be aid for at the contract unit price per square yard, complete in place, as provided in the proposal and contract.

The contract unit price shall be the total compensation for furnishing and placing all sod; for all rolling and tamping; for all water; for disposal of all surplus material; and for all material, labor, equipment, fuels and incidentals necessary to complete the work, all in accordance with the plans and specifications.

SECTION 1.8: SEEDING

PART 1: GENERAL

A. DESCRIPTION

Seeding shall consist of ground preparation, furnishing and planting approved seed, furnishing and placing of mulch, a curlex blankets, watering, furnishing and spreading approved commercial fertilizer, and mowing as required along and across such areas as may be designated on the plans and in accordance with these specifications.

The Contractor shall water, mow, and maintain all seeded areas until final acceptance thereof and any damage caused to the seeded areas prior to final acceptance shall be repaired at the Contractor's expense.

B. SUBMITTALS

Prior to beginning seeding operations the Contractor will furnish the Engineer with a seeding plan, which indicates the method of seeding, proposed. Signed copies of vendor's statements for each grass seed, stating common and botanical name, percentage by weight, of purity, germination and weed seed. Each container delivered shall be fully labeled and shall be in accordance with the requirements of the Federal Seed Act.

PART 2: PRODUCT

A. MATERIALS

1. General - All material for Turf grass provided shall be in accordance with these specifications and as noted in the plans and contract documents.

2. Bermuda grass Seed - Turf grass seed shall be "Cynodon Dactylon" (Common Bermuda grass). The seed shall be harvested within one year prior to planting, free of Johnson grass, field bind weed, dodder seed, and free of other weed seed to the limits allowable under the Federal Seed Act and applicable seed laws. The seed shall not be a mixture. The seed shall be hulled, extra fancy grade, treated with fungicide and have a germination and purity that shall produce, after allowance for Federal Seed Act tolerances, a pure live seed content of not less than 85 percent, using the formula: purity percent time (germination percent times plus hard or sound seed five percent). Seed shall be labeled in accordance with U.S. Department of Agriculture rules and regulations.

Certificate Submittal - Prior to planting, provide the Owner with the State of Texas Certificate stating analysis of purity and germination of seed.

3. Ryegrass Seed - Turf grass seed shall be "Lolium multiflorum" (Italian or Annual Ryegrass). The seed shall be harvested within one year prior to planting and shall be free of perennial ryegrass seed, other grass seed and weed seed to the limits allowable under the Federal Seed Act and applicable seed laws. Seed shall be at least 95 percent pure and shall have a 90 percent minimum germination rate.

Certificate Submittal - Prior to planting, provide the Owner with the State Certificate stating analysis of purity and germination seed.

4. Sprigs - Turf grass springs and stolons shall be "Cynodon dactylon" (Common Bermuda grass) (Hybrid Bermuda grass of the Tifway 419/Texturf 10/Tifgreen Strain). Sprigs shall be acquired from a healthy stand of grass, free of weeds and other grasses. The source is to be inspected and approved by the Owner. Sprigs and stolons are to be delivered and planted on the same day they are harvested to assure optimum rooting.

5. Hydromulch Materials

a. General - All mulch shall be manufactured from hardwoods only and shall be refined specifically for lawn hydromulch applications. Use "Conwed" or an approved equal.

b. Adhesive Agents - Adhesive agent for mulch shall be asphalt conforming to TxDOT Designation EA-11M. As an option, the following adhesive agent may be substituted for asphalt emulsions as a mulch tacking agent: Terra Tack AR or Terra Tack II, as manufactured by Grass Growers, 424 Cottage Place, Plainfield, New Jersey 02060.

B. EQUIPMENT

Not applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

The Contractor shall smooth all surfaces prior to initiating any seeding operation. Where required, the Contractor shall scarify the ground to prepare a proper seedbed.

Apply fertilizer at the rate of 5 lbs. per 1000 S. F. or as directed by the Engineer.

B. PLANTING RATES AND SEASONS

Type	Application Rate (Pounds per 1000 S.F.)	Planting Date
Hulled Bermuda	1	April 1 - Oct. 1
Mixed Bermuda & Rye (Bermuda Hulled)	1	Oct. 1 - April 1
Rye	5	Oct. 1 - April 1

C. BROADCAST SEEDING

Seed or seed mixture in the quantity specified shall be uniformly distributed over the areas shown on the plans and where directed. If the sowing of seed is by hand, rather than by mechanical methods, the seed shall be sown to two directions at right

angles to each other. Seed and fertilizer may be distributed at the same time, provided the specified uniform rate of application for both is obtained.

D. DISCED SEEDING

Soil over the area shown on the plans as directed to be seeded shall be loosened to a minimum depth of three inches. All particles in the seedbed shall be reduced to less that one-inch in diameter, or they shall be removed. The area shall then be finished to line and grade as specified.

Seed or seed mixture specified shall then be planted at the rate required, and application shall be made uniformly. If the sowing of seed is by hand rather than by mechanical methods, seed shall be sown in two directions at right angles to each other. Seed and fertilizer may be distributed at the same time, provided the specified uniform rate of application for both is obtained. After planting, the seed shall be raked or harrowed into the soil to a depth of approximately one-eighth inch. The planted area shall then be rolled with a corrugated roll of the "Cultipacker" type. All rolling of the slope area shall be on the contour.

E. HYDRO-MULCHING

Seed or seed mixture, applied at the rates shown in item B, *Planting Rates and Seasons*, of Section 1.8 Part 3 shall be uniformly distributed over the areas shown on the plans or where directed. Seed and fertilizer are to be distributed as a water slurry, and the mixture shall be applied to that area to be seeded within 30 minutes after all components are placed in the equipment. Fertilizer shall conform to the requirements of *Section 1.9, Fertilizer,* and shall be applied at the rate of 5 lbs. per 1000 S.F.

Wood cellulose fiber mulch or other approved material may be used in hydro mulching and shall contain no germination or growth inhabiting factors. It shall be dyed an appropriate color to allow visual monitoring of application. The mulching material shall have the property of becoming evenly dispersed and suspended when agitated in water. Wood cellulose fiber shall be applied at the rate of 50 pounds per 1,000 square feet.

F. SOIL RETENTION BLANKET

The work covered under this section of the specifications shall include the furnishing and installation of blankets where shown on the Drawings for slope protection.

1. Material - The blanket shall consist of a mat of curled wood of 80% six inch, or longer fiber length, with consistent thickness and fiber evenly distributed over the entire area.

The topside of each blanket shall be covered with a photodegradable extruded plastic mesh. The blanket shall be made smolder resistant without using chemicals. Geosynthetic mat shall be Landlok 300 by Propex Geosynthetics, or an approved equal. The mat shall be installed in accordance with manufacturer’s recommendations.

2. Installation - The area to be covered shall be properly, fertilized and seeded prior to blanket application. When the blanket is unrolled, the netting shall be on top and the fibers in contact with the soil over the entire area. In ditches, the blankets shall be applied in direction of water flow, butted snugly at the ends and sides and stapled. On slopes, the blankets shall be applied either horizontally or vertically to the slope. Ends and sides shall be butted snugly and stapled. It is not necessary to dig check slots, anchor ditches, or bury ends of the blanket.

Staples for securing the mat to the ground shall be driven vertically into the ground, spaced approximately two (2) linear yards apart, on each side, and one row in the center. Common row staples may be used on adjoining blankets.

3. Maintenance - The Contractor will begin maintenance of seeding immediately after each portion is planted and shall continue such until final acceptance. Maintenance includes watering, fertilizing, mowing (maintaining a height less than 4"), and all operations required to establish a smooth finish free from bare spots and erosion.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

All work performed and measured as prescribed by this item will be paid for as a unit rate (area), in accordance with the contract.

Acceptable material for broadcast seeding, disced seeding, asphalt mulch seeding soil retention blanket and hydro mulching shall be measured by the square yard or by the acre, complete in place. The work performed and materials furnished and measured as provided in this item shall be paid for at the unit price for broadcast seeding, disced seeding, asphalt mulch seeding, hydro mulching, or soil retention blankets of the type specified, as the case may be.

The price shall be full compensation for furnishing of all materials, including water and fertilizer, and for performing all operations necessary to complete the work.

SECTION 1.9: FERTILIZER

Part 1: General

A. DESCRIPTION

Fertilizing shall consist of providing and distributing fertilizer over such areas as are designated on the plans and in accordance with these specifications.

All fertilizer used shall be delivered in bags or containers clearly labeled to show analysis of the contents. The fertilizer is subject to testing by the Owner in accordance with the Texas Fertilizer Law. A fertilizer shall be used with an analysis as shown on the plans. The figures in the analysis represent the percent of nitrogen, phosphoric acid and potash nutrients, respectively, as determined by the methods of the Association of Official Agricultural Chemists. In the event it is necessary to substitute a fertilizer of a different analysis with a lower concentration, the total amount of nutrients furnished and applied per unit area shall equal or exceed that specified for each nutrient.

B. SUBMITTALS

Submit a sample label or specification of the fertilizer proposed to be used for the Owner's approval.

PART 2: PRODUCT

A. MATERIALS

1. General - Fertilizer shall be a commercial product, uniform in composition, free flowing and suitable for application with approved equipment. Fertilizer shall be delivered to the site in fully labeled original containers. Fertilizer, which has been exposed to high humidity and moisture, has become caked or otherwise damaged, making it unsuitable for use, shall be rejected.

2. Initial Planting Application - Fertilizer for the initial planting application shall contain by weight the following (or other approved) percentages of nutrients: 15-10-5 (N-P-K); also containing 10-15 percent sulphate and traces of iron and zinc as required and approved by the Owner.

Specification Submittal - Submit a sample label or specification of the fertilizer proposed to be used for the Owner's approval.

3. Post Planting Application - Fertilizer for the post planting application shall be a chemical base fertilizer containing by weight the following percentages of nutrients: 21-0-0 (N-P-K) ammonium sulphate; or the nitrogen equivalent of 33-0-0 ammonium nitrate.

Specification Submittal - Submit a sample label or specification of the fertilizer proposed to used for the Owner's approval.

B. EQUIPMENT

Not applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

When an item for fertilizer is included in the plans and proposal, the fertilizer shall be applied uniformly over the area specified to be fertilized and in the manner directed for the particular item of work. Fertilizer shall be in good physical condition. Distribution of fertilizer as a particular item of work shall meet the approval of the Owner.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

All work performed as prescribed by this item is considered to be subsidiary to the completion of the project.

Work performed and materials furnished as provided for in this section, shall not be paid for as a separate pay item but the cost of fertilizer will be included in such contract pay items as *Seeding* or *Sodding* which price shall be full compensation for the furnishing of all materials and performing all operations necessary to complete the work.

SECTION 1.10: STORM WATER POLLUTION PREVENTION

PART 1: GENERAL

A. DESCRIPTION

Furnish labor, materials, equipment, and incidentals necessary to provide storm water pollution prevention for the duration of the construction period including furnishing, installing, and maintaining erosion and sediment control structures and procedures and properly removing the features when no longer required.

Develop, implement, and maintain a storm water pollution prevention plan in compliance with Local, State, and Federal requirements. Provide preventive measures to keep sediment and other pollutants from the construction activity from entering any storm water system, including open channels. Comply with the Texas Commission on Environmental Quality General Permit (TXR150000) for storm water discharges from construction activities under the Texas Pollutant Discharge Elimination System (TPDES) program, and City of Waco Regulations.

This specification provides guidelines and Best Management Practices (BMPs) information for the Contractor to use in adhering to all Local, State, and Federal environmental regulations with respect to storm water pollution prevention during construction activity, as noted in *Section GP-3.6.D, Storm Water Pollution Prevention Plan (Erosion Control Plan).*.

The SWPPP must be approved and implemented by the City of Waco Stormwater Manager prior to the Contractor commencing work activities.

B. QUALITY ASSURANCE

1. Comply with applicable requirements of all governing authorities having jurisdiction. The Specifications and the Plans are not intended to be prescriptive but rather to convey the intent to provide complete slope protection, erosion control, and storm water pollution prevention for both the Owner's property and adjacent properties.

2. The Contractor shall develop and implement a storm water pollution prevention plan in accordance with TCEQ General Permit TXR150000 prior to the beginning of construction activity.

3. Storm water pollution prevention measures shall be established prior to the beginning of construction and maintained during the entire length of construction until final stabilization has been achieved for the area protected.

4. All land-disturbing activities shall be planned and conducted to minimize the area to be exposed at any one time as well as time of exposure, off-site erosion, sedimentation, and adverse water quality impacts.

5. Surface water runoff originating upgrade of an exposed area shall be managed to minimize erosion and sediment loss during the period of exposure.

6. Install measures to control both the velocity and rate of release so as to minimize erosion and sedimentation of the receiving water body (i.e., ditch, channel, stream) in accordance with regulatory requirements and as directed by the Owner, the Engineer, or the Owner's Representative.

7. Periodically clean out and dispose of all sediment and other pollutants as necessary to maintain adequate treatment capacity of each pollution control feature. Clean out and properly dispose of all sediment and other storm water pollutants at the time of completion of the Work.

C. SUBMITTALS

1. Submittals shall be in accordance with *Section 3.2, Submittals*, of *General Provisions.*

2. For small and large projects, maintain copies of a schedule of major construction activities, inspection reports, and revision documentation with the storm water pollution prevention plan (SWPPP) required under the TPDES General Permit (TXR150000) for Storm Water Discharges from Construction Activities.

3. Construction Activity (< 1 Acre)

- For projects less than 1 acre, the City Waco ordinance requires the Contractor to submit an Erosion and Sediment Control Plan, for approval to the City Environmental Department

4. Small Construction Activity (≥1 Acre but <5 Acres)

- On small construction projects (disturbed area equal to or greater than one acre and less than five acres) submit a copy of the Construction Site Notice to the Operator of any Municipal Separate Storm Sewer System (MS4) receiving construction site discharge prior to beginning construction activity.
- Post a copy of the Construction Site Notice at the construction site in a location where it is readily available for viewing by the general public and Local, State, and Federal authorities prior to starting construction activities and maintain the posting until completion of the construction activities.

5. Large Construction Activity (≥5 Acres)

- On large construction projects (more than five acres of disturbed area) submit the following to the TCEQ and the Operator of any Municipal Separate Storm Sewer System (MS4) receiving construction site discharge:
    - Notice of Intent (NOI) at least 48 hours prior to beginning construction activity. Construction activity may commence 24 hours after the submittal of an electronic NOI.

  - Notice of Change (NOC) letter when relevant facts or incorrect information was submitted in the NOI, or if relevant information in the NOI changes during the course of construction activity.
  - Notice of Termination (NOT) when the construction project has been completed and stabilized.
- Post a copy of the NOI at the construction site in a location where it is readily available for viewing by the general public and Local, State, and Federal authorities prior to starting construction activities and maintain the posting until completion of the construction activities.

D. JOB CONDITIONS, CODES, AND ORDINANCES

Comply with the local codes and ordinances. If local codes and ordinances require more stringent or additional storm water pollution prevention measures during construction beyond those required by State and Federal regulations, the Contractor shall provide such measures at no additional cost.

PART 2: PRODUCT

A. MATERIALS

1. All materials used for storm water pollution prevention shall meet the minimum design and specification requirements identified below for commonly used sediment loss prevention practices (referenced from the North Central Texas Council Of Governments (NCTCOG) integrated Storm Water Management (iSWM) Design Manual for Construction). The Contractor shall use appropriate control devices to protect against storm water pollution from construction site activity.

2. Erosion Control Blankets to hold seed and soil in place until vegetation is established on disturbed areas are subject to the following design criteria:

a. The type and class of erosion control mat must be specified as appropriate for the slope of the area to be protected and the anticipated length of service.

b. Erosion control blankets must meet the applicable Texas Department of Transportation (TxDOT) *Minimum Performance Standards for TxDOT* as provided in its *Erosion Control Report* and/or be listed on the most current annual *Approved Products List for TxDOT* applicable to TxDOT Item 169 Soil Retention Blanket and its Special Provisions.

3. Silt Fences for perimeter controls located downstream of disturbed areas are subject to the following design criteria:

a. If 50% or less soil by weight passes the U.S. Standard sieve No. 200, select the apparent opening size (A.O.S.) to retain 85% of the soil

b. If 85% or more of soil by weight passes the U.S. Standard sieve No. 200, silt fences shall not be used unless the soil mass is evaluated and deemed suitable by a soil scientist or geotechnical engineer concerning the erodibility of the soil mass,

dispersive characteristics, and the potential grain-size characteristics of the material that is likely to be eroded.

c. Silt fence fabric must meet the following minimum criteria:

(1) Tensile Strength, ASTM D4632 Test Method for Grab Breaking Load and Elongation of Geotextiles, 90-lbs.

(2) Puncture Rating, ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products, 60-lbs.

(3) Mullen Burst Rating, ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, 280-psi.

(4) Apparent Opening Size, ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile, U.S. Sieve No. 70 (max) to No. 100 (min).

(5) Ultraviolet Resistance, ASTM D4355. Minimum 70 percent.

d. Filter stone for an overflow structure shall be 1-1/2” washed stone containing no fine material. Angular shaped stone is preferable to rounded shaped stone.

e. Fence posts shall be galvanized steel or equivalent and may be T-section or L-section, 1.3 pounds per linear foot minimum, and 4 feet in length minimum. Wood Posts may be used depending on anticipated length of service and provided they are 4 feet in length minimum and have a nominal cross section of 2 inches by 4 inches for pine or 2 inches by 2 inches for hardwoods.

f. Silt fence shall be supported by galvanized steel wire fence fabric as follows:

(1) 4” x 4” mesh size, W1.4/1.4, minimum 14-gauge wire fence fabric;

(2) Hog wire, 12-gauge wire, small openings installed at bottom of silt fence;

(3) Standard 2” x 2” chain link fence fabric; or

(4) Other welded or woven steel fabrics consisting of equal or smaller spacing as that listed herein and appropriate gauge wire to provide support.

4. Inlet protection used in new developments that include new inlets or roads with new curb inlets or during repairs to existing roadways are subject to the following design criteria:

a. Filter fabric protection shall be designed and maintained in a manner similar to a silt fence.

b. Where applicable, filter fabric, posts, and wire backing shall meet the material requirements specified in the silt fence design requirements.

c. Filter gravel shall be ¾ inch (Block and Gravel Protection) or 1-1/2 to 2 inch (Excavated Impoundment Protection) washed stone containing no fines. Angular shaped stone is preferable to rounded shapes.

d. Concrete blocks shall be standard 8” x 8” x 16” concrete masonry units.

5. Stone Outlet Sediment Traps used in situations where flows are concentrated in a drainage swale or channel are subject to the following design criteria:

a. The embankment shall be placed on geotextile fabric meeting the following minimum criteria:

(1) Tensile Strength, ASTM D4632 Text Method for Grab Breaking Load and Elongation of Geotextiles, 250-lbs.

(2) Puncture Rating, ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products, 135-lbs.

(3) Mullen Burst Rating, ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, 420-psi.

(4) Apparent Opening Size, ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile, U.S. Sieve No. 20 (max).

6. Sediment Basins used as treatment devices for sites with disturbed areas of 10 acres and larger that are part of a common drainage area are subject to the following design criteria:

a. The sediment basin shall have minimum design dewatering time of 36 hours.

7. Check Dams used for long drainage swales or ditches to reduce erosive velocities are subject to the following design criteria:

a. Use geotextile filter fabric under check dams exceeding 18 inches in height. The fabric shall meet the material specified for the Stone Outlet Sediment Trap discussed above.

b. Rock Check Dams

(1) Stone shall be well graded with size range from 1-1/2 to 3-1/2 inches in diameter depending on expected flows.

(2) Rock Check Dams should be triangular in cross section with side slopes of 1:1 or flatter on the upstream side and 2:1 or flatter on the downstream side.

c. Sand Bag Check Dams

(1) Sand Bag Check Dams should have a maximum flow through rate of 0.1 cfs per square foot of surface with a minimum top width of 16 inches and bottom width of 48 inches. Bags should be filled with coarse sand, pea gravel, or filter stone that is clean and free of deleterious material.

(2) Bag length shall be 24-inches to 30-inches, width shall be 16-inches to 18-inches and thickness shall be 6-inches to 8-inches and having an approximate weight of 40-pounds.

(3) Bag material shall be polypropylene, polyethylene, polyamide, or cotton burlap woven fabric, minimum unit weight 4-ounces-per-square-yard, Mullen burst strength exceeding 300-psi as determined by ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, and ultraviolet stability exceeding 70 percent.

(4) PVC pipes may be installed through the Sand Bag Dam near the top to allow for controlled flow through the dam. Pipe should be schedule 40 or heavier polyvinyl chloride (PVC) having a nominal internal minimal diameter of 4 inches.

8. Stabilized Construction Entrances used for sites in which significant truck traffic occurs on a daily basis are subject to the following design criteria:

a. The geotextile fabric must meet the following minimum criteria:

(1) Tensile Strength, ASTM D4632 Test Method for Grab Breaking Load and Elongation of Geotextiles, 300-lbs.

(2) Puncture Strength, ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products, 120-lbs.

(3) Mullen Burst Rating, ASTM D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method, 600-psi.

(4) Apparent Opening Size, ASTM D4751 Test Method for Determining Apparent Opening Size of a Geotextile, U.S. Sieve No. 40 (max).

9. Stone stabilized entrance pads must meet the more stringent of the requirements listed above or *Part 2.1 Section 2.3, Base Courses – Gravel Base Course.* The stone shall be a minimum of 3 to 5-inch coarse aggregate.

10. Filter aggregate must meet the more stringent of the requirements listed above or *Part 2.1 Section 2.3, Base Courses – Gravel Base Course*.

11. Geotextile materials must meet the more stringent of the requirements listed above or *Section 6.12, Geotextiles for Use with Underground Pipes*.

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. PREPARATION

1. Prepare a storm water pollution prevention plan (SWPPP) in accordance with applicable permit requirements for construction activity. Develop the SWPPP in conformance with TPDES General Permit (TXR150000) for Storm Water Discharges from Construction Activities and any applicable Local requirements.

2. Prepare and implement the SWPPP prior to the beginning of construction activity in accordance with Local, State, and Federal requirements.

3. Owner's Representative may require Contractor to install storm water pollution prevention devices and/or practices during construction in addition to those required under the approved storm water pollution plan. Contractor shall remain solely responsible for complying with all Local, State, and Federal requirements.

B. INSTALLATION

1. Erosion Control Blankets to hold seed and soil in place until vegetation is established on disturbed areas are subject to the following installation criteria:

a. Prior to the installation of any erosion control matting, all rocks, dirt clods, stumps, roots, trash, and any other obstructions that would prevent the mat from lying in direct contact with the soil shall be removed. Anchor trenching shall be located along the entire perimeter of the installation area, except for small areas with less than 2 percent slope.

b. Installation and anchoring shall conform to the recommendations shown within the manufacturer's published literature for the approved erosion control blanket. Joints and overlapping material shall be securely fastened.

c. After installation, check blankets for uniform contact with the soil, security of the lap joints, and flushness of the staples with the ground.

2. Silt Fences for perimeter controls located downstream of disturbed areas are subject to the following installation criteria:

a. Construct fences along a line of constant elevation (along a contour line if possible).

b. Maximum drainage area shall be 0.25 acre per 100 linear feet of silt fence.

c. Maximum flow to any 20-foot section of silt fence shall be 1 cfs.

d. Maximum distance of flow to silt fence shall be 200 feet or less. If the slope exceeds 10 percent, the flow distance shall be less than 50 feet.

e. Maximum slope adjacent to the fence shall be 2:1.

Stone overflow structures or other outlet control devices shall be installed at all low points along the fence or spaced at approximately 300 feet if there is no apparent low point.

f. A 6-inch wide trench is to be cut 6 inches deep at the toe of the fence to allow the fabric to be laid below the surface and backfilled with compacted earth or gravel to prevent bypass of runoff under the fence. Fabric shall overlap at abutting ends a minimum of 3 feet and shall be joined such that no leakage or bypass occurs.

g. Sufficient room for the operation of sediment removal equipment shall be provided between the silt fence and other obstructions in order to properly maintain the fence.

h. The ends of the fence shall be turned upstream to prevent bypass of storm water.

3. Inlet protection for new developments that include new inlets or roads with new curb inlets or during repairs to existing roadways are subject to the following installation criteria:

a. Maintain barricades, signs, and safety features around the work in accordance with all provisions of the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD) when installing inlet protection on publicly traveled streets or

in developed areas. Ensure that inlet protection is properly designed, installed, and maintained to avoid flooding of the roadway or adjacent properties and structures.

b. Maximum depth of flow shall be 8 inches or less.

c. Positive drainage is critical in the design of inlet protection. If overflow is not provided for at the inlet, excess flows shall be routed through established swales, streets, or other watercourses to minimize damage due to flooding.

d. Filter Barrier Protection – Silt Fence shall consist of nylon geotextile supported by wire mesh, W1.4 X W1.4, and galvanized steel posts set a minimum of 1 foot depth and spaced not more than 6 feet on center. A 6-inch wide trench is to be cut 6 inches deep at the toe of the fence to allow the fabric to be laid below the surface and backfilled with compacted earth or gravel. This entrenchment prevents any bypass of runoff under the fence. If the inlet is installed within a paved area, provide sufficient material overlap at the base to allow for anchorage of the fabric to the concrete inlet slab by sand bags or other means in order to prevent bypass or runoff under the fence.

e. Block and Gravel Protection (Curb and Drop Inlets) – Concrete blocks are to be placed on their sides in a single row around the perimeter of the inlet, with ends abutting. Openings in the blocks should face outward, not upward. ½" x ½" wire mesh shall then be placed over the outside face of the blocks covering the holes. Filter stone shall then be piled against the wire mesh to the top of the blocks with the base of the stone being a minimum of 18 inches from the blocks. Alternatively, where loose stone is a concern (streets, etc.), the filter stone may be placed in appropriately sized geotextile fabric bags. Periodically remove and clean the stone or replace it with new stone when the stone filter becomes clogged.

f. Excavated Impoundment Protection – An excavated impoundment shall be sized to provide a storage volume of between 1800 and 3600 cubic feet per acre of disturbed area. The trap shall have a minimum depth of one foot and a maximum depth of 2 feet as measured from the top of the inlet and shall have side slopes of 2:1 or flatter. Install weep holes in the inlet walls to allow for the complete dewatering of the trap. When the storage capacity of the impoundment has been reduced by one-half, remove the silt and dispose of it at an approved location.

g. Inlet inserts are commercially available to remove sediment, constituents (pollutants) adsorbed to sediment, and oil and grease. Perform maintenance to remove sediment and debris that could clog the filters. Inlet inserts must have a bypass function to prevent flooding from clogging or high flows.

4. Stone Outlet Sediment Traps for situations where flows are concentrated in a drainage swale or channel are subject to the following installation criteria:

a. The maximum drainage area contributing to the trap shall be 10 acres. For larger drainage areas a sediment basin shall be used.

b. The minimum storage volume shall be 1800 cubic feet per acre of disturbed land draining to the device.

c. The surface area of the design storage shall be 1% of the area draining to the device.

d. The maximum embankment height shall be 6 feet as measured from the toe of the slope on the downstream side.

e. Minimum width of the embankment at the top shall be 2 feet.

f. Embankment slope shall be 1.5:1 or flatter.

g. The embankment shall have a depressed area to serve as the outlet with a minimum width of 4 feet.

h. A six-inch minimum thickness layer of ¾ to 2 inch (1-½ inch nominal) well graded filter stone shall be placed on the face of the embankment.

i. The embankment shall be comprised of well-graded stone with a size range of 6 to 12 inches in diameter. The stone may be enclosed in wire mesh or a gabion basket and anchored to the channel bottom to prevent washing away.

j. The outlet shall be designed to have a minimum freeboard of 6” at design flow.

k. Geotextile fabric, covered with a layer of stone, shall extend past the base of the embankment on the downstream side a minimum of 2 feet.

5. Sediment Basins for treatment devices for sites with disturbed areas of 10 acres and larger that are part of a common drainage area are subject to the following installation criteria:

a. Minimum capacity of the basin shall be the calculated volume of runoff from a 2-year, 24-hour duration storm event.

b. Deposited sediment shall be removed when the storage capacity of the basin has been reduced by 20%.

c. Minimum width of the embankment at the top shall be 8 feet.

d. Embankment slope shall be 3:1 or flatter.

e. Maximum embankment height shall be 6 feet as measured from the toe of slope on the downstream side. Sediment basins with embankments exceeding 6 feet are regulated by the Texas Commission on Environmental Quality (TCEQ) and must meet specific requirements for dam safety.

f. The basin outlet shall be designed to accommodate a 25-year design storm without causing damage to the containment structure.

g. The basin must be laid out such that the effective flow length of the basin should be at least twice the effective flow width.

h. The outlet of the outfall pipe (barrel) shall be stabilized with riprap or other form of stabilization with design flows and velocities based on 25-year design storm peak flows. For velocities in excess of 5 feet per second, velocity dissipation measures should be used to reduce outfall velocities.

i. The effectiveness of sediment basins may be increased by using baffles to prevent short-circuiting of flow through the basin.

6. Check Dams for long drainage swales or ditches to reduce erosive velocities are subject to the following installation criteria:

a. Check Dams shall be placed at a distance and height to allow small pools to form between each one. Typically, dam height should be between 18” and 36”.

Dams shall be spaced such that the top of the downstream dam is at the same elevation as the toe of the upstream dam.

b. Major flows (greater than 2-year design storm) must pass the check dam without causing excessive upstream flooding.

c. Check dams should be used in conjunction with other sediment reduction techniques prior to releasing flow offsite.

7. Stabilized Construction Entrances for sites in which significant truck traffic occurs on a daily basis are subject to the following installation criteria:

a. Stabilized Construction Entrances are to be constructed such that drainage across the entrance is directed to a controlled, stabilized outlet on site with provisions for storage, proper filtration, and removal of wash water.

b. The entrance must be sloped away from the paved surface so that storm water is not allowed to leave the site onto roadways.

c. Minimum width of entrance shall be 15 feet.

d. Stone shall be placed in a layer of at least 12-inch thickness. The stone shall be a minimum of 3 to 5-inch coarse aggregate.

e. Prevent shortcutting of the full length of the construction entrance by installing barriers as necessary

f. Vehicles shall not be permitted to track or drop sediment onto paved roads, streets, or parking lots. When necessary, vehicles must be cleaned to remove sediment prior to entrance onto paved areas. When washing is required, it shall be done on a constructed wheel wash facility that drains into an approved sediment trap or sediment basin or other sedimentation/filtration device.

g. Minimum dimensions for the entrance shall be as follows:

Tract Area	**Average Tract Depth**	**Minimum Width of Entrance**	**Minimum Depth of Entrance**
<1 Acre	100 feet	15 feet	20 feet
<5 Acres	200 feet	20 feet	50 feet
<5 Acres	>200 feet	25 feet	75-100 feet

8. Install pollution control devices in a manner consistent with their designed intent.

C. MAINTENANCE

1. Maintain pollution prevention control structures and procedures in full working order at all times during construction. This shall include any necessary repair or replacement of items, which have become damaged or ineffective. Remove sediment and other pollutants, which accumulate in pollution control devices as necessary to maintain the intended design efficiency for the pollution prevention measure.

2. Dispose properly of trash, debris, and other pollutants.

3. Place sediment material in approved earth spoil areas or return the sediment material to the area from which it eroded.

4. Maintain pollution prevention structures and procedures until construction is complete for the area protected and until the site achieves final stabilization. Unless more stringently defined by Local, State, or Federal requirements, final stabilization is defined as achieving 70 percent of background vegetative cover or placement of permanent cover, such as concrete or asphalt.

5. Upon completion of construction and achievement of final stabilization, properly remove the temporary pollutant control structures and complete the area as indicated. Pollution control devices made of organic materials designed to degrade naturally in place will not require removal, unless specifically required by the Owner, Engineer, or Owner's Representative.

6. Erosion Control Blankets shall be inspected regularly (at least as often as required by the TPDES Construction General Permit) for bare spots caused by weather related events. Missing or loosened blankets must be replaced or re-anchored. Also check for excess sediment deposited from runoff. Remove sediment and/or replace blanket as necessary. In addition, determine the source of excess sediment and implement appropriate Best Management Practices (BMPs) to control the erosion.

7. Silt Fences shall be inspected regularly (at least as often as required by the TPDES Construction General Permit) for buildup of excess sediment, undercutting, sags, and other failures. Sediment should be removed when it reaches approximately one-half the height of the fence. In addition, determine the source of excess sediment and implement appropriate Best Management Practices (BMPs) to control the erosion. If the fabric becomes damaged or clogged, it shall be repaired or replaced as necessary.

8. Inlet Protection shall be inspected regularly (at least as often as required by the TPDES Construction General Permit). When silt fences are also used and the fabric becomes clogged, it should be cleaned or, if necessary, replaced. Also, sediment should be removed when it reaches approximately one-half the height of the inlet protection device. If a sump is used, sediment should be removed when the volume of the basin is reduced by 50%.

For systems using filter stone, when the filter stone becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Dispose of clogged filter stone in an approved location.

9. Stone Outlet Sediment Traps shall be inspected regularly (at least as often as required by the TPDES Construction General Permit) to check for clogging of the void spaces between stones. If the aggregate appears to be silted in such that efficiency is diminished, the stone shall be replaced.

Deposited sediment shall be removed when the depth of sediment is equal to one-third of the height of the embankment as measured from the original toe of slope to the crest of the outlet, or has reached a depth of one foot, whichever is less. The removed sediment shall be stockpiled or redistributed in areas that are protected from erosion.

10. Sediment Basins shall be inspected regularly (at least as often as required by the TPDES Construction General Permit) to check for damage and to insure that obstructions are not diminishing the effectiveness of the structure. Sediment shall be removed and the basin shall be regraded to its original dimensions when the capacity of the impoundment has been reduced to 20% of its original storage capacity. The removed sediment shall be stockpiled or redistributed in areas that are protected by erosion and sediment controls.

11. Check Dams shall be inspected regularly (at least as often as required by the TPDES Construction General Permit). Remove silt when it reaches approximately 1/3 the height of the dam or 12 inches in height, whichever is less.

12. Stabilized Construction Entrances shall be inspected regularly (at least as often as required by the TPDES Construction General Permit). When sediment has substantially clogged the void area between the rocks, the aggregate mat shall be washed down or replaced. Periodic re-grading and top dressing with additional stone shall be done to keep the efficiency of the entrance from diminishing. If the stabilized construction entrance is not effectively removing sediment from wheels, then a wheel wash shall be implemented.

D. Field Quality Control

In the event of conflict between the specified requirements and storm water pollution control laws, rules, or regulations, or other Local, State, or Federal agencies, the more restrictive laws, rules, or regulations shall apply.

E. Schedules

Prior to start of construction, submit schedules to the Owner and Engineer for accomplishment of temporary and permanent erosion control work in connection with required clearing and grubbing, grading, construction, and paving. Include a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials in the submittal.

PART 4: MEASUREMENT AND PAYMENT

A. Measurement and Payment

Not applicable.

SECTION 1.11: SPRINKLING FOR DUST CONTROL

Part 1: General

A. DESCRIPTION

Sprinkling for dust control shall consist of the authorized application of water on those portions of the projects as shown on the plans or as directed and as herein specified.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Water shall be furnished by the Contractor and shall be clean, free from industrial waste and other objectionable matter.

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

The Contractor shall furnish and operate a sprinkler equipped with positive and rapidly working cutoff valves and approved spray bars, which shall insure the distribution of water in a uniform and controllable rate of application. It shall be the Contractor's continuous responsibility at all times including nights, holidays, weekends, etc., until acceptance of the project by the Owner, to maintain the project free of dust in a manner which shall cause the least inconvenience to the public.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

All work performed as prescribed by this item is considered to be subsidiary to the completion of the project.

The Contractor shall furnish and operate a sprinkler equipped with positive and rapidly working cutoff valves and approved spray bars, which shall insure the distribution of water in a uniform and controllable rate of application. It shall be the Contractor's continuous responsibility at all times including nights, holidays, weekends, etc., until acceptance of the project by the Owner, to maintain the project free of dust in a manner which shall cause the least inconvenience to the public.

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SECTION 1.12: FENCING

Part 1: General

A. DESCRIPTION

This item shall consist of furnishing and installing of a chain link security fence complete in place.

B. WARRANTY

The Contractor shall guarantee the fence against faulty or inadequate design, improper assembly or erection, and defective workmanship, materials, or other failures. The Contractor shall also furnish a written warranty agreeing to furnish and install, at his own expense, any part of the fence proving to be defective within 12-months from the date of final acceptance by the City of Waco.

C. SUBSTITUTION

The installation of any approved substitution is the Contractor's responsibility. Any changes required for the installation of any approved substitution must be made to the satisfaction of the City of Waco Water Utility representative and without additional cost to the owner.

D. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

1. General

a. 6-Foot Tall Fence - New fencing and gate shall consist of galvanized steel chain link fence with a fabric height of 6 foot and an overall height of 7 feet from the bottom of the fabric to the top of the barbed wire. The fence shall have a top and an intermediate brace rail, and three strands of barbed wire mounted on a 45-degree single extension arm. The upper strand shall be approximately 12 inches out from the fence and 12 inches above the top of the fabric. The main gate shall be 16 feet wide with two 8 feet wide swing-in frames. The personnel gate shall be 3 feet wide. Posts shall be set in concrete. In order to improve aesthetic appearance of the fence, the chain link mesh may be coated with vinyl or wooden privacy fencing may be attached to the outside of the chain link mesh.

b. 7-Foot Tall Fence - New fencing and gate shall consist of galvanized steel chain link fence with a fabric height of 7 foot and an overall height of 8 feet from the bottom of the fabric to the top of the barbed wire. The fence shall have a top and an intermediate brace rail, and three strands of barbed wire mounted on a 45-degree single extension arm. The upper strand shall be approximately 12 inches out from the fence and 12 inches above the top of the fabric. The main gate shall be 16 feet wide with two 8 feet wide swing-in frames. The personnel gate shall be 3 feet wide. Posts shall be set in concrete. In order to improve aesthetic appearance of the fence, the chain link

mesh may be coated with vinyl or wooden privacy fencing may be attached to the outside of the chain link mesh.

2. Fence Materials

All materials and hardware for the fence shall be galvanized according to Chain Link Fence Manufacturers Institute.

Fabric:	11 gauge core, 2 inch mesh, 24 ½ diamond count; galvanized, barbed selvage top and bottom, except knuckled selvage on bottom where shown on Plans.
Posts:	Extra strong steel pipe, all posts attached to concrete structures shall be SCH-40 galvanized steel pipe.
Line Posts:	2-3/8 in. OD pipe, 3.12 lb. per ft.
Terminal Posts:	2-5/8" OD pipe, 5.79 lb. per ft. (End, Corner & Pull)
Gate Post:	2-5/8 in. OD pipe, 4.875 lb./ft.
Gate Frames	Steel pipe, 2-3/8 in.
Gate Drop Rod & Appurtenances:	1-5/8 in. OD pipe
Top & Intermediate Brace Rail:	1-5/8" OD pipe, 1.82 lb. per ft.
Rail Couplings:	Sleeve type, 6 inches long.
Post Tops:	Malleable iron with pressed steel extension arms, with hole for top rail, designed to prevent entry of moisture into tubular posts.
Barbed Wire:	Galvanized, ASTM A 121, Class 2 two 12-1/2 gauge steel wires with 4-point barbs.
Stretcher Bars:	Steel 3/16 inch by 3/4 inch, or equivalent area.
Fabric Ties:	Galvanized wires.
Tension Wire:	Galvanized coated coil spring wire, 7 gauge

Setting Cement: Domestic Portland Cement with regular aggregate mixed to form concrete at 3000 PSI at 28 days

3. Personal Gate Materials - The 3-foot single swing gate shall be constructed of the same materials as the fence. The 3-foot gate shall have intermediate members as required for rigid construction and shall be free from sag or twist.

a. Gate Posts - The gateposts shall be 2-3/8 inches OD. When installed, the gates shall be of the same height as the fence and hinged to swing 180 degrees from open to close.

b. Hardware - The gates shall come complete with frames, hinges, braced, and pad lockable. The hinges shall not twist or turn under the action of the gate. The gate shall be installed so that it may not be removed without disassembling the hardware. The hardware attachment bolts shall be peened so that removal will be difficult.

4. Mowing Strip - Mowing strip shall be formed from Domestic Portland cement with regular aggregate. It shall be eighteen (18) inches wide and a minimum of four (4) inches thick with two (2) inches above ground level. Two (2) rows of number three (3) bars of steel shall be evenly spaced along the full length of the mow strip, and a number three (3) bar of steel shall be cross-tied every four (4) feet. Expansion joints shall be installed every twenty (20) feet. Fence posts shall be installed in center of mow strip.

B. EQUIPMENT

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. General

a. Rules and Regulations – All work and materials shall be in full accordance with the latest rules and regulations of the City of Waco.

b. Existing Conditions – The Contractor shall acquaint himself with all site conditions prior to beginning any work. The Contractor is responsible for determining the presence of any buried utilities in addition to the ones shown on the drawings. Should any utilities or work not shown on the plans be found during excavations, the Contractor shall notify the City of Waco designated representative as to the required course of action. The Contractor shall take necessary precautions to protect the site conditions. Should damage be incurred, the Contractor shall repair the damage to its original condition at his own expense.

c. Permits and Fees - The Contractor is required to obtain all permits and pay all required fees to any governmental agency having jurisdiction over this project. The Contractor shall also arrange for any inspections required by local agencies and ordinances during the course of the project.

d. Final Acceptance - Upon final acceptance, the Owner will assume responsibility for maintenance of the work. Final acceptance does not relieve the Contractor of the warranty obligations.

2. Contractors Responsibilities - The Contractor shall make a thorough examination of the site to familiarize himself with the nature and extent of the work to be encountered. The Contractor shall field verify all measurements. No extra compensation will be allowed for any work made necessary by unusual conditions or obstacles encountered during the progress of the work, which are readily apparent upon visiting the site. The Contractor shall be responsible for procuring all available plans and information concerning underground utilities, which might be encountered. Damage to these facilities due to the Contractor's negligence shall be repaired by qualified workmen at the Contractor's expense.

3. Excavation - The Contractor shall restore all excavated surfaces, and any utilities or structures damaged as a result of the excavation, to their original conditions. The Contractor shall thoroughly excavate and clean the inside of the inserts embedded for the fence posts, removing all dirt, trash, excess concrete, and any other material which might prevent secure bonding of the non-shrink grout to the walls of the inserts.

4. Fence Installation

a. The installed fence shall conform to the alignment and grade. All posts shall be plumb and spaced at a maximum 10-feet apart. The fence shall be installed to maintain not more than 2-inches of clearance below the bottom of the fence fabric.

b. Unless provided for otherwise, line posts shall be embedded at least 30" into concrete foundation; gate and terminal posts at least 36".

c. If bedrock is encountered, post excavation shall be continued to the 36-inch depth or 26 inch into the rock, whichever is less. Concrete foundations shall be circular in horizontal section, not less than 12 inches in diameter for line posts, and with a diameter not less than the post OD plus 12 inches for terminal and gate posts, except that foundations in bedrock shall be a minimum of 6 inches larger than the outside dimension of the post. Foundations shall extend 2" above the ground surface and shall be crowned approximately two inches. Concrete for foundations shall be cured for at least 72 hours before further work is done on the post.

d. Top and intermediate rails, and bottom tension wires shall be installed before the fabric. Top and intermediate rails shall be securely connected to gate and terminal posts. Tension wires shall be attached to each post and securely anchored at terminal and gateposts. A terminal post shall be provided at each change in slope.

e. Fabric shall be attached to the top and bottom rails at 24-inch centers and to the line posts at 15-inch centers. Barbed wire shall be fastened to each extension arm by internal clips or external fabric ties.

f. Stretcher bars shall be provided at each gate, terminal, and pull post. Each stretcher bar shall be threaded through the fabric and anchored to the post at 15-inch centers by positive mechanical means.

g. Each gate, terminal, and pull post shall be braced by a horizontal pipe brace and an adjustable truss(es) extending to an adjacent line post.

h. Center posts shall be braced in both directions.

i. Fabric shall be stretched taut and anchored so that a pull of 150 pounds at the middle of the panel will not lift the bottom of the fabric more than 6 inches.

5. Cleaning - The Contractor shall remove all excavated material and trash from the site after each working day. Any trash or material left on site at the end of each day, or at the end of the project, will be disposed of by City of Waco Personnel at the Contractor's expense.

6. Inspection - All identified deficiencies shall be corrected by the Contractor prior to the acceptance of the project by the City of Waco.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

All work performed and measured as prescribed by this item will be paid for as a unit rate (length), in accordance with the contract.

Chain-link and guard-link fences shall be measured in place from center to center of end posts or corner post and shall be the length of fence actually constructed, except the space occupied by the gates. Gates shall be measured in units for each gate installed and accepted.

Payment shall be made at the contract price per linear foot for chain or guard-link fences. This price shall be full compensation for furnishing all material; for all preparation, erection and installation of these materials; and for all labor, equipment, tools and incidentals necessary to complete the work.

Payment shall be made at the contract unit price per each for gates. This price shall be full compensation for furnishing all materials; for all preparation, erection and installation of these materials; for all labor, equipment, tools and incidentals necessary to complete the work.

Gates measured as provided in this item shall be paid for at the unit price bid for "gate" of the type, height and opening shown on the plans, which price shall be full compensation for furnishing all materials; fabricating; for all preparation, hauling, and erection; and for all labor, tools, equipment and incidentals necessary for a complete in-place gate installation.

SECTION 2
SUBGRADE AND BASE COURSES

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SECTION 2.1: ROLLING

PART 1: GENERAL

A. DESCRIPTION

Rolling shall consist of the compaction of embankment, subgrade or flexible base by the operation of approved power rollers, as herein specified and as directed by the Owner.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Not Applicable

B. EQUIPMENT

1. Steel Wheel roller - Steel wheel rollers shall be of the three wheel, self-propelled type, weighing not less than 10 tons and shall provide a pressure on the rear wheels of not less than 325 pounds per linear inch of wheel width. All wheels shall be flat. Rear wheels shall have a diameter of not less than 48 inches; and each shall have a tire width of not less than 20 inches.

2. Tamping Rollers - Tamping rollers shall consist of two metal rollers, drums or shells of not less than 40 inches in diameter; each not less than 42 inches in length and unit mounted in a rigid frame in such a manner that each roller may oscillate independently of each other. Each roller, drum or shell shall be surmounted by metal studs with tamping feet projecting not less than seven inches from the surface and spaced not less than six inches nor more than 10 inches measured diagonally center to center. The cross-sectional area of each tamping foot shall be not less than five square inches nor more than eight square inches.

The roller shall be equipped with cleaning teeth to provide self-cleaning. The roller shall be the type that by ballast loading, the load of each tamping flow may be varied uniformly from not less than 125 psi to 175 psi of cross-sectional area. The Contractor may use heavier rollers with compression valves up to 500 psi when approved by the Owner. The load per tamping foot shall be determined by dividing the total weight of the roller by the number of tamping feet in a row parallel to or approximately parallel to the axis of the roller. The compression to be provided at any time shall be as directed by the Owner. The tamping roller shall be drawn by approved power equipment of adequate tractive effort. Power equipment used for embankment construction shall be the crawler-type tractor. Two tamping rollers consisting of four cylinders, conforming to the previously prescribed requirements, drawn by approved power equipment, shall be considered as a roller unit.

3. Pneumatic Tire Roller - Tire rollers shall consist of not less than nine pneumatic-tired wheels, running on axles in such a manner that the rear group of tires shall not follow in the tracks of the forward group of tires, and mounted in a rigid frame. They shall be of the type suitable for ballast loading. The front axle shall be attached to the frame in such a manner that the roller may be turned in a practical circle. The pneumatic tire roller shall have an effective rolling width of approximately 60 inches. It shall be so designed that, by ballast loading, the load may be varied uniformly from 9,000 pounds to 18,000 pounds. The Contractor may use a heavier roller when approved by the Owner. The pressure of the tires and the compression to be provided shall be as directed by the Owner. The roller under working conditions shall provide a uniform compression under all wheels. The total combined width of effective tire treads shall be not less than 85 percent of the effective roller widths.

4. Vibratory Rollers - Rollers with vibrating drums may be used for compaction of embankment or subgrades when approved by the Owner.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

The embankment, subgrade or base course shall be sprinkled as directed by the Owner.

Rolling shall start longitudinally at the sides and proceed toward the center, overlapping on successive trips at least one-half the width of the rear wheel on the power roller, one-half the width of the tamping roller unit and one-half the width of the pneumatic tire roller unit. Alternate trips of the roller unit shall be slightly different in length; and rolling shall continue until ordered to stop by the Owner. On superelevated curves, rolling shall begin at the low side and progress to the high side.

The speed of the power roller and the tamping roller unit, unless otherwise directed by the Owner, shall be between two and three miles per hour. The speed of the pneumatic tire unit, unless otherwise directed by the Owner, shall be between four and twelve miles per hour for asphalt surfacing work and between two and six miles per hour for all other compaction.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Unless otherwise specified, the work performed as prescribed by this item is considered subsidiary to the completion of the project. The contract may include pay unit rate or hourly payment items.

If the contract includes unit rate compensation, the work area will be measured and payment made in accordance with contract provisions.

If the contract includes hourly compensation provisions, the contractor will provide daily time sheets indicating actual hours of directed roller operation to the construction inspector for approval. Payment will be made based upon approved daily time sheets.

SECTION 2.2: SUBGRADE COURSES

2.2.A Subgrade Preparation

PART 1: GENERAL

A. DESCRIPTION

These specifications shall govern for the preparation of the subgrade except as otherwise provided or specified. Subgrade is defined as "that portion of the roadbed upon which the base or pavement is to be placed and including 24 inches minimum beyond the back of the curb.

B. SUBMITTALS

Not applicable.

PART 2: PRODUCT

A. MATERIALS

Not applicable.

B. EQUIPMENT

All equipment necessary for the construction of this item shall be on the project and shall be approved by the Owner as to condition before the Contractor shall be permitted to begin construction operations on which the equipment is to be used.

Compaction Equipment - Compaction equipment shall conform to the requirements of *Section 2.1, Rolling*, with the exception that the roller for final subgrade shall be of the three-wheel or tandem, self-propelled type, weighing not less than eight tons.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Contractor shall set blue tops to finish subgrade elevations as per plans and specs. After the excavation of embankment has been substantially completed, the subgrade shall be brought to the proper alignment, cross section and elevation, so that after rolling as specified in *Section 2.1, Rolling*, and subsequent finishing operations, it shall conform to the correct alignment, cross section and elevation. Rolling and sprinkling shall be performed when and to the extent directed; and the roadbed shall be completed to or above the plane of the typical section shown on the plans and the lines and grades established by the Owner.

After completion of the compaction and immediately ahead of the application of base or pavement, the subgrade shall be finished to the required section. All irregularities which develop in excess of one-half inch in a length of 16 feet measured longitudinally shall be corrected by loosening, adding or removing material; reshaping; and recompacting by sprinkling and rolling. The completed subgrade shall have a uniform density of not less than 95 percent of the maximum density determined by

ASTM Designation D 698. Moisture content shall be within minus 2 to plus 2 of optimum.

The subgrade shall be maintained in a smooth, compacted condition, in conformity with the required section and established grade, until the base or pavement is placed, and shall be kept wetted down sufficiently in advance of placing any base or pavement to insure its being in a firm and moist condition for at least two inches below surface of the prepared subgrade. Only such subgrade as is necessary for the satisfactory prosecution of the work shall be completed ahead of the placement of base or pavement. Hauling or operating of unnecessary equipment on the completed subgrade shall be kept to a minimum. Complete drainage of the subgrade shall be provided at all times.

Finishing of the subgrade by hand shall be permitted on pavement widening projects, on sections where the pavement width is not uniform, at intersections and elsewhere where the operation of the subgrade planer would not be practical. Subgrade finished by hand shall conform to the requirements above specified.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

The work performed as prescribed by this item is considered subsidiary to the completion of the project.

Preparation of the subgrade or fine grading shall not be paid for as a separate contract pay item; and cost thereof shall be included in such contract items as are provided, which pay items shall be the total compensation for the furnishing of all labor, tools, materials, equipment and incidentals necessary to complete the work, including disposal or surplus material, all in accordance with the plans and specifications.

2.2.B Portland Cement Modification of Subgrade Soils

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of the treating the subgrade soils by pulverizing, addition of portland cement and water, mixing and compacting the mixture to the required density. This item applies to natural ground or embankment encountered in the construction. The cement-modified soil layer shall be constructed as specified herein and in conformity with the typical sections, lines and grades as shown on the plans or as established by the Owner.

B. SUBMITTALS

Not applicable.

PART 2: PRODUCT

A. MATERIALS

1. Portland Cement - Cement shall conform to the requirements in Item A.2, Cement, of Section 5.1 Part 2.

2. Water - Water shall conform to the requirements in Item A.5, Water, of Section 5.1 Part 2.

3. Soil - The subgrade shall consist of the in-situ soil or approved soil, free of roots and other objectionable matter.

B. MATERIAL TESTING

Refer to *Section 2.5, Material Testing.*

C. EQUIPMENT

All equipment necessary to properly prosecute, perform and complete the work within the contract time shall be on the project and shall be approved by the Owner as to type and condition before the Contractor shall be permitted to begin construction operations on which the equipment is to be used.

The cement-modified soil layer may be constructed with any machine or combination of machines and auxiliary equipment that shall produce the results meeting the requirements for soil pulverization, cement application, water application, mixing, incorporation of materials, compaction, and finishing as specified herein. The Contractor shall at all times provide sufficient equipment to enable continuous performance of the work and its completion in the required number of working days.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. General - The primary requirement of this specification is to secure a complete course of treated subgrade material containing a uniform portland cement

mixture, free from loose or segregated areas, of uniform density and moisture content, well bound and compacted for its full depth with a smooth surface suitable for placing additional sub-base, base or surface courses. It shall be the responsibility of the Contractor to regulate the sequence of his work to process a sufficient quantity of material so as to provide full depth as shown on plans, to use the proper amount of portland cement, maintain the work and to rework the courses as necessary to meet the foregoing requirements.

Before other construction operations are begun, the roadbed shall be graded and shaped as required to construct the portland cement modified subgrade layer in conformance with the lines, grades, thickness and typical cross sections shown on the plans. The subgrade shall be firm and able to support, without displacement, the construction equipment and obtain the compaction herein specified. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

2. Application of Cement - Portland cement shall be spread uniformly by an approved dry or slurry method on the soil at the rate specified on the plans or as determined by preliminary laboratory tests. If a bulk cement spreader is used, it shall be positioned by string lines or other approved method during spreading to insure a uniform distribution of cement.

The percentage of moisture in the subgrade soil at the time of cement application shall not exceed the quantity that shall permit uniform and intimate mixture of soil and cement during dry-mixing operations; and it shall not exceed the specified optimum moisture content for the soil and cement mixture.

In the event of high soil-moisture contents, cement may be applied at one-half the specified rate when approved by the Owner/Engineer. The remainder of the application rate of cement shall be applied the following day(s), not to exceed 48 hours. The usual construction sequence will then be resumed.

No equipment, except that used in the spreading and mixing, shall be allowed to pass over the freshly spread cement until it is mixed with the soil.

3. Mixing and Processing - The mixing procedure shall be the same for dry placement or slurry placement as described in this specification. The subgrade and the cement shall be thoroughly mixed by approved mixers or other approved equipment, and the mixing shall continue until a homogeneous, friable mixture of the subgrade material and cement is obtained, free from all clods or lumps. The mixture shall be kept moist throughout the operation. The mixture shall meet the following gradation requirements when tested in the moist condition by laboratory sieves:

Minimum passing 1¾ inch	100%
Minimum passing No. 4 sieve	60%

Subgrade material in small-localized areas, which will not mix readily, shall be mixed thoroughly and completely as determined by the Owner/Engineer and brought to the correct moisture content for compaction.

4. Compaction - Compaction shall begin after mixing and after gradation and moisture requirements have been met. The material shall be compacted at least 95 percent of the maximum density as determined by ASTM D 698. Moisture content shall be within minus 2 to plus 2 of optimum. It shall be aerated or wetted as necessary to provide optimum moisture. Moisture tolerances shall be as described below.

Description	Density, Percent	Moisture, Percent
For cement treated subgrade that will receive subsequent courses.	Not less than 95, except when shown otherwise on the plans.	Within 2 of optimum unless otherwise shown on the plans.

Prior to the beginning of compaction, the mixture shall be in a loose condition for its full depth. Compaction shall begin at the bottom and shall continue until the entire depth of the mixture is uniformly compacted.

In-Place Density tests shall be performed at the rate of one per 300 linear feet of paving for two (2) lanes. The suitability of the modification shall be confirmed by Atterberg Limit testing at the rate of one test per 2,500 cubic yards of processed material.

In addition to the requirements specified for density, the full depth of the material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests as necessary will be made by the Engineer. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements. Throughout this entire operation the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and in conformity with the typical section shown on the plans and to the established lines and grades. Should the material due to any reason or cause, lose the stability, density and finish before the next course is placed or the work is accepted, it shall be recompacted and refinished at the sole expense of the Contractor.

5. Finishing and Preparation for Surfacing - After the final layer or course of the cement-modified subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The completed section shall then be finished by rolling as directed with a pneumatic tire or other suitable roller sufficiently light to prevent hair cracking. Preparation for final surfacing may begin immediately.

B. MAINTENANCE

The Contractor shall be required to maintain the completed cement-soil subgrade within the limits of his contract, in good condition, satisfactory to the Owner as to grade, crown and cross section until such time as the surface course is constructed. All irregularities or other defects that may occur shall be repaired by the Contractor at his expense. Any low area shall be remedied by scarifying the surface to a depth of at least two (2) inches, filling the area with treated material and compacting.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

All work performed and measured as prescribed by this item will be paid for as a unit rate (area), in accordance with the contract.

This work shall be measured by the square yard of completed and accepted cement-modified soil. Measurement for cement shall be by the ton, 2,000 pounds of dry weight, as determined by certified weight tickets. No allowance shall be made for any materials used or work done outside the limits as established by the Owner.

The work performed and material furnished as prescribed by this item and measured as provided in this item shall be paid for at the unit price bid for cement-modified soil, which price shall be full compensation for pulverizing the soil material; for handling; hauling and spreading the dry or slurry cement mixture; for mixing the cement with the pulverized soil; furnishing, hauling and mixing water with the cement-soil mixture; spreading and shaping the mixture; compacting the mixture, including all rolling required for this compaction; surface finishing; and for all manipulation, labor, equipment, appliances, tools and incidentals necessary to complete the work and carry out the maintenance provisions in this specification.

Cement material measured as provided in this item shall be paid for at the unit price bid for cement material, which price shall be compensation for furnishing the material; for freight involved, for all unloading and storing; and for all labor, equipment, fuels, tools and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

SECTION 2.3: BASE COURSES

2.3.A Gravel Base Course

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of gravel for streets, driveways, cement stabilized base; and for foundation courses, for surface courses, other base courses, sidewalks, driveway approaches and/or curb, gutter, or curb and gutter.

B. SUBMITTALS

Not applicable.

PART 2: PRODUCT

A. MATERIALS

1. Gravel Base Course.

a. General - The material shall consist of durable particles of gravel mixed with approved binding material; and shall be free from thin or elongated pieces, clay lumps, soil loam or vegetable matter.

The material may be bank-run; or the binder may be added and incorporated by methods approved by the Owner.

Should the material be secured from pits, the overburden or stripping from the site of the pits shall be removed to such a distance that none shall fall or wash into the pit; and it shall be placed so as to divert surface drainage away from the pit site. The pit shall be well drained at all times.

The pits shall be opened in such a manner as to expose the vertical faces of all strata of acceptable materials; and, unless otherwise directed by the Owner, the materials shall be secured in successive vertical cuts extending through all the exposed strata, in order that a uniformly mixed material shall be secured.

B. MATERIAL TESTING

Also refer to *Section 2.5, Materials Testing*.

1. Tests - The soil binder shall meet the following requirements when tested in accordance with ASTM 4318:

The liquid limit shall not exceed 35.
The plastic limit shall be determined.
The plasticity index shall not exceed 12 nor be less than 4.
Samples should be prepared accordingly.
The linear shrinkage shall not exceed six percent.

2. Gradation - The material when tested by standard laboratory methods shall meet the following percentages by weight:

Passing 1¾ in. sieve	100%
Passing ⅜ in. sieve	40 to 80%
Passing No. 4 sieve	25 to 60%
Passing No. 40 sieve	15 to 35%

Material passing the No. 40 sieve shall be known as "soil binder."

Materials containing conglomerate or gravel larger than 2" in any dimension shall be broken up and uniformly mixed with the remainder of the materials. Upgrading by the addition of washed gravel in order to meet the requirements of this section shall be permitted. If additional binder and/or soil binder are considered necessary by the Owner after the gravel materials are spread and shaped, same shall be furnished and applied in the amount directed by the Owner; such additional binder and/or soil binder shall be carefully and evenly incorporated with the pit materials in place by scarifying, harrowing or other methods approved by the Owner.

5. Rejection - Gravel which fails to meet the requirements of these specifications may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Gravel sources, from which materials with properties not meeting these specifications are delivered, may be rejected as further supply sources to the project by the Owner. Such rejection shall incur no cost to the Owner.

C. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Preparation of the subgrade shall be in conformity with the requirements of *Section 2.2.A, Subgrade Preparation*. The material shall be delivered in approved vehicles. It shall be the responsibility of the Contractor that the required amount of acceptable material shall be delivered to the site.

Material placed upon the subgrade shall be spread and shaped the same day. In the event inclement weather or other unforeseen circumstances cause the spreading and shaping of the material during the first 24 hours after delivery to be impracticable, the material shall be scarified, if necessary, and spread as directed by the Owner. The material shall be sprinkled, as directed, and then bladed, dragged and shaped to conform to the typical sections shown on the plans and/or established by the Owner. All areas and nests of segregated coarse or fine material shall be corrected or removed and replaced with well-graded material. All irregularities, depressions or weak spots which develop in the foundation course shall be corrected immediately by scarifying the

areas affected, adding suitable material as required, reshaping and compacting by sprinkling and rolling.

Compaction rolling shall be done with tamping rollers and/or pneumatic tire rollers, as directed by the Owner. Finish rolling shall be done with three wheeled, 10-ton rollers. All rollers shall comply with the requirements of *Section 2.1, Rolling*.

One roller unit of the type required by the Owner shall be provided for each 100 cubic yards, or fraction thereof, of material placed per hour. The quantity placed per hour shall be determined by averaging the total quantity of material placed in any one day. The use of weights, extra rollers, drums, tires or other equipment attached to a roller unit shall not be considered as sufficient to reduce the number of roller units required on the project. When operations are so isolated from one another that one roller unit cannot perform the required compaction satisfactorily, additional roller units shall be provided and operated as directed by the Owner. Rolling shall be provided and operated as directed by the Owner. Rolling shall be in accordance with *Section 2.1, Rolling.*

In areas on which the use of a roller unit would be impracticable, other suitable methods of compaction may be used.

Any deviation in excess of one-fourth inch, as shown by the straightedge or template on the finished foundation course, shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling.

Succeeding courses shall be constructed by the same methods as specified for the first course.

The completed base course shall have a uniform density of not less than 95 percent of the maximum density determined by ASTM Designation D 698. Moisture content shall be within minus 2 to plus 2 of optimum.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Unless otherwise noted, all work performed as prescribed by this item will be paid for as a unit rate (area or volume), in accordance with the contract.

Gravel base, when provided for as a separate contract pay item in the proposal and contract, shall be measured and paid for in square yards of the compacted thickness shown on the plans.

The contract price shall be the total compensation for the furnishing of all labor, tools, materials, equipment and incidentals necessary to complete the work, including preparation of the subgrade, rolling finish and disposal of surplus materials, all in accordance with the plans and these specifications.

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2.3.B Flexible Base (Crushed Stone)

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of a foundation course for a surface course or for other base courses; shall be constructed as herein specified in one or more courses in conformity with the typical section shown on the plans and to the lines and grades as established by the Owner.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

1. Crushed Stone Base Course

a. General - This item shall consist of a foundation course for a surface course or for other base courses, and shall be constructed as herein specified in one or more courses in conformity with the typical section shown on the plans and to the lines and grades as established by the Owner.

Should the Contractor elect to produce the material from local pits, the material shall be secured from sources approved by the Owner. The pits as utilized shall be opened up in such a manner as to immediately expose the vertical faces of all the strata of acceptable material in the depth mined. Unless otherwise directed, the material shall be secured in successive vertical cuts extending through all of the exposed strata, in order that a uniform mixed material shall be secured.

B. MATERIAL TESTING

Also refer to *Section 2.5, Materials Testing.*

1. Tests - The soil binder shall meet the following requirements when tested in accordance with ASTM 4318:

The liquid limit shall not exceed 40.
The plastic limit shall be determined.
The plasticity index shall not exceed 12 nor be less than 4.
Samples should be prepared accordingly.

Materials retained on the No. 4 sieve shall have a percent wear of not more than 45 when tested according to ASTM Designation C 131.

The material when tested under the Wet Ball for Determining the Disintegration of Flexible Base Materials, TxDOT Test Method Tex-116-E, shall not develop more than 50 percent soil binder.

2. Gradation - The material shall be obtained from approved sources; shall be crushed; and shall consist of durable particles of limestone mixed with approved binding

materials. The material shall be approved by the Owner at the source. The process material when properly shaken and tested by standard laboratory methods shall meet the following requirements:

Passing 1¾ in. sieve	100%
Passing No. 4 sieve	35 to 55%
Passing No. 40 sieve	15 to 40%

Materials passing the No. 4 sieve shall be known as "binder." The portion of material passing the No. 40 sieve shall be known as "soil binder."

5. Rejection - Aggregate which fails to meet the requirements of these specifications may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Aggregate sources, from which materials with properties not meeting these specifications are delivered, may be rejected as further supply sources to the project by the Owner.

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Preparation of Subgrade - The preparation of the subgrade shall be in conformity with the requirements of *Section 2.2.A, Subgrade Preparation*.

2. Thickness - Where the base course exceeds six inches in thickness, it shall be constructed in two or more courses of equal thickness as indicated on the typical section.

3. Placing - Immediately before placing the base course material, the subgrade shall be checked as to conformity with grade and section.

The material shall be delivered in approved vehicles of a uniform capacity. It shall be the charge of the Contractor that the required amount of specified material shall be delivered to secure the proper thickness of the completed base course. Material deposited on the subgrade shall be spread and shaped the same day. All material shall be moved at least once from the original position in which it is deposited. In the event of inclement weather or other unforeseen circumstances, which render impracticable the spreading of the material during the first 24-hour period, the material shall be scarified and spread as directed by the Owner. The material shall be sprinkled, if directed, and

shall then be bladed, dragged and shaped to conform to the typical section as shown on the plans.

All areas and "nests" of segregated course of fine material shall be corrected or removed and replaced with well-graded material as directed by the Owner. If additional binder is considered desirable or necessary after the material is spread and shaped, it shall be furnished and applied in the amount directed by the Owner. Such binder shall be carefully incorporated with the material in place by scarifying, harrowing, brooming or by other approved methods. The course shall be sprinkled as required and compacted to the extent necessary to provide not less than the percent density as hereinafter-specified under "Density." In addition to the requirements specified for density, the full depth of flexible base shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section of flexible base is completed, tests as necessary shall be made by the Owner unless otherwise specified in the special provisions or in the plans. If the material fails to meet the density requirements, it shall be reworked as necessary to meet these requirements.

Throughout this entire operation, the shape of the course shall be maintained by blading. The surface, upon completion, shall be smooth and in conformity with the typical sections shown on the plans to the established lines and grades. On the surface on which pavement is to be placed, any deviation in excess of one-half inch in cross section and in a length of 16 feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompacting by sprinkling and rolling. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding suitable material as required, reshaping and recompacting by sprinkling and rolling.

Should the base course, due to any reason or cause, lose the required stability, density and finish before the surfacing is complete, it shall be recompacted and refinished at the sole expense of the Contractor.

4. Density - The density required under this item shall not be less than 95 percent compaction as determined by ASTM Designation D 698. Moisture content shall be within minus 2 to plus 2 of optimum.

5. Courses - Paving types with flexible base under the curb and gutter shall be placed and compacted at the same time and in the same operation as the flexible base under the pavement. The flexible base shall be placed in two courses, as shown on the plans. The first course shall be placed and compacted under the curb and gutter and under the pavement. The curb and gutter shall then be built upon the first course. The final course of the flexible base shall be placed after sufficient time has elapsed as stated in *Section 5.3, Concrete Curb and Gutter*.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Unless otherwise noted, all work performed as prescribed by this item will be paid for as a unit rate (area), in accordance with the contract.

Work and accepted materials as specified for this item shall be measured by the square yard of completed flexible base as follows:

- Where no curb and gutter is in place or is to be constructed in connection with the flexible base, measurement shall be made to the lines shown on the plans or established as the edge of the base to be constructed.
- Where curb and gutter is in place or is proposed to be constructed in connection with the placing of the flexible base, measurement shall be made to the lip of the gutter. Material placed under the curb and gutter or behind the curb shall not be measured as flexible base, but shall be considered as foundation courses for the curb and gutter.

The work performed and material placed (including additional binder if required) as prescribed for this item, measured as provided in this item, shall be paid for at the unit price bid per square yard for flexible base which price shall be full compensation for preparation of subgrade, furnishing of material, hauling, blading, sprinkling, compacting and furnishing all of labor and equipment necessary to complete the work.

2.3.C Portland Cement Treatment (Pug Base)

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of the treatment of the base or sub-base course, which is to be composed of a compacted mixture of soil, portland cement and water; and shall be constructed as herein specified and in conformity to the cross sections, lines and grades as established by the Owner. In the event new materials are placed, rather than using existing base or sub-base, the base or sub-base shall be constructed as herein specified and in conformity with the items governing the base or sub-base courses

B. SUBMITTALS

1. Mix Design - Prior to construction, the Contractor shall submit a proposed mix design for review and approval by the Engineer. The design data shall include type and amount of portland cement; source, gradation, and amount of gravel; and compressive strength verification tests. Compressive strength shall be in the range of 500 to 1200 psi at 7 days.

PART 2: PRODUCT

A. MATERIALS

1. Portland Cement - Cement shall conform to the requirements in *Item A.2, Cement, of Section 5.1 Part 2.*

2. Water - Water shall conform to the requirements in *Item A.5, Water, of Section 5.1 Part 2.*

3. Soil - The soil shall consist of approved soil, free from vegetation or other objectionable matter. It may be either the material encountered in the existing section, gravel material secured from approved sources shown on the plans or as designated by the Owner, or a combination of existing and additional soil from approved sources, as shown on the plans, or as directed by the Owner.

B. MATERIAL TESTING

REFER TO *SECTION 2.5, MATERIALS TESTING*.

C. EQUIPMENT

All equipment necessary to properly prosecute, perform and complete the work within the contract time shall be on the project and shall be approved by the Owner as to type and condition before the Contractor shall be permitted to begin construction operations on which the equipment is to be used.

Soil-cement may be constructed with any machine or combination of machines and auxiliary equipment that shall produce the results meeting the requirements for soil pulverization, cement application, mixing, water application, incorporation of materials, compaction, finishing and curing as specified herein. The Contractor shall at all times

provide sufficient equipment to enable continuous performance of the work and its completion in the required number of working days.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. General - The primary requirement of this specification is to secure a complete course of treated material containing a uniform portland cement mixture, free from loose or segregated areas, of uniform density and moisture content, well bound and compacted for its full depth with a smooth surface suitable for placing additional sub-base, base or surface courses. It shall be the responsibility of the Contractor to regulate the sequence of his work to process a sufficient quantity of material so as to provide full depth as shown on plans, to use the proper amount of portland cement, maintain the work and to rework the courses as necessary to meet the foregoing requirements.

Cement stabilized base shall not be mixed or placed when the air temperature is below 40 degrees Fahrenheit and falling, but may be mixed or placed when the air temperature is above 35 degrees Fahrenheit and rising, the temperature being taken in the shade and away from artificial heat; and with the further provisions that cement stabilized base shall be mixed or placed only when weather conditions, in the opinion of the Owner, are suitable.

Treatment for Materials in Place - Before other construction operations are begun, the roadbed shall be graded and shaped as required to construct the portland cement treatment for material in place in conformance with the lines, grades, thickness and typical cross sections shown on the plans. Unsuitable soil or material shall be removed and replaced with acceptable soil. The subgrade shall be firm and able to support without displacement the construction equipment and the compaction hereinafter specified. Soft or yielding subgrade shall be corrected and made stable before construction proceeds. The soil shall be so pulverized that, at the completion of moist-mixing 100 percent by dry weight it passes a one-inch sieve; and a minimum of 80 percent passes a No. 4 sieve, exclusive of gravel or stone retained on these sieves. Old bituminous wearing surface shall be pulverized so that 100 percent shall pass a two-inch sieve.

2. Application of Cement - Portland cement shall be spread uniformly on the soil at the rate specified on the plans or as determined by preliminary laboratory tests. If a bulk cement spreader is used, it shall be positioned by string lines or other approved method during spreading to insure a uniform distribution of cement. Cement shall be applied only to such an area that all the operations can be continuous and completed in daylight within six hours of such application.

The percentage of moisture in the base at the time of cement application shall not exceed the quantity that shall permit uniform and intimate mixture of soil and cement during dry-mixing operations; and it shall not exceed the specified optimum moisture content for the soil-cement mixture.

No equipment, except that used in the spreading and mixing, shall be allowed to pass over the freshly spread cement until it is mixed with the soil.

3. Mixing and Processing - The following method of mixing and processing may be used at the option of the Contractor.

a. Central Mixing Plant - The gravel, cement and water shall be dry-mixed in pug mill either of the batch or continuous-flow type. Gravel shall conform to the requirements of *Section 2.3.A, Gravel Base Course*. The plant shall be equipped with feeding and metering devices, which shall add the gravel, cement and water into the mixer in the specified quantities. Gravel and cement shall be mixed sufficiently to prevent cement balls from forming when water is added. Mixing shall continue until a uniform and intimate mixture of gravel, cement and water is obtained. The mixture shall be hauled to the construction site in suitable vehicles equipped with protective covers. The mixture shall be placed on the moistened subgrade in a uniform layer by an approved spreader or spreaders. Not more than 30 minutes shall elapse between the placement of soil-cement in adjacent lanes at any location except at longitudinal construction joints. Not more than 30 minutes shall elapse between the start of spreading the soil and cement mixture and start of compaction. Not more than 60 minutes shall elapse between the start of moist-mixing and the start of compaction of the soil-cement. The layer of soil-cement shall be uniform in thickness and surface contour; and in such quantity that the completed base shall conform to the required grade and cross section.

4. Compaction and Finishing - The material shall be compacted to at least 95 percent of the maximum density determined by ASTM D 698. Moisture content shall be within minus 2 to plus 2 of optimum. At the start of compaction, the percentage of moisture in the mixture and in unpulverized soil lumps, based on oven-dry weights, shall not be below or more than two percentage points above the specified optimum moisture content; and shall be less than that quantity which shall cause the soil-cement mixture to become unstable during compaction and finishing. When the uncompacted soil-cement mixture is wetted by rain so that the average moisture content exceeds the tolerance given at the time of final compaction, the entire section shall be reconstructed in accordance with this specification at the sole expense of the Contractor. The specified optimum moisture content and density shall be determined in the field on representative samples of soil-cement mixture obtained from the area being processed.

Prior to the beginning of compaction, the mixture shall be in a loose condition for its full depth. The loose mixture shall then be uniformly compacted to the specified density within two hours. After the soil and cement mixture, except the top mulch, is compacted, water shall be uniformly applied as needed and thoroughly mixed in with a spike tooth harrow or equal. The surface shall then be reshaped to the required lines, grades and cross section and then lightly scarified to loosen any imprint left by the compacting or shaping equipment.

The resulting surface shall be thoroughly rolled with a pneumatic tire roller and "clipped," "skinned," and "tight-bladed" by a power grader to a depth of approximately ¼

inch, moving all loosened soil and cement from the section. The surface shall then be thoroughly compacted with the pneumatic roller, adding small increments of moisture as needed during rolling. When directed by the Owner, surface finishing methods may be varied from this procedure, provided a dense, uniform surface, free of surface material, is maintained at its specified optimum during all finishing operations. Surface compaction and finishing shall proceed in such a manner as to produce, in not more than two hours, a smooth, closely knit surface; free of cracks, ridges or loose material; conforming to the drawn grade and line shown on the plans.

At the end of each day's operation or at a lapse of more than two hours between loads, a full depth transverse header (butt-joint) shall be installed, so that proper compaction and performance can be attained. No longitudinal joints will be allowed.

B. PROTECTION AND COVER

After the roadway has been finished as specified herein, it shall be immediately protected against rapid drying by applying two-tenths (0.2) gallon per square yard RC-2 cutback asphalt. Immediately prior to application of RC-2, the section shall be wetted by the use of pressure water distributors so that all voids in the soil-cement surface are filled with water, but without free water standing on the surface. The RC-2 cure shall be applied while this moisture condition exists so that undue asphalt penetration of the soil-cement surface shall be prevented; and at the same time aided in complete coverage by the RC-2. Should it be necessary for construction equipment or other traffic vehicles to pass over the section before the RC-2 has dried sufficiently to prevent pickup, it shall be the responsibility of the Contractor to dust or sand the surface before such use. The Contractor shall also maintain this curing cover during the seven-day protection so that all of the soil-cement base course shall be covered effectively with RC-2 during this period. The RC-2 curing coat shall remain in place for the additional asphalt-wearing surface.

C. OPENING TO TRAFFIC

The Contractor shall not be permitted to drive heavy equipment over completed portions. Pneumatic-tired equipment required for hauling cement and water may be permitted to drive over after the surface has hardened sufficiently to prevent the equipment from marring the surface, provided that protection and cover are not impaired. The soil-cement course may be opened to local traffic as soon as the RC-2 has been applied and dusted or sanded as necessary to prevent it from being picked up by traffic. Completed portions may be opened to all traffic after seven days, and if a minimum compressive strength of 500 psi has been attained.

D. MAINTENANCE

The Contractor shall be required, within the limits of the contract; to maintain the soil-cement treatment in good condition from the time he first starts work until all work has been completed. Maintenance shall include immediate repairs of any defect that may occur after the cement is applied. Such maintenance work shall be done by the Contractor at his own expense and repeated as often as necessary to keep the area

continuously intact. Repairs are to be made in such a manner as to insure restoration of a uniform surface for the full depth of treatment. Any low area shall be remedied by replacing the material for the full depth of treatment rather than adding a thin layer of stabilized material to the completed work.

E. HOT-MIX ASPHALTIC CONCRETE SURFACE COURSE

A hot-mix asphaltic surface course of specified thickness will be placed on the completed and approved base course after a fourteen (14) day curing period.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Unless otherwise noted, all work performed as prescribed by this item will be paid for as a unit rate (area or volume), in accordance with the contract.

This work shall be measured by the square yard of completed and accepted cement stabilized base course.

Measurement for cement shall be by the ton, 2000 pounds of dry weight, as determined by certified weight tickets for treatment of materials in place only. No allowance shall be made for any materials used or work done outside the limits as established by the Owner.

The work performed and material furnished as prescribed by this item and measured as provided in this item shall be paid for at the unit price bid for soil-cement treated base, or sub-base course, which price shall be full compensation for pulverizing the soil material; for handling; hauling and spreading cement; for mixing the cement with the pulverized soil; furnishing, hauling and mixing water with the soil-cement mixture; spreading and shaping the mixture; compacting the mixture, including all rolling required for this compaction; surface finishing; curing; and for all manipulation, labor, equipment, appliances, tools and incidentals necessary to complete the work and carry out the maintenance provisions in this specification.

Cement material for in place treatment measured as provided in this item shall be paid for at the unit price bid for cement material, which price shall be compensation for furnishing the material; for all freight involved, for all unloading and storing; and for all labor, equipment, fuels, tools and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

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2.3.D Rehabilitation of Existing Base and Pavement

PART 1: GENERAL

A. Description

This item shall consist of the preparation of the base course by lime treatment of the existing bituminous surface and the existing gravel base, and shall be constructed as specified herein and in conformity with the typical section, lines and grades shown on the plans or as established by the Owner.

B. Submittals

PART 2: PRODUCT

A. Materials

1. Gravel - The aggregate base material used for the production of the base shall be the existing gravel and bituminous treated surface to the extent possible. If the Engineer determines that the existing materials are inadequate or must be removed for any reason, any additional material shall conform to the requirements of *Section 2.3.A, Gravel Base Course*.

2. Cement - The cement shall meet the requirements of *Item A.2, Cement, of Section 5.1 Part 2.*

3. Lime - The lime shall meet the requirements of *Item A.2, Lime, of Section 2.4 Part 2* for the type of lime specified. When Type B, commercial lime slurry is specified, the contractor shall select, prior to construction, the grade to be used and shall notify the owner in writing prior to changing from one grade to another.

B. Material Testing

Refer to *Section 2.5, Materials Testing*.

C. Equipment

Not Applicable

PART 3: EXECUTION

A. Construction Methods

The existing bituminous surface courses and gravel base shall be scarified and pulverized to a depth of 8" minimum. Lime or cement shall be added at the rate of 25 lbs/SY and the base shall be prepared in accordance with the requirements of *Section 2.3.C, Portland Cement Treatment*, or *Section 2.4, Lime Treatment*. If the Engineer determines that the existing materials are inadequate or must be removed, the existing bituminous course and gravel shall be removed and windrowed. The subgrade material shall be removed to the depth determined by the Engineer and the windrowed material shall be spread uniformly over the surface. New material shall be brought in, lime or cement added at the rate of 25 lbs/SY, and placed in accordance with *Sections 2.3.C,*

Portland Cement Treatment, or *Section 2.4, Lime Treatment*. If the Engineer determines that there is excess material then the excess shall be removed and disposed of by the contractor

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Unless otherwise noted, all work performed as prescribed by this item will be paid for as a unit rate (area or volume), in accordance with the contract.

Lime or cement treatment of existing base and pavement materials shall be measured for payment in square yards for the thickness shown on the plans for the surface area of completed and accepted work. Lime or cement treatment shall be paid for at the contract unit price per square yard, including furnishing of the lime material, as provided in the proposal contract. The contract unit price shall be the total compensation for preparing the roadbed; for loosening, pulverizing, furnishing, and application of lime or cement, water content in the slurry mixture and the mixing water; mixing, shaping, sprinkling, compacting, finishing, curing and maintaining; for manipulations required; and for all labor, equipment, fuels, tools and incidentals necessary to complete the work, all in accordance with the plans and specifications.

New materials brought to the project shall be paid for by the CY or ton compacted in place.

Removal of excess or unacceptable materials will be paid for by the CY.

CAUTION: HANDLING AND USE OF QUICKLIME CAN BE DANGEROUS. QUICKLIME SHOULD BE PRESCRIBED BY A REGISTERED PROFESSIONAL ENGINEER FAMILIAR WITH ITS USE.

SECTION 2.4: LIME TREATMENT

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of treating subgrade, sub-base, and base courses by the pulverization, addition of lime, mixing and compacting the mixed material to the required density. This item applies to natural ground, embankment, existing pavement, base or sub-base courses placed under this contract, which shall be constructed as specified herein and in conformity with the typical section, lines and grades as shown on the plans.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

1. Base and Sub-base Materials - Base and sub-base materials shall meet the requirements shown on the plans or in the pertinent specifications.

2. Lime - This Section establishes the requirements for hydrated lime, quicklime and commercial lime slurry. When Type B, commercial lime slurry is specified, the Contractor shall select, prior to construction, the grade to be used and shall notify the Owner in writing before changing from one grade to another.

CAUTION: Use of quicklime can be dangerous. Users should become informed of the recommended precautions in the handling, storage and use of quicklime.

a. Types - The various types and grades are defined and identified as follows:

(1) Type A, Hydrated Lime - A dry powdered material consisting essentially of calcium hydroxide.

(2) Type B, Commercial Lime Slurry - A liquid mixture of essentially hydrated lime solids and water in slurry form.

(3) Type C, Quicklime - A dry material consisting essentially of calcium oxide. It shall be furnished in either of two grades, which differ in sizing.

(a) Grade DS - "Pebble" quicklime of a gradation suitable for either "Dry Placing" or for use in the preparation of a slurry for "Wet Placing."

(b) Grade S - Finely graded quicklime for use in the preparation of a slurry for wet placing. (**Note:** Due to the possibility of appreciable amounts of finely divided, powdered quicklime being present in this product, the use of Type C, Grade S Quicklime is restricted to "Slurry Placing" only. It is considered to be unsuitable for "Dry Placing.")

b. General - Lime shall be applied as provided for in the governing specifications, as a dry material or as a mixture of lime solids and water in the form of lime slurry.

For dry application, Type A, Hydrated Lime or Type C, Quicklime of **GRADE DS ONLY** may be used where specifications permit.

For wet application, lime slurry may be delivered to the job site as Type B, Commercial Lime Slurry, or a lime slurry may be prepared at the job site or other location approved by the Engineer, by using Type A Hydrated Lime or Type C Quicklime as specified.

The lime and lime slurry being furnished under the terms of this specification shall, in addition to all other requirements, also meet the following chemical and physical requirements.

(1) Chemical:

	TYPE		
	A	B	C
Total "active" lime content, % by wt (i.e., % by wt Ca(OH)2 + % by wt CaO, if present)	90.0 min[1]	87.0 min[2]	---
Unhydrated lime content, % by wt CaO	5.0 max	---	87.0 min
"Free Water" content, % by wt H_2O	5.0 max	---	---

(2) Physical:

	TYPE		
	A	B	C
Wet sieve requirement, as % by wt residue:			
Retained on No. 6 sieve	0.2 max	0.2 max[2]	8.0 max[3]
Retained on No. 30 sieve	4.0 max	4.0 max[2]	---
Dry sieve requirement, as % by wt residue:			
Retained on a 1" sieve	---	---	0.0
Retained on a ¾" sieve	---	---	10.0 max
Retained on a No. 100 sieve	---	---	Grade DS: 80% min. Grade S: No Limits

Note 1: *No more than 5.0% by weight CaO (unhydrated lime) will be allowed in determining the total "active" lime content.*
Note 2: *In "solids content" of the slurry.*
Note 3: *The amount of total "active" lime content, as CaO, in the material retained on the No. 6 sieve must not exceed 2.0 percent by weight of the original Type C lime.*

Type B, Commercial Lime Slurry or a slurry prepared at the job site from Type A Hydrated Lime or Type C Quicklime shall be furnished at or above the minimum "Dry Solids" content as approved by the Engineer and must be of a consistency that can be handled and uniformly applied without difficulty. The slurry shall be free of liquids other than water and any materials of a nature injurious or objectionable for the purpose intended.

3. If the minimum design strength or percent lime to be used for the treated subgrade, existing base, new sub-base or new base is specified, it shall be determined by preliminary laboratory tests at the Owner's expense.

B. Material Testing

Also refer to *Section 2.5, Material Testing*.

1. Lime Sampling and Testing - The sampling and testing of lime, if required, shall be as determined by Test Method Tex-600-J, "Lime Testing Procedure."

C. EQUIPMENT

1. Requirements - Machinery, tools and equipment necessary for proper performance of the work shall be on the project and approved by the Owner prior to the beginning of construction operations.

Machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

2. Hydrated Lime - Hydrated lime shall be stored and handled in closed, weatherproof containers until immediately before distribution on the road. If storage bins are used, they shall be completely enclosed. Hydrate lime bags shall be stored in weatherproof buildings with adequate protection from ground dampness.

3. Quicklime - Type C quicklime, when permitted by the Engineer, shall be shipped only in bulk, bagged material will not be allowed.

4. Trucks - If lime is furnished in trucks, each truck shall bear the weight of lime measured on certified scales; or the Contractor shall place a set of standard platform truck scales or hopper scales at a location approved by the Owner.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. General - It is a primary requirement of this specification to secure a completed course of treated material containing a uniform lime mixture, free from loose or segregated areas, or uniform density and moisture content, well bound for its full depth, and with a smooth surface and suitable for placing subsequent courses. It shall be the responsibility of the Contractor to regulate the sequence of his work, to use the proper amount of lime, maintain the work and rework the courses as necessary to meet the above requirements.

Prior to beginning any lime treatment, the roadbed shall be constructed and shaped to conform to the typical sections, lines and grades as shown on the plans or as established by the Owner.

a. Treatment of Materials in Place - Materials to be treated shall be excavated to the secondary grade (proposed bottom of lime treatment) and removed or wind rowed to expose the secondary grade. Any wet or unstable material below the secondary grade shall be corrected by scarifying, adding lime and compacting until it is of uniform stability. The excavated material shall then be spread to the desired cross section. If the Contractor elects to use a cutting or pulverizing machine that shall remove the subgrade material accurately to the secondary grade and to pulverize the material at the same time, he shall not be required to expose the secondary grade or wind row the material.

However, the Contractor shall be required to roll the subgrade before using the pulverizing machine and correct any soft areas that this rolling may reveal. This method shall be permitted only where a machine is provided which shall insure that the material is cut uniformly to the proper depth and which has cutters that shall place

the secondary grade to a smooth surface over the entire width of the cut. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.

b. Treatment for New Materials - The base and sub-base materials, as provided in the governing specifications, shall be delivered, placed and spread in the required amount per station. The material shall be manipulated as specified and thoroughly mixed prior to the addition of the lime.

2. Application - Lime shall be spread only on that area where the first mixing operation can be completed in the same working day. The application and mixing of lime with the materials shall be accomplished by the method hereinafter described as "slurry placing," unless otherwise approved by the Owner.

a. Dry Placing - The lime shall be spread by an approved screw type spreader box or by bag distribution at the rate shown on the plans or as directed by the Engineer.

The lime shall be distributed at a uniform rate and in such a manner as to reduce scattering of lime by wind to a minimum. Lime shall not be applied when wind conditions (in the opinion of the Owner) are such that blowing lime becomes objectionable to traffic or adjacent property owners. A motor grader shall not be used to spread Type A Hydrated Lime, but may be used to spread Type C Quicklime Grade "DS." The material shall be sprinkled until proper moisture content has been secured.

b. Slurry Placing - Lime shall be mixed with water and applied as a thin water suspension or slurry. Type A Hydrated Lime slurry shall be mixed to form a slurry with a solids content approved by the Engineer. Type B, commercial lime slurry shall be applied with a lime percentage not less than that applicable for the grade used. The distribution of lime at the rate shown on the plans or approved by the Engineer shall be attained by successive passes over a measured surface of roadway until the proper moisture and lime content have been secured.

When Type C Quicklime is applied as a slurry, the amount of dry quicklime shall be 80 percent of the amount shown on plans. The slurry shall contain at least the minimum dry solids content approved by the Engineer. The residue from the slurrying procedure shall be spread uniformly over the length of the roadway currently being processed unless otherwise approved by the Engineer. The residue is primarily inert material with little stabilizing value, but may contain a small amount of quicklime particles that slake slowly. A concentration of these particles could cause the compacted stabilized material to swell during slaking.

3. Mixing - Mixing procedure shall be the same for "dry placing" or "slurry placing" as hereinafter described.

a. Treatment for Materials in Place - Material and lime shall be thoroughly mixed by approved road mixers or other approved equipment, and the mixing continued until a homogenous, friable mixture of material and lime is obtained, free from all clods or lumps. Materials containing plastic clay or other materials which shall not readily mix with lime shall be mixed as thoroughly as possible at the time of the

lime application, brought to the proper moisture content, sealed with a pneumatic roller, and left to cure one to four days as directed by the Owner. During the curing period, the material shall be kept moist. After the required curing time, the material shall be uniformly mixed by approved methods. If the soil binder-lime mixture contains clods, they shall be reduced in size by raking, blading, discing, harrowing, scarifying or the use of other approved pulverization methods so that when all nonslaking aggregates obtained on the No. 4 sieve are removed, the remainder of the material shall meet the following requirements when tested dry by laboratory sieves:

Minimum passing 1¾ inch	100%
Minimum passing No. 4 sieve	60%

During the interval of time between application and mixing, hydrated lime that has been exposed to the open air for a period of six hours or more, or to excessive loss due to washing or blowing, shall not be accepted for payment.

b. Treatment for New Material - The base or sub-base material, lime and required water shall be thoroughly mixed and blended by approved road mixers or other approved equipment, and the mixing continued until a homogeneous, friable mixture is obtained. When lime is placed as a slurry and mixed by the use of blades, the material shall be bladed as the limewater mixture is applied; and after the total amount has been placed, the mixture shall be thoroughly blended to the satisfaction of the Owner.

During the interval of time between application and mixing, hydrated lime that has been exposed to the open air for a period of six hours or more, or to excessive loss due to washing or blowing, shall not be accepted for payment.

4. Compaction - Compaction of the mixture shall begin immediately after final mixing and in no case later than three calendar days after final mixing. The material shall be aerated or sprinkled as necessary to provide optimum moisture. Compaction shall begin at the bottom and shall continue until the entire depth of the mixture is uniformly compacted as shown on the plans or specified by the Owner. The compacted mixture shall have a uniform density of not less than 95 percent of the maximum density as determined by ASTM Designation D 698. Moisture content shall be within minus 2 to plus 2 of optimum. After each section is completed, such tests as are necessary shall be made by the Owner. If any portion fails to meet the density specified, it shall be reworked as necessary to obtain the specified density.

B. FINISHING, CURING, AND PREPARATION FOR SURFACING

After the mixture has been compacted, the surface shall be shaped to the required line, grades and cross sections; and then thoroughly rolled sufficiently light to prevent hair cracking. The completed section shall then be moist-cured for a minimum of seven days before further courses are added or any traffic permitted, unless otherwise directed by the Owner. In cases where subgrade treatment or sub-base sets up sufficiently to prevent objectionable damage from traffic, such layers may be opened

to traffic two days after compaction. The surface of the compacted layer shall be kept moist until covered by other base or paving material or application of a curing seal of emulsified asphalt. If a curing seal is used, it should be applied as soon as possible after completion of final rolling, at a rate of between 0.10 and 0.20 gallons per square yard, the exact rate to be determined by the Owner. No equipment or traffic shall be permitted on lime treated material for 72 hours after curing seal is applied, unless otherwise permitted by the Owner.

C. MAINTENANCE

The Contractor shall be required to maintain the completed soil lime base within the limits of his contract, in good condition, satisfactory to the Owner as to grade, crown and cross section until such time as the surface course is constructed. All irregularities or other defects that may occur shall be immediately repaired by the Contractor at his own expense. Repairs are to be made as directed by the Owner; and in a manner to insure restoration of a uniform surface and durability of the portion repaired.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT

Unless otherwise noted, all work performed as prescribed by this item will be paid for as a unit rate (area or volume), in accordance with the contract.

Lime treatment shall be measured for payment in square yards for the thickness shown on the plans for the surface area of completed and accepted work. The measurement for lime shall be by the ton of 2,000 pounds dry weight. Lime treatment shall be paid for at the contract unit price per square yard, as provided in the proposal and contract. The contract unit price shall be the total compensation for preparing the roadbed; for loosening, pulverizing, application of lime, water content in the slurry mixture and the mixing water; mixing, shaping sprinkling, compacting, finishing, curing and maintaining; for manipulations required; and for all labor, equipment, fuels, tools and incidentals necessary to complete the work, all in accordance with the plans and specifications. Lime material for "lime material" which price shall be full compensation for furnishing the material; for all freight involved; for all unloading, storing and hauling; and for all labor, equipment, fuels, tools and incidentals necessary to complete the work.

CAUTION: HANDLING AND USE OF QUICKLIME CAN BE DANGEROUS. QUICKLIME SHOULD BE PRESCRIBED BY A REGISTERED PROFESSIONAL ENGINEER FAMILIAR WITH ITS USE.

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SECTION 2.5: PRIME COAT

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of application of asphaltic materials on the completed base course and/or other approved area, which shall be applied in accordance with these specifications and as shown on the plans. A prime coat shall be applied on all chemically treated or stabilized subgrade or base unless the Owner and Engineer authorize otherwise.

B. SUBMITTALS

PART 2: PRODUCT

A. MATERIALS

1. Asphalt - The asphaltic material used for the prime coat shall be RC-2, or an approved equal, and when tested by approved laboratory methods, shall meet the requirements of *Items A.1, Oil Asphalt, and A.5, Emulsified Asphalt, of Section 3.1 Part 2.*

2. Sand - Base course sweepings shall be those sweepings obtained from cleaning the base. Native sand shall be local material obtained from approved sources and subject to the approval of the Owner.

B. EQUIPMENT

PART 3: EXECUTION

A. CONSTRUCTION METHODS

A combination of asphaltic material and sand shall be used as specified herein; the Owner may waive the requirement of sand therefore only asphaltic material shall be used.

Prime coat shall not be applied when the air temperature is below 50 degrees Fahrenheit and falling, but it may be applied when the air temperature is above 40 degrees Fahrenheit and is rising, the air temperature being taken in the shade and away from artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the Owner, are not suitable.

1. Asphaltic Material Only - When, in the opinion of the Owner the base is satisfactory to receive the prime coat, the surface shall be cleaned by sweeping or other approved methods, and dampened. The asphaltic material shall then be applied to the cleaned base at the approximate rate of two-tenths (0.2) to one-half (0.5) gallons per square yard of surface area. The application shall be made with an approved type of self-propelled pressure distributor so constructed and operated as to distribute the material evenly and smoothly in the quantity specified or directed. The Contractor shall provide all necessary facilities for determining the temperature of the asphaltic material in all of the heating equipment and in the distributor; and for determining the rate at which it is applied; and for securing uniformity at the junction of two distributor loads.

All storage tanks, piping, retorts, booster tanks and distributors used in storing and handling asphaltic material shall be kept clean and in good condition at all times. They shall be operated in such a manner that there shall be no contamination of the asphaltic material with foreign material. It shall be the responsibility of the Contractor to provide and maintain in good working order a recording thermometer at the storage heating unit at all times. The distributor shall have been recently calibrated and the Owner shall be furnished an accurate and satisfactory record of such calibration. After beginning the work, should the yield on the asphaltic material applied appear to be in error, the distributor shall be recalibrated in a manner satisfactory to the Owner before proceeding with the work.

No traffic, hauling or placing of subsequent courses shall be permitted over the freshly applied prime coat until authorized by the Owner.

The Owner shall select the temperature of application based on the temperature-viscosity relationship that shall permit application of the asphalt within the limits recommended in *Item A.1, Oil Asphalt, of Section 3.1 Part 2*. The Contractor shall apply the asphalt at a temperature within 15 degrees Fahrenheit of the temperature selected.

The Contractor shall be responsible for the maintenance of the surface until the work is accepted by the Owner.

WARNING TO CONTRACTORS: Attention is called to the fact that these materials are highly flammable. The utmost care shall be taken to prevent open flames from coming in contact with the asphaltic materials or the gases of same. The Contractor shall be responsible for any fires or accidents, which may result from heating the asphaltic materials.

2. Asphaltic Material and Sand - Native sand, as specified above, shall be hauled in vehicles of uniform capacity and placed on shoulders at a spacing designated by the Owner. After the surface preparation and the asphaltic application as specified hereinbefore, the surface shall then be covered with base sweepings and/or native sand as directed by the Owner. The surface shall then be dragged with an approved type of drag broom so as to evenly and smoothly distribute the cover material. This brooming or dragging shall continue until, in the opinion of the Owner, the course has properly cured under traffic.

All other provisions of paragraph (1), *Asphalt Material Only*, shall also apply.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

"Prime coat" shall not be measured for direct payment, but shall be considered as subsidiary work pertaining to the placing of the asphaltic mixtures of the type specified.

SECTION 2.6: MATERIALS TESTING

Construction Operation	Applicable Testing	Frequency of Testing
Subgrade		
Stabilization Determination	Atterberg Limits to determine if tabalization is necessary, pH to ermine amount of lime needed to stabalize	At request of Design
Lime Treatment	Gradations, Standard Proctor, Field Densities	Initial gradations performed to determine mixing pattern. Standard Proctor performed on each material that is visibly different. Densities performed at a rate of one per 300 LF of paving for two lanes.
Portland Cement Treatment	Unconfined Compressive Strength	1 sample per day of operations
Reclamation	Standard Proctor, Field Densities	Standard Proctor performed on each visibly different material. Densities performed at a rate of one per 300 LF of paving for two lanes.
Base Course		
Gravel Base Course	Gradations, Atterberg Limits, Standard Proctor, Field Densities	Gradation, Atterberg Limits, and Proctor at beginning of project on material submitted for use and at any time there is an apparent change in material. Densities to be project specific.
Flexible Base	Gradations, Atterberg Limits, Standard Proctor, Field Densities	Gradation, Atterberg Limits, and Proctor at beginning of project on material submitted for use and at any time there is an apparent change in material. Densities to be project specific.
Cement Treated Base (Pug Base)	Unconfined Compressive Strength	1 sample per day of operations

* Frequencies are minimums unless otherwise specified.

SECTION 3
Pavement and Surface Courses

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SECTION 3.1: Asphalts, Oils, and Emulsions

PART 1: GENERAL

A. DESCRIPTION

This section of the specifications consists of bituminous material, including oil asphalt, cut-back asphalt, road oils, emulsified asphalt, asphalt cement and other miscellaneous asphaltic materials. Asphalt for use in paving shall be a steam refined asphalt produced from crude asphaltic petroleum or a mixture of refined liquid asphalt and refined solid asphalt. It shall be homogeneous and free from water and residue from distillation of coal, coal tar or paraffin oil and shall not foam when heated to 340°F.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

1. Oil Asphalt

a. General - Oil asphalt, when used as a paving asphalt, shall be homogeneous, shall be free from water, shall not foam when heated to 340°F and shall meet the requirements for oil asphalt shown in *Table No. 1, Requirements for Oil Asphalt*.

b. Rejection - Any material specified in this section may be rejected for failure to meet any of the provisions of this specification, or for any defect causing it to be unsuitable for its intended use.

2. Asphalt Cement

a. General - The material for asphalt cement shall be homogeneous, shall be free from water, shall not foam when heated to 340°F and shall meet the requirements of *Table No. 2, Requirements for Asphalt Cement.*

b. Rejection - Asphalt cement material may be rejected for failure to meet any of the requirements of this specification.

TABLE NO. 1
REQUIREMENTS FOR OIL ASPHALT

Type-Grade	OA-30		OA-175**		OA-400	
	Min	Max	Min	Max	Min	Max
Penetration at 32°F, 200 g, 60 sec.	15	-	-	-	-	-
Penetration at 77°F, 100 g, 5 sec.	25	35	150	200	-	-
Penetration at 115°F, 50 g, 5 sec.	-	65	-	-	-	-
Ductility at 77°F, 5 cm/min, cms: Orginal	2	-	70	-	-	-
Flash Point C.O.C. °F	450	-	425	-	425	-
Softening Point, R. & B., °F	185	-	95	30	-	-
Thin Film Oven Test, $^{1}/_{8}$ in. Film, 50 g, 5 hours, 325°F	-	0.4	-	1.4	-	2.0
Penetration of Residue at 77°F, 100 g, 5 sec. % of Original Pen.	-	-	40	-	-	-
Ductility of Residue at 77°F, 5 cm/mi., cms	-	-	100	-	-	-
Solubility in Trichloroethylene, %	99.0	-	99.0	-	99.0	-
Spot Test on Original O.A.	Neg.		Neg.		Neg.	
Float Test at 112°F, sec	-	-	-	-	120	150
Tests on 85 to 115 Pen. Residue* Residue by Wt., %	-	-	-	-	75	-
Ductility, 77°F, 5 cm/min., Original Res., cms	-	-	-	-	100	-
Subjected to Thin Film Test, cm	-	-	-	-	100	-

*Determined by vacuum distillation (by evaporation if unable to reduce by vacuum).
**For use with latex additive only.

TABLE NO. 2
REQUIREMENTS FOR ASPHALT CEMENT

Test	Viscosity Grade									
	AC-3		AC- 5		AC-10		AC-20		AC-40	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, 140°F Stokes	300	+50	500	+100	1000	+200	2000	+400	4000	+800
Viscosity, 275°F Stokes	1.1	-	1.4	-	1.9	-	2.5	-	3.5	-
Penetration, 77°F, 100 g, 5 sec	210	-	135	-	85	-	55	-	35	-
Flash Point C.O.C. °F	425	-	425	-	450	-	450	-	450	-
Solubility in Trichloroethylene %	99.0	-	99.0	-	99.0	-	99.0	-	99.0	-
Tests on residues from thin film oven test: Viscosity, 140°F Stokes	-	900	-	1500	-	3000	-	6000	-	12000
Ductility, 77°F, 5cms per min cms	100	-	100	-	70	-	50	-	30	-
Spot Test	Neg.		Neg.		Neg.		Neg.		Neg.	

3. Latex Additives

a. General - A latex additive consisting of an anionic emulsion of butadiene-styrene low-temperature copolymer shall be added to the OA-175 asphalt or the AC-5 asphalt when specified on the plans or in the specifications in the contract. The latex additive shall consist of two percent by weight, latex additive (solids basis), stabilized with fatty-acid soap so as to have good storage stability. Latex additive shall possess the properties shown in *Table No. 3, Properties for Latex Additives*.

TABLE NO. 3
PROPERTIES FOR LATEX ADDITIVES

Monomer ratio, B/S	70/30
Minimum solids content	67%
Solids content per gal. @ 67%	5.3 lbs
Coagulum on 80-mesh screen	0.1% max
Type Anti-oxidant	staining
Mooney viscosity of polymer [M/L 4 @ 212°F]	100 min
ph of latex	9.4 – 10.5
Surface tension	28 - 42 dynes/cm²
Brookfield viscosity of latex	1200 ps max @ 67% solids

The finished latex-asphalt blend shall meet the viscosity and ductility requirements shown in *Table No. 4, Requirements for Latex Additives*

Table No. 4
Requirements for Latex Additives

Viscosity at 140°F, stokes	1500 min
Ductility at 39.2°F, 2 cm. per min., cm	100 min

b. Rejection - Latex additive material may be rejected for failure to meet any of the requirements of this specification.

4. Cut-back Asphalt

a. General - Cut-back asphalt shall consist of a liquid asphalt conforming to the following classifications:

(1) Slow curing products, designated by the letters SC, shall consist of natural crude oils or residual oils from the refining crude asphaltic petroleum, or the products resulting from fluxing of a paving asphalt with a light oil.

(2) Medium curing product, designated by the letters MC, shall consist of a paving asphalt conforming to the requirements shown in Tables Nos. 1, 2, and 4 above, fluxed or blended with a kerosene-type solvent.

(3) Rapid curing products, designated by the letters RC, shall consist of a paving asphalt conforming to the requirements in Table Nos. 1, 2 and 4, fluxed or blended with a naptha-solvent.

b. Test Reports and Certifications - Test Reports and certifications for cutback asphalt shall be furnished in accordance with *Item B, Tests and Certification of Bituminous Materials, of Section 3.1 Part 2*.

c. Temperatures - The cutback asphalt shall not be heated during its manufacture, storage or during construction so as to cause deformation of carbonized particles.

Unless authorized by the Owner, at no time after loading of the cut-back asphalt for transportation from the refinery to the purchaser shall the temperature of the asphalt be raised above that given in the last column of Table 9; and in no case shall the temperature be higher than 10°F below the actual flash point.

Unless authorized by the Owner, no asphalt, except tack coats, shall be applied when the air temperature is lower than 40°F.

Unless otherwise specified, the various grades of asphalt shall be applied at a temperature range as indicated on Table No. 9.

d. Material Requirements - The material for cutback asphalt shall meet the requirements shown in *Table No. 5, Requirements for Cut-Back Asphalt.*

e. Rejection - Cutback asphalt material may be rejected for failure to meet any of the requirements of this specification.

TABLE NO. 5
REQUIREMENTS FOR CUTBACK ASPHALT

Rapid Curing												
Type - Grade	**RC-1**		**RC-2**		**RC-250**		**RC-3**		**RC-4**		**RC-5**	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Water, %	-	.2	-	.2	-	.2	-	.2	-	.2	-	.2
Flash Point, T.O.C. °F	80	-	80	-	80	-	80	-	80	-	80	-
Furol Viscosity, sec.,												
At 122°F	100	160	200	300	-	-	-	-	-	-	-	-
At 140°F	-	-	-	-	125	250	250	400	-	-	-	-
At 180°F	-	-	-	-	-	-	-	-	125	250	350	500
The Distillate, expressed as percent by volume of total distillate to 680°F, shall be as follows:												
Off at 437°F	55	80	50	75	35	-	50	70	35	60	20	50
Off at 500°F	70	90	70	90	60	-	65	85	60	80	55	75
Off at 600°F	90	-	70	-	80	-	85	-	80	-	75	-
Residue from 680°F Distillation, Volume, %	50	-	70	-	65	-	73	-	78	-	82	-
Test on Distillation Residue:												
Penetration at 77°F, 100g, 5 sec	70	100	110	150	80	120	110	150	110	150	110	150
Ductility at 77°F, 5 cm/min., cms.	100	-	100	-	100	-	100	-	100	-	100	-
Solubility in Trichloroethylene %	99	-	99	-	99	-	99	-	99	-	99	-
Spot Test	Neg.		Neg.		Neg.		Neg.		Neg.		Neg.	

(Continued on next page.)

Medium Curing										
Test Description	**Grade**									
	MC-30		**MC-70**		**MC-250**		**MC-800**		**MC-300**	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Water, %	-	.2	-	.2	-	.2	-	.2	-	.2
Flash Point, T.O.C. °F	100	-	100	-	150	-	150	-	100	-
Kinematic Viscosity at 140°F C St.	30	60	70	140	250	500	800	1600	3000	6000
The Distillate, expressed as percent by volume of total distillate to 680°F, shall be as follows										
Off at 437°F	-	25	-	20	-	10	-	-	-	-
Off at 500°F	40	70	20	60	15	55	-	-	-	-
Off at 600°F	75	93	65	90	60	87	45	80	15	75
Residue from 680°F Distillation, Volume, %	50	-	55	-	67	-	75	-	80	-
Test on Distillation Residue:										
Penetration at 77°F, 100 g, 5 sec	120	250	120	250	120	250	120	250	120	250
Ductility at 77°F, 5 cm/min, cms.	100*	-	100*	-	100*	-	100*	-	100*	-
Solubility in Trichloroethylene %	99	-	99	-	99	-	99	-	99	-
Spot Test	Neg.		Neg.		Neg.		Neg.		Neg.	

Slow Curing										
Test Description	**ASTM Test No.**	**Grade**								
		SC-70		**SC-250**		**SC-800**		**SC-3000**		
		Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	
Flash Point, C.O.C. °F	D92	150	-	175	-	200	-	225	-	
Viscosity at 140°F Kinematic CS	D2170	70	140	250	500	800	1600	3000	6000	
Distillation Total Dist. to 680°F, Vol. %	D402	10	30	4	20	2	12	0	5	
Kinematic Viscosity on Residue at 140°F Stokes	D2170	4	70	8	100	20	160	40	350	
Ductility o Asph. Residue at 77°F, cm.	D113	50	-	60	-	70	-	80	-	
Asph. Residue at 77°F, cm **	D243	100	-	100	-	100	-	100	-	
Solubility in CCl., %	D2042	99.5	-	99.5	-	99.5	-	99.5	-	
Water, %	D95	-	.5	-	.5	-	.5	-	.5	
Heptane Xylene Equivalent, % (AASHTO-102)		-	35	-	35	-	35	-	35	

*If penetration of residue is more than 200 and ductility at 77°F (25°C) is less than 100 cm., the material shall be acceptable if its ductility at 60°F (15°C) is more than 100.

**If ductility at 77°F (25°C) is less than 100, the material shall be acceptable if the ductility at 60°F (15°C) is greater than 100.

5. Emulsified Asphalt

a. General - Emulsified asphalt shall be composed of a paving asphalt base uniformly emulsified with water. It shall be homogeneous throughout and, when stored, shall show no separation within 30 days after delivery. Emulsified asphalt shall be classified as anionic emulsions or cationic emulsions and shall meet the requirements shown in *Table No. 7, Requirements for Emulsified Asphalt.*

b. Testing Requirements - Test reports and certification shall be made for emulsified asphalt in accordance with *Item B, Tests and Certification of Bituminous Materials, of Section 3.1 Part 2*.

c. Temperature - Emulsified asphalt may be reheated, but at no time after loading for transportation from refinery to the purchaser shall the temperature of the emulsion be raised above 160°F. During reheating, the emulsified asphalt shall be agitated to prevent localized overheating. Emulsified asphalt shall not be permitted to cool to a temperature of less than 40°F. Unless otherwise specified, emulsified asphalt shall be applied at a temperature within the limits specified in *Table No. 9, Requirements for Storage, Heating and Application Temperature*. The Contractor shall furnish and keep on the site an accurate thermometer suitable for determining the temperature of the emulsified asphalt.

d. Rejection - Emulsified asphalt material may be rejected for failure to meet all of the requirements of this specification.

6. Flux Oil

a. General - Fluxing material shall be free from foreign matter and shall meet the requirements of *Table No. 6, Requirements for Flux Oil.*

TABLE NO. 6
REQUIREMENTS FOR FLUX OIL

Type	Flux Oil	
	Min	Max
Water %	-	.2
Furol Viscosity at 122°F	50	100
Flash Point, C.O.C. °F	250	-
Loss on Heating, 50 g, 5 hrs. at 325°F	-	5
Asphalt content of 85 to 15 Penetration by Vaccum distillation, weight,%	25	-

b. Rejection - Flux oil material may be rejected for failure to meet all of the requirements of this specification.

TABLE NO. 7
REQUIREMENTS FOR EMULSIFIED ASPHALT

Anionic Emulsion												
Type - Grade	Rapid Setting				Medium Setting				Slow Setting			
	EA-HVRS		EA-HVRS 90		EA-HVMS		EA-HVMS 90		EA-11M		EA-10S	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Furol Viscosity at 77°F, Sec, C.	-	-	-	-	-	-	-	-	30	100	30	100
Furol Viscosity at 122°F	100	300	100	300	100	300	100	300	-	-	-	-
Residue by Distillation, %	63	-	63	-	63	-	63	-	60	-	60	-
Oil Portion of Distillate, %	-	2.0	-	2.0	-	2.0	-	2.0	-	2.0	-	2.0
Sieve Test, %	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1	-	0.1
Miscibility (Standard Test)	-	-	-	-	-	-	-	-	Passing		Passing	
Coating	-	-	-	-	-	-	-	-	Passing		-	-
Cement Mixing, %	-	-	-	-	-	-	-	-	-	-	-	2.0
Demulsibility 50 cc of N/10 $CaC1_2$, %	-	-	-	-	-	-	-	-	-	70	-	-
Demulsibility 33 cc of N/50 $CaC1_2$	60	-	60	-	-	30	-	30	-	-	-	-
Settlement, 5 days, %	-	5.0	-	5.0	-	5.0	-	5.0	-	5.0	-	5.0
Freezing Test 3 Cycle	-	-	-	-	Passing*		Passing*		Passing*		Passing*	
Test Residue: Penetration at 77°F, 100 g, 5 sec	120	160	80	110	120	160	80	110	120	160	120	160
Solubility in Trichloroethylene, %	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-
Ductibility at 77°F 5 cm/min, cms.	100	-	100	-	100	-	100	-	100	-	100	-

*Applies only when Owner designates material for winter use

TABLE NO. 7 (Continued)

Cationic Emulsion												
Type - Grade	**Rapid Setting**				**Medium Setting**				**Slow Setting**			
	EA-CRS-2		**EA-CRS-2h**		**EA-CMS-2**		**EA-CMS-2h**		**EA-CSS-1**		**EA-CSS-1h**	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Tests on Emulsions:												
Viscosity, Saybolt Furol at 77°F, C	-	-	-	-	-	-	-	-	20	100	20	100
Viscosity , Saybolt Furol at 122°F, sec	100	300	100	300	100	300	100	300	-	-	-	-
Settlement, 5 days, %	-	5	-	5	-	5	-	5	-	5	-	5
Storage stability test, **1day, %	-	1	-	1	-	1	-	1	-	1	-	1
Demulsibility, ***35 ml 0.8 % sodium Dioctyl Sulfosuccinate, %	40	-	40	-	-	-	-	-	-	-	-	-
Coating, ability and water resistance												
Coating, dry aggregate	-	-	-	-	Good	Good	-	-	-	-	-	-
Coating, after spraying	-	-	-	-	Fair	Fair	-	-	-	-	-	-
Coating, wet aggregate	-	-	-		Fair	Fair	-	-	-	-	-	-
Coating, after spraying	-	-	-	-	Fair	Fair	-	-	-	-	-	-
Particle change test	Positive		Positive		Positive		Positive		Positive		Positive	
Sieve test, %	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10
Cement mixing test, %	-	-	-	-	-	-	-	-	-	2.0	-	2.0
Distillation: Oil distillate, by volume of emulsion	-	3	-	3	-	12	-	12	-	-	-	-
Residue, %	60	-	65	-	65	-	65	-	60	-	60	-
Tests on Residue from Distillation Test:												
Penetration, 77°F, 100 g., 5 sec	120	160	80	110	120	160	80	110	120	160	80	110
Ductility, 77°F, 5 cm/min., cm	100	-	100	-	100	-	100	-	100	-	100	-
Solubility in Trichloroethylene, %	98	-	98	-	97.5	-	97.5	-	97.5	-	97.5	-
Ash, %	-	-	-	-	-	2.0	-	2.0	-	2.0	-	2.0

* The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days' time; or the Owner may require that the settlement test be run from the time the sample is received until it is used, if the elapse is less than 5 days.

** The 24-h (1-day) storage stability test may be used instead of the 5-day settlement test.

***The demulsibility test shall be made within 30 days from the date of shipment.

7. Catalytically Blown Asphalt Joint and Crack Sealer

a. General - Catalytically blown asphalt shall be uniformly blended with 10 percent diatomaceous earth filler, which passes No. 325 sieve. It shall form a suitable joint and crack sealer, which may be melted to pouring consistency in the regular asphalt kettle at a temperature of approximately 450°F to 475°F. Requirements for the material shall be in accordance with *Table No. 8, Requirements for Catalytically Blown Asphalt Joint and Crack Sealer.*

b. Rejection - Catalytically blown asphalt joint and crack sealer material may be rejected for failure to meet all of the requirements of this specification.

TABLE NO. 8
REQUIREMENTS FOR CATALYTICALLY BLOWN ASPHALT JOINT AND SEALER

Type – Grade	68-88 Pen.		38-45 Pen.	
	Min	Max	Min	Max
Penetration, 77°F, 100 g, 5 sec	68	88	38	45
Penetration, 32°F, 200 g, 60 sec	38	-	-	-
Penetration, 115°F, 50 g, 5 sec	-	160	-	-
Softening Point, R & B, °F	175	200	185	200
Flash, C.O.C., °F	500	-	500	-
Ductility 77°F, 5 cm/min, cms	5	-	3	-
Flow, 140°F, cm	-	0.5	-	0.5
Ash, Weight, %	8	-	8	-
Settlement Ratio	-	1.02	-	1.02
Brittleness Test, 32°F	No Cracking		No Cracking	

B. TESTS AND CERTIFICATION OF BITUMINOUS MATERIALS

When tested according to ASTM or AASHTO test methods, the various materials shall meet the applicable requirements of this specification. At the time of delivery of each shipment of asphalt, the vendor supplying the material shall deliver to the Contractor certified copies of the test report. Two copies of the test reports shall be furnished to the Owner. The test reports shall indicate the name of the vendor, type and grade of asphalt delivered, date and point of delivery, quantity delivered, delivery ticket number, purchase order number, and results of the specified tests. The test report, signed by an authorized representative of the vendor, shall certify that the product delivered conforms to the specifications for the type and grade indicated. The certified test reports and the testing required in connection with the reports shall be at no cost to the Owner.

Until the certified test reports and samples of the material have been checked by the Owner to determine their conformity with the prescribed requirements, the material to which such report relates and any work in which it may have been incorporated as an integral component, shall be only tentatively accepted by the Owner. Final acceptance shall be dependent upon the determination by the Owner that the material involved fulfills the prescribed requirements.

C. EQUIPMENT
Not Applicable

PART 3: EXECUTION

A. STORAGE, HEATING AND APPLICATION TEMPERATURES

1. General - Asphalt materials should be applied at the temperature, which provides proper and uniform distribution with a maximum temperature of 340°F. Within practical limits, higher temperatures than necessary should be avoided. Satisfactory application should be obtained within the recommended ranges shown in *Table No. 9, Requirements for Storage, Heating and Application Temperature*. No material shall be heated above the maximum temperature shown.

Table No. 9
Requirements for Storage, Heating and Application Temperature

Type - Grade	Application and Mixing		Heating
	Recommended Range, °F	Maximum Allowable, °F	Storage Maximum, °F
AC-3, 5, 10, 20, 40, OA-175	275-325	340	400
OA-30	400-500	500	500
OA-400	220-300	350	350
RC-1	100-150	175	175
RC-2	125-180	200	200
RC-250	150-200	210	210
RC-3	160-210	230	230
RC-4	180-240	270	270
RC-5	215-270	285	285
MC-30	70-150	175	175
MC-70	125-175	200	200
MC-250	125-210	240	240
MC-800	175-260	275	275
MC-3000	225-275	290	290
EA-10S, EA-11M, EA-CSS-1, EA-CSS-1h	50-130	140	140
EA-HVRS, EA-HVMS, EA-HVRS-90, EA-HVMS-90, EA-DRS-2, EA-CRS-2h, EA-CMS-2. EA-CMS-2h	110-150	160	160
Catalytically Brown Asphalt	425-475	500	500

NOTE: Heating of asphaltic materials (except emulsions) constitutes a fire hazard to various degrees. Proper precautions should be used in all cases and especially with RC cutbacks.

2. Rejection - Materials provided that do not meet the requirements of this specification for storage, heating and application of asphaltic materials may be rejected.

NOTE: *Heating of asphaltic materials (except emulsions) constitutes a fire hazard to various degrees. Proper precautions should be used in all cases and especially with RC cutbacks.*

WARNING TO CONTRACTORS: Attention is called to the fact that asphaltic materials are highly flammable. The utmost care shall be taken to prevent open flames from coming in contact with the asphaltic materials or the gases of it. The Contractor shall be responsible for any fires or accidents, which may result from heating the asphaltic materials.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

All asphaltic materials included in this specification shall be measured and paid for in accordance with the governing specifications for the items of construction in which these materials are used.

SECTION 3.2: Tack Coat

PART 1: GENERAL

A. DESCRIPTION

This item shall govern the application of asphaltic material on completed base courses, existing pavement, bituminous surface, bridge deck, slab or prepared surface as indicated on the Drawings and as directed by the Owner.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

1. Tack Coat - The asphaltic material for tack coat may be either rapid curing cut-back asphalt RC 2 diluted by the addition of (not to exceed 15 percent by volume) an approved grade of gasoline and/or kerosene; emulsified asphalt, EA-11M diluted with 50 percent water, or a cut-back asphalt made by combining 50 to 70 percent of the asphaltic material specified for the paving mixture with 30 to 50 percent gasoline and/or kerosene by volume. Requirements for rapid curing cut-back asphalt or emulsified asphalt are shown on Table Nos. 5, 6, and 7.

Rapid curing cut-back asphalt or emulsified asphalt are shown on the preceding Table Nos. 5 and 7.

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Tack coat shall not be applied when the air temperature is below 50 degrees Fahrenheit and falling, but it may be applied when the air temperature is above 40 degrees Fahrenheit and is rising, the air temperature being taken in the shade and away from artificial heat. Asphaltic material shall not be placed when general weather conditions, in the opinion of the Owner, are not suitable.

Before the tack coat is applied, the surface shall be cleaned thoroughly to the satisfaction of the Owner. The tack coat shall consist of one application of the asphaltic material indicated; and shall be at the rate of one-tenth (0.10) gallons per square yard of surface area. The tack coat shall completely cover the area to be paved, and if emulsion is used, the emulsions shall break before paving operations begin. The surfaces of curbs, gutters, vertical faces of existing pavements and all structures in actual contact with asphaltic mixes shall be painted with a thin, complete coating of asphaltic material to provide a closely bonded, watertight joint. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutters, or structures. The Contractor shall clean splattered areas.

In those instances where the pavement mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Owner and Engineer. A prime coat must have been previously applied and in good condition, as approved

by the Owner, in order to eliminate the use of a tack coat. If the prime coat has been damaged a tack coat shall be applied where needed.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Tack coat shall not be measured for direct payment, but shall be considered as subsidiary work pertaining to the placing of asphaltic mixtures of the type specified.

SECTION 3.3: Hot-Mix Asphalt Concrete Pavement

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of a binder course, a leveling up course, a surface course or a combination of these courses as shown on the plans; shall be composed of a compacted mixture of mineral aggregate and asphaltic material; and shall be constructed on the previously completed and approved subgrade, sub-base course, base course, existing pavement, or in the case of a bridge, on the prepared floor slab, all in accordance with the specifications and in conformity with the lines, grades, quantities and typical sections as stated in the contract and/or established in the field by the Owner.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Mineral aggregates shall consist of a fine aggregate, coarse aggregate and a mineral filler Where required, representative samples of the materials proposed to be used in the mixture shall be submitted for tests in the quantities required by the Owner. Only materials conforming to the requirements of *Item A.1, Aggregates for Hot-Mix Asphaltic Concrete, of Section 3.3 Part 2* and approved by the Owner shall be used in the work. The materials, proposed to be used, may be inspected and tested at any time during the preparation of the work. If the sources of supply, which have been approved, do not furnish a uniform product, or if the product from any source proves unacceptable at any time, the Contractor shall furnish approved materials from other approved sources. No material, which after approval has in any way become unfit for use shall be used in the work. Approval of both the materials and sources of supply must be obtained from the Owner prior to delivery of the material.

The asphalt shall conform to the applicable paragraphs of *Section 3.1, Asphalts, Oils, and Emulsions*, and shall be the grade specified, shown on the plans, or as designated by the Owner after design tests have been made, using the mineral aggregates proposed to be used in the mixture. It shall be the grade of asphalt having the highest penetration, within the specified limits, that shall produce a mix having a maximum stability of the compacted mixtures as determined by laboratory tests for resistance to displacement of the compacted courses.

1. Aggregates for Hot-Mix Asphaltic Concrete (HMAC)

a. General Requirements

(1) General - Aggregates shall conform to the requirements contained in this section and shall be approved by the Owner prior to use. The integrity of the aggregate shall be such as to produce a workable HMAC material within the limits contained in this specification.

(2) Tests - Tests of aggregates, when required, shall be made in accordance with the applicable current ASTM Standards and Test Methods of the Texas Department of Transportation (TxDOT). The tests used for HMAC aggregates are as follows:

ASTM DESIGNATIONS	
C 131	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine (Tex-401-A)
C 136	Sieve Analysis of Fine and Coarse Aggregate (Tex-200-F)
D 2419	Sand Equivalent Value of Soils and Fine Aggregate (Tex-106-E)
D 4318	Method of Calculating the Plasticity Index of Soils (Tex 106-E)

TxDOT TEST METHODS	
Tex-217-F	(I & II) Determination of Deleterious Material and Decantation Test for Coarse Aggregates
Tex-413-A	Determination of Deleterious Material and/or Crushed Particles in Mineral Aggregate
Tex-203-F	Except where iron ore topsoil is used, combined mineral aggregate, after final processing by the mixing plant and prior to addition of asphalt and mineral filler, shall have a sand equivalent value of not less than 45 unless otherwise shown on plans. Mineral aggregates from each source shall meet the quality tests specified hereafter unless otherwise specified on the plans.

(3) Rejection - Aggregates which fail to meet the requirements of these specifications may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Aggregates sources from which materials with properties not meeting these specifications are delivered may be rejected as further supply sources to the project by the Owner. Such rejection shall incur no cost to the Owner.

b. Sand

(1) General - Sand material shall constitute a part of the fine aggregates for HMAC.

(2) Deleterious Substances - The sand used as fine aggregates shall be free from loam, clay balls or other injurious foreign matter.

(3) Tests - The plasticity index of that portion of the fine aggregates sand passing the No. 40 sieve shall not be more than eight when tested in accordance with ASTM D 4318.

(4) Gradation - Fine aggregate sand shall be that portion of the sand in the total aggregate passing the No. 10 sieve. It shall be well graded and composed of sound, durable sand particles.

c. Stone Screenings

(1) General - Stone screenings may constitute part or all of the fine aggregates for HMAC. Screenings shall be of the same or similar material for coarse aggregates.

(2) Deleterious Substances - The screenings shall be free from loam, clay balls or other injurious foreign matter.

(3) Tests - The plasticity index of that part of the fine aggregates passing the No. 40 sieve shall not be more than six when tested in accordance with ASTM D 4318. Fine aggregates from each source shall meet plasticity requirements.

(4) Gradation - The stone screening shall meet the following grading requirements unless otherwise shown on the plans:

	Percent by Weight or Volume
Passing ⅜-in. sieve	100%
Passing No. 200	0 to 30%

When authorized by the Owner, stone screenings containing particles larger than ⅜ inch may be used, but only that portion of the material passing the ⅜ inch sieve shall be considered as fulfilling the requirements for screenings when a minimum percent of screenings is specified for a particular mixture.

(5) Additional Requirements - Where limestone rock asphalt screenings are specified for use, they shall be screenings resulting from crushing operation.

(6) Rejection - Sand which fails to meet the requirements of these specifications may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Sand sources, from which materials with properties not meeting these specifications are delivered, may be rejected as further supply sources to the project by the Owner. Such rejection shall incur no cost to the Owner.

d. Coarse Aggregates

(1) General - Coarse aggregates shall consist of clean, tough, durable fragments of crushed stone, crushed gravel or gravel as specified herein, of uniform quality throughout.

(2) Deleterious Substances - The coarse aggregates shall be free from clay, organic or other injurious matter occurring either free or as a coating on the aggregates.

(3) Tests - Material removed by decantation in accordance with TxDOT Test Method Tex-217-F (Part 2, Decantation) shall not be more than two percent. The stone or gravel from which the aggregates are made shall have an abrasion of not more than 40 for all courses except the non-skid surface course, which shall have an abrasion of not more than 35. These figures may be calculated in accordance to the Los Angeles Abrasion Test, Test Method 410A.

(4) Gradation - The coarse aggregates shall be that portion of the total aggregates retained on the No. 10 sieve. The crushed gravel shall be so crushed that not less than 70 percent of the particles shall have two or more crushed faces. The use of uncrushed gravel shall be permitted only in the coarse binder course.

(5) Additional Requirements - When it is specified that the coarse aggregates be sampled from the hot bins and tested in accordance with TxDOT Test Method Tex-217-F (Part 2, Decantation), the amount of material removed shall not exceed one percent.

(6) Rejection - Coarse aggregates which fail to meet the requirements of these specifications may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Coarse aggregates sources from which materials with properties not meeting these specifications are delivered may be rejected as further suppliers to the project by the Owner. Such rejection shall incur no cost to the Owner.

e. Mineral Filler

(1) General - Mineral filler shall consist of a thoroughly dry stone dust portland cement or other mineral dust approved by the Owner.

(2) Deleterious Substances - The mineral filler shall be free from foreign and other injurious matter.

(3) Gradation - When tested by the method outlined in TxDOT Test Method Tex-200-F (Part 1 or Part 3 as applicable), it shall meet the following percentages by weight:

Passing No. 30 sieve	95 - 100%
Passing No. 80 sieve Not Less Than	75%
Passing No. 200 sieve Not Less Than	55%

(4) Rejection - Mineral filler which fails to meet the requirements of these specifications may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Mineral filler sources, from which materials with properties not meeting these specifications are delivered, may be rejected as further suppliers to the project by the Owner. Such rejection shall incur no cost to the Owner.

B. PAVING MIXTURE

The paving mixtures shall consist of a uniform mixture of coarse aggregate, fine aggregate, mineral filler, when required, and asphaltic material, accurately proportioned by

weight. The grading of each constituent shall be such as to produce, when properly proportioned, a mixture conforming to the following limitations for grading of the type specified. The exact proportions of each constituent producing the total aggregate within these limits shall be as directed by the Owner, and when tested by standard laboratory methods, the mixture shall conform to the master grading limits shown in the following table for the type mix specified on the plans.

MASTER GRADING
Percent Passing by Weight or Volume

Sieve Size	Type				
	A	B	C	D	F
	Coarse base	Fine Base	Coarse Surface	Fine Surface	Fine Mixture
1½"	100	---	---	---	---
1¼"	95-100	---	---	---	---
1"	---	100	---	---	---
7/8"	70-90	95-100	100	---	---
5/8"	---	75-95	95-100	---	---
½"	50-70	---	---	100	---
3/8"	---	60-80	70-85	85-100	100
¼"	---	---	---	---	95-100
No. 4	30-50	40-60	43-63	50-70	---
No. 10	20-34	27-40	30-40	32-42	32-42
No. 40	5-20	10-25	10-25	11-26	9-24
No. 80	2-12	3-13	3-13	4-14	3-13
No. 200	1-6*	1-6*	1-6*	1-6*	1-6*
VMA % minimum	11	12	13	14	15

* 2-8 when Test Method Tex-200-F, Part II (Washed Sieve Analysis) is used.

Asphalt for the paving mixture shall be of the type and grade of asphaltic cement specified in the mix design approved by the Owner and shall meet the requirements of *Item A.1, Oil Asphalt, of Section 3.1 Part 2*. If more than one type of asphaltic concrete mixture is specified for the project, only one grade of asphalt shall be required for all types of mixtures, unless otherwise shown on the plans. The Contractor shall notify the Owner of the source of his asphaltic material prior to production of the asphaltic mixture and prior to the paving of this course of the project except on written permission of the Owner.

C. EXTRACTION TEST

When required by the Owner, samples of the asphaltic mixture may be taken from the plant, trucks or finished pavement for check tests. The minimum weight of the test specimen in grams shall be 3000 times the maximum size of aggregate in inches, and when tested in accordance with Recovery of Asphalt from Solution by Abson Method and Quantitative Extraction of Bitumen from Bituminous Paving Mixtures, ASTM Designations D 1856 and D 2172, respectively, it shall not vary from the grading proportions specified for the mixture being used by more than five percent. . The percentages of asphalt shall not vary more than 0.5 percent from the proportions established by the Owner.

D. EQUIPMENT

All equipment necessary for the construction of the hot-mix asphaltic concrete pavement shall be on the project and shall be approved by the Owner as to condition before the Contractor shall be permitted to begin construction operations on which the equipment is to be used.

1. Spreading and Finishing Machine - The spreading and finishing machine shall be of a type approved by the Owner and capable of producing a surface that shall meet the requirements of the typical cross section and surface test.

2. Rollers

a. Pneumatic Tire Roller - This roller shall consist of not less than seven pneumatic tire wheels, running on axles in such manner that the rear group of tires shall cover the entire gap between adjacent tires of the forward group; mounted in a rigid frame; and provided with a loading platform or body suitable for ballast loading. The front axle shall be attached to the frame in such manner that the roller may be turned within a minimum circle. The tire shall afford surface contact pressures up to 90 pounds per square inch or more. The roller shall be so constructed as to operate in both a forward and a reverse direction with suitable provisions for moistening the surface of the tires while operating; and shall be approved by the Owner.

b. Two Axle Tandem Roller - This roller shall be acceptable power-driven, steelwheel, tandem roller weighing not less than eight tons. It must operate in forward and reverse directions; contain provisions for moistening the surface of the wheels while in motion; and shall be approved by the Owner.

c. Vibratory Steel Wheel Roller - If approved for use by the Owner, this roller shall have a minimum weight of six tons. The compactor shall be equipped with amplitude and frequency controls and shall be specifically designed to compact the material on which it is used. It shall be operated in accordance with the manufacturer's recommendation.

d. Temperature – All rolling shall be completed prior to the asphaltic material reaching 185º F.

3. Straightedges - The Contractor shall provide acceptable 16-foot straightedges for the surface testing. Satisfactory templates shall be provided as required by the Owner.

All equipment shall be maintained in good repair and operating condition.

E. STABILITY

The asphaltic mixtures when tested in accordance with the current methods outlined in ASTM D1559 (Marshall Method), shall have the following laboratory density and stability:

Density (%)	75 blows per side
Minimum	94
Maximum	98
Optimum	96
Stability	1800 min
Flow	8 to 12

If the mixture produced does not have the specified qualities, the mixture shall be changed until it does conform to the specified qualities.

F. TESTS

Test for abrasion of aggregate shall be in accordance with the test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine, ASTM Designation C 131.

Test for distillation of cut-back asphalt shall be in accordance with the test for Distillation of Cut-Back Asphaltic (Bituminous) Products, ASTM Designation D 402.

Test for flash of cut-back asphalt shall be in accordance with the test for Flash Point by Tag Closed Tester, ASTM Designation D 56.

Test for emulsified asphalt shall be in accordance with Emulsified Asphalts, ASTM Designation D 244, except as modified.

Sieve analysis of aggregates shall be in accordance with the test for Sieve Analysis of Fine and Coarse Aggregates, ASTM Designation C 136.

G. REJECTION

Asphaltic concrete may be rejected for failure to meet all of the requirements of this specification.

H. TESTING

Refer to *Section 3.7, Materials Testing*.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. General - The prime coat, tack coat or the asphaltic mixture shall not be placed when the air temperature is below 50 degrees Fahrenheit and is falling; but may be placed when the air temperature is above 40 degrees Fahrenheit and is rising, the temperature being taken in the shade and away from artificial heat; **with the provision that the asphaltic mixture shall be placed only when the humidity, general weather conditions, and temperature and moisture condition of the base, in the opinion of the Owner, are suitable.**

2. Tack Coat - Tack coat shall conform to the requirements of *Section 3.2, Tack Coat.*

3. Compacted Thickness of Asphaltic Concrete Surface Courses and Base Courses

a. Surface Courses - The compacted thickness or depth of the asphaltic concrete surface course shall be as shown on the plans. Where the plans require a depth or thickness of the surface course greater than two inches compacted depth, same shall be placed in multiple courses of equal depth, each of which shall not exceed two inches compacted depth. If, in the opinion of the Owner, an additional tack coat is considered necessary between any of the multiple courses, it shall be applied at the rate as directed.

b. Base Courses - The compacted thickness or depth of each base course shall be as shown on the plans. Where the plans require a depth or thickness of the course greater than 4 inches, same shall be accomplished by constructing multiple lifts of approximately equal depth, each of which shall not exceed these maximum compacted depths. If, in the opinion of the Owner, an additional tack coat is considered necessary between any of the multiple lifts, it shall be applied as hereinbefore specified and at the rate as directed.

4. Transporting Asphaltic Concrete - The asphaltic mixture shall be hauled to the job site in tight vehicles previously cleaned of all foreign material. The dispatching of vehicles shall be arranged so that all material delivered shall be placed and all rolling shall be completed during daylight hours. In cool weather, or for long hauls, canvas covers may be required. The inside of the truck body may be given a light coating of oil, if necessary, to prevent the asphaltic mixture from adhering to the body. Diesel oil will not be allowed. In situations where the weather is bad a canvas tarp is required.

5. Temperature - The asphaltic mixture shall be at a temperature between 290 and 340 degrees Fahrenheit when dumped from the mixer. The Owner shall determine the temperature, within the above limitations.

6. Placing - The asphaltic mixture shall be placed on the approved base course with the previously specified spreading and finishing machine in such manner that, when properly compacted, the finished course shall comply with the maximum thickness requirements, shall be smooth, of uniform density, and meet the requirements of the typical cross sections and the surface test. During the placing and spreading of the asphaltic material, care shall be taken to prevent the spilling of the material onto adjacent pavement, gutters or structures.

In small areas, which are inaccessible to the spreading and finishing machine, hand spreading may be authorized by the Owner, provided an acceptable surface can be obtained.

7. Compaction - Rolling with tandem rollers shall start longitudinally at the sides and proceed toward the center of the surface course, overlapping on successive trips by at least half the width of the rear wheels. Alternate trips of the roller shall be slightly different in length. Rolling with the pneumatic tire roller shall be done as directed by the Owner. Rolling shall continue until no further compression can be obtained and all roller marks are eliminated. The motion of the rollers shall be slow enough at all times to avoid displacement of the asphaltic surface material. If displacement should occur, it shall be corrected at once by the use of rakes and fresh asphaltic mixtures where required. The roller shall not be allowed to stand on adhesion of the surface course to the roller, the wheels shall be kept thoroughly moistened with water, but an excess of water shall not be permitted. All rollers must be in good mechanical condition. All necessary precautions shall be taken to prevent the dripping of gasoline, oil, grease or other foreign matter on the surface course while the rollers are in motion or when standing. In areas where the surface course cannot be compacted with the rollers, hand tamps, lightly oiled shall be used to secure the required compaction.

With approval by the Owner, the vibratory steel wheel roller may be substituted for the 3-wheel roller and tandem roller. Each course, after final compaction, shall have a density of not less than 95 percent of the density developed in the laboratory test method outlined in ASTM 1559 (Marshall Method)

8. Surface Tests - The finished surface of the pavement after compression shall be smooth and true to the established line, grade and cross section. When tested with a 16-foot straightedge placed parallel to the centerline of the roadway, the finished surface shall have no deviation in excess of $^{1}/_{8}$th inch per foot from the nearest point of contact. The maximum ordinate measured from the face of the straightedge shall not exceed ¼th inch at any point. Any point in the pavement surface not meeting these requirements shall be immediately corrected.

9. Pavement Thickness Test - Upon completion of the work and before final acceptance and final payment shall be made, pavement thickness test shall be made by the Owner or his authorized representative unless otherwise specified in the special provisions or in the plans. The number and location of tests shall be at the discretion of the Owner. The cost for the initial pavement thickness test shall be at the expense of the

Owner. In the event a deficiency in the thickness of pavement is revealed during normal testing operations, subsequent tests necessary to isolate the deficiency shall be at the Contractor's expense. The cost for the additional coring test shall be at the same rate charged by commercial laboratories.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Hot-mix asphaltic concrete material shall be measured by the square yard or ton (2000 lbs.) complete in place of the type or types used in the completed and accepted work. Weight shall be determined by a certified scale approved by the Owner and recorded on serially numbered weight tickets, identifying the vehicle and presented to the Owner's representative on the job. Work performed and materials furnished as prescribed by this item and measures as specified in this item shall be paid for at the contract unit price bid, for the type or types of courses and mixtures as shown on the proposal, which price shall be payment in full for quarrying; furnishing all materials; for all heating; mixing; hauling; cleaning existing base course or pavement; placing asphaltic mixtures; rolling and finishing; and for all labor, tools, equipment and incidentals necessary to complete the work, including the work and materials involved in the application of prime coat and tack coat.

SECTION 3.4: Warm-Mix Asphalt Concrete Pavement

This section is reserved.

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SECTION 3.5: Slurry Seal

Part 1: GENERAL

A. DESCRIPTION

The work covered by this specification includes the design, testing, construction, and quality control required for the proper application of an emulsified asphalt slurry seal surface (slurry seal).

The slurry seal shall consist of a mixture of an approved emulsified asphalt, mineral aggregate, water and specified additives, proportioned, mixed and uniformly spread over a properly prepared surface as directed by the Owner. The completed slurry seal shall leave a homogeneous mat, adhere firmly to the prepared surface, and have a skid resistant surface, and have a skid resistant surface texture.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. APPLICABLE SPECIFICATIONS

1. General - The following specifications and test methods form a part of this specification.

2.

AASHTO – American Association of State Highway and Transportation Officials.
ASTM – American Society for Testing and Materials.
ISSA – International Slurry Seal Association.

a. Aggregate and Mineral Filler

AASHTO T2	ASTM D75	- Sampling Mineral Aggregates
AASHTO T27	ASTM C136	- Sieve Analysis of Aggregates
AASHTO T11	ASTM C117	- Materials Finer than 200 in Mineral Aggregate
AASHTO T176	ASTM D2419	- Sand Equivalent Value of Soils and Fine Aggregate
AASHTO T84	ASTM C128	- Specific Gravity and Absorption of Fine Aggregate
AASHTO T19	ASTM C29	- Unit Weight of Aggregate
AASHTO T96	ASTM C131	- Resistance of Abrasion of Small Size Coarse Aggregate by use of the Los Angeles Machine
AASHTO T127	ASTM C183	- Sampling Hydraulic Cement
AASHTO T37	ASTM D546	- Sieve Analysis of Mineral Filler
AASHTO T104	ASTM C88	- Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
	ASTM D242	- Mineral Filler for Bituminous Paving Mixtures

b. Emulsified Asphalt

AASHTO T40	ASTM D140	- Sampling Bituminous Materials
AASHTO M140	ASTM D977	- Specification for Emulsified Asphalt
AASHTO M208	ASTM D2397	- Specification for Cationic Emulsified Asphalt
	ISSA T102	- Mixing, Setting and Water Resistance Test to Identify "Quick-Set" Emulsified Asphalts
AASHTO T59	ASTM D244	- Testing Emulsified Asphalt

c. Residue from Emulsion

AASHTO T59	ASTM D244	- Residue by Evaporation
AASHTO T49	ASTM D2397	- Penetration 100 gm at 5 sec. 77° (25°C)

d. Slurry Seal

ISSA T101	-	Guide to Sampling Slurry Mix for Extraction Test
ISSA T106	-	Measurement of Slurry Seal Consistency
ISSA T109	-	Test Method for Measurement of Excess Asphalt
ISSA T111	-	Outline Guide Design Procedure for Slurry Seal
ISSA T112	-	Method of Estimate Slurry Seal Spread Rates and to Measure Pavement Macro-Texture
ISSA T114	-	Wet Stripping Test for Cured Slurry Seal Mixes
ISSA T115	-	Determination of Slurry Seal Compatibility
ASTM D3910	-	Design, Testing and Construction of Slurry Seal
ASTM D2172	-	Quantitative Extraction of Bitumen for Bituminous Paving Mixtures
ISSA T139	-	Test Methods to Classify Emulsified Asphalt/Aggregate Mixture Systems by Modified Cohesive Tester Measurement of Set and Cure Characteristics.

B. MATERIALS

1. Emulsified Asphalt - The emulsified asphalt shall conform to CQS-1h as specified in AASHTO M208. The cement mixing is waived.

a. Quality Tests

Test	Quality	Spec
AASHTO T59 ASTM D244	Residue after Distillation	60% min
	TEST ON RESIDUE	
AASHTO T49 ASTM 2397	Penetration at 77°F (25°C)	*40-90

*Climate conditions should be considered when establishing this band.

Each load of emulsified asphalt shall be accompanied with a certificate of analysis/compliance to assure that it is the same as that used in the mix design.

2. Aggregate

a. General - The mineral aggregate shall be manufactured crushed stone such as granite, slag, limestone, or other high quality aggregate or a combination thereof. To assure the material is totally crushed, 100% of the parent aggregate will be larger than the largest stone in the gradation to be used**.**

b. Quality Tests - When tested according to the following tests, aggregates shall meet the following requirements:

Test	**Quality**	**Spec**
ASSHTO T176 or ASTM 2149	Sand Equivalent	65 min.
AASHTO T104 or ASTM C88	Soundness	15% max using NA2SO4 or 25% max using Mg SO4
AASHTO T96 or ASTM C131	Abrasion Resistance	35% max

c. Grading - When tested by AASHTO T27 (ASTM C136) and AASHTO T11 (ASTM C117) the aggregate (including mineral filler) shall meet the following gradation:

Sieve Size	Type 11 Mod. Percent Passing	Stockpile Tolerance
3/8	100	±5%
No. 4	90-100	±5%
No. 8	65-90	±5%
No. 16	25-46	±5%
No. 30	15-35	±5%
No. 50	10-25	±4%
No. 100	5-15	±3%
No. 200	5-15	±2%

The job mix (target) gradation shall be within the gradation band for the desired type. After the target gradation has been submitted (this should be the gradation that the mix design is based on) then the percent passing each sieve shall not vary by more than the stockpile tolerance and still remain within the gradation band.

The aggregate will be accepted at the job location or stockpile. The stockpile shall be accepted based on five gradation tests according to AASHTO T2 (ASTM D75). If the average of the five tests is within the gradation tolerances, then the materials will be accepted. If the tests show the material to be out, the contractor will be given the choice to either remove the material or blend other aggregates with the stockpiles material to bring it into specifications. Materials used in blending must meet the quality test before blending and must be blended in a manner to produce a consistent gradation. This may require a

new mix design. Screening shall be required at the stockpile if there are any problems created by having oversize materials in the mix.

3. Mineral Filler - Portland cement, hydrated lime, limestone dust, flyash or other approved filler meeting the requirements of ASTM D242 shall be used if required by the mix design. They shall be considered as part of the dry aggregate.

4. Water - All water shall be potable and compatible with the slurry mix. Compatibility must be insured by the Contractor.

5. Additives - Additives may be used to accelerate or retard the break-set of the slurry seal, or improve the resulting finished surface. The use of additives in the slurry mix (or individual materials) shall be made initially in quantities predetermined by the mix design with field adjustments if required, after approval by the Owner.

C. MATERIAL TESTING

1. General - Before work commences, the Contractor shall submit a signed original of a mix design covering the specific materials to be used on the project. This design must have been performed by a qualified laboratory. Previous lab reports covering the exact materials to be used may be accepted provided they were made during the calendar year. Once the materials are approved, no substitution will be permitted unless first tested and approved by the laboratory preparing the mix design.

2. Mix Design - The Contractor shall submit to the Owner for approval a complete mix design prepared and certified by the laboratory. Compatibility of the aggregate, emulsion, mineral filler, and other additives shall be verified by the mix design. The mix design shall be made with the same aggregate gradation that the contractor will provide on the project. Recommended tests and values are as follows:

Test	Description	Spec
ISSA T106	Slurry Seal consistency	
ISSA TB-139	Wet Cohesion	
(for quick-traffic	30 minutes min (set)	12kg-cm min
systems)	60 minutes min	20kg-cm min
ISSA TB-109	Excess Asphalt	50g/ft2 max
(for heavy traffic by LWT		(538 g/m2 max)
areas only)Sand Adhesion		
ISSA TB-114	Wet Stripping	Pass (90% min)
ISSA TB-100	Wet Track Abrasion Loss	
	One hour soak	75g/ft2 max
ISSA TB-113	*Mix Time	Controllable
		to 180 sec. min.

*The mixing test and set time test should be done at the highest temperatures expected during construction.

The wet track abrasion test is used to determine the minimum asphalt content.

The mixing test is used to predict how long the material can be mixed in the machine before it begins to break. It is more for information to be used by the Contractor than for the quality of the end product. It is however, a good field test to check for consistent sources of material, both emulsified asphalt and aggregate.

The laboratory shall also report the quantitative effects of moisture content on the unit weight of the aggregate (bulking effect). The report must clearly show the proportions of aggregate, mineral filler (min. and max.), water (min. and max.), additive(s) (usage), and asphalt emulsion based on the dry weight of the aggregate.

PART 3: EXECUTION

A. EQUIPMENT

1. **General -** All equipment, tools and machines used in the performance of this work shall be maintained in satisfactory working order at all times to ensure a high quality product.

2. **Slurry Mixing Equipment -** The slurry seal mixing equipment shall be a continuous flow mixing unit, either an individual unit that returns to the stockpile for reloading or a continuous run unit that is re-supplied on the job. All units must have suitable means of accurately metering each individual material being fed into the mixer. All feeding mechanisms must be continuous feed and proportioning must remain constant at all times. The units shall be equipped with approved devices so that the machine can be accurately calibrated, and the quantities of materials used during any on period can be estimated. In the event these metering devices stop working, the slurry unit(s) will stop the application process until they are fixed.

The mixer shall thoroughly blend all materials for form a homogeneous mass before leaving the mixer.

3. **Slurry Spreading Equipment -** The mixture shall be spread uniformly by means of a conventional surfacing spreader box attached to the mixer and equipped to agitate and spread the material evenly throughout the box. A front seal shall be provided insure no loss of the mixture at the road contact point. The rear seal shall act as final strike-off and shall be adjustable. The spreader box and rear strike-off shall be so designed and operated that a uniform consistency is achieved to produce a free flow of material to the rear strike-off. The spreader box shall have suitable means provided to side shift the box to compensate for variations in the pavement geometry. A secondary strike-off shall be provided to improve surface texture. The secondary strike-off shall have the same leveling adjustments as the spreader box. The primary and secondary strike-off shall be made of urethane rubber. A burlap drag will not be allowed.

4. **Auxiliary Equipment** - Suitable crack and surface cleaning equipment, barricading equipment, hand tools and any support equipment should be provided as necessary to perform the work.

B. MACHINE CALIBRATION AND VERIFICATION

1. **Calibration -** Each slurry seal mixing unit to be used in performance of the work shall be calibrated in the presence of the Owner prior to construction. No machine will be allowed to work on the project until the calibration has been completed and/or accepted.

2. **Verification -** Test strips will be made by each machine after calibration and prior to construction. Test strips shall be a portion of the project. Samples of the slurry seal will be taken and verification made as to mix consistency and proportioning. Verification of rate of application will also be made. Upon failure to any of the tests, additional test strips, at no cost to the Owner, will be required until each unit is authorized to work. Any unit failing to pass the tests after the third trail, will not be permitted to work on the project. Test strips must be accepted or rejected within 24 hours after application.

C. COMPOSITION, RATE OF APPLICATION AND TOLERANCES

1. **Composition -** All the component materials used in the mix design shall be representative of the materials proposed by the Contractor to be used on the project.

The percentages of each individual materials required shall be shown in the laboratory report. Adjustments may be required during the construction, based on the field conditions. The Owner will give final approval for all such adjustments.

The Owner shall approve the mix design and all slurry seal materials and methods prior to use. The component materials shall be within the following limits:

RESIDUAL ASPHALT	TYPE I – 10% - 16% TYPE II – 7.5% - 13.5% TYPE III – 6.5% - 12% Based on dry weight of aggregate.
MINERAL FILLER	0.5% - 2.0% Based on dry weight of aggregate.
ADDITIVES	As needed.
WATER	As needed to achieve proper mix consistency. Total mix liquids should not exceed the loose aggregate voids. ISSA T106 should be used to check optimum liquids.

2. **Rate of Application -** The slurry seal mixture shall be of proper consistency at all times so as to provide the amount of mixture required by the surface condition. The average application rate as measured by the Owner shall be a minimum of 16 to maximum of 18 lbs. Per s.y. based on dry aggregate weight.

The application rate must be a minimum of 16 lbs. Per s.y. based on dry

aggregate weight when tested by the City of Waco (in Place Paper Test) or other approved test methods satisfactory to the Engineer.

3. Tolerances - Tolerances for individual materials as well as the slurry seal mixture are as follows:

a. After the designed residual asphalt content is determined, a plus or minus one percentage point variation will be permitted.

b. The percentage of aggregate passing each sieve shall not vary more than ± 4.0% from the job mix formula.

c. The percent of aggregate passing shall not go from the high end to the low of the specified range of any two successive sieves.

d. The slurry consistency shall not vary more than ± 0.5 cm from the job mix formula after field adjustments.

e. The rate of application once determined by the Owner shall not vary more than ± 2 lbs per s.y. while remaining within the design application rate.

D. COMPOSITION, RATE OF APPLICATION AND TOLERANCES

1. Weather - The slurry seal shall not be applied if either the pavement or air temperature is below 55 degrees F (15 degrees C) and falling, but may be applied when both pavement and air temperature are above 45 degrees F (7 degrees C) and rising. No slurry seal shall applied when there is danger the finished product will freeze before 24 hours. The mixture shall not be applied when weather conditions prolong opening the traffic beyond a reasonable time.

2. Other - No slurry seal shall be applied before 8 A.M., and must be able to support traffic by 5 P.M. Weekend work is discouraged unless conditions warrant and is approved by the Engineer.

C. PREPARATION OF THE SURFACE

1. **General - I**mmediately prior to applying the slurry seal, the surface shall be cleared of all loose materials, silt spots, vegetation, oil spots and other objectionable material. Any standard cleaning method will be acceptable. If water is used, cracks will be allowed to dry thoroughly before slurry sealing. Manholes, valve boxes, drop inlets and other services entrances will be protected from the slurry seal by a suitable method. The Owner shall approve the surface preparation prior to sealing.

The Contractor shall remove and properly dispose of all debris, including any accumulations in the gutter lines.

D. APPLICATION

1. General - The surface shall be pre-wetted by fogging ahead of the slurry box when required by local conditions. Water used in pre-wetting the surface shall be applied such that the entire surface is damp with no apparent flowing water in front of the slurry box. The rate of application of the fog spray shall be adjusted during the day to suit temperatures, surface texture, humidity and dryness of the pavement surface.

The slurry mixture shall be of the desired consistency upon leaving the mixer and no additional materials shall be added. A sufficient amount of slurry shall be carried in all parts of the spreader at all times so that a complete coverage is obtained. Overloading of the spreader shall be avoided. No lumping, balling or unmixed aggregate shall be permitted.

No streaks, such as those caused by oversized aggregate, will be left in the finished surface. If excess oversize develops, the job will be stopped until the Contractor proves to the Owner that the situation has been corrected. Some situations may require screening the aggregate just prior to loading it into the units going from the stock pile are to the lay down operation.

2. Joints - No excessive buildup, uncovered areas or unsightly appearance shall be permitted on longitudinal or transverse joints. An excessive overlap will not be permitted on longitudinal joints. The Contractor shall provide suitable width spreading equipment to produce a minimum number of longitudinal joints throughout the project. When possible, longitudinal joints shall be placed on lane lines. Half passes and odd width passes will be used only in minimum amounts. If half passes are used, they should not be the last pass of any paved area. A maximum of 6” (152 mm) shall be allowed for overlap of longitudinal lane line joints.

3. Mix Stability - The slurry mixture shall possess sufficient stability so that premature breaking of the slurry seal in the spreader box does not occur. <u>The mixture shall be homogeneous during and following mixing and spreading, it shall be free of excess water or emulsion and free of segregation of the emulsion and aggregate fines from the coarser aggregate. Spraying of additional water into the spreader box will not be allowed.</u>

4. Hand Work - Areas which cannot be reached with the slurry seal machine shall be surfaced using hand squeegees to provide complete and uniform slurry seal coverage. The area to be hand worked shall be lightly dampened prior to mix placement and the slurry worked immediately. Care shall be exercised to leave no unsightly appearance from handwork. The same type finish as applied by the spreader box shall be required. Hand work shall be completed during the machine applying process.

5. Lines - Care shall be taken to insure straight lines along curbs and shoulders. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide a good appearance.

6. Rolling – Contractor shall roll final application in accordance with *Section 2.1*, *Rolling* unless otherwise authorized by the City Engineer.

7. Open to Traffic - The surface shall be suitable to open to rolling traffic within a period of 2 hours after placement.

8. Clean-up - All areas, such as man ways, gutters and intersections, shall have the slurry seal removed as specified by the Owner. The Contractor shall remove any debris associated with the performance of the work, on a daily basis.

E. QUALITY CONTROL

1. Materials - The Contractor will permit the Owner to take samples of the aggregate and asphalt and asphalt emulsion used in the project at the Owner's discretion. Gradation and sand equivalent tests may be run on aggregate and residual asphalt content tests on the emulsion. Test results will be compared to specifications. Tests will be run at the expense of the Owner. The Owner must notify the Contractor immediately if any test fails to meet the specifications.

2. Slurry Seal - Samples of the slurry seal will be taken directly from the slurry unit(s). Consistency and residual asphalt content tests may be made on the samples and compared to the specifications. Tests will be run at the expense of the Owner. The Owner must notify the Contractor immediately if any test fails to meet specifications.

3. Non-Compliance - If any two successive tests fails on the stockpile material, the job shall be stopped. It is the responsibility of the Contractor, at his own expense, to prove to the Owner that the conditions have been corrected. If any two successive tests on the mix from the same machine fail, the use of the machine shall be suspended. It will be the responsibility of the Contractor, at his own expense, to prove to the Owner that the problems have been corrected and that the machine is working properly.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

The slurry seal will be measured and paid for at the contract unit price per square yard, complete in place.

"Slurry Seal" shall be measured by the square yard of completed and accepted pavement. The price bid per square yard for slurry seal, as shown on the proposal, shall be full payment for furnishing and laying the slurry seal, and for all labor, equipment, materials, tools, and incidentals necessary to complete the work. Measurement for slurry seal shall be by the square measured in its final position.

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SECTION 3.6: Portland Cement Concrete Pavement

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of finished pavement constructed of portland cement concrete on the prepared subgrade or other base course, in conformity with the plans, as herein specified and as supplemented and/or amended by the "Special Provisions" and to the lines and grades as established by the Owner. Concrete shall be considered of satisfactory quality, provided it is: (a) made of materials accepted for the job; (b) in the proportions established by the Owner; and (c) mixed, placed, finished and cured in accordance with the requirements of this specification and the special provisions. All concrete pavement constructed on public thoroughfares shall conform to the provisions and requirements of these specifications.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

REFER TO *SECTION 5.1, CONCRETE AND REINFORCEMENT*.

1. Concrete - Concrete shall be Class A portland cement concrete as shown on the plans.

B. EQUIPMENT

Equipment for concrete pavement shall be in accordance with *Item C, Equipment, of Section 5.1 Part 2.*

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Placing and Removing Forms - Forms shall be set to line and grade a minimum of 200 feet, where practicable, in advance of paving operations. They shall be adequately staked with at least three pins per 10-foot section and capable of resisting the pressure of concrete placed against them and the thrust and the vibration of the construction equipment operating upon them without appreciable springing or settlement. Forms shall be jointed neatly and tightly and set with exactness to the established grade and alignment. Forms must be in firm contact with the subgrade throughout their length and base width. If the subgrade becomes unstable, forms shall be reset, using heavy stakes; or other additional supports may be necessary to provide the required stability.

a. Settling - When forms settle over one-eighth inch under finishing operations, paving operations shall be stopped, the forms reset to line and grade and the pavement then brought to the required section and thickness.

b. Cleaning and Oiling - Forms shall be thoroughly cleaned after each use and well oiled before reuse.

c. Removal - Forms shall remain in place until the concrete has been finished for a minimum of 24 hrs. At the time the forms are removed, earth shall be banked against the sides of the slab and immediately and thoroughly wetted.

d. Curb - Superimposed or monolithic curb shall be formed from the flowline of the gutter to the top of curb. All expansion joints in the curbs shall conform to the joint locations in the slab.

e. Placing Reinforcing Steel, Tie, and Dowel Bars - When reinforcing steel, tie bars, dowels, etc., are required, they shall conform to *Items A.6, Dowel Bars, and A.7, Steel Reinforcement of Section 5.1 Part 2* and shall be placed as shown on the plans. All reinforcing shall be clean, free from rust in the form of loose or objectionable scale, and of the type, size and dimensions shown on the plans. Reinforcing bars shall be securely wired together at all intersections and all splices and shall be securely wired to each intersected dowel and load-transmission unit intersected. All bars shall be installed in their required position as shown on the plans.

(1) Installation - All reinforcing bars and bar mats shall be installed in the slab at the required depth below the finished surface and supported by and securely attached to bar chairs installed on prescribed longitudinal and transverse centers as shown by sectional and detailed drawings on the plans. After the reinforcing steel is securely installed above the subgrade, as specifically required by plans and as herein prescribed, there shall be no loading imposed upon (or walking upon) the bar mats or individual bars before or during the placing or finishing of the concrete.

(2) Assembly - Expansion joints or dummy joints which may require an assembly of parts supported by special devices shall be completely assembled and rigidly supported in the correct position well in advance of the placing of concrete.

2. Joints

a. Expansion Joints - Expansion joints shall be installed perpendicularly to the surface and to the centerline of the pavement at the locations shown on the plans. Joint filler shall be of a premolded asphaltic type of approved quality; or redwood boards of the size and shape shown on the plans.

The oven-dry weight of the wood shall not exceed 30 pounds per cubic foot. Board joint material with less than 25 percent of moisture at the time of installation shall be thoroughly wetted on the job. Green lumber of much higher moisture content is desirable and acceptable.

(1) Joint Filler - The joint filler shall be appropriately drilled to admit the dowel bars when required. The bottom edge of the filler shall extend to or slightly below the bottom of the slab. The top edge shall be held approximately one-half inch below the finished surface of the pavement in order to allow the finishing operations to be continuous. Where the joint filler is of a premolded asphaltic type, the top edge shall be protected while the concrete is being placed and finished by a metal cap of at least 10-gauge material having flanges not less than 1½" in depth. The channel cap may remain in place during the joint finishing operations to serve as a guide for tooling the edges of the joint. After the removal of the side forms, the ends of the joints at the edges of the slab shall be carefully opened for the entire depth of the slab.

(2) Curb - Where a superimposed curb or a separate curb and gutter may be used, the expansion joints therein shall coincide and be continuous with the pavement joint and of the same size and type.

(3) Proximity to Existing Structures - When the pavement is adjacent to or around existing structures, expansion joints shall be constructed in accordance with the details shown on the plans.

(4) Dowel Bars - Dowel bars, where required on the plans, shall be installed through the predrilled joint filler and rigidly supported in true horizontal and vertical positions by an assembly of bar chairs and dowel holders welded to transverse bars extending across the slab and placed on each side of the joint. The chair assembly shall be similar and equal to that shown on the plans and shall be approved by the Owner prior to extensive fabrication.

b. Contraction Joints - Contraction or dummy joints shall be installed at the locations and at the intervals shown on the plans. The joints shall be constructed by sawing to a ¼" width and to the depth indicated on the plans. Joints shall be sawed into the completed pavement surface as soon after initial concrete set as possible to control cracking; but with enough elapsed time to prevent any damage by blade action to the slab surface and to concrete immediately adjacent to the joint. Any portion of the curing membrane, which has been disturbed by sawing operations, shall be restored by spraying the areas with additional curing compound. In the absence of joint sawing instructions on the plans, all sawing operations should be conducted and completed within that period of time from four to twenty four hours after the concrete slab is poured, including the sealing operation outlined in *Item A.10, Joint Sealing, of Section 5.1 Part 2*. The sawed groove shall be thoroughly cleaned for the full depth and width of the joint and filled as outlined in *Item A.9, Joint Filler, of Section 5.1 Part 2*. The type of equipment and methods for performing this work shall be approved by the Owner.

c. Construction Joints - Construction joints formed at the close of each day's work or when the placing of concrete has been stopped for 30 minutes or longer shall be constructed by use of metal or wooden bulkheads cut true to the section of the finished pavement and cleaned and oiled. Wooden bulkheads shall have a thickness of not less than 1½". Longitudinal bars shall be held securely in place in a plane perpendicular to the surface and at right angles to the centerline of the pavement. Edges shall be rounded to ¼" radius. Any surplus concrete on the subgrade shall be removed upon the resumption of the work.

In no case shall an emergency construction joint be placed within eight feet following a regular installation of expansion or contraction joint. If the emergency construction joint should fall within this limitation, the concrete shall be removed back to the previously installed joint.

d. Longitudinal Parting Strips - Longitudinal parting strips or planes of weakness, when required, shall be accurately placed as shown on the plans.

e. Longitudinal Construction Joints - Longitudinal construction joints shall be of the type shown on the plans. Longitudinal joints shall be constructed accurately to required lines in order to coincide with traffic lane lines. No width between longitudinal

construction joints shall exceed 24 feet, unless specifically authorized or directed by the Owner in writing.

3. Ready Mix - Mixing of concrete shall be in accordance with *Item C, Ready Mix, of Section 5.1 Part 3.*

4. Placing Concrete - The concrete shall be rapidly deposited on the subgrade in successive batches and shall be distributed to the required depth and for the entire width of the pavement by shoveling or other approved methods. Where bar mats are specified, see *Item A.2, Joints, of Section 3.6 Part 3* for method of concrete placement. Rakes shall not be used in handling concrete. The placing operation shall be continuous. At the end of the day, or in case of unavoidable interruption or delay of more than 30 minutes, a transverse construction joint shall be placed at the point of work stoppage, provided the point at which work has been suspended is not less than eight feet from the last regularly established joint. If the length is less than eight feet, the concrete shall be removed back to the last regularly established joint. Additional requirements for placing concrete are outlined in *Item E, Placing Concrete, of Section 5.1 Part 3.*

a. Honeycombing - Special care shall be taken in placing and spading the concrete against the forms and at all joints and assemblies so as to prevent honeycombing. Excessive voids and honeycombing in the edge of pavement, revealed by the removal of the side forms, may be cause for rejection of the section of slab in which the defect occurs.

b. Weather Conditions - The allowable weather conditions for placing concrete is outlined in *Item E.1, Weather Conditions, of Section 5.1 Part 3*

5. Finishing - Finishing of concrete pavement shall be done in accordance with *Item F, Finishing, of Section 5.1, Part 3.*

6. Hand - Hand finishing will be permitted with approval of the Engineer. The addition of one sack of cement per cubic yard shall be required for all hand-finished concrete.

When the hand method of striking off and consolidating is permitted, the concrete, as soon as placed, shall be approximately leveled and then struck off and screeded to such elevation above grade that, when consolidated and finished, the surface of the pavement shall be at the grade elevation shown on the plans. The entire surface shall then be tamped and the concrete consolidated so as to insure maximum compaction and a minimum of voids. For the strike off and consolidation, both a strike template and tamping template shall be provided on the work. In operation, the strike template shall be moved forward with a combined longitudinal and transverse motion, and so manipulated that neither end of the template is raised from the forms during the striking-off process. A slight excess of material shall be kept in front of the cutting edge at all times.

The straightedging, belting and joint finishing shall be as hereinabove prescribed.

7. Curing - The curing of concrete pavement shall be thorough and continuous throughout the entire curing period. Failure to provide proper curing as herein prescribed shall be considered as sufficient cause for immediate suspension of the paving operations. The curing method as herein specified does not preclude the use of any of the other commonly used methods of curing, and the Owner may approve them if so requested by the Contractor. If any selected method of curing does not afford the desired results, the Owner shall have the right to order that another method of curing be instituted. Immediately after the finishing of the surface, the pavement shall be covered with a continuous, uniform water-impermeable coating. The impermeable coating shall be of the type specified in *Item A.11, Curing Materials, of Section 5.1 Part*. After removal of the side forms, the sides of the slab shall receive a like coating before earth is banked against them. The solution shall be applied, under pressure with a spray nozzle, in such a manner as to cover the entire surfaces thoroughly and completely with a uniform film.

The rate of application shall be such as to insure complete coverage and shall not exceed 200 square feet per gallon of curing compound. When thoroughly dry, it shall provide a continuous and flexible membrane, free from cracks or pinholes; and shall not disintegrate, check, peel or crack during the curing period. If for any reason the seal is broken during the curing period, it shall be immediately repaired with additional sealing solution.

When tested in accordance with ASTM Designation C 156, the curing compound shall provide a film, which shall have retained within the test specimen the following percentages of the moisture present in the specimen when the curing compound was applied:

Time	Retained Moisture (Min.)
After 24 hours	97%
After 3 days	95%
After 7 days	91%

Additional requirements for concrete curing are outlined in Item H, Curing Concrete, of Section 5.1 Part 3.

8. Opening Pavement to Traffic - All traffic shall be excluded from the pavement for a period of not less than 14 days or a compressive strength of 3000 psi has been obtained from the test cylinders, unless the Owner directs that sections be opened to traffic at an earlier date. In all cases the pavement shall be cleaned and joints shall be filled and trimmed before being opened to traffic.

a. Traffic Access - When it is necessary to provide for traffic across the pavement, the Contractor shall, at his own expense, construct suitable and substantial crossings over the concrete, which shall be adequate for the traffic using it.

b. Time - Opening pavement to traffic shall not relieve the Contractor of responsibility for the work and shall not in any way affect the time charge on the entire

project. The number of days stated in the contract shall govern for the completion of the entire work covered by the contract.

9. Monolithic Curb - Concrete for monolithic curb shall be the same as for the pavement and, if carried back from the paving mixer, shall be placed within 20 minutes after being mixed. Concrete may be placed from the separate mixer if desired but in any case must be placed while the pavement concrete is still plastic. After the concrete has been struck off and sufficiently set, the exposed surfaces shall be thoroughly worked with a wooden float. The exposed edges shall be rounded by the use of an edging tool to the radius indicated on the plans. When the concrete in the curb has been sufficiently set, the inside form shall be carefully removed and the surface may be plastered with a mortar consisting of one part of portland cement and two parts fine aggregate. The mortar shall be applied with a template or "mule" made to conform to curb dimensions. All exposed surfaces of curb shall be brushed to a smooth and uniform surface.

10. Superimposed Curb - When sawed joints are used, curbs shall be doweled as shown on the plans and poured after sawing. Doweled curbs, which are placed with an extrusion machine, and the mixture shall conform to *Item A.4, Placing Concrete, of Section 3.6 Part 3*.

11. Slip Form Construction - At the option of the Contractor, and with the approval of the Owner, concrete pavement may be constructed by the use of slip form paving equipment.

Slip form paving equipment shall be provided with traveling side forms of sufficient dimensions, shape and strength so as to support the concrete laterally for a sufficient length of time during placement to produce pavement of the required cross section. The equipment shall spread, consolidate, screed and float-finish the freshly placed concrete in such a manner as to provide a dense and homogeneous pavement.

The concrete, for the full paving width, shall be effectively consolidated by internal vibration, with transverse vibrating units; or with a series of longitudinal vibrating units loaded with the specified thickness of pavement section and at a minimum distance ahead of the screed equal to the pavement thickness.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels offset to run a sufficient distance from the edge of the pavement to avoid breaking or cracking the pavement edge.

Final finishing for slip form pavement construction shall be to the tolerance as specified in *Item F, Finishing, of Section 5.1 Part 3*.

B. ALLEY PAVING

Alley paving shall be constructed in accordance with the specifications for street paving hereinbefore described in accordance with the details shown on the plans; and with the following additional provisions:

1. Alley paving shall be constructed to one of the typical cross sections shown on the plans.

2. Transverse expansion joints of the type shown on the plans shall be constructed at the property line on each end of the alley with a maximum spacing of 600 feet. Transverse contraction and dummy joints shall be placed at the spacing shown on the plans. Contraction and dummy joints shall be formed in such a manner that the required joints shall be produced to the satisfaction of the Owner. All joints shall be filled with top seal in accordance with the requirements of Item A.2, Joints, of Section 3.6 Part 3.

C. PAVEMENT LEAVEOUTS

Pavement leaveouts as necessary to maintain and provide for local traffic shall be provided at location indicated on the plans or as directed by the Owner. The extent and location of each leaveout required and a suitable crossover connection to provide for traffic movements shall be determined in the field by the Owner. Left or right-turn lanes and median openings shall not be considered as pavement leaveouts.

D. PAVEMENT TESTING

Also Refer to *Section 3.7, Materials Testing*.

1. Testing of Materials - Samples of all materials for test shall be made at the expense of the Owner, unless otherwise specified in the special provisions or in the plans. In the event the initial sampling and testing does not comply with the specifications, all subsequent testing of the material in order to determine if the material is acceptable shall be at the Contractor's expense at the same rate charged by the commercial laboratories.

2. Pavement Thickness Test - Upon completion of the work and before final acceptance and final payment shall be made, pavement thickness test shall be made by the Owner or his authorized representative. The number of tests and location shall be at the discretion of the Owner, unless otherwise specified in the special provisions or on the plans. The cost for the initial pavement thickness test shall be at the expense of the Owner. In the event a deficiency in the thickness of pavement is revealed during normal testing operations, subsequent tests necessary to isolate the deficiency shall be at the Contractor's expense. The cost for the additional coring test shall be at the same rate charged by commercial laboratories.

When the average thickness of pavement in the area found to be deficient in thickness by more than 0.2 inch, but not more than 0.5 inch, pavement shall be removed and replaced at the Contractor’s entire expense.

No additional payment over the contract unit price shall be made for any pavement of a thickness exceeding that required by plans.

3. Pavement Strength Test - During the progress of the work, the Owner shall cast test cylinders to maintain a check on the compressive strengths of the concrete being placed.

Four test cylinders shall be taken from a representative portion of the concrete being placed for every 150 cubic yards of concrete pavement placed, but in no case shall less than two sets of cylinders be taken from any one day's placement.

After the cylinders have been cast, they shall remain on the job site undisturbed for 24 hours and then transported, moist cured, and tested by the Owner.

Two of the cylinders in each set shall be tested in seven days; and then, if, in the opinion of the Owner, the seven-day test results are low enough, the other two cylinders in each set may be tested in 28 days.

If the 28-day test results indicated deficient strength, the Contractor may, at his option and expense, core the pavement in question and have the cores tested by an approved laboratory under supervision of the Owner to override the results of the cylinder tests.

Pavement not meeting the minimum specified strength shall be removed and replaced at the Contractor's entire expense.

No additional payment over the contract unit price shall be made for any pavement of strength exceeding that required by plans and/or specifications.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

"Concrete Pavement" shall be measured by the square yard of completed and accepted pavement. The price bid per square yard for concrete reinforced pavement, as shown on the proposal, shall be full payment for furnishing and laying the reinforced concrete pavement, including the foundation course, and for all labor, equipment, materials, tools, and incidentals necessary to complete the work. Measurement for reinforced concrete pavement shall be by the square measured in its final position.

The work performed and material furnished as prescribed by this item and measured as provided in this item shall be paid for at the unit price bid per square yard for concrete pavement, or the adjusted unit price for pavement of deficient thickness or deficient strength as provided under Pavement Thickness Test and Pavement Strength Test, which price shall be full compensation for shaping and fine grading the roadbed, including furnishing and applying all water required; for furnishing, loading and unloading, storing, hauling and handling all concrete ingredients, including all freight and royalty involved; for mixing, placing, finishing and curing all concrete; for furnishing and installing all reinforcing steel; for furnishing all materials and placing longitudinal, warping, expansion, and contraction joints, including all steel dowels, dowel caps and load transmission units required, wire and devices for placing, holding and supporting the steel bar, load transmission units, and joint filler material in the proper position; for coating steel bars where required by the plans; for all manipulations, labor, equipment, appliances, tools, traffic provisions and incidentals necessary to complete the work.

SECTION 3.7: Materials Testing

Construction Operation	Applicable Testing	Frequency of Testing
Surface Course		
Hot-Mix Asphaltic Concrete Pavement	Extraction, Gradation, Stability & Flow	1 sample per day of paving operations
Portland Cement Concrete Paving	Air Content, Slump, Compressive Strength	1 set of 4 cylinders per 150 CY but no less than 2 sets per day

SECTION 4
WATER, WASTEWATER, AND STORM WATER UTILITY CONSTRUCTION

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SECTION 4.1: GENERAL

PART 1: GENERAL

A. DESCRIPTION

This part of the specifications shall govern for construction of all types of sewer and water structures except where the requirements are revised by another governing specification. All structures shall be constructed in accordance with the design requirements and with the details shown on the plans; and in conformity with the requirements herein provided. Other applicable sections or parts of these specifications shall govern for such miscellaneous and incidental construction necessary to complete the work in accordance with the plans and specifications.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

All materials used in the construction of work specified in this division shall conform to the applicable materials sections of these specifications and approved by the Owner. Any materials placed before approval of the Owner shall be removed, if directed by the Owner, and replaced with approved materials.

1. **Material Storage -** Materials delivered to the site of the work in advance of their use shall be stored in manner which shall cause the least inconvenience to the public; and in a manner to best protect and preserve the material to the satisfaction of the Owner. Materials shall be sorted and stored neatly and accessibly. Materials not properly stored shall not be eligible for inclusion in partial estimates.

B. EQUIPMENT

Not applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. **Sequence -** The sequence of operations to be followed shall be prepared by the Contractor for approval by the Owner. The sequence shall meet the job requirements for completion time, avoid interference with plant operations, and shall conform to plan and specification requirements. The construction of all sewers shall begin at the outlet or lower end, unless otherwise directed by the Owner. Tributary lines for sewers shall not be started until the main sewer has been built to their junction points.

2. **Layout -** The Contractor shall construct the work in the locations and to the grades and elevations shown on the plans from base lines and bench marks as established by the Owner.

3. Signs - The required public information signs shall be placed at locations approved by the Owner prior to the start of construction.

4. Equipment - All machinery and equipment necessary for the construction of the work specified herein shall be on the project and shall be maintained in good condition to insure the completion of the work without excessive delays for repairs and replacements. Equipment used for disposal of surplus materials beyond the limits of the work shall be such as to avoid spilling or wasting of materials along the line of haul. The Contractor shall immediately clean up all materials spilled or wasted along the line of haul. The Owner reserves the right to approve the location and methods of disposal for surplus material.

5. Connections - The connections of pipes or appurtenances to pipes shall be made in accordance with the plans and as directed by the Owner. This work shall be done in such a manner so as not to damage any of the structures involved. No connecting pipe shall project beyond the inside surface of other pipes or appurtenances, except in case of pipe laid through a manhole.

6. Grades - The grade line shown on the profile is the elevation of the invert or flow line of the pipe. The Owner shall establish benchmarks, base lines and other principal control points for use in the construction. The Contractor shall, at his own expense, establish all working or construction lines and grades as required and determined from the base measurements and control points set by the Owner; and shall be solely responsible for the accuracy thereof. Wherever an offset needs to be over 10 feet, the Contractor shall be required to furnish a survey type tripod level or its equivalent in order to accurately transfer the grade to the trench or excavation. Where construction operations require the removal of the Owner's stakes, the Contractor shall reference such points in an approved manner. If they cannot be referenced, the Contractor must obtain authorization for their removal. In the case of their destruction or unauthorized removal, they shall be replaced by the Owner at the Contractor's expense.

The Contractor shall notify the Owner 3 working days prior to the beginning of construction to allow the Owner sufficient time to stake the alignment. Where the starting point is an end of an existing pipe, the Contractor shall uncover the same; and the Owner shall then provide the Contractor with grade stakes unless otherwise specified.

The full responsibility for holding to alignment and grade shall rest upon the Contractor.

The lines and grades shall be set by the Owner, as the work progresses, in such a manner as to cause the least possible inconvenience in the prosecution of the work. The Contractor shall so stockpile excavation and other materials as to cause no inconvenience in the use of the lines and grades given. The Contractor shall remove any obstruction created by him contrary to this provision.

Water mains shall be constructed with a minimum cover at 3.5 feet below proposed finished grades, unless shown otherwise on plans. The Contractor shall inform the Owner two working days in advance as to his need for line and grade. When necessary, working

operations shall be suspended for such reasonable time as the Owner may require for the establishment of the same.

7. Clean Up - The Contractor shall be required to maintain the construction site in a neat and orderly manner at all times and remove daily the trash, paper, rubbish and debris resulting from his operations. The Contractor is responsible to alleviate any dust nuisance in the work area, including furnishing of all equipment and materials required to alleviate dust. Upon completion of the project, all equipment, construction materials, surplus materials, trash, broken concrete, lumber, etc., shall be removed from the construction site. The entire construction site shall be graded and cleaned to present the appearance as it was prior to construction or better. Clean up shall be finished prior to acceptance of the project by the Owner.

8. Water for Construction - Unless otherwise specified in the contract, water required for construction and furnished from the Owner's distribution system shall be paid for at a rate established by the Owner. The Contractor shall make all necessary arrangement and means for hauling the water at his expense. Water shall be furnished free of charge from the Owner's main, if available, for filling newly constructed water mains for flushing, sterilizing and hydrostatic testing.

9. Street Cut Permit - If required by the Owner, the Contractor shall obtain a street cut permit prior to beginning the work. The Contractor shall have the executed permit available on the job site during the duration of the work.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Not applicable.

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SECTION 4.2: EXCAVATION AND BACKFILL

PART 1: GENERAL

A. DESCRIPTION

This work shall include the furnishing of all labor, materials, tools, equipment and machinery necessary for clearing and removing from the site of the work wherever located, all obstructions, trees, stumps, brush vegetation, woods and debris; and all earth, rock and other materials to be excavated; the removal of existing structures except where specifically paid for as separate contract pay items; the replacement of topsoil after backfilling is completed; the furnishing, placing and maintaining of all sheeting, shoring and bracing necessary to protect the work and adjacent properties, to support the sides and ends of the excavation and to support all adjacent structures above and below the ground; the installation and operation of all pumping, bailing and draining necessary to keep the excavation free from seepage water, water from sewers, drains, ditches, creeks and other sources, and to provide for the uninterrupted flow of sewers and surface waters during progress of the construction; the removal, after the completion of the work, of all sheeting, shoring and bracing not necessary to support the sides of the excavation; the satisfactory disposal of excess and unsuitable materials not required or which cannot be used for backfilling; compacting and refilling, after settlement of all excavated areas; the restoration of all streets, alleys, rights-of-way and other lands, private or public, damaged or occupied by the Contractor in the performance of the contract to the same (or improved) condition as they were prior to the beginning of the work. Replacement of previously constructed items, such as curb, gutter, sidewalks, driveways, paving, etc., shall conform to the specifications for new construction, unless directed otherwise by the Owner.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

1. Pipe Bedding Material for Storm Sewers

a. General - The pipe shall be bedded in accordance with details shown on the plans for the type of bedding indicated or specified. In general, if no particular type of bedding is shown on the plans nor specified, the pipe shall be bedded in accordance with the requirements for gravel bedding.

b. Gravel Bedding - The trench shall be excavated to a minimum depth below the grade of the outside of the pipe as shown on the standard drawings. The trench shall then be filled up to and around the pipe exterior with gravel or as shown on the standard drawings. The aggregates used shall meet the requirements of Type "A" Trench Backfill.

c. Rejection - Bedding material, which fails to meet the requirements of these specifications, may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Bedding material sources from which materials with properties not meeting these specifications are delivered may be rejected as further supply sources to the project by the Owner. Such rejection shall incur no cost to the Owner.

2. Pipe Bedding Material for Water and Sanitary Sewer Mains

a. Crushed Stone Embedment

(1) Description - The aggregates shall consist of durable particles of crushed stone; free from frozen material or injurious amounts of salt, alkali, vegetable matter or other material either free or as adherent coating; and its quality shall be reasonably uniform throughout. It shall have a wear of not more than 40 percent when tested in accordance with ASTM C 131.

(2) Test - When tested by standard laboratory methods, crushed rock embedment for each gradation shall meet the following requirements for percentage by weight as stated in the TxDOT Standard Specifications for Construction of Highways, Streets and Bridges.

Standard Crushed Rock Aggregate Grade 4	
	Percent
Retained on 1½ in. sieve	0%
Retained on 1 in. sieve	0 - 5%
Retained on ½ in. sieve	40 - 75%
Retained on No. 4 sieve	90 - 100%
Retained on No. 8 sieve	95 - 100%
Fine Crushed Rock Aggregate Grade 8	
	Percent
Retained on ½ in. sieve	0%
Retained on ⅜ in. sieve	0 - 5%
Retained on No. 4 sieve	35 - 60%
Retained on No. 8 sieve	90 - 100%
Coarse Crushed Rock	
	Percent
Passing 1½ in. sieve	100%
Retained on ¾ in. sieve	100%

b. Granular Material - Granular material shall be free flowing, such as sand or hydraulically graded crushed stone fines, or mixed sand and gravel. The material shall be free from lumps, stones over two inches in diameter, clay and organic matter. The material shall meet the requirements for Type "A" Trench Backfill.

c. Select Material - Select material shall be gravel, fine rock cuttings, sand, sandy loam or loam free from excessive clay. Rock cuttings shall have no dimension greater than two inches.

d. Rock for Foundation - The rock for foundation shall meet the requirements of *Item A.2.a, Crushed Stone Embedment*, *of Section 4.2 Part 2*, except the gradation shall be:

Passing 5 in. sieve	100%
Retained on 2 in. sieve	100%

e. Washed Gravel - Washed gravel shall consist of uncrushed stones meeting the requirements for wear as outlined in *Item A.2.a, Crushed Stone Embedment*, *of Section 4.2 Part 2*. The material shall be washed and screened and not have by weight more than one percent organic matter, clays or loam and not more than five percent by weight of any one of or combination of slate, shale, schist or soft particles of sandstone. The gradation shall be:

Passing 1½ in. sieve	100%
Retained on ¾ in. sieve	100%

f. Sand - Sand shall consist of clean, hard, durable, uncoated grains, free from lumps and organic material. All particles must pass a No. 8 sieve.

g. Concrete Cradle - The lower part of the pipe exterior shall be bedded in a continuous cradle of concrete having a minimum thickness under the pipe of 6" and extending up the sides of the pipe to a height as shown on the standard drawings. The subgrade shall be prepared to the lines and grades indicated in the plans and details. The trench shall be maintained free of water during the placing of the concrete. The pipe shall be placed on bricks or masonry blocks, then carefully place concrete around the pipe so as to not displace vertically or horizontally. Concrete cradle shall be Class B (2,000 psi).

3. Trench Backfill

a. Type "A"

(1) General - Type "A" backfill shall be sandy gravel material and shall meet the following requirements:

(a) Tests - The liquid limit shall not exceed 35 when tested in accordance with ASTM Designation D 4318.

The plasticity index shall not exceed 12 nor be less than 0 when calculated in accordance with ASTM Designation D 4318.

The linear shrinkage shall not exceed six percent when Type "A" backfill is used for pavement base material. For gravel street surfacing, it shall have a minimum plasticity index of 4.

(b) Gradation - The material when tested by standard laboratory methods shall meet the following percentages by weight:

Passing 2 in. sieve	100%
Passing ½ in. sieve	50 to 85%
Passing No. 4 sieve	20 to 65%
Passing No. 100 sieve	0 to 5%

(c) Field Sand Material - Field sand having the following requirements may be used in lieu of Type "A" backfill for filling trenches upon approval by the Engineer. The field sand material shall be obtained from approved sources; shall consist of durable particles; and shall be free of thin or elongated pieces, lumps of clay, soil, loam or vegetable matter. The material shall be required to meet the following gradation curve when tested from source of supply test samples:

Passing No. 4 sieve	100%
Passing No. 16 sieve	80 to 100%
Passing No. 50 sieve	20 to 60%
Passing No. 100 sieve	10 to 40%
Passing No. 200 sieve	0 to 10%

Compaction should be a minimum of 95 percent of maximum density as determined by ASTM D 698. Moisture content shall be within ± 2% of optimum.

b. Types "B" and "C"

(1) General - Types "B" and "C" backfill shall meet the following requirements:

(a) Tests - The liquid limit shall not exceed 35 when tested in accordance with ASTM Designation D 4318.

The plasticity index shall not exceed 12 nor be less than 4 when tested in accordance with ASTM Designation D 4318.

(b) Gradation

MATERIAL REQUIREMENTS	TYPE BACKFILL	
	B Sandy Gravel	**C Trench Excavation**
Percent of rock volume allowed regardless of trench width	50%	50%
Greatest dimension of rock allowed in trenches 4' or less in width	3"	3"
Percent of maximum allowable dimension rock to total backfill volume, regardless of trench width	3%	3%
Greatest dimension of rock allowed in trenches greater than 4' in width. Total volume not to exceed 1% of backfill.	4"	4"
All rock must be reasonably uniform in distribution throughout the backfill material in order to be considered acceptable for use, regardless of the width of trench, in which the material is to be used.		
Percent of backfill, by volume, of clay or gumbo lumps permitted regardless of trench width	25%	25%
Largest dimension of clay or gumbo lumps in trenches 4' or less in width	6"	6"
Largest dimension of clay or gumbo lumps permitted in trenches greater than 4' in width. Total volume not to exceed 1%	6"	6"
All lumps must be reasonably uniform in distribution throughout the backfill material in order to be considered acceptable for use, regardless of the width of trench in which the material is to be used.		

c. Excavated Material - Excavated material may be used in the trench backfill, provided (a) that all hard rock and stones having any dimensions greater than four inches in diameter and frozen earth, debris and roots larger than two inches are removed; and (b) the material is approved for backfill by the Owner.

d. Stabilized Backfill - Stabilized backfill shall consist of a mixture of native soils including the trench excavation, approved for use by the Owner, and two sacks of

cement per cubic yard. All material shall be mixed in a concrete mixer or transit mix unless approved otherwise by the Owner. The stabilized backfill shall be compacted in a moist condition; or water added to provide a free flowing mixture. If a free flowing mixture is used, the initial set must be permitted prior to placement of any material on the surface of the stabilized backfill.

e. Concrete Backfill - Concrete backfill shall consist of selected rock material or granular material mixed with a minimum of two sacks of cement per cubic yard. All material shall be mixed in a concrete mixer or transit mixed unless approved otherwise by the Owner.

f. Flowable Backfill - Flowable backfill shall consist of a mixture of manufactured materials, cement and/or fly ash, and water. Any materials used shall be primarily granular, with a Plasticity Index <12 and with 100% passing a ¾" sieve. The flowable mixture shall be mixture shall be mixed in a pug mill, concrete mixer or transit mixer. The flowable mixture must be allowed to set prior to the placement of any overlying material. The flowable backfill material shall meet the following: cement 50 lbs, fly ash 250 lbs, fine aggregate 2910 lbs, and water 60 gal.

g. Rejection - Materials, which fail to meet the requirements of these specifications, may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Material sources, from which materials with properties not meeting these specifications are delivered, may be rejected as further supply sources to the project by the Owner. Such rejection shall incur no cost to the Owner.

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Site Preparation - The construction site shall be prepared for construction operations by the methods discussed in *Section 1, Site Work.*

2. Maintenance of Streets During Construction - The Contractor shall at all times maintain the surfaces of streets on which he is working or has worked. The maintenance required shall include the filling of holes, blading or otherwise smoothing of the street surfaces (particularly the trench area), cleaning and removal of surplus excavation material, rubbish, etc., sprinkling of streets with water or other approved materials to abate dust nuisances and the elimination of interference resulting from blocking the street to residents thereon. Any or all of such operations shall be performed by the Contractor upon demand by the Owner, but the Contractor shall not wait for instruction from the Owner before performing maintenance work obviously in need of being done to meet the requirements of these specifications. All costs of work covered by this paragraph shall be included in the prices bid for the various items of work; and no separate payment shall be made.

In the event the Contractor fails or refuses to properly maintain the surfaces of streets on which he is working or has worked, the Owner, after due notice to the Contractor, shall perform the necessary maintenance. All costs to the Owner incurred in the performance of such work shall be deducted from any monies due or to become due to the Contractor for work performed, or the Contractor shall be billed for such costs directly as the Owner shall elect. Notice to the Contractor to be given by the Owner shall be in writing, and it shall be delivered to the Contractor or his authorized agent. Except in emergency cases, where immediate action is required under the provisions of *Section 8.11, Public Convenience and Safety, of General Provisions* the Contractor shall have 24 hours in which to comply with the instructions of the Owner. Should the Contractor fail to do so, the Owner shall proceed with the work as set forth above.

Where traffic must cross open trenches, such as street intersections and driveways, the Contractor shall provide suitable backfill bridges, protective barricades and such other safety equipment as required. The use of machinery must be so regulated as to preclude any unnecessary interference with traffic, utilities, etc. The Contractor shall abide by all applicable federal, state or local laws governing excavation work.

Cold mix asphaltic material will be placed around water valves and manhole covers if the surface will not be placed within one (1) week.

3. Geotechnical Testing - Wherever the Owner has caused certain test borings to be made on the site, or when any information pertaining to the character or depth of materials is found from observations, records or otherwise, such information revealed thereby may be indicated on the plans. The action of the Owner in revealing such information shall not, in any manner, be construed as a warranty on the part of the Owner of the exact nature of the subsurface conditions that shall be encountered during construction of the work. Although the information is shown as accurately as possible, the Owner does not guarantee that any materials to be encountered at any point or points are even approximately the same, either in character or elevations, as those shown on the plans. The information thus furnished by the Owner is intended only as a guide to the Contractor in making his own investigations preliminary to submitting a bid for the work.

4. Existing Structures - All existing structures, improvements and utilities shall be adequately protected, at the expense of the Contractor, from damage that might otherwise occur due to construction operations. Where construction comes in close proximity to existing structures or utilities, or if it becomes necessary to move services, poles, guy wires, pipe lines or other obstructions, the Contractor shall notify and cooperate with the utility or structure Owner. The utility lines and other existing structures shown on the plans are for information only and are not guaranteed by the Owner to be complete or accurate as to location and/or depth. The Contractor shall be liable for damage to any utilities resulting from his operation. During construction, all fire hydrants, valve boxes, fire or police call boxes and other existing utility controls shall be left intact, unobstructed and accessible unless noted on the plan.

a. Relocating or Replacing Utilities - Unless noted on the plans that utilities are to be moved by others, any cost of temporarily or permanently relocating City utilities

shall be borne by the Contractor. The cost of these replacements shall be included in the Contractor's bid price for the various items of work; and no separate payment shall be made. In case damage to an existing structure or utility occurs, whether such damage results directly or indirectly from the Contractor's operations, the Contractor shall be responsible to restore the structure or utility to its original condition and position without extra compensation. Temporary shut down of water and/or sewer services shall not extend overnight, holidays or weekends. The Owner shall approve all shut downs and may assist in the shut down operations. Utility companies shall adjust or relocate their facilities at no cost to the Contractor.

b. Sewer House Services - All house sewer services within City ROW damaged during construction shall be replaced by the Contractor at his expense. Sewer service reconnections, including necessary adjustments to a sanitary sewer replacement, shall not require the services of a master plumber, and shall be inspected by the Owner. It shall be the responsibility of the Contractor to maintain such services throughout the construction process.

c. Water Services - Service lines shall not be removed during excavation; and the Contractor shall provide adequate support for the services across the open ditch.

d. Interrupted Service - Cuts or breaks in water or sewer mains and laterals, or service connections, shall be restored at the earliest practicable moment in order to give the least possible interruption in service. The Contractor shall be responsible for notifying customers of temporary interruption of service.

e. Other Utilities - All water mains, water services, sanitary sewers, sanitary sewer house laterals, and storm sewers encountered during construction shall be supported or replaced.

Where the exact depth of any utility or obstruction is not shown on a plan, excavation shall be made prior to reaching the obstruction in order to determine adjustments in grade if needed to prevent interference. Redesign to eliminate conflicts may be necessary. Extra compensation shall not be paid for such delays.

When it is necessary to remove or adjust any utility, a representative of that utility shall be notified to decide method and work to be done. No extra compensation shall be paid due to delays caused by removal of utility structures.

f. Street Sign Posts and Signs - The Contractor shall be responsible for all damage to street signposts and signs within the limits of his operations that remain in place or are removed and replaced. In the event street signposts and signs are damaged or destroyed by the Contractor's operations, they shall be replaced at the Contractor's expense.

g. Methods of Removal and Disposal - Materials or parts of structures, which are to be broken up, dismantled or removed, and which are to be salvaged, shall be removed, loaded, cleaned and unloaded at sites designated by the Owner. Materials, which are not designated to be salvaged, shall become the property of the Contractor; and he shall dispose of the material at his own cost and expense.

4. Excavation

a. General - In general, all excavation shall be made in open cut from the surface of the ground and shall be no greater in width or depth than is necessary to permit the proper construction of the work in accordance with the plans and these specifications. All excavation shall be to the line and grade as provided by the Owner. The Contractor shall abide by all applicable federal, state and/or local laws governing excavation work. The entire foundation area in the bottom of all excavation shall be firm, stable and at uniform density as nearly as practicable. Unless necessary, materials shall not be disturbed. The final cleaning off and preparing of the foundation area shall be done immediately prior to the placing of the embedment materials or structures.

(1) Trench Bottom Elevation - All trenches for installation of water, storm sewer and/or sanitary sewer lines shall be excavated to a point below the barrel of the pipe for the type of embedment specified and as described in *Item A.5.c, Embedment of Section 4.2 Part 3.*

(2) Trench Overcut - Should the Contractor excavate below the plan trench bottom for water or sewer lines, he shall backfill to trench bottom grade shown on the plan with approved aggregate, consolidated and compacted to meet the Owner's approval or install 2,000 psi concrete.

If the Contractor elects to overcut the trench and use gravel and drain pipe as an underdrain in lieu of, or in conjunction with, pumping, draining or well pointing, the additional work shall be considered as incidental work, and additional compensation shall not be allowed.

Where the character of the foundation material is such that a proper foundation cannot be prepared at the elevation shown on the plans, then when directed by the Owner, the Contractor shall deepen the excavation to where a proper foundation entirely satisfactory to the Owner can be prepared. Such materials removed shall be replaced with foundation materials as specified in *Item A.6, Foundation, of Section 4.2 Part 3*, or with other material satisfactory to the Owner and thoroughly compacted in place to the finish grade elevation in a manner satisfactory to the Owner.

(3) Excess Trench Width - When the maximum trench width as defined in the drawings and standard details is not maintained to a point of one foot above the top of the pipe, the Contractor shall provide, at his expense, the next higher class embedment; or embedment as directed by the Owner which shall provide adequate support.

(4) Progress - The Owner shall have the right to limit the amount of trenches that shall be opened, or partly opened, in advance of or following the pipe laying operation. Unless otherwise directed by the Owner, the completion of backfill shall immediately follow the pipe laying. In the event the Contractor fails to comply with this requirement, the Owner may stop the pipe laying until the requirements are met.

(5) Excavation for Altered Grade - If excavation for the pipe or appurtenance due to the altered grade is altered more than one foot and has not been classified as a separate contract pay item, the increased or decreased amount of excavation due to the altered grade may constitute a basis for revised consideration by either party to the contract.

c. Excavation Classifications - All excavation is "unclassified" and involves removal of all materials necessary to permit carrying on the completion of the work.

Bidders must satisfy themselves as to the actual existing subsurface conditions, including but not limited to the depth, location, and sizes of pipe or conduits of various kinds in place.

d. Alternate Methods of Excavation - Prior to commencing any excavation, the Contractor shall provide ample labor, equipment, shoring material and such other safety equipment as required to insure that the work shall be carried on without interruption or damage to existing installations; and to provide the least interruption of traffic commensurate with the project requirements.

(1) Blasting - In cases where the plans and specifications do not require the use of explosives, if (after written approval by the Owner) the Contractor elects to use explosives in the performance of the work, utmost care shall be exercised so as not to endanger life or property. The Contractor shall use only such methods as are currently utilized by persons, firms or corporations engaged in a similar construction business. The Contractor shall be solely responsible for the determination as to whether explosives shall be used and for any result from the use of explosives. He shall indemnify and hold the Owner whole and harmless against any claim for damage or injury to persons or property, real or personal, as the result of the use of explosives by the Contractor or any subcontractor.

The following criteria with regard to the use of explosives and blasting must be satisfied:

(a) Certification - Certifications by the proper authorities for personnel involved with the actual use of explosives are required and must be obtained prior to the use of explosives.

(b) Insurance - The Contractor shall furnish the Owner with evidence of insurance sufficient to cover any such possibility, which insurance shall either include the Owner as an assured or be of such character as to protect the Owner.

(c) Restrictions - No blasting shall be permitted within highway right-of-way or railroad right-of-way without written permission from the Texas Department of Transportation (TxDOT), the railroad involved, and from the Owner.

(d) Limitations - When blasting is authorized, the blast shall be covered with heavy timbers chained together, a rope mat, or some other equally effective method of blast effect protection, approved by the Owner.

All explosives shall be stored in a safe and secure manner and such storage places shall be clearly marked, **"DANGEROUS - EXPLOSIVES."** Blasting caps and explosives shall be stored separately. In addition to the **"DANGEROUS - EXPLOSIVES"** sign which must be displayed, two signs marked **"EXPLOSIVES, TURN ALL RADIOS OFF"** shall be placed in a conspicuous location readily visible to vehicular traffic and not less than 350 feet from electric explosive caps storage area. During each blast, the exposed end of the pipe shall be covered with planking.

(e) Notification - The Contractor shall notify each utility company having structures in proximity to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such

steps, as they may deem necessary to protect their property from injury. Such notice shall not relieve the Contractor of responsibility for any damage resulting from his blasting operations.

(f) Laws and Ordinances - The method of blasting, storing and handling explosives must be carried on in full conformance with the requirements of all federal and state laws, and municipal ordinances.

(2) Tunneling - When the Contractor installs sewer and/or water mains by jacking, boring or tunneling, the Contractor shall comply with the provisions of *Section 4.4, Jacking, Boring, or Tunneling.*

(a) Tunneling as Directed - When shown on the plans or proposal or as directed by the Owner, the Contractor shall be paid for this work as outlined in the bid proposal.

(b) Tunneling at the Contractor's Option - If approved by the Owner, the Contractor may elect by tunneling, boring or jacking to install any portion of the work that is designated on the plans for open cut installation. The Contractor shall be paid for only the items that would have been paid for if the work had been done by open cut.

(3) Cofferdam - Where shown and/or detailed on the plans, excavation shall be performed within a cofferdam. The Contractor shall install and securely brace the cofferdam and shall remove the excavation within the area so protected without damage to or displacement of the cofferdam and bracing.

(4) Shoring and Sheeting - When necessary to prevent caving or unduly hazardous working conditions, or to comply with existing laws, trench walls shall be appropriately braced; or sheeted and braced. Where bracing or sheeting and bracing are used, the trench width shall be increased accordingly, shall be considered as incidental work; and shall not be paid for as a separate item. In wet, saturated or flowing materials where it is necessary to install tight sheeting or cofferdams, wood or steel sheet piling of a design and type approved by the Owner shall be used. All sheeting, shoring and bracing shall have sufficient strength and rigidity to withstand the pressure exerted; to maintain the sides of the excavation properly in place; and to protect all persons or property from injury or damage. When excavations are made adjacent to existing buildings or other structures, or in paved streets, particular care shall be taken to adequately sheet, shore and brace the sides of the excavation to prevent undermining of, or settlement beneath the structures or pavement. Underpinning of adjacent structures or pavement shall be done by the Contractor at his own cost and expense, and in a manner satisfactory to the Owner; or, when required by the Owner, the pavement shall be removed, the void satisfactorily refilled, compacted and the pavement replaced by the Contractor. The entire expense of such removal and subsequent replacement thereof shall be borne by the Contractor. Wooden sheeting, shoring and bracing shall be left in place where it is adjacent to the pipe embedment for the initial lift of backfill.

The removal of all sheeting, shoring and bracing shall be done in such manner as not to endanger or damage either new or existing structures, private or public properties; and so as to avoid cave-ins, or sliding of the banks. All holes or voids left by the removal of the sheeting, shoring or bracing shall be immediately and completely filled and compacted with suitable materials. If, for any reason, the Contractor, with the

approval of the Owner, elects to leave in place the sheeting, shoring or bracing, no payment shall be allowed for such material left in place unless ordered by the Owner to be left in place.

(5) Disposal of Excavated Materials - Suitable excavated materials may be piled adjacent to the work to be used for backfilling. Excavated materials unsuitable for backfilling, or in excess of that required for backfilling, shall be disposed of by the Contractor. Desirable topsoil, sod, etc., shall be carefully removed and piled separately adjacent to the work when required. Excavated materials shall be handled at all times in such manner as to cause a minimum of inconvenience to public travel and to permit safe and convenient access to private and public property adjacent to or along the line of the work. The excavated material in rock, which is not suitable material for bedding or backfill, shall be disposed of by the Contractor. The requirements for disposal of excavated materials as stated in this specification apply in general to all projects with the exception of utility projects within streets that will not be reconstructed or reclaimed. Excavation for these types of projects will be directly loaded into trucks and removed from the project. In accordance with the *General Provisions*, the Contractor shall indemnify and hold harmless the Owner and all of his officers, agents and employees from all suits, actions or claims of any character resulting from his arrangements for and disposal of soil.

(6) Dewatering - The Contractor shall remove all water from any source which may accumulate in the excavation. The embedment or pipe shall not be installed in water. All water removed from excavations shall be disposed of in an approved manner, so as not to create unsanitary conditions; nor to cause injury to persons or property; nor damage to the work in progress; nor to interfere unduly with the use of streets, private driveways or entrances. Pumping, bailing and draining, underdrains, ditches, etc., shall be considered as incidental work and shall not be paid for as separate items; but their cost shall be included in such contract prices as are provided for in the contract.

5. Backfill

a. Backfill Procedure - Backfill procedure is that procedure required to return trenches or excavated areas to a condition satisfactory to the Owner. Such backfilling occurs in two general areas. They are: (a) areas outside of the ROW, and (2) areas within the ROW.

The methods of backfilling to be used shall vary with the width of trench, the character of the materials excavated, the method of excavation, the type of pipe and the degree of compaction required. The placing of backfill shall not begin until the pipe structure has been properly bedded and jointed and until approval has been given by the Owner. The excavation shall be backfilled only with approved material. Backfill is divided into two major categories: (1) embedment, and (2) trench backfill material.

(1) Embedment - is the material upon which the pipe rests, and which covers sewer and water lines.

(2) Trench backfill material - is the material required to fill the trench from the top of the embedment to ground elevation or subgrade of a street.

b. Compaction - Compaction of all backfill material shall be performed in a manner that shall not crack, crush and/or cause the installed pipe to be moved from the established grade and/or alignment, as shown on the plans. Satisfactory density shall be obtained at various depths on all backfill material as indicated from random selected test points prior to the required exfiltration or pressure tests that are to be performed on lines being constructed. The required densities shall be at not less than the optimum moisture of the material.

(1) Densities: Areas Within ROW - The trench backfill shall be mechanically compacted to the top of the subgrade in twelve-inch lifts (loose measurement) to at least 95 percent of maximum density as determined by ASTM Designation D 698. Moisture content shall be within ± 2% of optimum.

The embedment shall be compacted by a method approved by the Owner to a density as specified under the description of the embedment required as outlined in *Item A.5.c, Embedment of Section 4.2 Part 3.*

(2) Densities: Areas Outside of ROW - The trench backfill shall be placed in layers not more than 12 inches in depth (loose measurement) and shall be mechanically compacted subject to the restrictions outlined in *paragraph 5, Compaction Methods*, located below, to a density of 90% comparable with the adjacent undisturbed material as determined by ASTM Designation D 698.

The embedment shall be compacted by a method approved by the Owner to a density as specified under the description of the embedment required as outlined in *Item A.5.c, Embedment of Section 4.2 Part 3.*

(3) Special Situations - In areas specifically designated in the plans and specifications, the entire backfill shall be backfilled and compacted to the density specified.

(4) Limitations - Densities as specified shall be obtained as the project progresses. No more than 75 percent of the pipe installation on the project is to be completed until specified compaction and density requirements have been ascertained on backfill material for at least 50% percent of the pipe laid; or until an approval to proceed with pipe installation has been given by the Owner.

(5) Compaction Methods – The backfill material shall be mechanically compacted by a device designed for this purpose, approved by the Owner and Engineer, in a manner meeting or exceeding specified densities. Other methods of compaction may be used pending approval by the Owner.

Compaction of any backfill material by flooding or jetting shall not be permitted unless authorized by the Owner.

(6) Rejection - If the backfill does not meet the specified density and optimum moisture requirements throughout its depth, the Owner shall require its removal and replacement to meet the above requirements at the Contractor's expense.

c. Embedment - The type of embedment to be used for storm sewers, sanitary sewers or water mains shall be specified in the contract document or on the plans. For each type of embedment listed, the minimum depth of trench below the pipe shall be as shown on the plan detail sheet. The types of embedment generally used are outlined in

Items A.1, Pipe Bedding Material for Storm Sewers, and *A.2, Pipe Bedding Materials for Water and Sanitary Sewer Mains, of Section 4.2 Part 2*

Densities shall be shown as a percent of the maximum dry density at not less than optimum moisture of samples of the material as determined by the "Maximum Density Optimum Moisture Test," ASTM Designation D 698.

Large diameter flexible pipe may be strutted vertically prior to backfilling. After backfilling, the struts shall be removed and the deflection checked to verify that excessive deflection as specified has not occurred. If excessive deflection has occurred, the pipe shall be removed and reinstalled.

6. Foundation - During the progress of the work, should the foundation for the pipes be in soft, yielding or spongy materials, which are not the result of the Contractor's negligence to make proper provisions for adequate drainage of the excavation, the Contractor shall remove such unsuitable subgrade material to the depth directed by the Owner. The space thus created shall be filled with rock, coarse crushed rock as described in *Items A.1, Pipe Bedding Material for Storm Sewers, or A.2, Pipe Bedding Material for Water and Sanitary Sewer Mains, of Section 4.2 Part 2*, or Class B concrete as described in *Section 5.1, Concrete and Reinforcement*. The type of material to be used for the foundation shall be determined by the Owner. In lieu of removing the subgrade material or in conjunction with placement of the foundation material, the Owner may require a geotextile material as described in the contract documents to be placed between the bedding and the subgrade or between the foundation material and the subgrade.

a. Responsibility - The Contractor shall be responsible for the adequate pumping, draining and bailing of water from the excavation. In case of failure to make such provisions, resulting in unstable subgrade conditions, and which shall require any of the hereinbefore described foundations, such foundations shall be placed at the entire cost of the Contractor; and shall not be measured or paid for as separate contract pay items.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

1. Trench Excavation and Backfill

Unless specified otherwise in the contract documents trench excavation and backfill shall be considered subsidiary to the price for the utility being placed.

a. If, in areas outside the right of way, the Contractor elects to use a material other than the excavated material as trench backfill and the use of the material is approved by the Owner, but not directed by the Owner, the material shall be furnished and placed at no cost to the Owner. The excavated material shall be disposed of at no cost to the Owner.

If the Owner orders the excavated material to be removed and disposed of and replaced with another material and a separate bid item is not established as a bid item, the material shall be paid as an extra. The disposal of the rejected excavated material shall be at no cost to the Owner.

2. Embedment - If the Owner orders an embedment material other than that specified in the contract, it shall be paid for as an extra in price per linear foot as compacted in place, except if a higher class embedment is ordered by the Owner because the Contractor has over-excavated the trench width.

If the Contractor elects to use a higher-class embedment and the use of the embedment is approved by the Owner, but not directed by the Owner, there will be no extra pay.

If the Owner orders the excavated material to be removed and disposed of and replaced with another material because of neglect of the Contractor to properly remove or store the material, or if the Contractor fails to compact the excavated material in the trench to the density requirements and the Owner orders the material removed, the excavated material shall be replaced with a material approved by the Owner and at no cost to the Owner. The disposal of the rejected material shall be at no cost to the Owner.

The contract unit price shall be total compensation for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work, including all excavation and disposal of surplus material.

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SECTION 4.3: STREET CUT EXCAVATION AND REPAIR STANDARDS

PART 1: GENERAL

A. GENERAL REQUIREMENTS

1. Marking - All concrete cut repairs shall be marked with the Contractor's name if required by the Owner.

2. Sawed Breakout Groove - The removal and replacement of portions of permanent concrete pavement (portland cement concrete or asphaltic concrete), drives slabs, sidewalks, etc., shall require a breakout groove to be sawed by the use of an approved power-driven concrete saw in accordance with this specification; or as directed by the Owner.

Where saw-cut locations coincide with or fall within three feet of the present location of either dummy joints, construction joints or expansion joints, breakout shall be to the existing joint, there not being a requirement to cut an additional groove.

The grooves shall be cut perpendicularly to the surface and as directed by the Owner and shall be sawed to a minimum depth of 1½".

This work will not be paid for directly, but will be subsidiary to the various project bid item.

3. Arterials and Collectors - No interference with traffic flow on thoroughfares shall be permitted during the hours of 6:30 a.m. to 9:30 a.m. and 3:30 p.m. to 6:30 p.m., Monday through Fridays, unless directed otherwise by the Owner. Emergency closures during these hours shall be with the approval of the Owner.

When work is stopped for the day, all lanes of streets shall be opened to traffic. A traffic lane shall be considered satisfactorily open if it is paved with hot-mix or cold-mix asphalt paving.

If the cut is to be covered, the Contractor shall use steel plates of sufficient strength and thickness to support all the traffic. The edges of the plates shall be built up with hot-mix or cold-mix asphalt paving to give a smooth riding surface. Cold mix will be removed when plates are removed.

Exceptions to these specifications must be approved by the Owner.

4. Minimum Size of Repair - Sidewalks shall be removed and replaced to the nearest existing joint. No horizontal dimension of any cut shall be less than two feet in a paved street or alley.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Not Applicable

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Street Surfaces

a. General Requirements - Street surfaces are to be replaced in accordance with standard details as rapidly as possible. Use of fast setting concrete and similar techniques is encouraged. Completion of the job, including replacement of pavement and cleanup, shall normally be accomplished within 3 working days after the repair work involving the cut is made.

Removal of unsatisfactory work shall begin within 15 days and replacement shall be completed within 30 days of written notification of the Owner.

In the event it is necessary to place a temporary surface on any cut opening, it shall be composed of permanent type paving material, specifically excluding gravel or flex base as the surface material, unless approved by the Owner. Temporary surfaces shall be adequately compacted and sealed to prevent degradation of the repair during the temporary period. Any temporary surface that fails to provide a nondegraded riding surface shall be removed and replaced at the Contractor's expense.

b. Replacing Curb and Gutter, Sidewalks, Driveways, Etc. - Curb, curb with gutter, sidewalks, drives, etc., shall be replaced as per City Standard Details.

Measurement for payment shall be for that removed in square yard or linear feet as specified in the bid item. The removal or replacement of curbs, curbs and gutters, sidewalks, drives, etc., in excess of that specified or approved by the Owner, shall be at the expense of the Contractor.

c. Surface Repair - The street surface shall be repaired in to the class shown on the plans in accordance with City Standard Details.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Pavement repair shall be paid by LF complete in place.

Curb and curb and gutter shall be paid at the contract unit price per linear foot, complete in place. Concrete drive approaches and sidewalk shall be paid for at the contract unit price per square foot.

The contract unit price shall be total compensation for furnishing and placing all materials, including rolling and finishing, for disposal of all surplus material, and for all labor, tools, equipment and incidentals necessary to complete the work, all in accordance with the plans and specifications.

SECTION 4.4: JACKING, BORING, OR TUNNELING

PART 1: GENERAL

A. DESCRIPTION

This specification shall govern for the provision of the required opening for the installation of pipes by the methods of jacking, boring or tunneling as shown on the plans and in conformity with this specification.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

The encasement and carrier pipe shall be of the type and strength as indicated on the plans.

B. EQUIPMENT

Not Applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. General - Where encasement or carrier pipe is required to be installed under railroad embankments or under highways, streets or other facilities by jacking, boring or tunneling methods, construction shall be made in a manner that shall not interfere with the operation of the railroad, highway or other facility; and shall not weaken or damage any embankment or structure. During construction operations, barricades and lights to safeguard traffic and pedestrians shall be furnished and maintained as directed by the Owner, until such time as the backfill has been completed and then shall be removed from the site.

The Contractor shall take the proper precautions to avoid excavating earth or rock, or shattering rock beyond the limits of excavation needed to install the pipe. All damages by excavating and blasting, either to surface or subsurface structures, shall be repaired or replaced by the Contractor at his own cost and expense.

2. Construction by Jacking - If the grade of the pipe at the jacking end is below the ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the jacking operations and for placing end joints of the pipe. This excavation shall not be carried to a greater depth than is required for placing of the guide and jacking timbers, and a horizontal distance no nearer the roadbed than the minimum distance shown on the plans.

At the other end of the pipe, an approach trench shall be excavated accurately to grade. All open trenches and pits shall be braced and shored or their walls sloped in such a manner as shall adequately prevent caving or sliding of the walls into the open trench or pit.

Heavy-duty jacks suitable for forcing the pipe through the embankment shall be provided. In operating jacks, even pressure shall be applied to all jacks used. Suitable bracing between jacks and the jacking head shall be provided, so that pressure shall be applied to the pipe uniformly around the ring of the pipe. The jacking head shall be of such weight and dimensions that it shall not bend or deflect when full pressure is applied at the jack. The jacking head shall be provided with an opening for the removal of excavated material as the jacking proceeds. A suitable jacking frame or backstop shall be provided. The pipe to be jacked shall be set on guides, which are straight and securely braced together in such a manner as to support the section of the pipe and to direct it in the proper line and grade. All timber and other materials used in the construction of the jacking assembly shall be of such quality and dimensions that they shall withstand all stresses to which they are subject in such a manner as to insure even pressures on the pipe during jacking operations. The whole jacking assembly shall be placed so as to line up with the direction and grade of the pipe.

As the jacking proceeds, the embankment material shall be excavated slightly in advance of the pipe in such a manner as to avoid making the excavation larger than the outside diameter of the pipe, with the excavated material being removed through the pipe. The excavation for the underside of the pipe, for at least one third of the circumference of the pipe, shall conform to the contour and grade of the pipe. The excavation for the top half of the pipe shall conform closely to the outside diameter of the pipe and a clearance greater than two inches shall not be permitted. All voids between the pipe and the earth shall be filled with grout per ASTM Designation C 476. Grout holes may be provided in the pipe, or grouting may be made through drill holes from the ground surface if practicable. The grouting shall follow immediately upon completion of the jacking operation.

All carrier pipe installed by jacking shall be supported by a quarter point cradle of Class B concrete across the jacking pit and to the first joint in the ditch section on each end.

The distance that the excavation shall extend beyond the end of the pipe depends on the character of the material, but it shall generally not exceed two feet. The pipe, preferably, shall be jacked from the low or downstream end. Lateral or vertical variation in the final position of the pipe from the line and grade established by the Owner shall be within limits specified on plans or as directed by the Engineer.

When jacking of pipe is once begun, the operation shall be carried on without interruption, insofar as practicable to prevent the pipe from becoming firmly set in the embankment.

Any pipe damaged in jacking operations shall be repaired if approved by the Owner or removed and replaced by the Contractor at his entire expense.

The pits or trenches excavated to facilitate operations shall be filled immediately after the jacking of the pipe has been completed unless an encasement only has been installed; in which case, the trenches and pits may be left open until the carrier pipe has been laid through and manholes have been built if required. The pits or trenches shall then be backfilled in accordance with the location; and conditions as are covered elsewhere in these specifications.

If a carrier pipe is laid through an encasement pipe, the bedding of crushed rock, concrete, grout or granular material, if any, shall be considered a part of the unit price of the jacking operation.

3. Construction by Boring - The hole shall be bored mechanically with a suitable boring assembly designed to produce a smooth, straight shaft and so operated that the completed shaft shall be at the established line and grade. The size of the bored hole shall be of such diameter to provide ample clearance for bells or other joints. The holes are to be bored mechanically. The boring shall be done by using either a pilot hole or a dry bore method.

A pilot hole boring shall be constructed by the following method:

> An approximate two-inch pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole shall serve as the centerline of the larger diameter hole to be bored.

The dry bore shall be constructed as follows:

> The casing pipe shall be advanced as the spoil is removed by augers. Bentonite may only be used as a lubricant. Casing shall be new, or used steel pipe approved by the Owner, with a minimum inside diameter as shown on plan detail sheets.

All carrier pipe installed by boring shall be supported by a quarter point cradle of Class B concrete, when directed by the Engineer, across the boring pit and to the first joint in the ditch section on each end. All pits should have crushed rock and sump areas to remove water. Where groundwater is found, pits shall be lined with filter fabric.

All voids shall be grouted per ASTM Designation C 476; and shall be considered a part of the unit price of the boring operation.

In addition to the requirements stated above, the applicable provisions of *Item A.2, Construction by Jacking, of Section 4.4 Part 3* which regard to the construction of trench, tolerance in line and cradle, method of operation, backfilling, etc., shall govern for construction by boring.

4. Construction by Tunneling - The tunnel shall be excavated in such a manner and to such dimensions, which shall permit placing of the proper supports necessary to protect the excavation. The Contractor shall take the proper precautions to avoid excavating earth or rock or shattering rock beyond the limits of excavation shown on the plans. All damages by excavating and blasting, either to surface or subsurface structures, shall be repaired or replaced by the Contractor at his own cost and expense. Adequate provisions shall be made for safety and health of the workers. All equipment operated in the tunnel shall be powered by either air or electricity. No equipment shall be permitted in the tunnel that uses a petroleum product as fuel.

Electric lights shall be used for illumination of completed portions of the tunnel used for passage and wherever lighting is needed for inspection of the work. A sufficient number of lamps shall be used to properly illuminate the work; and all wiring for electric power and lights shall be installed and maintained in a safe and secure manner in accordance with the current applicable electrical specifications of the Owner. Contractor shall maintain the tunnel air in a condition suitable for the health of the workers and sufficiently clear for surveying operations. A sufficient supply of fresh air shall be provided and maintained at all times in all underground places. Provisions shall be made for the quick and complete removal of gases and dust resulting from blasting or other tunnel operations. Except when unnecessary due to natural ventilation, artificial ventilation shall be maintained in the tunnel by ventilating plants of ample capacity operated when needed to meet the preceding requirements.

If required by the plans or if required for safety, suitable steel or timber sheeting, shoring and bracing shall be used to support the sides and roof of the excavation. Supports may be left in place, provided that they clear the encasement or carrier pipe. No separate payment shall be made for supports left in place. Nothing contained herein shall prevent the Contractor from placing such temporary or permanent supports, as he shall deem necessary; nor shall it be construed as relieving the Contractor from his full responsibility for the safety of workers, and for all damages to personal property.

If the tunnel is to be lined with concrete as a monolithic structure, then the overbreak, if any, or voids shall be poured with Class A concrete. The Contractor shall not be compensated for overbreaks.

No pipe shall be placed until the foundation is in a condition satisfactory to the Owner. Tunnel dimensions shown on the plans are minimum dimensions. Any excess excavation and subsequent backfill, concrete or grout fill shall be at the expense of the Contractor. The pipe shall be laid in the tunnel true to line and grade. Tolerance in line and grade shall be as specified in *Item A.2, Construction by Jacking, of Section 4.4 Part 3.*

If indicated or specified, the entire void between the outside of the pipe and the tunnel walls or the inside face of the tunnel lining shall be grouted per ASTM Designation C 476 unless the permanent sheeting, bottom, sides and roof of the tunnel are in a condition satisfactory to the Owner. The minimum thickness of grout backfill shall be maintained throughout. Pneumatically injected river-run gravel may be used in lieu of grout if approved by the Owner. The Contractor must submit the gravel gradation and means and methods of construction to the Owner for approval. Grout required for backfill in excess of the minimum dimensions shown on the plan shall be at the entire expense of the Contractor.

All pipe damaged during construction operations shall be repaired, if approved by the Owner; or removed and replaced by the Contractor at his entire expense.

5. Joints - When reinforced concrete pipe 24 inches and larger in diameter with tongue-and-groove joints is used for the encasement pipe, the interior joints for the full circumference shall be sealed, packed with mortar and finished smooth and even with the adjacent section of pipe.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Openings provided by jacking, boring or tunneling shall be measured for payment in linear feet along the centerline of the opening measured from face to face of the trench ends or pit walls between which the jacking, boring or tunneling traverses; and shall not be classified for payment according to depth. The carrier pipe, when required, shall be measured for payment as provided elsewhere in these specifications. Openings provided by jacking, boring or tunneling shall be paid for at the contract unit price per linear foot, complete in place, as provided in the proposal and contract. The contract unit price shall be the total compensation for furnishing and placing all materials including encasement pipe, if required, and grout backfill; for all jacking, boring, tunneling, excavation and backfill; for all sheeting, shoring, bracing and drainage; for disposal of all surplus materials; and for all labor, tools, equipment and incidentals necessary to complete the work, all in accordance with the plans and these specifications. The carrier pipe, when required, shall be paid for as provided elsewhere in these specifications. Exfiltration test shall not be paid for separately, but shall be considered a part of the jacking, boring or tunneling operation.

The Contractor shall only be paid for the limits as shown on the plans. Any overrun, except as approved by the Owner, shall be at the Contractor's expense.

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SECTION 4.5: STREET, HIGHWAY, AND RAILROAD CROSSINGS

PART 1: GENERAL

A. DESCRIPTION

This specification shall govern for the construction of storm sewer, water, or sanitary sewer mains on or across streets, alleys, highways or railroads as detailed in the plans. The Contractor shall provide and employ adequate warning signs, barricades, lights, watchmen, etc., to fully protect his workers and the traveling public. No changes shall be made in location as shown on the plans without prior authorization of the appropriate agency and the Owner.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Not Applicable

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHOD

1. State Highway Crossings - All crossings shall conform to the Texas Department of Transportation (TxDOT) Utility Accommodation Policy Manual Special Specifications. All state highway crossings shall be permitted by TxDOT.

2. Street and Alley Crossings - The construction of underground pipes on or across street and alley rights-of-way and the removal and replacement of pavement curb and gutter, etc., shall be in accordance with the following requirements:

The Contractor shall protect the street and alley surface and all existing improvements from excavated materials, equipment operations and other construction operations. If jacking, boring or tunneling is indicated or specified, the work shall be performed in accordance with the requirements of *Section 4.4, Jacking, Boring or Tunneling*. If open-cut method is indicated or specified, the construction operations shall be conducted in accordance with the requirements of *Section 4.2, Excavation and Backfill*.

3. Railroad Crossings - All railroad crossings shall conform to these specifications and the following requirements:

Railroad crossings for all sanitary sewer lines, storm sewer, and for water lines shall require an encasement pipe of a diameter as shown on the plans. Encasement pipe shall be steel or reinforced concrete to suit conditions of the crossing. Encasement pipes shall be plugged at the upper and lower end with concrete.

Encasement pipe shall be installed in accordance with railroad company requirements.

The encasement pipe may be installed by jacking, boring or tunneling. Regardless of the method used, the encasement pipe shall be installed with even bearing throughout its length; and all voids between the encasement pipe and the earth or rock shall be grouted per ASTM Designation C 476. Timber supports shall not be permitted.

The carrier pipe shall be of the kind and class shown on the plans with joints made up in place in the encasement pipe or made up outside and pushed through the end if sufficient room is not available inside the encasement pipe.

The Contractor must obtain insurance and other requirements of the railroad company prior to beginning any work within the railroad right-of-way.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Each crossing within the limits noted on the plans and/or set forth in the proposal shall constitute a separate pay item where indicated on the plans and specifications and shall be paid for as shown in the proposal.

SECTION 4.6: UNDERGROUND PIPE INSTALLATION

PART 1: GENERAL

A. DESCRIPTION

This specification shall govern the general installation of all underground piping in the City of Waco ROW and public underground piping in private property.

B. SUBMITTALS

Not applicable.

PART 2: PRODUCT

A. MATERIALS

Not applicable.

B. EQUIPMENT

Not applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Pipe Handling - All pipe, fittings and specials shall be handled in such a manner as not to damage the material. All dirt and trash shall be removed from the pipe prior to installation. All pipe and fittings handled with clamps or slings must meet with the approval of the Owner; no hooks shall be permitted. When it becomes necessary to deflect the pipe to avoid obstructions, the deflection of each joint must be within the limits provided by the manufacturer and be approved by the Owner.

The pipe is to be kept clean during the laying operation and free of all dirt and trash. At the close of each operating day, the open end of the pipe is to be effectively sealed against the entrance of all objects and especially water.

2. Stringing of Pipe - Unless prior approval from the Owner is granted to do otherwise, stringing of pipe in advance of the laying operation shall be restricted to one week's laying or as directed by Engineer, and shall be done in such a manner as to create no hazard to, nor interference with, traffic or citizens. Ready access shall be provided to all streets, alleys and driveways. The pipe shall be protected with barricades and warning signs at all times. Any damage to the pipe shall be corrected at the expense of the Contractor.

3. Laying Underground Pipe - Previous to being lowered into the trench, each pipe shall be carefully inspected; and those not meeting specifications shall be rejected and either destroyed or removed from the job. All lumps or excrescences on the ends of the pipe shall be removed before it is lowered into the trench. No pipe shall be laid except in the presence of the Owner, unless otherwise specified; and the Owner may order the removal of and re-laying of any pipe not so laid. The pipe and specials shall be so laid in the trench that after the project is completed, the interior surface shall conform accurately

to the grade and alignment indicated on the plans. Bell holes shall be excavated and all pipe shall be carefully adjusted to fit snugly in cradling or bedding so that the entire length bears on cradling or bedding material with no wedging or blocking to hold up the bell. All pipe shall be laid in the dry, regardless of the type of joint used.

Pipes shall be laid with the bell or groove end upgrade unless otherwise approved by the Owner; and, in any event, shall be laid with the bell or collar away from the last section placed.

Before laying the pipe, the interior of the joints shall be carefully bored smooth and clean, and the annular space shall be kept free from dirt, stones or water. Pipe shall be installed and joints made up in complete conformance with the instructions and recommendations regarding proper installation and assembly furnished by the manufacturer. Proper facilities shall be provided for hoisting and lowering the section of the pipe into the trench without disturbing the prepared foundation and the sides of the trench. All pipe shall be so laid that the contact in the joint between two lengths of pipe shall be uniform throughout the circumference of the joint. Where curves in the alignment are indicated on the drawings, standard pipe (short sections of pipe or bevels) shall be used with the outside edge of the joint pulled away from the seat to make a smooth curve.

When work is suspended on the line for any reason, the end of the line shall be properly closed with an effective watertight seal or plug manufactured for this purpose.

4. Existing Utilities - Pipe capable of supporting its weight approximately at right angles to the ditch shall not require additional support, unless otherwise directed by the Owner or shown on the plans, other than the exercise of care in placing new pipe under same and in placing backfill, except when the span is excessive. If directed by the Owner, utilities shall be replaced with ductile iron or any suitable piping to convey the contents, supported with concrete or a concrete utility support per details on the plans, as directed by Owner. After the new utility is laid, the backfill to the base of the concrete support shall be stabilized by the use of cement-stabilized soil, if directed by the Owner.

Pipes parallel to and in the edge of cut, shall be supported or rerouted if so indicated on the plans. Utilities parallel to and in edge of cut shall be adequately protected without additional compensation except as set out in the contract and proposal.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

1. Utility Supports

a. Measurement - Concrete piers and beam supports shall be measured in cubic yards in place.

No measurement shall be made for reinforcing steel.

No measurement shall be made for the removal and replacement of utility pipe even if the utility pipe is replaced with a different pipe.

Cement stabilized backfill shall be measured for payment in cubic yards in place.

b. Payment - There shall not be a payment for a support as a unit, but the contract unit prices for the concrete and cement-stabilized backfill shall be the total compensation for the furnishing of all labor, tools, materials, equipment and incidentals necessary to complete the work, including excavation, furnishing, installation and removal of the piping, construction of piers and supports, and striping of forms, disposal of surplus materials, in accordance with the plans and specifications.

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SECTION 4.7: PIPING MATERIALS

PART 1: GENERAL

A. DESCRIPTION

This section contains the various pipes and materials for Wastewater, Water, and Storm Water Systems.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. PIPES

1. Polyvinyl Chloride (PVC) Sewer Pipe & Fittings with Dimension Control

a. General - PVC Sewer Pipe and Fittings shall conform to the current ASTM Designation D 3034 or ASTM Designation D 2241 as shown on the plans for 4 inch through 15-inch diameter, and ASTM Designation F 679 or ASTM Designation D 2241 for greater than 15 inches diameter. Engineering evaluations of specific installation requirements is recommended.

b. Pipe Sizes

(1) For pipe sizes 4 through 15 inches in diameter, the pipe shall be Type PSM SDR-26 as specified in ASTM Designation D 3034 or ASTM Designation D 2241.

(2) For pipe sizes greater than 15-inch diameter, the pipe shall be Type T-1 A and T-2 B as specified in ASTM Designation F 679 or ASTM Designation D 2241.

c. Material - The pipe shall be made of PVC plastic having cell classification of 12454-B, 12454-C, or 12364-C and fittings shall be made of PVC plastic having cell classifications of 12454-B, 12454-C, or 13343-C as defined in ASTM Designation D 1784.

d. Joints - Joints shall be the compression rubber gasket type conforming to ASTM D-3212 with gaskets conforming to ASTM F 477.

e. Installation - Pipe produced to this specification shall be installed in accordance with ASTM Designation D 2321. The internal diameter of the installed barrels of the pipe must not be reduced by more than 5% of its base inside diameter when measured not less than 30 days following completion of installation.

f. Testing - All pipe shall meet ASTM requirements for flattening, impact resistance, stiffness, joint tightness and extrusion quality as specified in ASTM Designation D 3034 and F 679.

2. Polyvinyl Chloride (PVC) Water Pipe

a. General - Unplasticized polyvinyl chloride (PVC) water pipe shall meet the requirements of AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water, AWWA Standard C900, with cast-iron outside dimensions. Laying lengths shall be 20' ± 1".

b. Thickness Class - PVC water pipe shall meet the dimension ratios (DR's) and physical dimensions as shown in the following table. The pressure classification

refers to the maximum hydrostatic pressure to which the pipe shall be subject in normal operations. Pipe will be Class 150 (DR-18) unless noted otherwise.

PVC WATER PIPE DIMENSIONS			
Nominal Size	O.D.*	Class 200 (DR 14)	Class 150 (DR 18)
		Min. Wall Thickness	Min. Wall Thickness
Inches	Inches	Inches	Inches
4	4.800	0.343	0.267
6	6.900	0.493	0.383
8	9.050	0.646	0.503
10	11.100	0.793	0.617
12	13.200	0.943	0.733
* CAST IRON PIPE O.D. DIMENSIONS.			

c. Joints - PVC water pipe shall be furnished with gasketed joints. Lubricant used for pipe and fittings assembly shall be nontoxic and shall have no detrimental effect to either gasket or pipe.

d. Fittings - Fittings for PVC water pipe shall conform to American National Standard for Gray-Iron and Ductile-Iron Fittings, 3 in. through 48 in., for Water and Other Liquids, AWWA Standard C110 (ANSI A21.10), unless otherwise specified in the proposal, special specifications or on the other plans.

Fittings joints shall be mechanical joints, unless called for otherwise. Bolts and nuts for mechanical joints shall be of high-strength, corrosion-resistant, low-alloy steel and shall conform to ASTM Designation A 325 (Type 3).

e. Approvals - PVC water pipe shall be approved by the Underwriter's Laboratories and shall be accepted by the State Fire Insurance Commission for use in water distribution systems in cities and towns of Texas. PVC water pipe shall also bear the seal of approval (or "NSF" mark) of the National Sanitation Foundation testing Laboratory for potable water pipe.

f. Rejection - PVC water pipe may be rejected for failure to meet all of the requirements of this specification.

3. Ductile Iron Pressure Pipe and Fittings

a. General - Ductile iron pressure pipe 3" in diameter and larger shall conform to the current American National Standard for Ductile Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids, AWWA Standard C151 (ANSI A21.51).

Ductile iron pipe less than 3" in diameter shall conform to the manufacturer's standards, either centrifugally or statically cast with a minimum thickness of 0.25".

All potable water materials shall be in accordance with current AWWA Standards. In the absence of AWWA Standards, City review may be based upon the standards of the ASTM, commercial and other recognized standards utilized by design engineers.

(1) All newly installed pipes and related products must conform to ANSI/NSF Standard 61 and must be certified by an organization accredited by ANSI.

(2) The use of pipes and pipe fittings that contain more than 8.0 percent lead and flux that contains more than 0.2 percent lead is prohibited in the following circumstances:

(a) For installation or repair of any public water supply, and;

(b) For installation or repair of any plumbing in a residential or nonresidential facility providing water for human consumption and connected to a public drinking water supply system.

(3) No modification of water quality by any of the materials will be permitted.

b. Design Requirements - The ductile iron shall conform in all respects to the specifications for Ductile Iron Castings, ASTM Designation A 536. The requirements for ductile iron pipe is Grade 60-42-10 (60,000 psi minimum tensile strength, 42,000 psi minimum yield strength, and 10% minimum elongation), in accordance with AWWA C151, or most recent. The requirements for ductile iron fittings is Grade 70-50-5 (70,000 psi minimum tensile strength, 50,000 psi minimum yield strength, and 5% minimum elongation) or Grade 60-42-10, in accordance with AWWA C110 and C153.

Ductile iron thickness shall conform in all respects to the current American National Standard for the Thickness Design of Ductile Iron Pipe, AWWA Standard C150 (ANSI A21.50), based on a minimum of 200 psi working pressure, laying condition "Type 2" with 8' of cover.

Different pressure classification pipes may be considered. The engineer of record must submit all applicable calculations and information necessary for City of Waco review and approval, in accordance with Section GP 5.1F.[1]

c. Joints - All ductile iron pressure pipe shall be furnished with one of the following types of joints and as described in the proposal or bid request:

[1] The intent is to allow project specific consideration of Class 150 pipe for sizes 30 in. and larger.

Type Joint	AWWA Standard
Push-on	AWWA C111
Mechanical Joint	AWWA C111
Flanged Ends	AWWA C110

Bolts and nuts for mechanical joints or flanged ends (if used underground) shall be of high-strength low-alloy corrosion-resistant steel and shall conform to High Strength Bolts for Standard Steel Joints, ASTM Designation A 325 (Type 3).

All screwed flanges shall be ductile iron.

d. Coating and Lining - All ductile iron pipe for potable water use shall be cement-mortar lined inside and coal tar for coated outside in accordance with AWWA Standard C104 (ANSI A21.4) and AWWA C151.

Ductile iron pipe for sanitary sewer use shall be lined with a ceramic epoxy lining. The lining material for pipe and fittings shall be virgin polyethylene complying with ANSI/ASTM D1248, compounded with an inert filler and with sufficient carbon black to resist ultraviolet rays during above ground storage of the pipe or fitting by heat. The lining material may also be an amine cured novalec epoxy containing a minimum of 20% by volume of ceramic quartz pigment.

All surface areas to be lined shall be blast cleaned comparable to the requirements of SSPC-SP6 or NACE #3.

Ceramic epoxy linings shall cover the inner surface of pipe and fittings as described herein. In pipe utilizing push-on gaskets, the lining shall extend from the spigot end through the socket to the edge of the gasket sealing area. In mechanical joint pipe the lining shall extend from the spigot end through the socket to the edge of the gauging ring. The lining in fittings shall cover the interior surfaces including the socket areas as defined above.

Lining thickness in pipe and fittings shall be 40 mils nominal thickness. Minimum lining thickness shall be 30 mils.

(1) Film - The polyethylene film shall be 8 mils (0.008") thick, with the following minimum flat tube widths for the specified pipe sizes. The polyethylene film shall be extracted from polyethylene resin, Type I, Class C, Grade E-1, and as specified in Polyethylene Plastics Molding and Extrusion Materials, ASTM Designation D1248, with the following characteristics:

Flow rate	0.4 maximum
Tensile Strength	1200 psi minimum
Elongation	300% minimum
Dielectric Strength	volume resistivity
Minimum ohm, cm3	1015
800 Volts per mil thickness minimum	

(2) Polyethylene Tape - The polyethylene tube seams and overlaps may be wrapped and held in place by means of 2" wide plastic backed adhesive tape 10 mils (0.010") thick. The tape shall be Polyken No. 900, Scotchwrap No. 50, or approved equal.

c. Minimum Width of Film Tube (When Laying Flat)

Nominal Pipe Size (inches)	Push-on Joint Flat Tube Width (inches)	Mechanical Joint Bell Flat Tube Width (inches)
4	14	16
6	17	20
8	21	24
10	25	27
12	29	30
14	33	34
16	37	37
18	41	41
20	45	45
24	53	53

Failure to meet any of the specifications contained in this section shall be cause for rejection of the materials.

e. Fittings - Fittings shall be of ductile iron and shall conform to the American National Standard for Gray Iron and Ductile Iron Fittings, 3 in. through 48 in., for Water and Other Liquids, AWWA Standard C110 (ANSI A21.10), or American National Standard for Ductile Iron Compact Fittings, 3 in. through 64 in. for Water and Other Liquids, AWWA Standard C153 (ANSI A21.53), unless otherwise specified in the proposal, special specification or in the plans.

All fittings shall be rated for a minimum of 250 psi working pressure.

Fittings for force mains shall be lined and coated as outlined in *Paragraph d, Coating and Lining.*

Special fittings using end condition combinations of bells, spigots, mechanical or push-on joints, flanges or special internally lock joints shall be to dimensions in accordance with AWWA Standard C110 (ANSI A21.10).

Where plans, details, or field conditions call for or necessitate a restrained joint, the fittings must be connected with EBBA series 1100 (or pre-approved equal) mechanical joint retainer gland accessory kit for each joint. Contractor may, at his option, use EBBA retainer glands at locations not specifically called for. Blocking will be required as shown on the detail sheet, except on an upper vertical bend.

Bolts and nuts for mechanical joints or flanged ends shall be of high-strength corrosion-resistant low-alloy steel and shall conform to ASTM Designation A 325 (Type 3).

Fittings shall be cement-lined inside and asphaltic coated outside.

f. Underwriter's Approval - Ductile iron pipe shall be approved by the Underwriter's Laboratories, Inc., and shall be accepted by the State Fire Insurance Commission for use in water distribution systems without penalty. All pipe and fittings shall be new and domestically produced.

g. Tests - All ductile iron pipe and fittings shall be tested in accordance with the applicable provisions of the specifications relating thereto and the class, weight, and casting period shall be shown on each pipe.

h. Rejection - Ductile iron and fittings may be rejected for failure to meet all of the requirements of this specification.

4. Fiberglass Sewer Pipe

This fiberglass pipe shall conform to ASTM D 3262 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe. This pipe shall also be pipe manufactured by HOBAS with a minimum stiffness number of 36 or approved equal. Fiberglass pipe installed in casing shall have joints manufactured with flush coupling with gasket seal. Fiberglass pipe installed in open cut outside of casing may have joints manufactured with bell and spigot with gasket seal.

Fiberglass pipe installed in boring by jacking shall have jacking bell and spigot. The following stiffness numbers shall be required in the given conditions:

SN-36	Direct bury with depth of cover up to 15'
SN-46	Direct bury with depth of cover to +15' - 20'
SN-72	Direct bury with depth of cover to +20' and above
SN-210	Pipe placed through bore by jacking

5. Reinforced Concrete Culverts and Storm Drain Pipe

a. General - Except as modified herein, materials, manufacture and design of pipe shall conform the ASTM Designation C 76 for Circular Pipe, ASTM Designation C 506 for Arch Pipe, or ASTM Designation C 507 for Elliptical Pipe. All pipe shall be machine made or cast by a process which shall provide for uniform placement of the concrete in the form and compaction by mechanical devices which shall assure a dense concrete. Concrete shall be mixed in a central batch plant or other approved batching facility from which the quality and uniformity of the concrete can be assured. Transit mixed concrete shall not be acceptable for use in precast concrete pipe.

b. Design - The pipe shall be Class III unless otherwise indicated on the plans. The shell thickness, the amount of circumferential reinforcement, and the strength of the pipe shall conform to the requirements of ASTM Designation C 76 for Circular Pipe, C 506 for Arch Pipe, or C 507 for Elliptical Pipe, except as modified as follows:

(1) All pipe shall be machine made by a process which shall provide for uniform placement of zero slump concrete in the form and compaction by a mechanical device which shall assure a dense concrete in the finish.

(2) Sizes larger than 60-inch diameter shall be manufactured using two lines of circular reinforcement.

(3) When Class III pipe of sizes larger than 60-inch diameter is specified on plans, minimum "Wall B" shell thickness shall apply, and the minimum steel areas as listed for two circular cages under Table II may be submitted at the manufacturer's option, for those listed in Table III, provided test strength requirements for Class III pipe are satisfactorily met.

c. Physical Test Requirements - The acceptability of the pipe shall be determined by the results of the three-edge-bearing test for the load to produce the one-hundredth (0.01) inch crack and the ultimate load; by such material tests as are required in ASTM Designation C 76, C 506 or C 507; by absorption tests on selected samples from the wall of the pipe; and by inspection of the finished pipe to determine its conformance with the design prescribed in these specifications and its freedom from defects. Three-edge-bearing tests for the one-hundredth (0.01) inch crack only shall be performed on eight-tenths (0.8) percent of the pipe joints. Three-edge-bearing tests for both the one-hundredth (0.01) inch crack and the ultimate load shall be performed on two-tenths (0.2) percent of the pipe joints.

Pipe which has been tested only to the formation of a one-hundredth (0.01) inch crack and meet the requirements for this test shall be accepted for use. Tested pipe accepted for use shall be marked "TEST" or otherwise appropriately identified so that such may be used at the end of the structure or other location not subject to impact loads. The methods of testing shall conform to ASTM Designation C 76, C 506 or C 507.

As an alternate to the three-edge-bearing test, concrete pipe 60 inches in diameter and over may be accepted, at the option of the manufacturer, on the basis of material tests and inspection of the completed product. Acceptability of pipe on this basis shall be determined by the results of material tests as required in ASTM Designation C 76, C 506 or C 507; by crushing tests on cores taken from the barrel of the completed and cured pipe; by absorption tests on samples from the wall of the pipe; and by inspection of the finished pipe, including amount and placement of reinforcement, to determine its conformance with the design prescribed in these specifications and its freedom from defects.

The manufacturer shall furnish facilities and personnel for taking the cores from the pipe barrel and for determining the compressive strength of the samples. When the cores cut from a section of pipe successfully meet the strength requirement, the core-holes shall be plugged and sealed by the manufacturer in a manner such that the pipe section shall meet all of the test requirements of ASTM Designation C 76, C 506 or C 507. Pipe sections, so sealed, shall be accepted for use.

All classes or strengths of reinforced concrete pipe shall be tested in accordance with the current specifications for Concrete Pipe, Sections, or Tile, ASTM Designation C 467.

d. Sizes and Permissible Variations

(1) Variations - Variations in diameter, size, shape, wall thickness, reinforcement, placement of reinforcement, laying length and the permissible underrun of length shall be in accordance with the applicable ASTM Specification for each type of pipe as referred to previously.

(2) Rubber Gasket Pipe Joints - Where rubber gasket pipe joints are to be used, the design of joints and permissible variations in dimensions shall be in accordance with ASTM Designation C 443, Sections 5 and 6.

e. Workmanship and Finish - Pipe shall be substantially free from fractures, large or deep cracks and surface roughness. The ends of the pipe shall be normal to the walls and centerline of the pipe within the limits of variations allowed as stated previously.

f. Curing - Pipe shall be cured in accordance with the applicable ASTM Specification for each type of pipe as referred to above.

g. Pipe Marking - The following information shall be clearly marked on each section of pipe:

(1) The class of pipe.

(2) The date of manufacture.

(3) The name or trademark of manufacturer.

(4) Where elliptical reinforcement is used, one end of each section or joint of pipe shall be clearly marked during the process of manufacture or immediately thereafter on the inside and the outside of opposite walls to show the location of the "top" or "bottom" of the pipe as it should be installed. Markings shall be indented on the pipe section or painted thereon with waterproof paint.

"Top" and "bottom" shall not be required on pipe having such an external shape that the correct position of the top and bottom is obvious.

h. Joints - Pipe to be placed along curves shall consist of whatever pipe joint lengths or beveled end joints of pipe, or combination thereof that are required to place the pipe on the designated centerline curve with no more than one-half of the tongue length of the pipe exposed from its normal fully closed joint position. The amount of bevel, "drop" or shortening of the pipe joint length by the bevel shall not exceed the amount shown below for the pipe sizes indicated.

Pipe Diameter	Maximum Amount of Bevel or Drop
From 12-inch to 27-inch inclusive	2 inches
From 30-inch to 51-inch inclusive	3 inches
From 54-inch to 84-inch inclusive	4 inches

Where pipe joints are not fully closed, special care shall be taken to fill completely, on both inside and outside, the entire annular space at the joint with cement mortar firmly caulked or pressed and compacted to form a dense, tight joint. Joints may be made with Portland cement mortar, rubber gaskets, plastic asphalt sewer joint compound, or cold applied preformed gasket plastic.

(1) Portland cement mortar for joints shall be one part Portland cement and two parts sand by volume. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar, but in no case shall exceed five and one-half (5½) gallons of water per sack of cement. The sand shall conform to the specifications M85-53 of the

American Association of State Highway Officials. The pipe ends shall be thoroughly cleaned and wetted with water before the joint is made.

Stiff mortar shall then be placed in the lower half of the bell or groove of the pipe section already laid. Next, mortar shall be applied to the upper half of the spigot or tongue of the pipe section being laid. Then, the spigot or tongue end on this pipe shall be inserted in the bell or groove end of the pipe already laid, the joint pulled up tight, taking care to see that inner surface of the abutting pipe sections are flush and even.

(2) Rubber gaskets for jointing shall conform to the "Standard Specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets," American Society for Testing Materials (ANSI/ASTM) Designation C443-76 or latest revision thereof.

(3) Cold applied, plastic asphalt sewer joint compound shall be suitable for jointing concrete pipe. It shall consist essentially of natural and/or processed asphalt base, suitable volatile solvents, and inert filler, a portion of which shall be asbestos fiber. The consistency is to be such that the ends of the pipe can be coated with a layer of the compound up to one-half inch thick by means of a trowel. It shall cure to a firm, stiff plastic condition after application. The material shall be of uniform mixture and any small separation occurring in the container before use must be readily stirred back to form a uniform mix.

Detailed requirements: The material shall meet the following requirements when tested according to TxDOT Test Method Tex-526-C:

Asphalt Base, 100-(% Volatiles + % Ash), % by weight	28 - 45
Volatiles by 212°F Evaporation, 24 hrs, % by weight	10 - 26
Mineral Matter determined as Ash, % by weight	30 - 55
Consistency/Cone Penetration, 150 g, 5 sec 77°F	150 - 275

Joints using Cold Applied, Plastic Asphalt Sewer Joint Compound shall be made as follows:

Both ends of pipe shall be clean and dry. Under no circumstances shall this type of joint be attempted on wet pipe. After the pipe has been set to proper line and grade in the trench, a one-half inch thick layer of the compound shall be trowelled or otherwise placed on the groove end of the pipe covering not less than two-thirds of the joint face around the entire circumference. Next, the tongue end of the next pipe shall be shoved home with sufficient pressure to make a tight joint. After the joint is made, any excess mastic projecting into the pipe shall be removed. Backfilling of pipe laid with asphalt mastic joints may proceed as soon as the joint has been inspected and approved by the Engineer. Special precautions shall be taken in placing and compacting backfill to avoid damage to joints.

(4) Preformed plastic gaskets shall be suitable for sealing joints of tongue and groove concrete pipe. The gasket sealing the joint shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes or obnoxious odors. The gasket joint sealer shall not depend on oxidizing, evaporation, or chemical action for its

adhesive or cohesive strength, and shall be supplied in extruded rope-form of suitable cross-section. The size of the plastic gasket joint sealer shall be in accordance with the manufacturer's recommendations and be of sufficient size to properly seal the joint. The plastic gasket joint sealer shall be so constructed as to provide evidence of proper installation either by means of "squeeze-out" of the gasket material on the inside or outside around the complete pipe joint circumference or by means of tabs, projections or other such indicators placed at established intervals around the circumference of the pipe joint. Plastic gasket joint sealers shall be Type 1 or Type 2. Type 1 gaskets shall meet the "squeeze-out" requirements and Type 2 gaskets shall meet the requirements for tabs, projections, or other indicators. The gasket joint sealer shall be protected by a suitable wrapper designed that when removed, the jointing material maintains integrity.

The chemical composition of the gasket joint sealing compound for Type 1 and 2, as shipped, shall meet the following requirements:

COMPOSITION	TEST METHOD	ANALYSIS
Bitumen, Petroleum Plastic Content, % by weight	ASTM D4	50 - 70
Ash-Inert Mineral Matter, % by weight	Tex-526-C	30 - 50
Volatile Matter, 325°F, % by weight	Tex-506-C	2.0 max.

The gasket joint sealing compound when immersed for 30 days at ambient room temperature separately in five (5) percent solution of caustic potash; a five (5) percent solution of hydrochloric acid; a five (5) percent solution of sulfuric acid; and a saturated H_2S solution, shall show no visible deterioration.

The physical properties of the gasket joint sealing compound as shipped shall meet the following requirements:

PROPERTY	TEST METHOD	TYPICAL ANALYSIS	
		Min.	Max.
Specific Gravity at 77°F	ASTM D 71	1.20	1.35
Ductility at 77°F Min.	ASTM D 113	5.0	-
Softening Point at 77°F	ASTM D 36	320	-
Penetration			
32°F (300 gms) 60 sec.	ASTM D 217	75	-
77°F (150 gms) 5 sec.	ASTM D 217	50	120
115°F (150 gms) 5 sec.	ASTM D 217	-	150
Flashpoint C.O.C. °F	ASTM D 92	600	-
Fire Point C.O.C. °F	ASTM D 92	625	-

i. Rejection - Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements.

All rejected pipe shall be plainly marked by the Engineer and shall be replaced by the Contractor with pipe, which meets the requirements of these specifications. Such rejected pipe shall be removed immediately from the site of the work.

B. TRENCHLESS REHAB PIPE

1. Cured-In-Place Pipe (CIPP)

a. General - It is the intent of this specification to provide for the reconstruction of pipelines and conduits by the installation of a resin-impregnated flexible tube, which is inverted into the original pipe by use of a hydrostatic head. The resin is cured by circulating hot water within the tube. When cured, the finished pipe (CIPP) will be continuous and tight fitting.

b. Referenced Documents - This specification references ASTM F1216 which is made a part hereof by such reference and shall be the latest edition and revision thereof. In case of conflicting requirements between this specification and ASTM F1216, this specification will govern.

c. Prequalification - Only bids based on prequalified products will be read. Bids submitted based on products or from Contractors that have not been prequalified will be returned unopened. The Contractor and the proposed method of reconstruction and the product manufacturer's name shall be clearly identified on the bid envelope.

d. Materials

(1) Tube - The tube material shall meet the requirements of ASTM F1216, Section 5.1.

The tubes shall have a uniform thickness that when compressed at installation pressures will equal the specified nominal tube thickness.

The tube shall be fabricated to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion.

The outside layer of the tube (before inversion) shall be plastic coated with a translucent flexible material that clearly allows inspection of the resin impregnation (wetout) procedure. The plastic coating shall not be subject to delamination after curing of the CIPP.

The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No materials shall be included in the tube that are subject to delamination in the cured CIPP.

The wall color of the interior pipe surface of the CIPP after installation shall be a light reflective color so that a clear detail examination with closed circuit television inspection equipment may be made.

(2) Resin - The resin system shall meet the requirements of ASTM F1216.

e. Structural Requirements - The CIPP shall be designed as per ASTM F1216, Appendix XI. The CIPP design shall assume no bonding to the original pipe wall.

The layers of the cured CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers; nor shall separation of the layers occur during testing performed under the requirements of this specification.

The cured pipe material (CIPP) shall conform to the minimum structural standards, as listed below.

Cured Pipe	Standard	Results
Flexural Stress	ASTM D-790	4,500 psi
Modulus of Elasticity	ASTM D-790	250,000 psi

f. Testing Requirements -

(1) Chemical Resistance - The Contractor shall certify that CIPP shall meet the chemical resistance requirements of ASTM F1216, Appendix X2. CIPP samples for testing shall be of tube and resin system similar to that proposed for actual construction. It is required that CIPP samples with and without plastic coating meet these chemical-testing requirements.

(2) Hydraulic Capacity - The Contractor shall certify that the CIPP shall have a minimum of the full flow capacity of the original pipe before rehabilitation. Calculated capacities may be derived using a commonly accepted roughness coefficient for the existing pipe material taking into consideration its age and condition. The roughness coefficient of the CIPP shall be verified by third party test data.

(3) CIPP Field Samples - When requested by the Owner, the Contractor shall submit test results from previous field installations in the USA of the same resin system and tube materials as proposed for the actual installation. These test results

must verify that the CIPP physical properties specified in ASTM F 1216, Section 5.3 have been achieved in previous field applications. Testing samples for this project shall be made and tested as described later in this specification under the heading of "Inspection."

g. Rejection - CIPP may be rejected for failure to meet any of the requirements of this specification.

2. Deformed PVC Pipe

a. General - Work consists of furnishing all labor, material and equipment necessary for the reconstruction of sanitary sewer lines by the insertion of a deformed polyethylene liner pipe into the existing sewer line. The liner shall be inflated by circulating hot water or other approved method to reform the deformed pipe back into its original extruded configuration. When inflated, the new material should extend over the length of the insertion in a continuous, tight fitting, pipe-within-a-pipe.

b. Reference Specifications - This specification references American Society for Testing and Materials (ASTM) standard specifications, which are made a part hereof by such reference and shall be the latest edition and revision thereof.

- D-1248 Specification for Polyethylene Plastic Molding and Extrusion Materials.
- D-1693 Test for Environmental Stress-Cracking of Ethylene Plastics.
- D-2122 Determining Dimensions of Thermoplastic Pipe and Fittings.
- D-2837 Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
- D-3035 Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter. (Up to 6" IPS)
- D-3350 Specification for Polyethylene Plastic Pipe and Fittings Materials.
- F-714 Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter (3" IPS and larger)

c. Materials

(1) Properties - The sewer liner pipe and fittings shall be manufactured from a polyethylene compound, which conforms to ASTM D-1248 and meets the requirements for Type III, Class C, Grades P34, Category 5.

(a) Pipe made from this compound must have a long-term hydrostatic strength rating of 1,600 psi or more, in accordance with ASTM D-2837.

(b) When the environmental stress crack resistance of the compound is measured in accordance with ASTM D-1693, Condition C, the compound shall withstand not less than 192 hours in 100% solution Igepal CO-630 at 100°F before reaching a 20% failure point.

The pipe shall have the following minimum physical properties:

PROPERTY	U.S. STANDARD	RESULTS
Flexural Stress (Yield)	ASTM D-638	3,300 psi
Flexural Stress (Break)	ASTM D-638	4,500 psi
Flexural Stress of Elasticity	ASTM D-790	133,000 psi

(2) Tests - Tests for compliance with this specification shall be made according to the applicable ASTM specification. A certificate of compliance with this specification upon request shall be provided by the manufacturer for all material furnished under this specification. In addition, the purchaser may, at his own expense, witness inspection and test of the materials, when requested at the time of purchase by the purchaser.

(3) Dimensions - The outside diameter and minimum wall thickness shall be fabricated to a size that when installed will neatly fit the internal circumference of the pipe specified. Allowance shall be made for misaligned and missing pipe.

The minimum length shall be that deemed necessary by the Contractor to effectively span the distance from the inlet to the outlet of the respective manholes unless otherwise specified. The Contractor shall verify the lengths in the field before manufacturing. Individual insertion runs can be made over one or more manhole sections as determined in the filed by the Contractor and approved by the Engineer.

Standard Dimension Ratio is calculated by dividing the specified outside diameter by the minimum wall thickness.

The wall thickness tolerance shall be within plus 12%.

(4) Rejection - Any materials may be rejected for failure to meet any of the requirements of this specification.

C. MANHOLES

1. Precast Reinforced Manhole Sections

a. The Precast Reinforced Concrete Manhole sections shall be made from crushed limestone coarse aggregates and natural silica fine sand aggregates. The concrete when tested in compression shall not be less than 4000 psi in seven days and absorption shall not exceed 9%.

Cone sections will be made with a 5" minimum wall at the bottom and an 8" wall thickness at the top. All base riser sections will be made with the bottom cast monolithically. The minimum thickness of the bottom shall be 6" for all manhole diameters. The manhole diameter to be used shall be as indicated on the plans.

b. The joints between the manhole sections will be made with "O" Ring rubber gaskets or gasket joint compound and shall meet the requirements of ASTM C443 with a nominal clearance of not more than 1/16 inch. The gasket compound must extrude prior to placing next section. There shall be a suitable rectangular recess cast into the tongue of each manhole component to contain the rubber gasket such that

when the joint is made, the rubber will be confined on all four sides. The rubber gaskets shall be installed on the manhole sections as follows:

(1) Clean all joint surfaces.

(2) Lubricate the recess and the gasket thoroughly with an approved lubricant.

(3) Snap gasket into the recess and equalize the rubber in tension by running a screwdriver shaft or other suitable tool around the section under the gasket.

(4) Thoroughly lubricate sliding surfaces of both the gasket and the inside surface of the bell.

(5) When gasket is properly installed and all sliding surfaces are lubricated, the manhole sections may be coupled immediately.

c. Two lift holes shall be cast into each cone or riser section for the purpose of handling and laying.

d. Manholes shall comply with ASTM C478 latest revision. Acceptable manufacturers are:

- Gifford-Hill
- Hanson

Other manufacturers may be approved upon review of their manhole.

e. Suitable openings for the inlet and outlet sewer pipe shall be placed in the base sections (riser section for drop manholes). These openings shall be true size, circular and located as required for each manhole. The pipe to manhole connector system shall provide a flexible watertight connection where the pipe enters the manhole.

(1) The connector shall be the sole element relied on to assure a flexible watertight seal of the pipe to the manhole. No adhesives or lubricants shall be employed in the installation of the connector into the manhole. The rubber for the connector shall comply with ASTM C443 and ASTM C923 and consist of EPDM and elastomers designed to be resistant to ozone, weather elements, chemicals, including acids, alkalis, animal and vegetable fats, oils and petroleum products from spills.

(2) All stainless steel elements of the connector shall be totally non-magnetic Series 304 Stainless, excluding the worm screw for tightening the steel band around the pipe, which shall be Series 305 Stainless. The worm screw for tightening the steel band shall be torqued by a breakaway torque wrench available from the precast manhole supplier, and set for 60 - 70 inch/lbs.

(3) The connector shall be installed in the manhole wall by activating the expanding mechanism in strict accordance with the recommendation of the connector manufacturer.

(4) The connector shall be of a size specifically designed for the pipe material and size being utilized on the project.

(5) Acceptable flexible connector manufacturers are:

- Hanson

f. The manhole shall be placed on a bedding of 3/4" washed rock a minimum of 6" thick.

g. No more than one 12" riser section may be used in any location except near the top of the manhole.

h. Test cylinders will be required to be taken by the City of Waco or for the City of Waco.

i. Manholes shall have factory paved inverts with a slope to the side of the manhole of 1"/1' minimum. This side slope shall begin at, or above, the spring line of the pipe diameter.

j. The paved inverts shall be constructed such that each lateral within the manhole has a clear straight run of at least 30" to provide for clearance of the sewer camera.

k. All manholes shall be manufactured without steps.

l. Manholes shall also comply with the following:

(1) All manholes shall be machine made by a process, which shall provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which shall assure a dense concrete in the finished product.

(2) Aggregates for the concrete shall provide corrosion protection by using high alkalinity limestone aggregate. The corrosion protection method/design shall be 100% limestone aggregate and crushed limestone for fine aggregate, as required, to produce an alkalinity of 0.7 or higher (as equivalent calcium carbonate). Also, provide a minimum concrete cover of 1.0 inch (min) over reinforcing steel on the inside of the pipe.

(3) Alkalinity - The alkalinity of the cover concrete shall be determined by the manufacturer and verified by an independent testing laboratory. Samples of the interior concrete for alkalinity determination shall be obtained by use of a one (1) inch diameter carbide concrete drill. The drill holes will be made in what would be the crown of the pipe in the "installed" position two (2) feet from the ends of the pipe section. The depth of the drill hole will be equal to the depth of cover over the reinforcing steel. The ground (pulverized) concrete from this drilling shall be the sample material used for the alkalinity determination. The alkalinity of the test pipe section shall be computed as the average of the two drill samples.

2. Fiberglass Manholes

a. General - Fiberglass manholes shall conform to all ASTM standards governing plastic laminations and the latest Glass Fiber-Reinforced Polyester Manholes, ASTM Designation D 3753, with supplementary details or additions as set forth in these specifications.

b. Manufacturing - The barrel and cone shall each be produced in a continuous manufacturing process, which insures continuous reinforcement and uniform strength and composition. The cone section, if produced separately, shall be affixed to the barrel section at the factory with a reinforced glass-resin joint resulting in a one-piece unit. Field-made joints shall not be acceptable.

c. Manhole Configuration - The manhole shall be a circular cylinder with a minimum internal diameter of four feet.

The cone of the manhole shall have a bearing surface wide enough to facilitate the placement of concrete adjustment rings or brick courses. The ring and cover shall not be placed directly on the manhole.

The manway reducer shall be concentric with respect to the manhole cylinder. Eccentric manway reducers shall not be permitted.

d. Watertight Construction - The manhole shall be of watertight construction to prevent infiltration and exfiltration.

e. Testing - All tests included in Glass Fiber-Reinforced Polyester Manholes, ASTM Designation D 3753, shall be required. A product certification shall be provided to the Owner if requested. This certification shall confirm the fiberglass manhole provided is in compliance with the testing requirements outlined in the ASTM standard.

f. Rejection - Fiberglass manholes shall be subject to rejection as follows:

(1) Any manhole shall be rejected for failure to conform with any of the requirements of these specifications.

(2) Any manhole found to be defective or damaged resulting from improper handling or installation shall be removed and replaced at no additional expense to the Owner. Patching shall not be acceptable.

D. JOINTS

1. Rubber Gasket Joints - Rubber gaskets shall conform to the applicable specifications under which the pipe is supplied. Loose gaskets shall be protected from sunlight, contamination and contact with gasoline or fuels.

Rubber gasket joints for water mains consist of four general types:

(1) Push-on type used for ductile iron, steel and plastic pipe.
(2) Mechanical type used for ductile iron and fittings for asbestos-cement pipe.
(3) Rubber and steel joint ring type used for steel cylinder type, reinforced concrete pipe.
(4) Double rubber gasket couplings used for pressure pipe.

Each type, except mechanical, requires the use of a lubricant to facilitate assembly. The lubricant shall be nontoxic, shall not support the growth of bacteria and shall have no deteriorating effects on the gasket. The lubricant shall not impart taste or odor in a pipe that has been flushed in accordance with *Purging and Disinfection of Water Mains* in *Section 4.9, Water Pipe*. Care should be taken not to overuse the lubricant, since it would then require excess effort to disinfect.

a. Rubber Gasket Joints

(1) Rubber Gaskets - Unless specifically approved by the owner all joints shall be rubber gasket joints. The rubber gasket shall be required to conform with requirements for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, ASTM Designation C 443 and C 361.

The gaskets shall be the product of a manufacturer having a successful experience record of at least five years in the manufacture of rubber gaskets for concrete pipe joints. The gasket shall be the Forsheda 138 gasket or equal. The gasket shall be made of SBR rubber with a hardness of 43 ± 5% shore durometer Type A.

(2) Joint Approval - A detailed design of the joint or joints, including design and durometer hardness of the rubber gasket proposed to be furnished under this specification, shall be approved by the Owner prior to installation. The design shall also include minimum and maximum interior joint opening in the assembled position in straight alignment and the maximum interior joint opening in the maximum deflected position.

b. Other Joints - Other type joints should be installed as per instructions from the pipe or joint manufacturer, after approval of the joint by the Owner. Jointing of pipe of different type materials shall be made using flexible adapters.

c. Tests - The connecting joints shall be subject to the hydrostatic tests set forth in the current Joints for Circular Concrete Sewer and Culvert Pipe.

The rubber gasket shall be required to meet and be tested in accordance with ASTM Designation C 443.

E. VALVES

1. Gate Valves

a. Gate Valves 3"-48" shall conform strictly to "AWWA Standard for Resilient-Seated Gate Valves, 3" through 48" NPS for Water and Sewage Systems," AWWA C-515 latest revision except for the changes and revisions outlined below:

(1) Valves shall have non-rising stems.

(2) Valves shall have mechanical joint end connections except where noted otherwise.

(3) Valves shall be installed in a vertical position.

(4) Valves shall open to the left.

(5) Valve stem seals shall be "O" rings.

(6) Valves shall have 2" square wrench nuts.

(7) Tapping valves shall have lip for tapping machine.

(8) All external nuts, bolts and washers shall be minimum a 304 stainless steel.

(9) If called for in the plans, details, or field conditions, EBBA series 1100 (or pre-approved equal) Mechanical Joint Retainer Gland accessory kit shall be provided for each specified connection.

(10) The valves shall be epoxy coated inside and outside, process of manufacturer to be submitted for approval. AWWA C550 or latest revision.

(11) Approved Manufacturers:

- American Flow Control 2500 Series
- Mueller A2361

2. Air Valves

a. General - Unless otherwise indicated in the plans or contract specifications, air valves shall meet the requirements specified herein.

b. Description - Air valves shall be of two types as follows:

(1) An air valve called for on the plans shall mean an air and vacuum valve of the ball type designed to permit the escape of air from a pipeline when the line is being filled and to permit air to enter the pipeline when the line is being emptied.

(2) A combination air valve called for on the plans shall mean a combination air and vacuum, and air release valve designed to fulfill the functions of an air and vacuum valve, and also, designed to permit the escape of air accumulated in the line at the high point when the line is under pressure while in operation. Air valves 3" and smaller shall be self-contained in one unit. Air valves larger than 3" may be a combination of two valves.

c. Material - The valves shall be stainless steel or iron body, stainless steel, brass or bronze fulcrum levers and links, stainless steel ball floats and pins, steel flange bolts and nuts, Buna-N synthetic rubber seats against bronze or stainless steel, and brass for other parts.

d. Inlets and Outlets - Inlets shall be threaded for 2" and smaller and flanged for 3" and larger. Outlets shall be threaded through 4".

e. Operating Pressure and Testing - The valves shall be designed to operate under an operating pressure of 200 psi and shall be tested to 1½ times that pressure.

f. Rejection - Air valves may be rejected for failure to conform to the requirements of this specification.

3. Brass Wheel Valves

a. General - Valves furnished under this specification shall be wedge disc, non-rising stem gate valves with screwed ends. They shall be equipped with bronze hand wheels and nuts, and shall have bronze packing gland followers. They shall be of all brass and/or bronze construction.

b. Pressure Rating - Valves shall be rated for 125 psi saturated steam working pressure and 200 psi liquids and gases up to 150 degrees Fahrenheit.

c. Tests - Each valve furnished under these specifications shall be tested at a hydrostatic pressure of 250 psi with the valve open. Under this test the valve shall not show any indication of leakage at the packing or anywhere on the body.

Each valve shall also be tested at a hydrostatic pressure of 250 psi applied to one end only with the valve closed. There shall be no indication of leakage by the gate or through the packing under this test.

d. Direction to Open - Valve shall open by turning the handwheel counterclockwise.

e. Material Specifications - The materials used in the manufacture of these valves shall equal or exceed the specifications shown in the following table:

PART	SPECIFICATION/DESIGNATION
Packing	Teflon impregnated asbestos or approved equal
Body	ASTM Designation B 62 for Bronze
Bonnet	ASTM Designation B 62 for Bronze
Gates	ASTM Designation B 62 for Bronze
Handwheel	ASTM Designation B 62 for Bronze
Handwheel Nut	Bronze
Gland & Packing Nut	ASTM Designation B 16 for Brass
Stem	ASTM Designation B 62 for Bronze, 50,000 psi (344,700 kPa) minimum tensile strength

f. Stem - Stem shall be completely free of visible flaw, and machining shall be smooth and free of defect. A back seating surface shall be provided on the wedge or on the lifting nut to seat tightly against the bonnet when the valve is open to seal the packing gland against line pressure so that the valve may be repacked against line pressure.

g. Screwed Ends - Valve ends shall be threaded internally with American National Taper pipe threads. Thread shall be clean, smooth, true to form and concentric with the axis of the valve. Variations in alignment of thread shall not exceed $^{1}/_{16}$" per foot. Thread shall be chamfered approximately to the major diameter of the thread at the face of the valve, at an angle approximately 45 degrees with the axis of the thread for the purpose of easy entrance in making a joint and for protection of the thread.

h. Valve Body - The body of the valve shall offer sufficient support to the gate while it is moving to keep the gate wedge in place and to accurately align the gate on the body seat. The waterway opening shall be equal to or greater than the nominal pipe size.

i. Gate - The gate shall be of wedge design and may be furnished either solid or two-piece. Two-piece or "split" disc gates shall be equipped with lifting nut.

Gate faces shall be accurately machined and fitted into the valve body in such a manner that the center of the gate circle is very slightly above the center of the seat circle when the valve is tightly closed.

j. Workmanship - All valve parts shall be true to form, free from injurious defects and shall be seated and finished in a workmanlike manner. Casting shall be free from blowholes, porosity, hard spots, excessive shrinkage, cracks or other injurious defects. They shall be smooth and well cleaned both inside and outside and all fins and similar roughness shall be removed. Castings shall not be repaired, plugged, brazed or burned in.

k. Packaging - Valve shall be closed for shipment and wrapped or packaged in accordance with best commercial practice as necessary for mechanical protection and ease in handling.

l. Rejection - Valves may be rejected for failure to meet any of the requirements of this specification.

4. Butterfly Valves

a. General - Butterfly valves and operators shall conform to AWWA Standard for Rubber-Seated Butterfly Valves, AWWA Standard C504, and to these specifications:

(1) Type of body shall be short body, flanged.
(2) Body material shall be cast iron or ductile iron.
(3) Class shall be as specified on the plans or contract specifications.
(4) Shafts shall be Type 304 or 316 stainless steel.
(5) Flange holes shall be drilled full size.
(6) Valve seats shall be natural rubber or Buna-N and polished stainless steel, Type 304 or 316, 90° seating angle only, with a 360° uninterrupted seating surface.
(7) Shaft seals shall be standard split-V packing or double O-ring seal cartridges.
(8) Discs shall be ductile iron, cast iron, or fabricated steel.
(9) Operating nuts shall be ductile iron.

b. Submittals

The following shall be furnished to the Owner. Incomplete data shall be cause for rejection of bid.

(1) Weights and drawings in accordance with AWWA Standard C504.
(2) Guaranteed delivery time after receipt of purchase order.
(3) Number of turns of handwheel required to close valve.
(4) The required operator torque (T_o) in foot-pounds for each butterfly valve based on the specified operating conditions of pressure and flows.
(5) Seating-unseating torque (T_o) in foot-pounds for each butterfly valve.
(6) Rated torque capability of each butterfly valve operator.

The following data shall be furnished, if not previously available to the Owner:

(1) Experience - Furnish evidence of at least five years satisfactory experience building butterfly valves to AWWA Standards.
(2) Operate torque tests in accordance with rubber seated butterfly valves, AWWA Standard C504.

(3) Proof of design tests in accordance with AWWA Standard C504.

c. By-Pass Valves - By-pass valves shall conform to the requirements of AWWA Standard C500 with the following exceptions:

(1) By-pass valves are required on all 18-inch valves and larger.

(2) Properties, construction and design requirements herein specified are applicable to by-pass valves, except stems on by-pass valves over 4-inch shall have the same physical qualities as for 30-inch and larger.

d. Ends - Valves shall have flanged, push-on or mechanical joint ends or any combination of these as may be specified.

(1) Mechanical joint ends shall conform to AWWA Standard C111 (ANSI A21.11).

(2) Push-on joint ends shall conform to AWWA Standard C111 (ANSI A21.11).

(3) Flanged ends shall conform to AWWA Standard C110 (ANSI A21.10), Class 250 lbs. (112.5 kg).

(4) Bolts and nuts for mechanical joints shall be of a high-strength low-alloy corrosion-resistant steel conforming to ASTM Designation A 325 (Type 3).

e. Horizontal Valves - All valves over 16 inches in diameter shall be designed for horizontal installation pipeline unless otherwise called for on the plans or specifications. All other valves shall be vertical.

f. Operators

(1) Manual Operators

(a) All operators shall be located as follows, unless otherwise noted, looking in the direction of flow:

- At the right end of a horizontal shaft.
- Input shaft vertical and upward.

(b) The valve shall close by turning the input shaft clockwise. All handwheels shall turn clockwise to close the valve.

(c) All manual operators shall be totally enclosed worm gear type, or rack and pinion type.

(d) All operators shall be equipped with a disc position indicator with each valve. The indicator shall be highly visible, clearly showing the legends "Open" and "Closed" at the ends of a 90° arc, with a pointer to show the disc position (Closed - 0° and Open - 90°). The arc shall be graduated in degrees.

(e) All manual worm gear type operators shall be Limitorque, Type HBC, or approved equal.

(f) Each valve operator shall be sized for the maximum valve torque requirement based on the operating pressures and flow rates as specified.

(2) Electric Motor Operator - Each electric operator shall conform to AWWA Standard C504 and shall be of sufficient size to open and close the valve against maximum differential pressure and maximum required torque conditions when voltage at motor terminals is 90 percent of nominal voltage: and shall have totally enclosed worm gear reducer with spur gear attached. Limit switches shall be of the four train-gear with switches adjustable to operate at any point in the opening or closing cycle of the valve.

Limit switches and torque switches shall be located in a special compartment that is an integral part of the operator and shall be readily accessible. Each limit switch shall have two normal closed contacts. Limit switch gearing shall be in step at all times whether in power or manual operation. Limit switch gearing shall be stainless steel or high-grade bronze. Two torque switches shall be furnished, one for opening direction and one for closing direction. The torque switches shall be connected in series, so that they shall operate regardless of the phasing of the power.

Torque and thrust loads in both closing and opening directions shall be limited by torque switches. Each torque switch shall be provided with a micrometer adjustment and reference setting indicator. The adjustment and reference setting indicator. The adjustment shall permit a variation of approximately 40 percent in torque setting. Switches shall have a rating of not less than six amperes at 120 volts ac and 2.2 amperes at 115 dc. The torque switches shall be in series with the opening and closing coils of the starter.

The torque switches shall be factory adjusted by the manufacturer for this application.

A hand wheel for manual operation shall be provided. Motor shall not rotate when hand wheel is in use. A fused motor shall not interfere with manual operation. For valve control, furnish for each valve, a reversing starter in watertight enclosure, which is integral with the operator housing. Furnish a push-button station NEMA-4 with red and green indicating lights separate from the valve operator. Space heaters shall be provided to protect the motor, reversing starter, and limit switch compartments from moisture condensation. Valve control wiring diagrams shall be furnished with submittal data.

Valve operators shall conform to latest revision of AWWA Standard C504, and shall be designed to hold the valve in any intermediate position between fully opened and fully closed without creeping and fluttering.

(3) Other Operators - Other types of operators shall conform to AWWA Standard C504.

g. Shipment and Storage Requirements - Electric motor operated valves shall be shipped to bonded covered warehouse storage to be designated by the Owner. Valves shall be stored indoors and shall have space heaters energized.

Full face flange protectors of waterproof plywood shall be at least one-inch thick.

h. Tests - All butterfly valves shall be tested by the manufacturer in accordance with AWWA Standard C504. Test results shall be furnished to the Owner.

i. Rejection - Any butterfly valve may be rejected for failure to meet all of the requirements of this specification.

F. OTHER

1. Fire Hydrants - All fire hydrants shall meet or exceed AWWA C-502, or latest revision, and shall comply with Factory Mutual Research Corporation and Underwriter's Laboratories UL 246 Standard. Rated working water pressure shall be 250 psi. Test pressure shall be 500 psi. Hydrants shall additionally conform to the following requirements:

a. The bury depth shall be a minimum of 3½ feet. A fire hydrant connector pipe (Gradelok or pre-approved equal) shall be required on each fire hydrant lead, and located adjacent to the fire hydrant. 45 degree bends may be additionally used to install fire hydrant at the proper grade.

b. Fire hydrant leads shall be Ductile Iron Pipe.

c. All fittings shall be ductile iron pipe only.

d. The inlet shall be six inch (6") and shall be mechanical joint provided with EBBA series 1106 DEC (or pre-approved equal) Mechanical Joint Retainer Gland accessory kit. The fire hydrant shoe shall be epoxy coated inside and outside.

e. The main valve closure shall be of the compression type, opening against the pressure and closing with the pressure. The main valve shall be of hard rubber, not of leather or fiber.

f. The main valve opening shall not be less than 5¼", and be designed to permit the removal of all working parts, including the waste valve, from the top of the hydrant without disturbing the soil around the hydrant, and without disassembling the ground line joint or nozzle sections.

g. Hydrants shall have two hose outlets, which shall be 2½" National Standard with cap on each outlet.

h. Hydrants shall have one pumper outlet, which shall be National Standard fire hose coupling screw threads, AWWA C502-73, Appendix A, Table A.2. Nominal size of hose coupling, 4½".

i. Hydrant nozzles shall consist of two hose nozzles and one pumper nozzle and shall be field replaceable without special tools. Caps must be furnished for nozzles. Threading of nozzles and shape of operating nut must be National Standard.

j. Hydrant bonnet assembly shall be provided with a lubrication reservoir that automatically circulates lubricant to all operating stem threads and bearing surfaces each time the hydrant is operated. Downward stem travel shall be limited by a travel stop.

k. The operating nut shall be tapered, pentagon (five sided) measuring ½" point to flat and 1" flat measurement (National Standard), and shall open by turning to the right (clockwise).

l. The hydrant shall be the traffic "breakaway" type with safety stem coupling and breakable flanges that permits full 360-degree rotation of the nozzle section.

m. Hydrants shall be provided with a minimum of one internal and two external automatic and positively operating non-corrodible drain valves so as to allow main pressure to flush the drain valves completely during the opening motion and drain the hydrant completely when the main valve is shut. Outlets for drainage of the barrel shall be made of bronze or non-corrodible metal or bushed therewith completely from the valve to the outside.

n. Friction losses through the hydrant shall not exceed 2.5 psi at 1000 gpm (through a 4½" pumper connection) when flow tested in accordance with Section 5 of AWWA C502-80, as evidenced by a certified friction loss graph from the manufacturer and applicable to the specific model to be finished. Flow testing shall be conducted by an independent testing laboratory on a production hydrant, and pressure drops shall be

established by that laboratory. All hydrants will be shop tested in accordance with AWWA C502, latest revision.

o. All nuts, bolts and washers below ground shall be a minimum 304 stainless steel.

p. Top cap or bonnet, and outlet caps to be green; all other exterior parts of the hydrant shall be yellow.

q. Approved Models:

- American Darling B84B
- Mueller Centurion

2. Fittings

a. General - Ductile Iron Compact Fittings shall consist of standard crosses, tees, bends, reducers, sleeves, plugs, blind flanges, etc. Fittings for reinforced concrete pressure pipe, steel cylinder type, shall consist of special crosses, tees, bends, reducers, dished plugs, closure sections, flanged outlets, blind flanges, bored flanges, etc.

Use of Ductile Iron Compact Fittings is prohibited if soil resistivity measurements are less than 1000 ohms/cm^3.

3. Brass Stops, Cocks and Fittings for Waterworks Service

a. General - Stop, cocks and fittings furnished under these specifications shall be of the size and type specified, with all parts of brass, conforming to alloy 85-5-5-5, ASTM Designation B 62 - Table 1.

b. Physical Properties - Brass used shall have a tensile strength (as determined form test bars) of not less than 30,000 psi when tested as prescribed by ASTM Designation B 208 (Fig. 5).

Fittings shall be designed for 200 psi working pressure, and when subjected to hydrostatic test pressures 1½ times working pressure or when subjected to a minimum of 85 psi air pressure while submerged in water, shall not leak or show signs of structural failure.

Stops and cocks containing brass parts shall be shipped prelubricated with a light fluid lubricant between key and body. Lubricant shall remain fluid indefinitely, either in storage or in service.

c. Design Features of Curb Stops and Corporation Stops

(1) Description - All curb stops and corporation stops shall be made of Water Works bronze AWWA standards (ASTM B 62 - Index 115 - 85-5-5-5) and shall utilize a resiliently seated ball or cylinder. Both ports must be resiliently seated against the ball or cylinder. The operating head must be solidly locked into the body of the valve. The ball or cylinder must be Teflon coated to provide for nonbinding operation.

(2) Additional Requirements for Curb Stops - Both end connections shall have female iron pipe threads. The tee head shall have 360 degree operation and shall be equipped with padlock wings.

(3) Additional Requirements for Corporation Stops - The inlet connection shall have AWWA corporation threads. The outlet shall have a copper compression coupling as specified and approved.

(4) Approved Curb Stops

- Ford: B11, less stop; full port only

(5) Approved Corporation Stops

- Ford: FB1000G

d. Design Features Of Fittings - All castings shall be smooth, free from burrs, scales, sand holes and defects of every nature which would make them unfit for the use for which they are intended.

Nuts shall be smooth cast and shall have symmetrical hexagonal wrench flats.

Flare-joint fittings shall be smooth cast. Seating surfaces for metal-to-metal seal shall be machined to proper taper or curve, free from any pits or protrusions.

All thread fittings, of all types, shall have N.P.T. threads, and male threaded ends shall be protected in shipment by a plastic coating or other equally satisfactory means.

Compression tube fittings shall have a Buna-N beveled gasket or equal. Compression nut shall have:

(1) For plastic or copper pipe and tubing, an approved restraining device must be provided.

(2) For iron pipe, a stainless steel set screw to bite in and lock on the pipe.

All water works brass with compression couplings shall have gripper rings.

e. Tests - All brass fittings included in this section shall be tested in accordance with the applicable provisions of the specifications relating thereto.

f. Rejection - Brass stops, cocks, and fittings may be rejected for failure to meet any of the requirements of this specification.

4. Seamless Copper Tubing

a. General - This specification pertains only to Type K, Class 1, annealed (soft) copper water tubing for use with flared or compression-type fittings. The copper tubing shall conform to Seamless Copper Water Tube, ASTM Designation B 88.

b. Quality - The vendor shall be responsible for submission of a laboratory analysis of the products supplied. The manufacturers own laboratory analysis is acceptable. The certificate of analysis shall state size and type of analysis and results obtained. A statement shall be made and validated that tests confirm compliance with the requirements of this specification.

The Owner reserves the right to conduct or cause to have conducted independent laboratory tests. Where the results of such tests prove the quality requirements have not been met: (1) the costs of tests shall be charged to the vendor's account, and (2) the entire shipment may be rejected on the basis of such tests.

c. Rejection - Seamless copper tubing may be rejected for failure to meet any of the requirements of this specification.

5. Stainless Steel Tapping Sleeve

a. Description - The tapping sleeve shall be made completely of stainless steel.

The tapping sleeve shall have a flange face gasket, branch sealing gasket, and complete circle gasket all permanently attached to the sleeve from the factory.

All welding shall be passivated so as to return the welded stainless steel to its original corrosion resistant state.

There shall be no paper or plastic adhesive labels attached to the sleeve, any information appearing on the sleeve shall be stenciled.

The tapping sleeve shall be rated for a minimum working pressure of 150 psi 11kg/cm²).

Test plug is required.

b. Material Specifications - The shell shall be 18-8 type 304 stainless steel or equal.

The flange shall be 18-8 type 304 stainless steel or ductile iron. Carbon steel flanges are not acceptable. The flange shall conform to AWWA C207 Class D ANSI 150 drilling.

The armor plate shall be 18-8 type 304 stainless steel, bonded to the complete circle gasket.

The bolts and nuts shall be 18-8 type 304 stainless steel 5/8" NC threads. Either shall be coated to prevent galling or seizing.

The gaskets shall be of virgin Buna-N or equal, compounded for water service.

Approved Models:

- Ford Fast
- Romac SST

6. Leak Clamps

a. Description - "All Leak Clamps (except 2" clamps) MUST BE ALL STAINLESS STEEL Construction with Stainless Steel Bolts and Nuts, with Lugs Either CAST OR WELDED FLAT STOCK STAINLESS STEEL"

Approved Models:

- Romac SS1, SS2
- Ford FS1, FS2
- Smith-Blair 256, 257, 261, 262

7. Service Saddles

a. Description - All Service Saddles MUST BE DOUBLE STRAP Design. They shall be fusion bond nylon (12 mils). All nuts and bolts must be stainless steel.

Approved Models:

- Ford FC 202
- Romac 202N
- Mueller H161 Double Strap
- Smith-Blair 317

8. Pitot Outlets

a. General - Pitot outlets shall be of the type indicated on the plans or appurtenance sheet.

9. Vaults - Vaults shall be provided as specified and/or detailed for access to manholes, gate valves, air release valves, etc.

a. General Construction - Vaults may be of concrete, reinforced concrete, precast reinforced concrete pipe as shown on the project plans. General construction shall include the following:

(1) Vaults used for blow-off manhole applications shall be of water containment construction, utilizing either the monolithic pour-in-place concrete or precast reinforced concrete pipe with trapped O-ring gasket.

(2) Vaults used for nonwater-containment construction such as for valve installations shall be either pour-in-place 2500psi reinforced concrete or precast reinforced concrete tongue-and-groove design pipe meeting ASTM C 76, Class III using trapped O-ring type rubber seals.

b. Specific Requirements - Specific requirements include the following:

(1) Material requirements for vaults shall be as controlled under the material requirements of these general contract documents as applicable with specific inference placed on material specifications.

(2) For in-place vaults, walls shall be formed on all sides to the thickness specified. Unless specified otherwise, walls shall not be less than six inches thick.

(3) Top slabs shall normally be poured below final grade and grade rings used to achieve final grade ring elevations.

(4) Grade rings, covers, vents, etc., shall be installed as detailed in *Item A.3, Sanitary Sewer Manholes, of Section 4.8 Part 3,* as shown on the project plans, or as directed by the Owner. Manhole steps will not be used.

(5) The vault top slab invert and inside wall shall be given a rubbed finish in accordance with *Item F, Finishing, of Section 5.1 Part 3.*

(6) Water-containment vault structures shall be tested for exfiltration as directed by the Engineer. In the event that leakage occurs in excess of allowable limits, the vault shall be completely sealed with an approved mastic sealer. Any visible seepage of free water shall require sealing on either water containment vaults or manholes.

10. Precast Reinforced Concrete Box Sections

a. General - Precast reinforced concrete box sections shall conform to the current specifications for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers, ASTM Designation C 789, or Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers With Less Than 2 Feet of Cover Subjected to Highway Loadings, ASTM Designation C 850. Two-piece box culverts, if approved by the Owner, must meet or exceed the load requirements of ASTM C 789 and ASTM C 850. Materials and construction methods shall be submitted to the Owner prior to the beginning of work.

11. Materials for Storm Sewer Appurtenances - All materials used in the construction of work specified in this section shall conform to the applicable sections of Part II of these specifications.

Unless otherwise specified, all concrete shall have an average compressive strength of 28 days equal to or greater than 3,000 psi and shall conform to the requirements of *Section 5.1, Concrete and Reinforcement*.

12. Corrosion Resistant Coatings and Liners for Sanitary Sewers and Appurtenances

a. General - Coatings and liners are used as a protective barrier attached to the interior walls of concrete pipe or manhole sections, or special concrete appurtenances for protection against the corrosive chemical elements, which may occur in certain sewer environments, and for protection against certain corrosive wastes from industry.

b. Basis of Acceptance - The acceptability of the protective material and its attachment to the pipe or appurtenances shall be determined by the results of tests, by inspection, and by approval of its experience record. The tests are designed to prove, demonstrate and insure:

(1) Whether or not the protective material is the same as used in the tests;
(2) surface continuity and lack of holidays;
(3) adhesion;
(4) resistance to temperature changes;
(5) resistance to abrasion;
(6) resistance to fire; and
(7) chemical resistance.

The inspection at the manufacturing plant or in the field is to determine:

(1) Whether or not the protective material is the same as used in the tests;
(2) that it is attached in the same manner, and as uniformly as it is attached to the concrete in the test; and
(3) that the joint areas are adequately protected.

The experience record of the protective material attached to the pipe or appurtenances must be acceptable.

To qualify the material, and the attachment of that material to the pipe or appurtenances for acceptance, all tests must be met or certified to for the specific protection intended; all conditions to be evaluated by inspection must be met; and the experience record must be submitted and approved.

c. Responsibility for Testing, Inspection and Experience Records - Unless otherwise specified, the manufacturer of the protective material is responsible for meeting the testing, inspection standards and experience records as described herein, except in the case of a pipe manufacturer electing to procure the protective material and applying the material as the pipe is manufactured. In such a case, the pipe manufacturer would be responsible.

The test results shall be certified by a recognized testing laboratory acceptable to the consumer and do not necessarily have to be made on each project.

The inspection results shall be attested to in writing by a licensed Professional Engineer or witnessed by the Engineer representing the Owner. The experience record shall be documented with dates, locations, actual number of feet of protected conduit in the ground, length of time in the ground, the nature of the environment against which the conduit is being protected and the names and addresses of responsible references who shall verify the facts in the experience record.

d. Physical Test Requirements

(1) Chemical Resistance - The consumer may designate which of the solutions mentioned may be used or he may designate others.

The chemical resistance test shall be made as follows:

(a) The specimens, approximately 5" long, 2¼" wide and 1" thick, shall be cut from the pipe. The protective material shall be attached to these test specimens in the same manner as it would be attached to the pipe. The protective material shall be to manufacturer's specified minimum thickness. If curing is required, the protective material shall be cured to the manufacturer's recommendations.

(b) The protective material on the prepared test specimens shall be tested for indentation hardness in accordance with the requirements of Rubber Property-Durometer Hardness, ASTM Designation D 2240, and the hardness recorded.

(c) The prepared test specimens shall then be placed in wide mouth glass containers half submerged in the following solutions:

5%	sulfuric acid
5%	hydrochloric acid
3%	salt (NaCL) water
1%	phenol
5%	alum
5%	phosphoric acid
10%	biodegradable detergent
100%	motor oil

(d) The containers shall be closed and held at 100°F for six months.

(e) After six months the specimens shall be taken from the containers and tested again for indentation hardness in accordance with the requirements of Rubber Property-Durometer Hardness, ASTM Designation D 2240. The test durometer hardness shall be made in both the area exposed to the liquid and in the area exposed to the vapor above the liquid. There shall be no loss of indentation hardness either in the area below the liquid or in the area above the liquid.

(2) Surface Continuity and Holidays - The surface continuity and holiday test shall be made as follows:

(a) An electrical holiday detector, capable of producing and maintaining a voltage equal to 800 times the square root of the specified minimum protective thickness expressed in mils, shall be used to determine the complete continuity of the protective surface.

(b) The protective material to be tested with the electrical holiday detector shall be used on a full size piece taken from a production run.

(c) Voids or holidays shall be cause for rejection.

(3) Adhesion to the Pipe or Appurtenances

(a) Where the protective material adheres directly to the concrete:

(i) Make a test specimen by drilling a core hole through the protective material and the pile to produce a core sample 1" in diameter by ¾" or more depth. (This hole may be repaired and the pipe from which the sample was taken may be used.)

(ii) Check the protective material for thickness.

(iii) Cement the test specimens onto a solid wooden block at least 2" x 2" x 1" in thickness so that the protective material is cemented onto the wooden block.

(iv) Allow sufficient time for the cement to set.

(v) Support the wooden block so that the test specimen is on its underside and hang a 40-pound weight on the test specimen. This can be done using an ordinary wooden clamp.

(vi) This test should be made at an ambient temperature of between 60°F and 90°F.

(vii) The protective material shall adhere to the material, usually for a minimum of two hours.

(b) Where the protective material is anchored to the concrete by fins embedded or dovetailed into the concrete:

(i) Using a large enough square footage of the protective material to be a representative sample, the fins shall not be capable of being pulled out of the material, usually concrete, nor the protective material torn away from the embedded fins using less than a pull equal to 50 psi.

(ii) For the adhesion test, either *Item F.14.d.(3), Adhesion to the Pipe of Appurtenances, of Section 4.7 Part 2* shall be used, or *Item (i)* directly above, but not both.

(4) Resistance to Temperature Changes - The test for resistance to temperature changes for those materials that adhere directly to the concrete shall be made in accordance with the latest ASTM Method when required by the Owner.

(5) Resistance to Abrasion - The test for resistance to abrasion shall be made as follows:

(a) A one-foot length of pipe, which has been lined with the protective material, shall be suitably capped and arranged on rollers so that it can be revolved at high speeds. A door shall be left in one end so that access can be had to the interiors of the test section.

(b) A slurry shall be made composed of six pounds of gravel and three pounds of water; and it shall be place inside the test section and the test section shall be rotated so that the protective material has peripheral speed of four feet per second. After 1,500,000 revolutions, the protective material shall not show visible signs of wear or abrasion.

(6) Resistance to Fire - The test for resistance to fire shall be made as follows: The protective material, if plastic, shall be tested for resistance to fire by meeting the requirements of Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position, ASTM Designation D 635. The material shall be self-extinguishing or nonburning according to ASTM D 635.

e. Workmanship and Finish

(1) Joints - Adequate protection shall be provided at the ends of the joints.

(2) Specials

(a) All special shapes such as tees and wyes, branches, slants and curves shall be protected with the protective material, and they shall be given the same degree of protection provided to the production run of pipe.

(b) Lift holes, if called for on the plans or in the specifications, shall be sealed with epoxy or sealant recommended by the coating or liner manufacturer that shall pass the tests as set out in *Item F.14.d, Physical Test Requirements, of Section 4.7 Part 2.*

f. Inspection

(1) General

(a) The tests required under the physical test requirements section of this specification need only be made once on any one project.

(b) Each length of pipe or special may be subject to visual inspection during manufacture, transportation or laying by the Owner in order to cull and reject pipe as specified in Item F.14.g, Rejection, of Section 4.7 Part 2.

(2) Repairs - Where the protective material is damaged or where the adhesion of the protective material to the concrete is damaged, repairs may be made at the discretion of the Owner.

g. Rejection - The protective material shall be rejected if:

(1) All the tests described under the physical test requirements are not met;

(2) the manufacturing method of applying, adhering and curing the protective material differs from that used on the test samples;

(3) the protective material thickness as used on the test samples exceeds the minimum specified in the manufacturer's specification by more than five percent; and

(4) if it cannot be adequately repaired in the field.

13. Polyethylene Wrap for Metal Pipe and Fittings

a. General - These specifications cover polyethylene film used as a wrap to protect cast iron and other metals in a corrosive soil environment.

b. Material

(1) Film - The polyethylene film shall be 8 mils (0.008") thick, with the following minimum flat tube widths for the specified pipe sizes. The polyethylene film shall be extracted from polyethylene resin, Type I, Class C, Grade E-1, and as specified in

Polyethylene Plastics Molding and Extrusion Materials, ASTM Designation D1248, with the following characteristics:

Flow rate	0.4 maximum
Tensile Strength	1200 psi minimum
Elongation	300% minimum
Dielectric Strength	volume resistivity
Minimum ohm, cm^3	1015
800 Volts per mil thickness minimum	

(2) Polyethylene Tape - The polyethylene tube seams and overlaps may be wrapped and held in place by means of 2" wide plastic backed adhesive tape 10 mils (0.010") thick. The tape shall be Polyken No. 900, Scotchwrap No. 50, or approved equal.

c. Minimum Width of Film Tube (When Laying Flat)

Nominal Pipe Size (inches)	Push-on Joint Flat Tube Width (inches)	Mechanical Joint Bell Flat Tube Width (inches)
4	14	16
6	17	20
8	21	24
10	25	27
12	29	30
14	33	34
16	37	37
18	41	41
20	45	45
24	53	53

d. Rejection - Failure to meet any of the specifications contained in this section shall be cause for rejection of the materials.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Not Applicable

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Not Applicable

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SECTION 4.8: SANITARY SEWER

PART 1: GENERAL

A. GENERAL

Sewer line shall be constructed as required and shown on the plans or when designated by the Owner

B. SUBMITTALS

Submittals will be made for alkalinity test results and design details for reinforced concrete pipe, if used in jacking/tunneling construction.

PART 2: PRODUCT

A. MATERIALS

Refer to *Section 4.7, Piping Materials.*

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Rubber Gasket Joints - Rubber gaskets shall conform to applicable specifications under which the pipe is supplied. Loose gaskets shall be protected from sunlight, contamination and contact with gasoline or fuels. On pipe for which the gasket is not fixed in place by the manufacturer, the bell-and-spigot or tongue-and-groove shall be thoroughly cleaned by wire brushing and wiping until clean and dry. On pipe, which does not require the rubber gasket to be cemented in place, the rubber gasket shall be placed in position on the spigot ring just prior to laying the pipe. The lower edge of the gasket shall be placed under the spigot in the seat and stretched evenly upward on each side to fit over the top of the spigot; and the rubber gasket shall fit snugly and not have uneven tensile stresses.

After checking to be sure that the bell-and-spigot are thoroughly clean, the inside surface of the bell shall be lubricated with a suitable solution (flax soap) to facilitate the telescoping of the joint. Petroleum lubrication shall not be permitted. The spigot end of the pipe shall be entered into the bell of the adjoining pipe and forced into position. Exceptional care shall be taken in making the field joint. Bumping of the pipe shall not be permitted. On small pipe, if the bottom of the trench is firm enough, a bar having a blade on the end may be pushed into the ground, then the bar may be used to seat the pipe in accordance with the manufacturers recommendations. Caution shall be exercised to ensure insertion beyond specified line. However, if trench conditions are too unstable, or are in rock, it shall be necessary to use mechanical means to bring the pipe together positively. Each joint shall be partially backfilled or suitably blocked to prevent creeping.

Where the pipe has been corrosion protected, and an annular space is open, only the bottom half of the inside annular space shall be filled with mortar; and a ready-mix cold-pour compound shall be used in the upper half, as hereinbefore described, that is

resistant to acid alkalies and gasses and is compatible with rubber. The joint shall be finished smoothly and all surface materials removed.

2. Sewer Appurtenances

a. Description - This section shall govern for the construction of all miscellaneous sanitary sewer structures such as junctions, transitions, special concrete manholes, creek crossings, river crossings and utility supports; and for the construction of appurtenances such as manholes, cleanouts, deep-cut connections, wyes, stoppers and bulkheads, fittings and such other miscellaneous structures or appurtenances which may be shown on the plans.

b. Construction Requirements - The construction of reinforced concrete sanitary sewer structures -- including junctions, transitions, special concrete manholes, vaults, and such other similar structures as may be covered by this specification -- shall be performed in accordance with the requirements of *Section 5.1, Concrete and Reinforcement*, and the following additional requirements. Excavation shall be made to the required depth and of sufficient width to construct the work to grade, form and dimensions. All soft and yielding materials shall be removed and replaced with acceptable materials. The subgrade shall be moistened to a minimum depth of two inches before placing of the concrete. All formed surfaces of the concrete exposed to public view shall be given a rubbed finish. All other formed surfaces shall be given the "Ordinary Horizontal Surface Finish," as described in *Item F, Finishing*, of *Section 5.1 Part 3*. Corrosion protection shall be applied as may be called for on the plans or the proposal and shall be in accordance with the requirements of *Item F.14, Corrosion-Resistant Coatings and Liners for Sanitary Sewers and Appurtenances, of Section 4.7 Part 2.*

Connections of pipe sewer to existing sewers or sewer appurtenances shall be as shown on the plans or as directed by the Engineer. Connections shall be made to prevent the occurrence of bid-metallic corrosion or any other corrosion that can result by joining incompatible materials. The bottom of the existing structure shall be mortared or concreted if necessary, to eliminate any drainage pockets by the new connection, and in general accord with details for the new structure as shown on the plans. Where the sewer is connected into old structures, which are to remain in service, any damage to the structure resulting from the work of making the connection shall be restored by the Contractor to the satisfaction of the Engineer.

c. Creek Crossings - Creek crossings using pier construction shall be made in accordance with the details shown on the plans.

d. River Crossings, Siphons and Miscellaneous Pipe Structures - River crossings, siphons and miscellaneous pipe structures which may be necessary shall be designed in detail on the plans.

3. Sanitary Sewer Manholes - Sanitary sewer manholes shall be fabricated in different configurations to meet with specific needs required in the sanitary sewer system.

a. General - Manholes shall have an inside diameter as shown on the plans. Manholes constructed in advance of paving projects shall be constructed with the top of the concrete portion of the manhole below the final finished grade. The ring and cover

shall be placed on a built-up section of concrete risers and mortar. Manholes shall be watertight. The type and size, if other than four feet inside diameter, shall be shown on the plans for each location.

(1) Cast-In-Place - The base, wall and cone shall be 3,000 psi concrete poured and vibrated to assure a monolithic structure. Construction joints with water stops must be approved by the Owner.

(2) Precast - The base shall be 3,000 psi concrete. The precast sections shall be of the bell-and-spigot design incorporating tapped O-ring gaskets, or tongue-and-groove with premolded joint sealing compound. The manhole shall be placed on a bedding of ¾" washed rock a minimum of 6" thick.

Lift holes may be used, but must be filled with a nonshrink grout after the section is in place.

Combination of joints shall be selected to minimize the number of individual segments. Long joints shall be used in the bottom and shorter segments utilized for top adjustments. No more than one 12" riser section shall be used in any location, except near the top of the manhole.

Concrete cylinders will be required to be taken by the City of Waco or for the City of Waco.

(3) Fiberglass - Fiberglass manholes shall be installed in accordance with the manufacturer's recommendation and with supplementary details, additions or exceptions as directed by the Owner and/or as shown on the plans.

A minimum of eight holes ⅝ inches in diameter shall be drilled around the periphery of the manholes, four inches from the bottom for use in inserting #4 reinforcing bars to be keys into the concrete base to prevent the manhole from floating.

(4) Drop - Drop manholes shall be constructed in accordance with details on the plans. The construction is the same as that for a cast-in-place manhole with special provisions incorporated to provide drop piping.

(5) Rings and Covers - Installation of rings and covers shall be shown on the plans. The Contractor shall furnish a ladder for access for inspection. Manhole covers shall be detailed on the plans.

b. Special Requirements

(1) Invert - The invert of standard manholes shall be formed in a typical pattern regardless of the wall construction.

(a) Flow Channel - When specified in the special provisions or in the plans, the sanitary sewer pipe shall be laid through the manhole stations where possible, prior to concreting, so that the full depth of the pipe is embedded in concrete to form the flow channel.

(b) Flow Channel Alternate - Where pipe cannot be used through the manhole due to intersecting flow channels, flow channels equivalent to the top of pipe shall be formed with concrete, then troweled to a smooth, even finish with a steel trowel.

(c) Manhole Bottom - The manhole bottom from the wall line to flow channels shall be sloped and troweled smooth on a minimum grade of one inch per foot with a liberal radius applied at flow channel intercepts. Each lateral within the manhole shall have a straight run of at least 30".

c. Testing of Manholes – All manholes shall be tested for leakage. The Contractor must use an approved test method and the manhole must pass the test. The Contractor may use the following test, which is based upon ASTM C 1244-05a.

(1) Scope - This test method is approved for testing precast concrete manhole sections

(2) Preparation - The manholes shall have all lift holes permanently plugged and all pipes temporarily plugged prior to testing. The plugs and pipes shall be braced to prevent them from migrating into the manhole during testing.

(3) Procedure - The test head shall be installed in accordance with the manufacturer's recommendations.

A vacuum of 10 inches Hg (mercury) shall be drawn and the valve closed. The time shall be measured and recorded for the vacuum to drop to 9 inches of mercury.

The manhole will be accepted if the time for the change in vacuum meets the following Table, *Minimum Acceptable Test Times*.

If the manhole does not pass this test, it shall be repaired in accordance with the project specifications and the test repeated until a successful test is completed.

As is customary for all acceptance tests, the construction inspector shall record the results of all manhole tests in the project daily log. A copy of daily logs shall be maintained in the Engineering Department files.

MINIMUM ACCEPTABLE TEST TIMES
Time (measured in seconds)

Manhole Diameter (measured in inches)													
Depth - feet (Less than or equal to)													
	48	**54**	**60**	**66**	**72**	**78**	**84**	**90**	**96**	**102**	**108**	**114**	**120**
4	10	12	13	15	16	18	19	21	23	24	25	27	29
6	15	18	20	22	25	26	29	31	34	36	38	41	43
8	20	23	26	29	33	35	38	41	45	48	51	54	57
10	25	29	33	36	41	44	48	52	56	60	63	67	71
12	30	35	39	43	49	53	57	62	67	71	76	81	85
14	35	41	46	51	57	62	67	72	78	83	89	94	100
16	40	46	52	58	67	70	76	83	89	95	101	108	114
18	45	52	59	65	73	79	86	93	100	107	114	121	128
20	50	53	65	72	81	88	95	103	111	119	126	135	142
22	55	64	72	79	89	97	105	114	122	131	139	148	156
24	59	64	78	87	97	106	114	124	133	143	152	161	170
26	64	75	85	94	105	114	124	134	144	155	164	175	185
28	69	81	91	101	113	123	133	145	155	167	177	188	199
30	74	87	98	108	121	132	143	155	166	178	189	202	213

4. Cleanouts for Sanitary Sewers - Cleanouts shall be constructed on service connections in accordance with the plans and these specifications for materials and construction..

B. TRENCHLESS REHAB CONSTRUCTION METHODS

1. Sanitary Sewer (CIPP)

a. Installation - CIPP installation shall be in accordance with ASTM 1216, Section 7, with the following additional requirements:

(1) Resin Impregnation - The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process shall be used. A roller system shall be used to uniformly distribute the resin throughout the tube.

(2) Temperature gauges shall be placed to determine the temperature of the incoming and outgoing water from the heat source. Another such gauge shall be placed inside the tube at the remote end to determine the temperature at that location during the cure cycle.

(3) Installation and curing shall be accomplished by inversion utilizing water under hydrostatic pressure of a vertical standpipe.

b. Installation Responsibilities For Incidental Items - It shall be the responsibility of the Owner to locate and designate all manhole access points open and accessible for the work, and provide rights of access to these points. If a street must be closed to traffic because of the orientation of the sewer, the Owner shall institute the actions necessary to do this for the mutually agreed time period. The Contractor shall apply and pay for a water meter on fire hydrants for cleaning, inversion and other work items requiring water.

(1) Cleaning of Sewer Lines - The Contractor, when required, shall remove all internal debris out of the sewer line that will interfere with the installation of CIPP. The Owner shall also provide a dumpsite for all debris removed from the sewers during the cleaning operation. Unless stated other wise, it is assumed this site will be at or near the sewage treatment facility to which the debris would have arrived in absence of the cleaning operation. Any hazardous waste material encountered during this project will be considered as a changed condition.

(2) Bypassing Sewage - The Contractor, when required, shall provide for the flow of sewage around the section or sections of pipe designated for repair. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. The Owner may require a detail of the bypass plan to be submitted.

(3) Inspection of Pipelines - Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by close circuit television. The interior of the pipeline shall be carefully inspected to determine the location of any conditions, which may prevent proper installation of CIPP into the pipelines, and it shall be noted so that these conditions can be corrected. A videotape and suitable log shall be kept for later reference by the Owner.

(4) Line Obstructions - It shall be the responsibility of the Contractor to clear the line of obstructions such as solids and roots that will prevent the insertion of CIPP. If pre-installation inspection reveals an obstruction such as a protruding service connection, dropped joint, or collapse that will prevent the inversion process, and it cannot be removed by conventional sewer cleaning equipment, then the Contractor shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Owner's representative prior to the commencement of the work and shall be considered as a separate pay item.

c. Reinstatement Of Branch Connections - It is the intent of these specifications that branch connections to buildings be reopened without excavation, unless noted otherwise for site specific conditions, utilizing a remotely controlled cutting device, monitored by a video TV camera. The Contractor shall certify he has a minimum of 2 complete working units plus spare key components on the site before each inversion. No additional payment will be made for excavations for the purpose of reopening connections and the Contractor will be responsible for all costs and liability associated with such excavation and restoration work.

d. Inspection - CIPP samples shall be prepared and tested in accordance with ASTM F1216, Section 8.1 using either method proposed.

Leakage testing of the CIPP shall be accomplished during cure while under a positive head. CIPP products in which the pipe wall is cured while not in direct contact with the pressurizing fluid (e.g., a removable bladder) must be tested by an alternative method approved by the Owner.

Visual inspection of the CIPP shall be in accordance with ASTM F1216, Section 8.4.

e. Clean-Up - Upon acceptance of the installation work and testing, the Contractor shall reinstate the project area affected by the operations.

2. Sanitary Sewer (Deformed PVC Pipe)

a. Preparatory Procedures - The following installation procedures shall be adhered to unless otherwise approved by the Engineer.

(1) Safety - The Contractor shall carry out his operations in strict accordance with all OSHA and manufacturer's safety requirements. Particular attention is drawn to those safety requirements involving working with scaffolding and entering confined spaces.

(2) Cleaning of Sewer Line - It shall be the responsibility of the Contractor to remove all internal debris out of the sewer line.

(3) Inspection of Pipelines - The Contractor shall provide inspection of pipelines by experienced personnel trained in locating breaks, obstacles and service connections by closed circuit television. The interior of the pipeline shall be carefully inspected to determine the location of any conditions, which may prevent proper liner installation into the pipelines, and it shall be noted so that these conditions can be corrected. A videotape and suitable log shall be submitted for later reference to the Field Engineer.

(4) Bypassing Sewage - The Contractor shall bypass the sewage around the section or sections of the line that are to be lined, if the annular space and pulling head openings are incapable of handling the flow. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow.

(5) Line Obstructions - It shall be the responsibility of the Contractor to clear the line of obstructions such as solids, dropped joints, protruding service connections or collapsed pipe that will prevent the insertion of the liner. If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, then the Contractor shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved by the Engineer prior to the commencement of the work.

b. Installation Procedures

(1) Excavation and Backfill - Before any excavation is done for any purpose, it will be the responsibility of the Contractor to check with various utility companies and determine the location of their facilities. Any necessary temporary

construction and/or right-of-way areas will be arranged by the Contractor. Any damage resulting to utilities and resulting repair, temporary service, cost, etc., shall be borne by the Contractor.

In all excavations where the polyethylene pipe is exposed and not within the existing sewer lines (such as at service connections, fittings, or other points where the old pipe must be removed), there shall be placed a bedding below the pipe and encasement around and above the pipe using cement stabilized sand. This encasement of the polyethylene pipe shall be of a minimum of 6" below the pipe and 12" above and on the sides of the pipe. After the encasement material is in place and accepted by the Engineer, backfill is placed and compacted to required finished grade in accordance with the General Contract Documents. Particular care shall be taken to insure compaction of earth beneath the lateral pipe in order to reduce subsidence and resultant bending at the lateral connection at the sewer main. The cost of encasement shall be incidental to the lining.

(2) Insertion of the Liner - The polyethylene liner shall be inserted into the existing sewer line with a power winch and steel cable connected to the end of the liner by use of a non-flexible steel pulling head of equal O.D. or greater than the liner so that the liner can be fed into the existing sewer. A second pulling head may be attached to the other end of the liner for attachment of a tag line to pull the liner back out of the sewer line, if necessary. Length of the liner pipe to be inserted at any one time shall be governed by the winch drum capacity and winching power available and consideration of the size and condition of the sewer.

During insertion, precautions such as some type of bumper shall be provided in order to prevent the ragged edges of the existing pipe from scarring the outside of the liner as it is pulled into the pipe. Precautions shall be taken not to damage the liner or break any of the joints. Once insertion is initiated, it is desirable to continue the pull to completion without interruption.

After insertion is completed, the Contractor shall supply a suitable heat/pressure source and water recirculation equipment. The equipment shall be capable of delivering hot water/pressure throughout the section to uniformly raise the water temperature above the temperature required to reform the liner. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. The Contractor shall cool the liner to a temperature below 100°F before relieving the reforming pressure. Cool-down may be accomplished by the introduction of cool water or other approved method into the recirculation network. The finished liner shall be continuous over the entire length of the insertion and be as free as commercially practicable from visual defects such as foreign inclusions. It shall also meet the pressure test specified in *Item C.2, Low Pressure Air Testing, of Section 4.8 Part 3*.

During the warranty period, any defects, which will affect the integrity or strength of the liner, shall be repaired at the Contractor's expense, in a manner mutually agreed upon by the City and the Contractor.

(3) Service Connections - After the liner has been reformed into place, each existing service connection, as directed by the Engineer, shall be reconnected to the new liner. A portion of the existing sewer pipe around each service connection shall

be removed to expose the liner pipe and provide sufficient working space for making the new service connection. Service laterals shall be connected by the use of a prefabricated polyethylene saddle or approved alternative. The polyethylene saddle shall be a one-piece saddle equipped with a neoprene gasket, so that a complete seal is accomplished when the strap-on saddle is tightened with two stainless steel bands, one on each end. The stub-out attached to the saddle must protrude into the polyethylene liner a distance equal to the wall thickness of the polyethylene liner in place. The 4", 6", or 8" stub-out or lateral with PVC flexible coupling shall be "Fernco" or approved equal. At least a 6" diameter stub-out connection shall be installed on liners in 10" or larger sewer lines.

Prior to backfilling where the existing sewer has been broken open, the adjacent annular space between the existing sewer and the new liner shall be sealed to preclude migration of the backfill material into this annular space. This annular space may be sealed with cement or expandable foam; or the upper half of the sewer pipe may be replaced and grouted. The entire exposed service connection shall be encased in cement-stabilized sand for a minimum of 6" and 12" above and on the sides of the pipe.

The Contractor may also be able to reconnect the existing service connections by utilizing an interior cutting device. Entering the liner and using a television camera, the cutter shall re-establish each connection to not less than 90% capacity.

(4) Sealing Liner in Manholes - Liner is to be cut flush with the existing pipe at the manhole walls. Invert of manhole shall be reworked (smoothed and built up) to match the flow line of the new liner material.

C. TESTS

1. Tests and Television Inspection - In order to ascertain that the main shall perform the function for which it was designed and constructed, performance tests shall be routinely executed. Visual inspection by photographic means shall be performed when so desired by the Owner. Air tests may be made on sections of the contract work to assure that contract performance is satisfactory.

All sewer pipe shall be air tested upon completion of backfill.

Sanitary sewer force mains shall be hydrostatically tested.

Testing shall be performed by the Contractor in the presence of the Owner after all backfilling and compaction are complete. All sections between manholes or between a manhole and a dead end shall be tested separately. In the making of all tests, the Contractor shall furnish the required equipment and labor, under the direction of the Owner. Tests may be repeated until each sewer individually meets the specifications as to quantity of allowable infiltration or exfiltration or air leakage as set out below. All testing work shall be included in the bid price.

A representative from the City's Engineering Department must be present during the television inspection. Videoing the new sewer lines shall be done in a manner that includes the linear footage of pipe shown automatically on the video relative to the manhole entered. The manhole in which the camera was inserted shall also be identified as means of reference, along with the direction the camera goes (it is preferred that the

camera video goes from upstream to downstream). The camera shall move at a maximum speed of 30 feet per minute.

Additionally, the video format shall be compatible with Windows Media Player and submitted on a DVD. All other formats will be rejected. The recording shall be conducted in a manner that is slow and allows for visual inspection. Recordings shall be in color. The length of the cable connecting to the camera shall be able to reach 250 linear feet, to allow for inspection of every foot of the new main to a maximum of 500 feet between manholes. The camera shall have a mountable, rotating head that can tilt and zoom to identify private services and shall be a motorized unit. The lens of the camera must be kept clear during the operation. All oil, grease or other water content or debris must be cleaned off before recording can proceed. The camera is to be functional in 100% humidity conditions. Lighting shall provide enough brightness such that the entire inner pipe wall is visible for at least 10 feet in front, regardless of pipe material.

The camera unit shall be an Envirosight Rovver 600 Crawler or an approved equal. Specifications for this unit can be found on the following page.

Control Unit

Size: 420 mm (16.5 in.) D x 343 mm (13.5 in.) W x 292 mm (11.5 in.) H
Pendant Control: Left/right steering, crawler speed, light intensity, modular slide-in cards for upgrades/accessories
Power: 110/230 VAC, 50/60 Hz CE
Output: NTSC composite (EIA-170A) video (PAL available)
19 inch rack mounted controller is available
Weight: 18.2 kg (40.5 lbs.)

Lights

Camera: 10 W, 16 x 0.6 W, halogen
Tractor: 40 W, 2 x 20 W, halogen
Auxiliary: 40 W, 2 x 20 W, dichroic reflector
Maximum: 90 W

Cable Drum

Cable: 7 mm (0.28 in.) diameter
Multi-conductor with 227 kg (5000 lbs) Kevlar® strength member and polyethylene outer jacket
Length: Available up to 200 m (660 ft.)
Drum: Slip-ring cable drum with various cable length
Optional - automatic motorized cable reel with level wind feature
Weight: Approximately 23 kg (50 lbs.) - model, cable length dependant
Rating: IP64

Crawler

Length: 282 mm (11.1 in.) with axial camera 374 mm (14.7 in.) with pan-and-tilt camera
Width: 118 mm (4.6 in.)
Height: 90 mm (3.5 in.)
Weight: 8 kg (17.6 lbs.)
Material: Nickel plated brass, stainless steel, aluminum
Drive: 2 x 20 W DC motor, 6-wheel drive, steerable, speed controls
Sonde: 33 kHz or 512 Hz (optional)
Depth Rating: 1 bar (14.7 psi.)– Equivalent to water depth of 10 m (33 ft.)
Inclination Sensor: +/- 10 % (optional)
Wheel Sets: Ø 86 mm (3.4 in.) wheels (6) for 150 mm or 6 in. pipe
Ø 110 mm (4.3 in.) wheels (6) for 200 mm or 8 in. pipe
Ø 135 mm (5.3 in.) wheels (4) for 225 mm or 10 in. pipe
Rating: IP68

Camera

Type: 1/2 in. color CCD camera
Resolution: 380,000 pixels, 360 HTV lines of resolution
Lens: 4 mm, ƒ1.2, remote focus
Lens FOV: 68˚ x 90˚ x 100˚ (V x H x D)
Focus: 6 mm (0.25 in.) to infinity (remotely adjustable)
Dimensions: Axial - ø 48 mm (1.9 in.) x 78 mm (3.1 in.)
Pan (175˚)-and-tilt (135˚) – ø 88 mm (3.5 in.) x 192 mm (7.6 in.)
Rating: IP68

2. Low Pressure Air Testing

a. General - The Contractor shall furnish adequate personnel and equipment required to perform the tests. This test covers procedures for testing sewer pipe lines, when using the low pressure air test method to demonstrate the integrity of the installed pipe line and the construction procedures. This test is used for testing 4" to 33" circular sewer pipe lines utilizing gasketed joints. Mains 36" and larger may be tested by the individual joint method.

b. History - The low-pressure air test was developed to enable detection of damaged pipe or improper jointing and is a test, which determines the rate at which air under pressure escapes from an isolated section of sewer. The rate of air loss is intended to indicate the presence or absence of pipe damage and whether or not the joints have been properly constructed. The test is not intended to indicate water leakage limits and cannot be used as a measure of infiltration or exfiltration leakage under service conditions.

c. Testing Methods -The two most common air test methods used are the "Constant Pressure Method" and the "Time Pressure Drop Method." The Contractor may utilize either of these methods of low pressure air testing.

(1) Preparation of the Sewer Line to be Tested - The section of sewer line to be tested shall be flushed and cleaned prior to conducting the low-pressure air test. This serves to clean out the debris, wet the pipe and produces the most consistent results.

(2) Test Procedures - 1) Isolate the section of sewer line to be tested by means of inflatable stoppers or other suitable test plugs. The ends of all branches, laterals, tees, wyes and stubs to be included in the test should be plugged to prevent air leakage. All plugs should be securely braced to prevent possible blowout due to the internal air pressure. One of the plugs should have an inlet tap, or other provision for connecting a hose to a portable air control source. **2)** Connect the air hose to the inlet tap and a portable air control source. The air equipment should consist of necessary valves and pressure gauges to control the rate at which air flows into the test section and to enable monitoring of the air pressure within the test section. Also, the testing apparatus should be equipped with a pressure relief device to prevent the possibility of loading the test section with the full capacity of the compressor. **3)** Add air slowly to the test section until the pressure inside the pipe is raised to 4.0 psig. **4)** After a pressure of 4.0 psig is obtained, regulate the air supply so that the pressure is maintained between 3.5 and 4.0 psig for a period of two minutes. This allows the air temperature to stabilize in equilibrium with the temperature of the pipe walls. The pressure will normally drop slightly until equilibrium is obtained. During this period all assessable plugs should be checked with soap solution to detect any plug leakage. **5)** Determine the rate of air loss be either the constant pressure method or the time pressure drop method. For the constant pressure method, air is supplied to the pipe test section at a rate sufficient to maintain a gauge pressure of 3.0 psi. The rate of airflow in cubic feet (M^3) per minute is read directly by means of a rotameter. The rate of airflow must be corrected for pressure and temperature under standard conditions. **6)** Upon completion of the test, the bleeder valve is opened and all air is allowed to escape. Plugs should not be removed until all air pressure in the

test section has been released. Also no one should be allowed in the trench or manhole while the test is being conducted.

(3) Constant Pressure Method - 1) Air is supplied to the pipe test section at a rate sufficient to maintain a gauge pressure of 3.0 psi. The rate of air flow in cubic feet per minute is read directly by the means of a rotameter. The rate of airflow shall be corrected for pressure and temperature under standard conditions. **2)** The requirements for air loss under the "Constant Pressure" method shall be considered satisfied if the air loss does not exceed a rate of 0.0015 cfm per square foot of internal pipe surface area with a total rate of air loss not greater than 2.0 cubic feet per minute, based on a wetted pipe.

(4) Time Pressure Drop Method - 1) Air is slowly introduced into the section of pipe to be tested, until the air pressure is raised to approximately 4.0. The air shall be allowed to stabilize for a period of two minutes. The air supply is disconnected and the test pressure allowed to decrease to 3.5 psig. The time required for the test pressure to drop from 3.5 to 2.5 psig is determined, and this time interval is then compared to the required time to determine if the rate of air loss is within the allowable. **2)** Minimum holding times required per pipe diameter are shown in the table "Duration Requirements for Air Testing." (**Note:** Test times are independent of the line length once the minimum holding time has been reached.)

d. Individual Joint Test Method - All concrete sewer main 36" and larger in diameter shall be 100% air tested at each joint connection only. The method of testing shall be described in Item C.2, Low Pressure Air Testing, of Section 4.8 Part 3. The time allowed for the pressure drop from 3.5 to 2.5 psi shall be 10 seconds. No joint shall be air tested until the pipe has been backfilled. Air testing shall be performed as pipe installation progresses. At no time shall pipe installation exceed 100 feet from the last joint tested. If the joint fails to pass the joint air test, necessary repairs as recommended by the pipe manufacturer may be made if approved by the Owner and the joint retested. Failure to pass the air test after repairs have made may be cause for rejection.

TABLE - DURATION REQUIREMENTS FOR AIR TESTING*

SPECIFICATION TIME REQUIRED FOR LOSS OF PRESSURE FROM 3.5 PSIG TO 2.5 PSIG FOR SIZE AND LENGTH OF PIPE INDICATION FOR Q=0.0015										
Pipe Dia.	Min. Time	Length for Min. Time	Specifications Time for Length (L) Shown (min:sec.)							
(in.)	(min: sec)	(ft.)	100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
4	3:47	596.66	3:47	3:47	3:47	3:47	3:47	3:47	3:47	3:47
6	5:40	397.77	5:40	5:40	5:40	5:40	5:40	5:40	5:40	5:40
8	7:33	298.33	7:33	7:33	7:33	7:33	7:36	8:52	—	8:52
10	9:27	238.66	9:27	9:27	9:27	9:54	11:52	—	—	11:52
12	11:20	198.89	11:20	11:20	11:24	14:15	—	—	—	14:15
15	14:10	159.11	14:10	14:10	17:48	—	—	—	—	17:48
18	17:00	132.59	17:00	19:14	—	—	—	—	—	19:14
21	19:50	113.65	19:50	26:11	—	—	—	—	—	26:11
24	22:40	99.44	22:48	—	—	—	—	—	—	22:48
27	25:30	88.39	28:51	—	—	—	—	—	—	28:51
30	28:20	79.55	35:37	—	—	—	—	—	—	35:37
33	31:10	72.32	43:06							43:06

*This table is based on T=0.0850 DK/Q where:

T = time, seconds
K = 0.000419 DL, but not less than 1.0
Q = rate of loss, 0.0015 $ft^3/min/ft^2$ internal surface
D = pipe diameter, in.
L = length of pipe being tested, ft.

**Taken from April, 1972, Journal of Water Pollution Control Federation article entitled "Testing New Sewer Pipe Installation" by Roy E. Ramseier.

5 PERCENT DEFLECTION MANDREL

Nominal Size, In	Mandrel O.D., In	Tolerance In	Nearest $^{1}/_{16}$"	Minimum Runner Length, In	Minimum Number of Mandrel Runners
6	5.45	± 0.01	$5^{7}/_{16}$	4	6
8	7.28	± 0.01	$7^{4}/_{16}$	4	6
10	9.08	± 0.01	$9^{1}/_{16}$	5	8
12	10.79	± 0.01	$10^{13}/_{16}$	6	8
15	13.20	± 0.01	$13^{3}/_{16}$	8	8
18	16.13	± 0.01	$16^{2}/_{16}$	8	12
21	19.00	± 0.01	19	8	12
24	21.36	± 0.01	$21^{6}/_{16}$	8	12
27	24.07	± 0.01	$24^{1}/_{16}$	8	12
18	16.53	± 0.01	16½	8	9
21	19.30	± 0.01	$19^{5}/_{16}$	8	9
24	22.08	± 0.01	$22^{1}/_{16}$	8	9
27	24.84	± 0.01	$24^{13}/_{16}$	8	9
30	27.62	± 0.01	27⅝	10	9
33	30.38	± 0.01	30⅜	10	9
36	33.15	± 0.01	33⅛	12	9
42	38.68	± 0.01	$38^{11}/_{16}$	12	9

3. Deflection Testing - Upon completion of all flexible and semi-rigid sanitary sewer pipe installations, the Contractor shall pull a mandrel through the pipe to test for a maximum 5 percent deflection. The mandrel shall be sized and constructed as listed on the applicable mandrel deflection table. Deflection test for pipe will be performed after all trench backfill is compacted and accepted by the City. No pipe shall exceed a deflection of 5%. Any pipeline or portion of line that will not allow easy passage of the test plug will be replaced and retested. The test shall be performed without mechanical pulling devices.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

1. Sanitary Sewer Pipe Installation

a. Measurement - Pipe, including corrosion protection, if in place on the pipe, or unless otherwise covered by a special bid item, shall be measured for payment in linear feet along the centerline of the pipe actually laid. Deductions shall be made for special structures. Pipe, which extends only through the wall of the structure, shall be measured to the actual end of the pipe. No deductions shall be made for fittings, measurements being from center to center of fitting. Where a change in the size of the pipe occurs in the line, the measurement shall be to the center of the fitting. Where change in the size of the pipe occurs in the line, measurement shall be to the center of the reducer. Pipes shall be classified for payment according to depth as specified.

b. Payment - Pipe, including corrosion protection in place on the pipe, or unless otherwise covered by a separate bid item, shall be paid for at the contract unit price per linear foot, complete in place, as provided by the contract. The contract price per linear foot shall be the total compensation for furnishing of all labor, materials, tools, equipment, and incidentals necessary to complete the work, including excavations, backfill and disposal of surplus material, in accordance with the plans and these specifications.

2. Creek Crossings - Creek crossings shall be measured for payment as a lump sum or in linear feet of pipe furnished and placed, plus the cubic yards of concrete in place, or a combination of two methods as may be set out in the contract and proposal.

The contract price or combination of prices shall be compensation for the furnishing of all labor, tools, materials, equipment and incidentals necessary to complete the work including: excavation for piers; erecting piers; stripping forms; erecting pipe and supporting pipe, if required; and disposal of surplus materials, in accordance with the plans and specifications.

3. River Crossings, Siphons and Miscellaneous Pipe Structures - The structures shall be measured for payment as per each or in linear feet between the limits set out on the plans. Miscellaneous concrete shall be measured for payment and paid for at the contract unit price as provided for in the proposal and contract. The contract price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including all excavation, disposal of surplus materials and backfill, in accordance with the plans and these specifications.

4. Manholes - Measurement and payment for manhole structures shall be on a per each basis and shall cover all cost for the structure complete in place as designed. Included shall be all excavation, castings, reinforcing steel, concrete, backfill and all appurtenances for a complete and functional unit. The payment for extra depth in excess of the basic manhole depth shall be made under a separate item of bid as defined below. If a separate bid item is not established in the contract, there shall not be any payment for extra depth; and the manhole shall be paid for as per each regardless of the depth.

Unless specified otherwise, only one bid item shall provide payment for extra depth of manhole structures in excess of the basic depth for all types of manholes under consideration. Such extra depth shall be allocated on the total depth of all manholes, excluding shallow manholes, specified for the project. Payment for extra depth of the various types of manholes shall be at a unit price bid per vertical foot of additional depth measured to the nearest $^{1}/_{10}$th foot over the basic depth stipulated for the type manholes under bid. A standard manhole is five feet deep measured from the top of the manhole cover to the flow line of the invert.

5. Cleanouts- Cleanouts shall not be measured and paid for directly, but the cost for their installation shall be considered as subsidiary to the project bid item with which it is associated. The work required shall be for the furnishing of all labor, materials, tools and equipment and incidentals necessary to complete the work, including earth excavation,

disposal of surplus materials and backfill all in accordance with the plans and specifications.

6. Trenchless Rehab

a. Sanitary Sewer (CIPP)- Payment for the work included in this section will be in accordance with the prices set forth in the proposal for the quantity of work performed.

b. Sanitary Sewer (Deformed PVC Pipe)- The unit price bid to furnish and install Deformed PVC Pipe for existing sanitary sewer lines shall be full compensation for all labor, equipment and material required to rehabilitate the designated sewer lines in the project. This item shall be paid for at the unit price bid per linear foot for each size pipe. Measurement shall be based on the actual linear foot quantity installed.

This item shall include full compensation for sealing of pipe at manholes.

This item shall also include all cost of installing and maintaining any bypass pumping required to provide reliable, regular sewer service to the area residents. All bypass pumping shall be incidental to the project. Any cleanup required after the sealing process shall also be included in the unit price bid to furnish and install Deformed PVC Pipe for existing sanitary sewers.

The unit price bid for service connection reinstatement shall be full compensation for all labor, equipment and material required to reactivate any existing service connections in this project. This item shall include full compensation for excavation and backfill necessary to re-establish these service connections. This item shall be paid for at the unit price bid per each service reinstated, specified either internal or external.

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SECTION 4.9: WATER PIPE

PART 1: GENERAL

A. DESCRIPTION

This work shall include the installation and construction, complete in place, of pipes and fittings as specified herein and in conformity with the lines, grades, dimensions, materials and designs shown on the plans. Contractor must notify users and fire department 24 hours in advance of water cut-off and give date when source will be restored.

B. SUBMITTALS

Not applicable.

PART 2: PRODUCT

A. MATERIALS

Refer to *Section 4.7, Piping Materials*.

1. General - The pipe shall be of the kind and strength shown on the plans and provided in the proposal and contract. Materials for corrosion protection of water pipes and appurtenances shall be of the type as may be called for on the plans or in the special specifications.

Any pipe, fitting, or flux, which is used in the installation or repair of any public water system, must be lead-free. For purposes of this section, "lead-free" means flux containing not more than 0.2 percent lead, and pipes and pipe fittings containing not more than 8.0 percent lead.

B. EQUIPMENT

Not applicable.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Laying Water Pipe - Laying pipe shall not begin until after the initial embedment has been placed in the trench and after the condition of trench, line and grade have been approved by the Owner.

The pipe, after being visually inspected and approved for laying by the Owner, shall be laid, beginning at an existing opening, unless otherwise approved by the Owner; and, in any event, shall be laid with the bell or collar away from the last section placed.

Valves over 16 inches in diameter shall be installed in a special vault; or the gear box shall be enclosed in a manhole and supported on a concrete pad; smaller valves shall be supported with concrete, all as detailed in appurtenance sheets attached to the plans.

All pipe shall be so laid that the contact in the joint between two lengths of pipe shall be uniform throughout the circumference of the joint. Where curves in the alignment are indicated on the drawings, and the curves are flat, standard pipe shall be used with the outside edge of the joint pulled away from the seat to make a smooth curve. Deflection of

the joint to form curves shall not exceed the manufacturer's recommendations. Where curves are sharp, short sections of pipe, bevels or bends shall be used and blocked.

When pipe is cut by the Contractor to insert a valve or fitting, the bell and remaining section may be laid beyond the valve or fitting.

2. Pipe Joints - All joints in pipe systems shall be thoroughly cleaned at the time the joint is made.

3. Hydrostatic Test - Before being accepted, all ductile iron or plastic pipe lines constructed shall be tested with a hydraulic test pressure of not less than 150 psi at the low point and not less than 120 psi at any point maintained over a period of not less than two hours unless otherwise specified by the Owner. Concrete pressure pipe shall be tested with a hydraulic test pressure of 120 percent of the design pressure. Steel pressure pipe shall be tested with a hydraulic test pressure not to exceed 150 percent and not less than 120 percent of the designed working pressure. The rate of leakage of all pipe tested shall not exceed 25 gallons per inch of nominal diameter of pipe per mile over a 24-hour period. Water lines of materials in combination shall be tested for the type of pipe (material) with the least stringent hydraulic test pressure and maintained over a period of not less than two hours. Refer to the provided table, "Allowable Leakage for 2 Hours at Test Pressure of 150 psi," to determine acceptable test values.

The Contractor shall furnish adequate and satisfactory equipment and supplies necessary to make such hydrostatic tests.

Materials and labor for the installation of corporation cocks in water mains for this purpose will be furnished by the Contractor.

The Contractor shall be responsible for all excavation, etc. in preparation for installation of taps.

The section of line to be tested shall be gradually filled with water, carefully expelling the air, and the specified pressure applied. The City will furnish water required for the testing at its nearest City line. All air shall be expelled from the pipe before applying the required test pressure.

All exposed joints shall be examined during the pressure test. All pipe, fittings, and valves shall be examined while the test is in progress, and any items found to be defective shall be removed and replaced by the Contractor and retested after repairs are completed. The Contractor shall provide a suitable locking device, such as a steel cup that will entirely cover the top nut and packing housing of the valve with chains welded to each side of the cup that will reach around the body of the valve enabling the Engineer to place a padlock on the device, preventing operation of the valve without the authorization and presence of the Engineer.

In order to determine the quantity of water lost through leakage in all sections of pipe under the required test pressure, the Contractor will be required to measure all water used in the pressure test through an approved method.

The water main may be tested against an existing live water main provided only if a manufacturer's certified test results for that particular valve is furnished to the Engineer for approval. The valve shall pass all tests as outlined in AWWA Standard Specifications for

gate valves, AWWA C 500, latest revisions. Valves that show evidence of damage or improper handling after such test is made will be considered unsatisfactory. Otherwise an air gap shall be provided between the new line to be tested and the existing water main.

Extreme care shall be taken to ensure that the tested valve, between the new main and the existing main, will not be operated after installation until after that part of the line has been chlorinated and disinfected and the chlorine removed from the line.

The Contractor will be required to correct defects and bring the leakage within the specified limits before the contract is accepted by the City.

Permanent pavement shall not be placed over any pipe until all leakage tests on the section of pipeline involved have been completed.

The cost of testing and finding leaks, repairing same, and retesting if necessary shall be at the expense of the Contractor and shall be included in the unit price bid for laying water pipe shown in the Special Contract Documents.

Hydraulic Pressure Tests against live connections shall not be made until after that part of the line has been chlorinated and disinfected and the chlorine removed from the line.

ALLOWABLE LEAKAGE (GALS) FOR 2 HOURS AT TEST PRESSURE OF 150 PSI

Length (In Ft.)	PIPE SIZE (IN INCHES)															
	6	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**24**	**30**	**36**	**42**	**48**	**54**	**60**	**66**
100	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80	0.94	1.18	1.42	1.66	1.90	2.14	2.36	2.60
200	0.48	0.64	0.80	0.96	1.12	1.28	1.44	1.60	1.88	2.36	2.84	3.32	3.80	4.28	4.72	5.20
300	0.72	0.96	1.20	1.44	1.68	1.92	2.16	2.40	2.82	3.54	4.26	4.98	5.20	6.42	7.08	7.80
400	0.96	1.28	1.60	1.92	2.24	2.56	2.88	3.20	3.76	4.72	5.68	6.64	7.60	8.56	9.44	10.40
500	1.20	1.60	2.00	2.40	2.80	3.20	3.60	4.00	4.70	5.90	7.10	8.30	9.50	10.70	11.80	13.06
600	1.44	1.92	2.40	2.88	3.36	3.84	4.32	4.80	5.64	7.08	8.52	9.96	11.40	12.84	14.16	15.60
700	1.68	2.24	2.80	3.36	3.92	4.48	5.04	5.60	6.58	8.26	9.94	11.62	13.30	14.98	16.52	18.20
800	1.92	2.56	3.20	3.84	4.48	5.12	5.76	6.40	7.52	9.44	11.36	13.28	15.20	17.12	18.88	20.80
900	2.16	2.88	3.60	4.32	5.04	5.76	6.48	7.20	8.46	10.62	12.78	14.94	17.10	19.26	21.24	23.40
1000	2.40	3.20	4.00	4.80	5.60	6.40	7.20	8.00	9.40	11.80	14.20	16.60	19.00	21.40	23.60	26.00
VALVE	0.19	0.25	0.31	0.37	0.44	0.50	0.56	0.62	0.75	0.94	1.12	1.31	1.50	1.68	1.87	2.06

Valve Leakage Allowable = 0.0078 Gal/Hour/In. of nominal valve size

Test: Grey Iron, Ductile Iron, Plastic, and AC at 150 psi
Concrete 120% of Design Pressure
Steel 120% Min. to 150% Max. Design Working Pressure

4. Water Pipe Appurtenances

a. Description - This section shall govern for the construction of all miscellaneous water main structures.

b. Materials - All materials used in the construction of work specified in this section shall conform to the applicable sections of these specifications.

c. Excavation and Backfill - In general, excavation and backfill shall conform to the requirements of *Section 4.2, Excavation and Backfill*.

d. Construction Requirements - The construction of reinforced concrete water main structures shall be performed in accordance with the requirements of *Section 5.1, Concrete and Reinforcement*, and the following additional requirements:

All formed surfaces of the concrete exposed to public view shall be given a stone rubbed textured finish. All other formed surfaces shall be given the "Ordinary Surface Finish" as described in *Item F, Finishing*, of *Section 5.1 Part 3*.

e. Creek Crossing - Creek crossings using pier construction shall be made in accordance with the details shown on the plans.

f. River Crossings, Siphons and Miscellaneous Pipe Structures - River crossings, siphons and miscellaneous pipe structures which may be necessary shall be designed in detail on the plans.

5. Connections to Existing Water Mains

a. General - Connection to an existing water main shall include not only branch connections, but in-line connections for the purpose of making required pipe adjustments as well. Any connection or series of connections required to be performed on an existing water main shall meet with the Owner's specific approval as to the seasonal period when the work can be performed; the length of time required for the work to be completed; the work procedures proposed; or any other facet that could affect curtailment of quality or quantity of water supply to the affected area. The work shall be performed with stringent built-in safeguards (such as adequate backup equipment, labor and materials available) to insure that time schedules are met without failure and subsequent setback. Every effort shall be made to accomplish as much of the work as possible before actual tie-in is made into the existing main. This is especially applicable where vertical and horizontal concrete thrust blocks are a necessity to impose proper restraint of the pipe when the main is returned to full service.

b. Description - Where indicated on the plans and/or herein specified, the Contractor shall connect the new main to existing mains. The Contractor shall furnish all labor, materials, equipment and services required for the locating and uncovering of the existing line; the making of cuts in the existing line; the removal, relocation, and/or lowering of existing lines as required; dewatering of the trench; connecting of the existing lines to the new main; and all appurtenant work required for complete connection. Relocated mains or lines shall be laid so that all valves shall be set vertically. The Contractor shall be required to plug and block lines, crosses, tees or other fittings installed in the new main to permit testing and chlorination prior to making of connections. Such plugs and blocking shall be adequate to withstand a test pressure of 150 psi.

Unless the Contractor has provided a valve tested in accordance with these specifications, only such connections to existing mains as are necessary to load, test and

sterilize mains under construction with water from the City mains will be permitted prior to the chlorination of new mains.

Where cut-ins are made immediately adjacent to valves which are under pressure, the Contractor shall take all necessary precautions to brace such valves with temporary blocking. Bracing, which shall be of ample size and properly placed to prevent movement or blowing off of any pipe, valves or fittings due to water pressure on the main.

Connections to existing water mains shall be made at the locations shown, as specified, and/or as directed by the Owner. All such connections shall be made in a most expeditious and workmanlike manner to cause the least inconvenience to water customers and to traffic. The detailed schedule of operations for making each connection shall be approved by the Owner before any work thereupon is commenced.

On dead end lines, a fire hydrant or permanent blow-off connection (2" minimum) shall be provided for flushing, testing, and chlorination.

6. Taps and Tap Assemblies in Water Mains

a. General - Taps and/or tap assemblies of the specified size shall be installed in locations as detailed and indicated on the plans or as specified.

(1) Taps - Taps for transmission of water or air from the main into system service accessories will be made by clamping an approved service clamp equipped with a sealed threaded port on the periphery of the main; then drilling through the pipe wall to complete each service port. Taps may be made either on an uncharged system or into a main under pressure.

(2) Tap Assemblies - The tap assembly shall consist of a corporation stop and an iron-to-copper connection attached to a hard copper (Type K) tubing terminating approximately one foot below ground surface with a brass gate valve as shown and detailed on the plans to serve as additional air release.

(a) Tap assemblies may be required by the project plans and specifications adjacent to gate valve installations. Tap assemblies so required shall be installed in the water main on either side of the valve. Payment for the tap assemblies shall be included in the unit price bid for furnishing and installing the gate valve complete in place.

(b) When taps are required for flushing, chlorination and/or testing, the Contractor shall locate the taps in accordance with the detail drawings, plans or in locations directed by the Owner. No separate payment shall be made for taps required for testing, flushing and/or chlorination.

Upon completion of the testing and sterilization - bacteriological test, the Contractor shall return to the job site, remove the blow-off down to the corporation stop, backfill leaving the corporation stop in place, and replace all pavement. The Contractor's removal of the blow-off shall include all labor, materials, tools, equipment and incidentals necessary to complete the work, including excavation, backfill and disposal of surplus materials without additional compensation.

b. Tapping Cast Iron or Ductile Iron Pipe - Service taps, unless otherwise specified shall be made in cast iron or ductile iron pipe utilizing service saddles as specified.

c. Tapping Concrete Pipe - Tap location shall be provided to the pipe manufacturer, when available, and taps shall be made by the manufacturer during the

fabrication phase of the pipe when locations are so furnished. When taps are required to be made in the field, the taps shall be made in accordance with the pipe manufacturer's recommended procedures and to the satisfaction of the Owner. Taps with a diameter less than or equal to 1" shall be provided with brass insert bushings. Taps 1½" or larger shall be provided as flanged outlets with flange to thread insulator adapter kits.

d. Tapping Asbestos Pipe - Taps to asbestos pipe shall be made directly to the pipe with double strap tapping saddles as specified. If the taps are made directly to the pipe with tapping saddle, the tap and the tapping saddle shall be considered a part of the service.

e. Tapping of PVC Pipe - Service taps in AWWA C-900 PVC pressure pipe shall be made utilizing service saddles as specified.

7. Line Valve Installation

a. General - At locations shown on the plans, there shall be furnished and installed valves of the type and size indicated. Valve vaults shall be furnished as provided in the special contract documents and constructed in accordance with *Item A.17, Vaults, of Section 4.9 Part 3.*

b. Handling and Installing Gate Valves - Valves shall be carefully handled and lowered into position in such a manner as to prevent damage to any part of the valve. The valve shall be placed in the proper position and held securely until all connections have been made. Where valves are to be placed in a concrete structure, the floor shall be completed before installing the valve. The valve shall be securely blocked so that its weight is carried by the floor rather than being supported by connected piping.

8. Air Release Valves

a. General - The term "air release valve" as used in this section shall apply to the installation of both air release valve and combination air and vacuum release valves. Vaults shall be furnished as an integral part of either air release valve or combination air and vacuum release valve installation.

b. Installing Air Release Valves - Air valves shall be installed in the manner shown on the plans. The proper valve and fitting sizes shall be installed on mains in accordance with the details shown on the plans.

Fittings required for mounting air valves shall be as shown on the plan detail sheets. All fittings shall be tight, leak free and plumbed true to the required position.

9. Fire Hydrants

a. General - Fire hydrants shall be installed as shown on the plan detail sheets or as directed by the Owner.

b. Installation - The hydrant shall set truly vertical and be securely braced and blocked on well-compacted or undisturbed soil surrounded by ¾" minimum washed rock to permit free draining of the hydrant, with the large steam nozzle facing the nearest curb. Fire hydrants will be installed in accordance with plan detail sheets.

Any adjustments needed after installation shall be made by the Contractor without extra compensation.

c. Use of Fire Hydrant and Valves - The Contractor shall not operate any fire hydrant or valve in the existing water system without the permission of the Owner. If permission is granted, the Contractor shall use only approved fire hydrant and valve wrenches. The Owner shall inspect all fire hydrants and/or valves operated by the Contractor prior to final acceptance of the project. All repairs or replacements required to restore satisfactory operation of fire hydrants and/or valves shall be at the expense of the Contractor.

10. Services and Bullheads

a. General - "Service" shall be defined as a service line to an individual customer. "Bullheads" shall be defined as an individual service line with branches at the end to service two or more customers.

The details on installation and materials required are shown on the detail sheets attached to the plans.

11. Facilities for Dewatering of Water Lines

a. General - There shall be constructed, at the location shown and detailed in the plans, permanent standard blow-offs and drains and special dewatering facilities to permit the blowing off and/or dewatering of lines or sections of line.

b. Standard Blow-Off and Drain - Where shown on the plans, standard blow-offs and drains shall be constructed.

c. Creek and River Crossing and Miscellaneous Pipe Structures - Creek and river crossings, riprap and miscellaneous pipe structures, which may be necessary, shall be designed in detail on the plans.

12. Blocking

a. General - Each change in direction of a pressure pipe and plugs in pressure pipes shall be blocked with 1,500 psi concrete as is detailed on the detail sheet or as may be detailed on the plans for special blocking in such a manner as shall substantially brace the same against undisturbed trench walls.

13. Purging and Disinfection of Water Mains

a. General - Before any newly constructed water main shall be permitted to be placed into service, it shall be purged and tested; or purged, disinfected and tested by the Owner unless otherwise specified until the bacterial count within the main meets the standards of purity established by the Owner's chemical laboratory.

The Contractor's personnel shall perform the actual purging, disinfection and testing activities. Should the Contractor's carrier be required to transport potable water to the job site for main testing, tankage and all piping, including pumps used to transport or transfer potable water into the main, shall be disinfected and/or approved for that use by the Owner.

b. Procedure - When the entire pipeline or selected sections, as approved by the Owner, thereof have been completed, the line or section shall be disinfected according to the requirements of TCEQ.

c. Addition of Chlorinated Lime - For convenience in certain locations, it may be directed by the owner that chlorinated lime (HTH) be placed in the pipe as laid, in lieu of standard gas chlorination.

d. Discharging - Chlorinated water having a maximum 3.2 parts per million shall not be discharged such that it can enter a receiving stream. It shall be the responsibility of the contractor to ensure compliance with TCEQ. The contractor shall submit to the City Engineer a plan of discharge prior to discharging chlorinated water.

14. Plugs - Permanent plugs shall be placed where shown on the plans.

15. Vaults - Vaults shall be provided as specified and/or detailed for access to manholes, gate valves, air release valves, etc.

a. General Construction - Vaults may be of concrete, reinforced concrete, precast reinforced concrete pipe as detailed in the COW Standard Details, or as shown on the project plans. General construction shall include the following:

(1) Vaults used for blow-off manhole applications shall be of water containment construction, utilizing either the monolithic pour-in-place concrete or precast reinforced concrete pipe with trapped O-ring gasket.

(2) Vaults used for nonwater-containment construction such as for valve installations shall be either pour-in-place 2500psi reinforced concrete or precast reinforced concrete tongue-and-groove design pipe meeting ASTM C 76, Class III using trapped O-ring type rubber seals.

b. Specific Requirements - Specific requirements include the following:

(1) Material requirements for vaults shall be as controlled under the material requirements of these general contract documents as applicable with specific inference placed on material specifications.

(2) For in-place vaults, walls shall be formed on all sides to the thickness specified. Unless specified otherwise, walls shall not be less than six inches thick.

(3) Top slabs shall normally be poured below final grade and grade rings used to achieve final grade ring elevations.

(4) Grade rings, covers, vents, etc., shall be installed as detailed in Item A.3, Sanitary Sewer Manholes, of Section 4.8 Part 3, as shown on the project plans, or as directed by the Owner. Manhole steps will not be used.

(5) The vault top slab invert and inside wall shall be given a rubbed finish in accordance with *Item F, Finishing*, of *Section 5.1 Part 3*.

(6) Water-containment vault structures shall be tested for exfiltration as directed by the Engineer. In the event that leakage occurs in excess of allowable limits, the vault shall be completely sealed with an approved mastic sealer. Any visible seepage of free water shall require sealing on either water containment vaults or manholes.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

1. Water Pipe Installation

a. Measurement - Pipe, including corrosion protection if in place on the pipe, shall be measured for payment in linear feet along the centerline of the pipe actually laid. No deductions shall be made for fittings and valves, measurements being from center to center of fittings.

Where a change in the size of the pipe occurs in the line, the measurement shall be to the center of the fitting. Where a change in the size of the pipe occurs in the line, the measurement shall be to the center of the reducer. Pipes shall be classified for payment according to depth as specified.

b. Payment - Pipe, including corrosion protection in place on the pipe, shall be paid for at the contract unit price per linear foot, complete in place, as provided by the proposal and contract. The contract price per linear foot shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including excavations, backfill and disposal of surplus materials, in accordance with the plans and these specifications.

2. Connection to Existing Mains - Connections to existing mains shall be paid for at the unit price bid for size of connection indicated. Furnishing and placing of fittings, valves, pipe and concrete blocking are included elsewhere in the proposal and contract as separate pay items.

3. Taps and Tap Assemblies in Water Mains- Measurement shall be for individual taps made by size; and payment shall be absorbed under *Item A.1, Water Pipe Installation, of Section 4.9 Part 4* unless otherwise specified.

4. Line Valve Installation- Where valves are furnished by the Owner, the valves shall be measured for payment for placing only, per each, grouped by size. Where the valves are to be furnished by the Contractor, the valves shall be measured for payment for furnishing and placing per each, grouped by size. The price bid for valves would include roadway box, cover, extension pipe and pad supports, since separate pay items shall not be set up for these items. Manholes for valve gearboxes shall be paid for at the contract unit price per each, grouped by sizes complete in place, if provided in the proposal and contract. The contract unit price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work.

5. Air Release Valves - Unless otherwise specified, payment shall be made at the unit price bid for installing the air release valve complete in place which shall be full compensation for furnishing, hauling, handling, placing, installing, jointing, testing and all incidental expenses necessary to install valves in strict accordance with drawings, specifications, and/or instructions of the Owner, including vault.

6. Fire Hydrants - Fire hydrants shall be paid for at the contract unit price per each, complete in place, as provided in the proposal and contract. The contract price shall be the total compensation for the furnishing of all labor, material, tools, equipment, hydrant lead, gate

valve and box, excavation, backfill, hydrant extensions and incidentals necessary to complete the work.

7. Fittings- Payment for fittings shall be made only if a separate bid item is established in the contract. If a separate bid item is not established, the fittings shall be included in the price of the pipe bid item.

Cast Iron, Grey Iron, Ductile Iron or Ductile Iron Compact Fittings shall be measured for payment as shown in contract bid items.

Special fittings of reinforced concrete pressure pipe, steel cylinder type shall be measured for payment per each, grouped as to size and kind. Fittings that are an integral part of a special item, such as bored flange in an air valve installation, shall not be measured for payment, per each, but shall be included in the contract unit price for that special item. Fittings shall be paid for at the contract unit price, complete in place, as provided in the proposal and contract. The contract price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work.

8. Services and Bullheads - Where water services have to be transferred from a line to be replaced, killed or salvaged, to a line being constructed, they shall be paid for per each, as set out in the proposal and contract.

Bullheads or water services shall be measured and paid for at the contract price per each, in accordance with size and location, complete in place, as provided in the proposal and contract. The tapping saddle shall be measured and paid for as part of the service.

The contract price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including excavation and backfill.

9. Pitot Outlets - Pitot outlets shall be measured for payment per each. Pitot outlets shall be paid for at the contract unit price per each.

10. Facilities for Dewatering of Water Lines

a. Standard Blow-offs - Permanent blow-offs and drains shall be measured as complete units.

Payment shall be made for permanent blow-off and drain at the unit price bid, which shall be full compensation for the complete installation.

Payment for permanent blow-offs with dewatering sump manhole shall be made on a lump-sum basis at the unit price bid which shall be full compensation for complete installation, including excavation and backfill from blow-off fitting to manhole; furnishing and installing sump manhole and other items needed for complete installation exclusive of items for which there are bid items in the proposal.

b. Creek and River Crossing and Miscellaneous Pipe Structures - The structures shall be measured for payment per each or in linear feet between the limits set out on the plans. Miscellaneous concrete shall be measured for payment paid for at the contract unit price as provided in the proposal and contract.

Each pipe structure shall be paid for at the contract unit price, complete in place, as provided in the proposal and contract. The contract price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including all excavation, disposal of surplus materials and backfill, in accordance with the plans and these specifications.

11. Blocking - Concrete blocking may be measured or may be considered subsidiary to the various bid items to which it is related.

12. Purging and Disinfection of Water Mains - Chlorination of mains will not be paid for as a separate pay item, but the cost thereof should be included in such contract pay items as are provided in the proposal and contract. The price shall be total compensation for furnishing all labor, materials, tools, equipment and incidentals necessary to complete the work, including all excavation, disposal of surplus material and backfill, all in accordance with the plans and specifications.

13. Plugs - Where plugs are classified separately as contract pay items, payment shall be made in accordance with the contract unit price per each, complete in place, as provided in the contract. The price shall be total compensation for furnishing all labor, materials, tools, equipment and incidentals necessary to complete the work, including all excavation, disposal of surplus material and backfill, all in accordance with the plans and specifications.

14. Vaults - Measurement and payment for vaults shall be as hereinafter defined, unless specified otherwise in the special contract documents.

Measurement for vault structures shall be on a per each basis complete in place with all accessories and shall include appurtenant work including excavation through backfill to provide for the structure complete in place as designed for the project.

Each vault structure is to be complete in place with all system components to be housed as in the following outline:

a. Access Manhole Vault - Since the flanged access outlet and cover are usually furnished as a fitting for concrete cylinder pipe, the vault shall be the only item considered for payment under this bid item category in the proposal.

b. Air Valve or Combination Air and Vacuum Release Valve in Vault - Payment under this bid item category in the proposal shall include furnishing and installing the air valve or combination air and vacuum release valve, together with all subsidiary piping valves and other appurtenances complete in place as detailed as well as construction of the vault structure. The connecting taps on the main shall be included in the bid price for furnishing and installing fittings or shall be subsidiary to the price bid for furnishing and installing pipe, whichever is most applicable for a specified project.

c. Gate Valve in Vault -Payment under this bid item category in the proposal shall include the construction of the vault as well as furnishing and installing the gate valve complete in place on concrete blocking along with all appurtenances as detailed for complete and functional installation.

d. Blow-off and Vault - Payment under this bid item category in the proposal shall include the construction of a water-containment vault structure as well as furnishing and installing piping (exclusive of the M.J. bell outlet on concrete mains or M.J. tee on cast iron mains), valves blocking and other appurtenances as detailed with polyethylene wrapping.

15. Waterstops - No separate payment shall be made for waterstop material or for installation of this item. The costs shall be included in the price bid for the completed structure into which the materials are incorporated.

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SECTION 4.10: STORM SEWER

PART 1: GENERAL

A. DESCRIPTION

This item shall govern and control the furnishing and placing of reinforced concrete pipe or drainage lines, including pipe fittings, connecting drain lines to curb inlets, all joints, all connections to new or existing pipe or headwalls, manholes, etc., to the lines and grades shown on the plans. All pipe and fittings shall be of the classes, sizes and dimensions as shown thereon; and as may be required to complete the work.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Refer to *Section 4.7, Piping Materials*

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Reinforced Concrete Pipe

a. Excavation and Embedment - All excavation and pipe embedment shall conform to the requirements of *Section 4.2, Excavation and Backfill*.

b. Installation of Pipe - The Contractor shall furnish, at his own expense, and place in position as directed by the Engineer all necessary batter boards, string lines, plummets, graduated poles, and laser grade control instruments required in establishing and maintaining the lines and grades. The batter boards and all location stakes must be protected from possible damage or change of location.

(1) Trench Location - All pipe and fittings shall be laid and jointed in a dry trench

(2) Pipe Laying - Unless otherwise authorized by the Engineer, the laying of the pipe on the prepared foundation shall be started at the outlet or downstream end with the spigot or tongue end of the pipe joint pointing downstream. Laying shall proceed toward the inlet or upstream end with each abutting section of pipe properly matched, true to the established lines and grades. Approved facilities shall be provided for hoisting and lowering the sections of pipe or the sides of the trench. The ends of the pipe shall be carefully cleaned before the pipe is placed in the trench. As each length of the pipe is laid, the open end shall be protected to prevent the entrance of earth or bedding material. The pipe shall be fitted and matched so that when laid in the prepared bedding, it shall form a smooth, uniform pipe. When elliptical pipe with circular reinforcing, or circular pipe with elliptical reinforcing, is used, the pipe shall be laid in the trench in such a position that the markings "top" or "bottom" shall not be more than five degrees from the vertical plane through the longitudinal axis of the pipe.

c. Erosion Control - All necessary precautions will be taken to insure that sediment does not enter the storm sewer system while it is under construction. This section must also meet the requirements of *Section 1.10, Storm Water Pollution Prevention*

d. Jointing - Joints using cold applied preformed plastic gaskets shall be made as follows:

A suitable primer of the type recommended by the manufacturer of the gasket joint sealer shall be brush applied to the tongue-and-groove joint surfaces and the end surfaces and allowed to dry and harden. No primer shall be applied over mud, sand or dirt or sharp cement protrusions. The surface to be primed must be clean and dry when primer is applied.

Before laying the pipe in the trench, attach the plastic gasket sealer around the tapered tongue or tapered groove near the shoulder or hub of each pipe joint. Remove the paper wrapper from one side only of the two-piece wrapper on the gasket and press it firmly to the clean, dry pipe-joint surface. The outside wrapper is not to be removed until immediately before pushing the pipe into its final position.

When the tongue is correctly aligned with the flare of the groove, remove the outside wrapper on the gasket and pull or push the pipe home with sufficient force and power (backhoe shovel, chain hoist, ratchet hoist or winch) to cause the evidence of squeeze-out of the gasket material on the inside or outside around the complete pipe joint circumference. Remove any joint material that pushed out into the interior of the pipe that would tend to obstruct the flow. (Pipe shall be pulled home in a straight line with all parts of the pipe on the line and grade at all times.)

Pipe damaged by this operation shall be subject to review by the Owner and, if necessary, a change in the jointing procedure may be required. Backfilling of pipe laid with plastic gasket joints may proceed as soon as the joint has been inspected and approved by the Engineer. Special precautions shall be taken in placing and compacting backfill to avoid damage to the joints.

When the atmospheric temperature is below 60°F, plastic joint seal gaskets shall either be stored in an area warmed to above 70°F, or artificially warmed to this temperature in a manner satisfactory to the Engineer. Gaskets shall then be applied to pipe joints immediately prior to placing the pipe in the trench, followed by connection to previously laid pipe.

e. Backfill - All backfill of pipe trenches shall be in accordance with *Section 4.2, Excavation and Backfill*.

f. Fittings for Concrete Pipe - All changes in pipe size, grade, intersection, bends, etc. must be made at manholes or inlets.

2. Storm Sewer Appurtenances - This section shall govern for the construction of all miscellaneous storm sewer structures such as junctions, transitions, manholes, special concrete manholes, creek crossings, river crossings, utility supports, and miscellaneous structures or appurtenances which may be shown on the plans.

a. Construction Requirements - The construction of reinforced concrete storm sewer structures including junctions, transitions, special concrete manholes, vaults and such other similar structures as may be covered by this specification shall be performed in

accordance with the requirements of *Section 5.1, Concrete and Reinforcement*, and the following additional requirements. Excavation shall be made to the required depth and of sufficient width to construct the work to grade, form and dimensions. All soft and yielding materials shall be removed and replaced with acceptable materials. The subgrade shall be moistened to a minimum depth of two inches before placing of the concrete. All formed surfaces of the concrete exposed to public view shall be given a rubbed finish. All other formed surfaces shall be given the "Ordinary Horizontal Finish" as described in *Item F, Finishing, of Section 5.1 Part 3*. Corrosion protection shall be applied as may be called for on the plans or the proposal and shall be measured for payment and paid for at the contract price as set out in the invitation for bids, all as detailed in *Item F.14, Corrosion Protection of Sewers and Appurtenances, of Section 4.7 Part 2.*

3. Storm Sewer Manholes - Storm sewer manholes shall be fabricated in different configurations to meet with specific needs required in the storm sewer system.

a. General Construction - Unless specified otherwise, standard manholes shall be constructed as monolithic concrete structures or as a precast reinforced concrete structure.

(1) Standard Manhole - Standard manholes shall conform to the standard details.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

1. Reinforced Concrete Pipe

a. Measurement - The reinforced concrete pipe shall be measured in linear feet along the longitudinal centerline of each size pipe specified. Measurement shall begin at the initial beginning point as shown on the plan-profile sheet, extend only to the inside faces of manhole walls (excluding the inside manhole diameter) and terminate at the extreme end of construction as provided on the plan-profile sheets.

2. Storm Sewer Appurtenances

a. Measurement - New pipe or pipe used to replace existing storm sewers shall be measured in linear feet from end to end of pipe.

Concrete for piers and beam supports shall be measured in per each in place.

No measurement or payment shall be made for reinforcing steel.

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SECTION 4.11: PIPE BURSTING

PART 1: GENERAL

A. DESCRIPTION

This specification includes requirements to rehabilitate existing sanitary sewer mains by the pipe bursting method, which splits the existing pipe and immediately installs a new sanitary sewer pipe. Rehabilitation includes reconnecting existing sewer house connections, television inspection of the new pipe and complete installation in accordance with the Contract documents.

B. SITE CONDITIONS

1. Contractor's Safety - Without excluding other safety considerations, Contractor is advised that the sanitary sewer system, existing and proposed, may contain dangerous or deadly concentrations of gases.

2. Existing Conditions - Surface Waters. Site is subject to frequent inundating rains, and may be subject to localized flooding and surface flows. Site is subject to groundwater conditions, which may impede work sequence.

C. QUALITY ASSURANCE

1. The Contractor shall be certified by the particular Pipe Bursting System Manufacturer that such firm is a licensed installer of their system.

2. Polyethylene pipe jointing shall be performed by personnel trained in the use of thermal butt-fusion equipment and recommended methods for new pipe connections. Personnel directly involved with installing the new pipe shall receive training in the proper methods for handling and installing the polyethylene pipe. Training shall be performed by qualified representative.

3. The Contractor shall hold the City and Engineer harmless in any legal action resulting from patent infringements.

4. The Contractor is solely responsible for quality assurance during the length of the project. The Contractor is responsible for any costs associated with corrective measures required to replace or repair items not meeting the quality standards specified by the Owner.

D. SUBMITTALS

The Contractor shall submit the following items for review and approval by the Owner in accordance with the Contract Documents. Owner approval of the submittals shall be obtained prior to ordering pipe materials and/or commencing the pipe replacement process.

1. Certifications of training by the pipe bursting systems manufacturer stating that the operators have been fully trained in the use of the proposed pipe bursting equipment

by an authorized representative of the equipment manufacturer.

2. Certifications of training by the pipe fusion equipment manufacturers that the operators have been fully trained in the use of the fusion equipment by an authorized representative of the equipment manufacturer.

3. Detailed construction procedures, and layout plans to include sequence of construction.

4. Locations, sizes and construction methods for the service reconnection pits.

5. Methods of construction, reconnection and restoration of existing service laterals and methods of maintaining sanitary sewer service.

6. Detailed engineering calculations of the bursting force or static pulling force required to install pipe for each run.

7. Detailed procedures for the installation and bedding of pipe in launching and receiving pits, including temporary alignment of new pipe prior to insertion.

8. Sewer bypass plans, including methods and list of equipment to be utilized.

9. Description of method to remove and dispose of the host pipe, if required.

10. Safety plan in conformance with the Contract Documents and OSHA regulations.

11. Project schedule.

E. METHODS FOR NEW PIPE INSTALLATION

The most commonly used methods for pipe bursting utilize static or impact force. Static systems are hydraulic, while impact systems generally involve a combination of pneumatic and hydraulic technology.

The pipe bursting tool shall be designed and manufactured to force its way through the existing pipe materials by fragmenting the pipe and compressing the old pipe sections into the surrounding soil as it progresses. The bursting unit shall generate sufficient force to burst and compact the existing pipeline. The bursting tool size shall be in accordance with the manufacturer's recommendations for the diameters being burst and replaced.

The pipe bursting tool shall be pulled through the sewer by a cable or rods located at the machine pit. The bursting unit shall pull the polyethylene (PE) pipe with it as it moves forward from the insertion pit. The bursting head shall incorporate a shield/expander to prevent collapse of the hole ahead of the new pipe insertion. The pipe bursting unit shall be remotely controlled. Sectional replacement pipe shall be

pushed as well as pulled behind the bursting head.

The bursting action of the tool shall increase the external dimensions sufficiently to break the existing pipe and simultaneously expand the surrounding ground sufficiently to permit pulling the new pipe through the annular space.

PART 2: PRODUCT

A. GENERAL

1. Sizes of the insertions to be used shall be as shown on the plans.

2. All pipe shall be made of virgin material. No rework except that obtained from the manufacturer's own production of the same formulation shall be used.

3. The pipe shall be homogenous throughout and shall be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.

4. Internal material color shall be white or green.

B. MATERIALS

1. Polyethylene (PE) Plastic Pipe

a. Polyethylene Plastic Pipe shall be high density polyethylene pipe and meet the applicable requirements of ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, ASTM D1248, ASTM D3550.

b. Dimension Ratios: The minimum wall thickness of the polyethylene pipe shall meet the following:

Minimum Depth of Cover (Feet)	SDR of Pipe
0 - 16.0	17
> 16.1	11

C. TESTS

Tests for compliance with this specification shall be made as specified herein and in accordance with the applicable ASTM Specification. A certificate with this specification shall be furnished, upon request, by the manufacturer for all material furnished under this specification. Polyethylene plastic pipe and fittings may be rejected for failure to meet any requirements of this specification.

D. DELIVERY, STORAGE, AND HANDLING

1. Transport, handle, and store pipe and fittings as recommended by manufacturer.

2. If new pipe and fittings become damaged before or during installation, it shall be replaced as required by the Engineer at the Contractor's expense, before proceeding further.

3. Deliver, store and handle other materials as required to prevent damage.

E. EQUIPMENT
Not Applicable

PART 3: EXECUTION

A. SERVICE CONNECTIONS

1. All sewer service connections shall be identified, located and excavated prior to the pipe insertion to expedite reconnection. Upon commencement, pipe insertion shall be continuous and without interruption from one manhole to another, except as approved by the engineer and/or his representative. Upon completion of insertion of the new pipe, the Contractor shall expedite the reconnection of services to minimize any inconvenience to the customers.

2. Service laterals shall be connected by the use of a prefabricated mechanical saddle. Mechanical saddles shall be made of polyethylene pipe compound that meets the requirements of ASTM D1248, Class C or polyvinyl chloride pipe compound that meets the requirements of ASTM D3034. Mechanical saddles shall have stainless steel straps and fasteners, neoprene gasket and backup plate. Mechanical saddles shall be Strap-On-Saddle Type or Tapping Saddle as manufactured by Fernco Joint Sealer Co., DFW Plastics, Inc. or approved equal. Once the saddle is secured in place, drill hole full inside diameter of saddle outlet in pipe liner.

B. BYPASSING SEWAGE

1. By-Pass Pumping: The Contractor, when and where required, shall provide diversion for the pipe bursting/replacement process. The pumps and by-pass lines shall be of adequate capacity and size to handle all flows. All costs for by-pass pumping, required during installation of the pipe shall be subsidiary to the pipe reconstruction item.

2. The Contractor shall be responsible for continuity of sanitary sewer service to each facility connected to the section of sewer during the execution of the work.

3. If sewage backup occurs and enters buildings, the Contractor shall be responsible for clean up, repair, property damage cost and claims.

C. TELEVISION INSPECTION

Television inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by closed circuit color television.

Television inspection shall include the following:

1. Post construction videotapes to be submitted to the city before final payment.

Pre-construction videotapes shall be made available to the city for review prior to beginning construction.

2. Post construction videotapes to remain property of the city; Contractor may retain second copy for his use.

3. All flows tributary to reach of sewer being inspected are to be completely by-passed around the reach during inspection.

4. Pre-construction: Clean and videos tape each reach of sewer with the voice description, as appropriate, with stationing of services indicated. Data and stationing to be on video.

5. Post construction: Videotape upon completion of reconstruction of each reach of sewer with the voice description, as appropriate with stationing of services indicated. Data and stationing to be on video.

6. Should any portion of the inspection tapes be of inadequate quality or coverage, as determined by the City, the Contractor will have the portion re-inspected and video taped at no additional expense to the City.

D. CONSTRUCTION METHODS

1. Insertion or launching pits shall only be allowed at locations approved by the Owner to minimize impact to existing trees. Contractor will submit proposed pit locations with his construction procedures.

2. Equipment used to perform the work shall be located away from buildings so as to minimize noise impact. Provide silencers or other devices to reduce machine noise as required to meet requirements.

3. The Contractor shall install all pulleys, rollers, bumpers, alignment control devices and other equipment required to protect existing manholes, and to protect the pipe from damage during installation. Lubrication may be used as recommended by the manufacturer. Under no circumstances will the pipe be stressed beyond its elastic limit.

4. The installed pipe shall be allowed the manufacturer's recommended amount of time, but not less than four (4) hours, for cooling and relaxation due to tensile stressing prior to any reconnection of service lines, sealing of the annulus or backfilling of the insertion pit. Sufficient excess length of new pipe, but not less than four (4) inches, shall be allowed to protrude into the manhole to provide for occurrence.

E. FIELD TESTING

1. After the existing sewer is completely replaced, internally inspect with television camera and video tape as required. The finished tape shall be continuous

over the entire length of the sewer between two manholes and to be free from visual defects.

2. Defects which may affect the integrity or strength of the pipe in the opinion of the Owner and Engineer shall be repaired or the pipe replaced at the Contractor's expense.

F. PIPE JOINING

1. The polyethylene pipe shall be assembled and joined at the site using the thermal butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections are not permitted. All equipment and procedures used shall be used in strict compliance with the manufacturer's recommendations. Fusing shall be accomplished by personnel certified as fusion technicians by a manufacturer of polyethylene pipe and/or fusing equipment.

2. The butt-fused joint shall be true alignment and shall have uniform roll-back beads resulting from the use of proper temperature and pressure. The joint shall be allowed adequate cooling time before removal of pressure. When cool, all weld beads shall then be removed from both the inside and outside surface such that the joint surfaces shall be smooth. The fused joint shall be watertight and shall have tensile strength equal to that of the pipe. All joints shall be subject to acceptance by the Owner and Engineer prior to insertion. All defective joints shall be cut out and replaced at no cost to the City. Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than ten percent (10%) of the wall thickness, shall not be used and must be removed from the site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above. In addition, any section of pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the Owner and Engineer shall be discarded and not used.

3. Terminal sections pipe that are joined within the insertion pit shall be connected with a full circle pipe repair clamp. The butt gap between pipe ends shall not exceed one-half (1/2) inch.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Not Applicable

SECTION 4.12: BACKFLOW PREVENTION

PART 1: GENERAL

A. DESCRIPTION

Backflow Prevention will be installed as regulated by and in accordance with TCEQ and COW Standard Details.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Not Applicable

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Not Applicable

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Not Applicable

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SECTION 4.13: LIFT STATIONS

PART 1: GENERAL

A. DESCRIPTION

The intent of this specification is to outline the minimum requirements for standard lift station for the City of Waco Water Utility. It is anticipated that the design engineer will review these requirements and process all submittals noted through the appropriate Utility and Engineering representatives.

The information contained in this document delineates the minimum requirements for a wet well lift station design, as it is anticipated that any lift station with sufficient design capacity to warrant a dry well design will also require a much more detailed and project specific design.

Any recommendations or requests to deviate from these specifications must be approved in advance. It is the Contractor's or Engineer's responsibility to provide the necessary information demonstrating functional equivalence or superiority. Any such submittals must be made with sufficient lead time to prevent adverse impact to the project.

PART 2: WET WELL & VALVE VAULT

The wet well may be constructed of either concrete or fiberglass reinforced plastic.

A. Concrete Wet Well

The concrete wet well may utilize either a cast in place or pre-cast design.

1. **Cast in Place Construction -** If wet well is to be cast in place, the design engineer shall utilize the appropriate City of Waco structural concrete specifications and details in the design, with the following modifications. Pipe penetrations shall be wall pipe. All penetrations must be sealed with products approved by the Waco Water Utility.

The base shall be a minimum of 12" thick and be constructed of concrete with 2 rows of number 5 steel rebar on 12-inch center (minimum). The base water-stop gasket shall be Synko-Flex. A second water-stop seal shall be applied at the base of the wall prior to keying into slab. The wall should be keyed into the slab a minimum of 4 inches.

2. **Pre-cast construction -** If wet well is to be constructed incorporating pre-cast walls, C-478 concrete pipe sections should be used. The wet wells shall comply with the appropriate City of Waco structural concrete specifications and details, with the following modifications. Pipe penetrations shall be wall pipe. All penetrations must be sealed with products approved by the Waco Water Utility.

The base shall be a minimum of 12" thick and be constructed of concrete with 2 rows of number 5 steel rebar on 12-inch center (minimum).

The wet well slab and wall surface shall be coated with a bonding agent (i.e. concrete glue). The base water-stop gasket shall be Synko-Flex. A second water-stop seal shall be applied at the end of C-478 pipe prior to keying into slab. The pipe should be keyed into the slab a minimum of 4 inches. Ram-neck shall be used to seal between

joints. Canusa Wrapid Seal shall be installed on the outside of each joint according to manufacturer's instructions. Wet well fillets shall be grouted with fiber-filled grout or approved equal.

Acceptable Manufacturers for pre-cast wet wells are Gifford-Hill American or approved equal.

3. Coatings and Materials - The wet well shall be coated inside with 705 Coating (Color shall be white or light blue) as manufactured by Polibrid Coatings, Raven epoxy coating, or approved equal, to a minimum thickness of 80 mils in accordance with manufacturer's recommendations. The exterior of the manhole shall be coated with coal tar epoxy, minimum 15-mil thickness, or approved equal, in accordance with manufacturer's recommendations. The contractor may utilize the same coating system on the exterior as specified for the interior.

The wet well access hatch shall be sized large enough for removal of any equipment or piping inside the wet well.

All hardware and fasteners used in the wet well shall be 300 series stainless steel.

4. Vents -Wet well vents shall be constructed of coated ductile iron pipe or schedule 40 stainless steel and be a minimum diameter of 4 inches. Vents shall be sized based upon maximum air change at maximum pumping rate. The end of the vent shall terminate at least six inches above the top of the slab. The vent pipe shall be topped with a 180 degree bend and a protective stainless steel screen to prevent the introduction of foreign objects, insects, or rodents into the wet well.

5. Access Covers / Hatches - The access covers to the wet well shall be a minimum of 36-inch by 36-inch for all wet wells greater than 48" in diameter. In all cases, if equipment is located in the wet well; the cover shall be large enough to allow the equipment to be removed easily. The access frame and cover to the wet well shall be constructed of aluminum tread plate. The doors shall open to 90° and automatically lock. The lifting handles, hinges, and all fastening hardware shall be stainless steel, Type 316. The covers shall be able to be secured by a padlock using a lockbar. Owner will provide padlock at the time of acceptance of the station. Acceptable Manufacturers are Bilco, Halliday, Flygt, or approved equal.

B. FIBERGLASS WET WELL

Fiberglass reinforced polyester (FRP) wet wells shall be one-piece units with fiberglass bottoms made of composite laminate. The laminate shall consist of thermo-setting chemical resistant polyester resin, fiberglass reinforcement, and additions as required. Structures shall be sized on the plans for applicable stations.

FRP wet wells shall be installed on a concrete slab with a minimum thickness of 12", as measured from the bottom of the wet well. The Engineer shall calculate the necessary weight to offset any possible buoyancy and adjust the base slab thickness accordingly. The Engineer shall ensure the lift station vendor provides a structural anchor system adequate for all buoyancy forces.

The FRP wet well shall be fabricated with a FRP top consistent with the laminate and resin design for the balance of the wet well. A cast in place reinforced concrete slab, designed to support a live load suitable for the project specific location. The design live load shall be indicated on the drawings submitted to the Waco Water Utility.

The top of the wet well shall be designed and fabricated to support the dead weight of the reinforced concrete slab.

FRP wet wells shall be designed and constructed according to ASTM 3753-current, and as listed below:

1. ASTM C-581 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber Reinforced Structures Intended for Liquid Service
    a. ASTM C-582 Standard Specification for Contact-Molded Reinforced Thermosetting Plastic RTP) Laminates for Corrosion-Resistant Equipment.
    b. ASTM D-695 Test Methods for Compressive Properties of Rigid Plastics
    c. ASTM D-570 Standard Test Method for Water Absorption of Plastics
    d. ASTM D-695 Standard Test Methods for Compressive Properties of Rigid Plastics
    e. ASTM D-648 Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise position
    f. ASTM D-790 Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
    g. ASTM D-1259 Standard Test Method for Nonvolatile Content of Resin Solutions
    h. ASTM D-2583 Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
    i. ASTM D-2584 Test Method for Ignition Loss of Cured Reinforced Resins
    j. ASTM D-3299 Standard Specification for Filament–Wound Glass–Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks
    k. ASTM D-3753 Standard Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells

C. CONSTRUCTION

Fiberglass Reinforced Top and Bottom: Bottoms are to be attached to wet well pipe with fiberglass lay-up complying with A.S.T.M.-D3299 specifications. When

reinforcement is necessary for strength, the reinforcement shall be completely enclosed with a fiberglass lay-up per A.S.T.M.-D3299.

Pump Mounts: One half inch (minimum) a thick stainless steel plate, completely enclosed (threaded studs will protrude from the fiberglass bottom) in the fiberglass bottom, will be required for each submersible pump. The plate will be a minimum of 4-inches beyond the centerline of the mounting bolts of the pumps in length and width. Stainless steel threaded studs will be welded to the plate for the mounting of the pumps. Or an alternative method can use stainless steel bolts threaded into a same sized stainless steel plate.

Minimum Thickness: Each wet well will have a thickness design to withstand pressures for underground structures at the depths required with a minimum safety factor of 2.5. However, the thickness of walls bottoms and tops will not be less than one half inch.

The Interior of the Bottom: The bottom of the wet well will be designed with a slope to minimize collection of solids and to reduce formation of a vortex.

D. ACCEPTABLE MANUFACTURERS

Fiberglass Reinforced Polyester (FRP) Wetwell manufacturers that are acceptable:

A. Containment Solutions Inc.
5150 Jefferson Chemical Road
Conroe, Texas, 77301-6834

B. L.F. Manufacturing Inc.
P.O. Box 578
Highway 290 East
Giddings, Texas, 78742

C. Alternatively, a company that is approved by the Waco Water Utility after the manufacturer has shown competency and experience with the product.

E. BACKFILL

The design engineer shall be a Type A trench backfill as specified in the City of Waco Standard Specifications for Construction. The back fill shall not begin until the concrete base has cured sufficiently to withstand construction loads. The backfill shall be placed in even 12” maximum lifts with a minimum density of 95% Proctor. Contractor shall notify designated City of Waco representative to schedule the density testing with a minimum of 24 hour notice. All lifts will be tested, except as specifically waived by the designated representative.

F. VALVE VAULTS

1. Construction - Vaults may be constructed of either pre-cast or cast in place sections. The bases for each type of construction shall comply with paragraphs A.1 (cast in place walls) or A.2 (pre-cast walls), and with section E (backfill).

The precast section shall be keyed 4 inches into base and secured with a minimum of (6) anchor collars with Hilti Hit anchors. The floor shall be grouted at a slope to drain into a 4-inch diameter floor drain.

The valve vaults may be either circular or rectangular in shape. The valve vault MUST provide a minimum of 12" clearance from any potential maintenance or operations access point. The contractor shall submit a detailed dimensioned layout demonstrating compliance with applicable requirements.

Acceptable Manufacturers are Gifford-Hill American, Dal-Worth Quick Set, Hill Country Concrete Products.

2. Coatings - Use coatings for wet well. Please refer to Part 2.A.3.

3. Required Clearances - The vault shall be sized large enough to provide a minimum of one (1) foot clearance around valves and between the wall and any flanges. The vault access hatch shall be sized large enough for removal of any equipment or piping inside the vault.

4. Drain Line - The lift station shall have a 4-inch diameter drain line from the valve vault to the wet well. The drain line shall have a gas trap and a flap valve to prevent backflow of liquid and gasses into the valve vault. The floor drain in the valve vault shall have a stainless steel drain cover.

G. VENTS

Valve vault vents and screens shall be constructed of stainless steel and be a minimum of four (4) inches in diameter.

PART 3: PUMPS

A. PUMP SELECTION

The design engineer shall select the appropriate type and size of pump for the project specific requirements. The contractor shall submit all pertinent pump selection information to the Waco Water Utility for their review and approval.

B. APPURTENANCES

The contractor shall provide a MTM rail system for a minimum of two (2) submersible pumps, discharge elbow, connecting flange assembly, guide connector, upper guide bracket, lifting chain, access frame and hatch cover, guide rails and discharge piping. The rail system and all appurtenances shall be stainless steel.

The discharge elbow designed to mount directly to the sump floor shall be supplied for each pump. It shall have a standard 125-pound flange faced and drilled on

the outlet side, with a machined mating inlet connection. The design shall be such that the pump to discharge connection is made without the need for any nuts, bolts or gaskets. The base elbow shall also anchor and align the two stainless steel guide rails.

A cast iron connecting flange/rail bracket shall be mounted on each pump discharge. It shall have a machined mating flange, which matches the base elbow discharge connection. Sealing of this discharge connection shall be accomplished by a simple linear downward motion of the pump culminating with the entire weight of the pumping unit supported entirely by the base elbow.

The upper guide bracket shall align and support the two guide rails at the top of the sump. It shall bolt directly to the hatch frame or concrete opening and incorporate an expandable rubber grommet for secure rail installation.

Each pumping unit shall be provided with a stainless steel lifting chain, and be of sufficient length to extend from the pump to the top of the wet-well. The access frame shall provide a hook to attach the chain when not in use. The lifting chain shall be sized to the pump weight.

An aluminum or steel hatch shall be furnished with a clear door opening sized to access the pump(s).

A guide rail system shall be used to direct the pump in proper alignment with the stationary discharge piping. Supports shall not interfere with removal of pump. The rail system and supports shall be corrosion resistant and shall be fabricated of 300 series stainless steel or approved equal. Guide rails for each pump must be supplied by the pump manufacturer to ensure compatibility with supplied equipment. The pump shall be easily removed for inspection or service. Personnel shall have no reason to enter the wet well. Supports shall be provided for the guide rail for every 8 feet of rail. The supports shall be evenly spaced along the length of the rail.

The guide brackets and hardware shall be constructed of 300 series stainless steel. Guide brackets for each pump must be supplied by the pump manufacturer to ensure compatibility with supplied equipment.

Acceptable Manufacturers are Flygt, Hydromatic, Fairbanks Morse, KSB or approved equal.

C. GRINDER PUMPS AND MOTORS

The grinder unit shall be capable of macerating all materials in normal domestic and commercial sewage including reasonable amounts of foreign objects such as wood, sticks, plastic, thin rubber, sanitary napkins, disposable diapers and the like into fine slurry that will freely pass through the pump and the discharge pipe and valves. The pump volute, motor and seal housing shall be high quality gray cast iron, ASTM A-48, Class 30.

Grinder cutters shall be constructed of stainless steel. The grinder unit shall be on the suction side of the pump impeller and discharge directly into the impeller inlet leaving no exposed shaft to permit packing of ground solids. The grinder shall be capable of grinding all materials found in domestic sewage into a finely ground slurry with particle dimensions no greater than 1/4-inch.

The motors shall be constructed as an integral part of submersible pump/ motor assemblies. Each motor shall be electrically and mechanically suited for the pump to which it shall be applied. The motor shall be compatible with the pump to which it shall be applied and the motor shall operate efficiently, without overheating or abnormal vibration. The motor shall be designed to provide a 20-year life. Motor shall be housed in separate, dedicated chamber that is either oil cooled or constructed for water-cooling of motor's generated heat. The motor chamber shall be fitted with moisture/leak detector for signaling chamber's breach for water.

Motor shall be Underwriters Laboratories (UL) or Factory Mutual (FM) approved as explosion proof. Rated voltage shall be 1 phase, 60 Hz, 240 V operation up to 3 hp motors and rated voltage shall be 3 phase, 60 Hz, 460 V operation for motors 3 hp and above unless shown otherwise on the plans. Motor shall be rated 1 phase NEMA L or 3 Phase NEMA B with a Class B temperature rise unless specified otherwise. The motor shall comply with NEMA Standard MG-1 and associated ASA and IEEE Standards unless specifically amended hereafter.

Motor shall be constructed of ASTM Type A-48 Class 30 Cast Iron. The housing shall be coated for corrosion resistance.

D. NON-CLOG PUMPS

The pump volute, motor, and seal housing shall be high quality gray cast iron, ASTM A-48, minimum of Class 30. Outside of the volute shall be coated to prevent corrosion. The pump shall be protected from leakage at the point that the shaft passes through the pump casing by mechanical seals. Mechanical seals must meet the following requirements:

1. The seal shall be a double mechanical seal in a bronze or cast iron seal housing constructed in two sections with a registered fit.

2. The housing shall be recessed into the pump back head.

3. The seal shall be of double carbon and ceramic construction (or approved equal) with mating surfaces lapped to a flatness tolerance of one light band.

The minimum pump efficiency at design pumping rate shall be as follows:

Mine Eff. @ GPM	<50' TDH	Min. Eff. @ 50' to <100' TDH	Min. Eff. @ >100' TDH
<100	40%	30%	20%
100-500	60%	40%	30%
500-1000	65%	65%	60%
1000-5000	65%	65%	65%
>5000	70%	75%	75%

Should pump manufacturers not be able to meet or exceed the above table for a specific pumping condition, a submittal with complete verification data will be required prior to acceptance of a lesser efficient pumping unit.

Please refer to section C for additional motor specification information.

PART 4: CONTROLS

A. NON-CLOG PUMPS

The lift station control system shall comply with Specification 13392 attached to this specification. The Waco Water Utility shall approve any proposed deviations from these requirements in advance.

B. PRESSURE TRANSDUCER

The transducer shall be of the solid-state head-pressure sensing type, suitable for continuous submergence and operation and shall be installed in accordance with manufacturer's instructions. The sensor shall be mounted using a stainless steel cable system.

The transducer assembly shall be installed where directed by the engineer and connected with other system elements and placed in successful operation. It shall be provided with input power and output signal transient protection, associated control elements as specified herein and in accordance with manufacturer's instructions.

Provide an intrinsically safe barrier between the upper and lower assemblies (or ahead of the entire transducer in the case of the 157FSCD.) The barrier shall render the level sensing system suitable for use in Class 1, Division 1 Groups A, B, C and D, Class 2, Division 1, Groups E, F and G, and Class 3, Division 1 hazardous locations.

The transducer shall be a Dwyer Mercoid PBLT2 or PBLTX. The transducer shall be a 4-20 mADC, 2-wire, 15 to 40 VDC loop-powered type with its output signal directly proportional to the measured level excursion over a factory-calibrated range.

PART 5: GENERAL ELECTRICAL REQUIREMENTS

A. ELECTRICAL SPECIFICATION SUMMARY

Supplemental electrical specifications, as listed in Section 9, have been included with this lift station specification. In the event the specifications may contain conflicting information, the lift station specification shall supersede the other requirements.

The specification information for the general electrical components are listed in Section 9. This list includes items that may not be needed on all installations. The Waco Water Utility shall approve any proposed deviations from these requirements in advance.

B. CONDUITS AND CONNECTIONS

The contractor shall provide a junction box normally located directly adjacent to the wet well. The location of the junction box shall be approved prior to installation by either the Engineering Department construction inspector or the Waco Utility representative. The contractor shall install one conduit from the wet well to the junction box for each pump, sized to accommodate the power and control cable. A minimum of one additional conduit shall be sized and installed for the floats and the pressure transducer.

C. GENERATORS & TRANSFER SWITCHES

Lift stations shall include emergency generator power receptacles using Crouse Hinds AJ37 Base and Crouse Hines AR1042-S22 receptacle.

In the event an emergency generator is included with the lift station, Caterpillar, Kohler or Stewart Stevenson generators equipped with Caterpillar, Detroit, Cummins or John Deere engines. Please submit the proposed specifications to the Waco Water Utility for their review and approval.

PART 6: GENERAL REQUIREMENTS – SUBMITTALS, MANUALS & WARRANTY

A. SUBMITTALS

All submittals, shop drawings and design data, shall be complete, providing all the information necessary to document compliance with all specifications.

The contractor is responsible determine and verify that he has determined and verified all materials, field measurements, and field construction criteria related thereto, and that he has checked and coordinated the information contained within such submittals with the requirements of the work and of the contract documents.

A list of required submittals has been included in Part 5, section D.

1. Shop Drawings, Product Data, Samples

a. Shop Drawings

Shop Drawings, as specified in individual work Sections, shall comply with the City of Waco Standard Specifications for Construction.

b. Product Data

Product data as specified in individual Specification Sections, include, but are not necessarily limited to, standard prepared data for manufactured products (catalog data); manufacturer's product specification and installation instructions and any other information needed in sufficient detail to accurately reflect the proposed installation.

c. Submission Requirements

Each submittal shall clearly identify the associated specification section.

Number of submittals required:

Shop Drawings: Submit 4 hard copies (unless otherwise specified) and 1 pdf copy.

Product data: Submit 4 hard copies (unless otherwise specified) and 1 pdf copy.

B. MANUALS

Furnish City Representative with four (4) hard copies and 1 pdf draft copies, and six (6) hard copies and 1 pdf final instruction manuals, explaining the proper installation, operation, and maintenance requirements for each piece of equipment used.

1. Format - Provide each manual with a project name, station address, station phone number, volume number, number of volumes in the set, date and a complete

index for all volumes in the set. The index shall indicate the volume and section for each piece of equipment.

Manual shall be 8.5 X 11 inches. Drawings shall be 11" x 17", folded to 8.5 X 11. The manual shall be a maximum of 4" thick. If 8.5 X 11 or 11 X 17 is not practical, drawings may be inserted into an envelope into the appropriate section.

Materials in manuals shall be suitable for photographic reproduction. Where copies of identical material are included, clarity and quality of copies shall be equal to the original, square to the page. Faxed copies will not be accepted.

Manuals shall be customized to describe the equipment actually furnished. Manufacturer's pre-printed literature may be accepted provided underlining the specific model used has modified it.

Divide manuals into sections paralleling the equipment specifications.

The front of each section shall have a cover sheet indicating the contractor performing the installation, local suppliers name, address and phone number of each piece of equipment in the section.

In addition to drawings supplied in the equipment sections, provide an additional, legible copy of all vendor supplied drawings for each piece of equipment in a separate binder and included as a drawing volume in the O&M manual set.

2. Content - The O&M manuals shall contain complete information on all mechanical, electrical, and instrumentation equipment used including, but not limited, to the following.

a. Written description of the sequence of operation. Provide written instructions (with control diagrams and other information if necessary) on the normal operation of the complete system.

b. Detailed description of the function of each principal component in the system. Provide a written description of the individual components function in the overall operation outlined in number A above.

c. Test procedures and factory test results if required. Provide a copy of all factory tests performed and a copy of the test results, and performance curves, where applicable.

d. Bill of material detailing the model, rating and size of each specific component used in the installation. Provide a list of equipment used in the installation. List shall detail the tag name used in the installation, model number, ratings, serial numbers of all pumps, motors, electrical apparatus and instrumentation, and enough information to purchase a replacement.

e. Safety precautions. List personnel hazards and equipment or product safety precautions for all operating conditions.

f. Maintenance instructions and manufacturer's recommended preventative maintenance frequency. Include information that will give step-by-step instructions to isolate and determine the problem. Also include manufacturer's recommended routine maintenance and include recommended frequency.

g. Recommended calibration instructions and frequency. Instructions shall provide detailed description of the procedure to calibrate the unit.

h. Emergency shutdown and troubleshooting guide. Provide information to shutdown and startup the equipment under emergency situations.

i. List of all protective relays, breaker types, cable and fuse sizes and settings (where applicable).

Protective Relays	Provide information on the relay type used and time current curves.
Breakers	Provide catalog numbers and breaker trip curves.
Cables	Provide cable size, cable type and length of each cable installed.
Power Fuses	Provide fuse catalogue number, rating and fuse curve.

j. Documentation of field functional tests and performance test described in the specifications.
Include the test results and calibration reports of all equipment.

k. Renewal Parts Bulletin
Include parts lists pertinent to the components used in the installation.

l. Manufacturer's recommended spare parts.
Include lists of spare parts required for maintenance and items are subject to wear or breakage.

m. Calibration data sheet including set points.
Include all calibration data sheets, as outlined in Calibration and Testing Section.

n. Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.

o. Certified pump curves.

C. WARRANTY

The Contractor shall bear full responsibility for the proper installation of the wet well. Any deviation or exception from these specifications shall be clearly noted in writing with the bid submittal

The Contractor and Manufacturer shall guarantee that the station's structure shall be free from defects in design, materials and workmanship for one year from date of acceptance by the City of Waco.

D. SUBMITTALS

The concrete wet well may utilize either a cast in place or pre-cast design.

Cast in Place Wet Well - design drawing
Pre-cast Wet Well – design drawing
Fiberglass Wet Well – design drawing
Wet Well Coatings – interior and exterior
Wet Well Cover and Hatch
Wet Well Hardware
Valve Vault – design drawing
Valve Vault coatings
Pumps – materials of construction curves, rail system, brackets & materials, mounting bracket, associated hardware
Pressure Transducer
Electrical components
Junction boxes & Control panels

PART 7: REFERENCE SPECIFICATIONS

The following codes and standards will be complied with as applicable.

Code	Title
NFPA 70	National Electrical Code (NEC)
TNRCC 30	TAC Chapter 317

Standard	Title
• NEMA 250	Enclosures for Electrical Equipment (1,000 volts maximum)
• ANSI C80.1	Rigid Aluminum Conduit and Rigid Galvanized Steel Conduit
• ANSI C80.4	Fittings and Supports for Conduit and Cable Assemblies
• NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

- NEMA TC3: PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- NEMA RN1: PVC Coated Galvanized Rigid Steel Conduit.
- UL6: Rigid Metal Conduit
- UL7 514B Fittings for Conduits and Outlet Boxes
- UL 651: Schedule 40 and 80 Rigid PVC Conduit
- ANSI, AWWA C-500 (current), AWWA C-508 (current) valves.
- AWWAC – 115 and 151 piping and components
- AFBMA, AISI, ANSI, ASTM, Hydraulic Institute, IEEE, NEC, NEMA MG-1, NFPA, and UL standards pump and motors
- ANSI, ASTM, IEEE, NEC, NEMA, MG-1, NFPA, UL, AEIC, IEC, ISA and ISO9001/9003 PLC based RTU design, construction, and testing

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SECTION 4.14: PACKAGE LIFT STATION SPECIFICATIONS

PART 1: LIFT STATION CONTROL SYSTEM

A. OPERATION

The required number of Lift Station Control Panels shall be provided as shown on the drawings. Each panel shall come complete with the following:

- Enclosure
- Programmable Logic Controller (PLC)
- Text Display
- Surge Suppression
- Power Supply
- LED Pilot Lights
- Timers
- Radio Modem

The Lift Station Control Panel shall be capable of operating from both a level transmitter, with a 4-20mA input, as well as float level switches. The Lift Station Control Panel must be able to accommodate Lift Stations with up to 3 pumps, by the use of an operator entry from the Text Dipslay. It is intended that the PLC and radio be installed in the control panel. The contractor may provide a separate separate enclosure meeting the same specifications with the City's approval.

The system shall have a text display to be able to view the level, adjust all setpoints, and to view run hours on each pump. The PLC system will be used to alternate all pumps when they are controlled with the level transmitter. A primary/secondary switch, reset button, and lights shall be provided to notify and/or to manually switch and reset the system to a different mode (level transmitter control or float control). The system shall automatically switch to the secondary (float) mode upon a high level, level transmitter, or PLC failure. In addition, any one-float switch will not disable the system or prevent the pumps from operating under normal conditions. They system shall be capable, without further modification, of powering a rotary strobe light to notify personnel that a problem has occurred. The strobe light will only be installed at the direction of Waco Water. Dry contacts shall be provided to interface with an RTU, Autodialer, or similar system to notify operating personnel that an alarm has occurred. In addition, an LED pilot light shall be mounted on the interior door of the enclosure to indicate the status of each float.

A series of timers shall be used as a backup to the PLC system. In the event of the activation of the high level float switch for a predetermined period of time, each pump shall be started based on an individual timer. Every critical device in the system shall have a backup; the pressure transducer will be the primary control for the pumps, it will be backed up by the high (all on) and low (all off) floats; and the PLC shall be backed up by timers.

B. ENCLOSURE

Enclosure shall be Nema 4X SS with quarter turn latches. The enclosure must be able to accept a standard pad lock. The enclosure shall be UL Listed by the enclosure manufacturer.

An interior swing out door shall be provided for mounting text display and any other pilot devices, and to prevent unauthorized access to display. Interior door shall be manufactured from ¼" ABS Plastic. Metallic swing-out panels are not acceptable. Interior door shall use a quarter turn latching mechanism to secure swing-out panel to enclosure.

C. PROGRAMMBLE LOGIC CONTROLLER

Each panel shall be provided with an Allen-Bradley PLC based controller. The controller shall have two communication ports. One port must be able to be configured for Allen Bradley DFI slave as a minimum. The controller shall have an EEPROM for storage of program in the event of long-term power loss. All operator adjustable setpoints shall be saved to retentive Flash memory such that a battery backup is not necessary. All analog I/O shall be individually fused. The controller shall be capable of expansion through addition of I/O modules. The PLC system must be an open-architecture format. Proprietary controllers shall not be allowed.

D. DISPLAYS

Each panel shall be provided with a two line Text Display to show status of all information. The Display shall also be used to send and verify receipt of test signals to a master RTU site. The Display shall be an LCD with an LED backlight and flash memory. The Display shall meet the rating of the area in which it shall be installed. The display shall have a minimum of 5 user defined pushbuttons, and allow up to 256 messages. The Text Display shall be used to show status of all information and to allow all setpoint changes. All setpoints must be password protected.

Setpoints must be provided for the following (as applicable):

- Pump OFF
- Lead Pump ON
- Lag 1 Pump ON
- Lag 2 Pump ON
- Lag 3 Pump ON
- Lag 4 Pump ON
- High Alarm
- # of Pumps
- Delay Timer for each Lag Pump
- Scaling:
    - Low Range Value
    - High Range Value

  - Offset
  - Specific Gravity
- Calibration
  - Low Range Calibration Value
  - High Range Calibration Value

The following information shall be displayed:

- Actual Level
- Run Times for each pump
- Which pump(s) is being called to Run

E. SURGE SUPPRESSION

Each panel shall be provided with a 120VAC surge suppression on the incoming mains. The surge suppression shall be rated for 45KAIC and include an LED for power indication. The surge suppression shall also provide active noise filtering. The surge suppressor shall be series connected, and shall be rated UL 1283.

F. POWER SUPPLY

Each panel shall be provided with a 24VDC Power Supply, rated 2.5 amps minimum. Power supply shall be din rail mounted. Power supply shall have an LED indicating power is on.

G. RELAYS

All internal control relays shall have contacts rated at 10 Amps. Only square or octal style bases shall be used. All relays shall have a minimum of DPDT contacts, and shall be provided with an LED or mechanical indicator.

H. TIMERS

All internal timers shall have contacts rated a minimum of 10 Amps. All times shall be octal style with LED's to indicate status of timer. Timers shall be adjustable for 0.1 secs to 10 hours. Timers shall have a minimum of DPDT contacts.

I. PILOT DEVICES

All pilot lights shall be an LED light, minimum of 30.5mm, Nema 4X rated housing, and shall be push-to-test. All bulbs shall be replaceable.

All pushbutton and switches shall be rated Nema 4X, 10 Amp contacts, and a minimum size of 30.5mm. All contacts shall have a Nema A600 rating.

The following devices shall be provided:

- Red Light for up to seven Floats
- Green Light for Primary Mode
- Amber Light for Secondary Mode
- Red Light for Master Control Failure

- Primary-Secondary Mode Selector Switch
- System Reset Button

J. TERMINAL BLOCKS

All internal terminal blocks shall be rated a minimum of 600VAC, 30 Amps. Terminal blocks shall be suitable for #10 awg wiring. All terminal blocks shall be of finger safe construction. All field wiring shall be terminated on terminal blocks. Wiring directly to relays, PLC's, or other devices is not permitted.

K. RADIO MODEM

The radio modem will be Microwave Data Systems (MDS) manufacturer and model TransNet 900. The radio will have full internal diagnostic capability from both the local and master radio locations.

L. MANUALS

Each panel shall come complete with an Operations Manual. The Operations Manual shall consist of the following: Overview of System, Control Narrative, Troubleshooting Guide, Recommend Spare Parts, and As-Built Drawings.

M. QUALITY & MANUFACTURER

The Manufacturer shall be regularly engaged in the fabrication of control panels and RTU systems. The manufacturer must show proof of UL508A certification for a minimum of 5 years, with a volume level of over 150 control panels per year. The manufacturer shall have at least three qualified persons on staff that are able to provide panel startup assistance, as well as a minimum of two qualified persons that can assist in setting up and troubleshooting the radio system.

Each Lift Station Control Panel shall be as manufactured by Control Panels USA Inc., Part Number LSC2000

PACKAGE LIFT STATION SPECIFICATION ADDENDUM

Specified Items Summary

Part No.	Item	Description	Catalog # / Manufacturer
1	RTU/PLC		Allen Bradley Micro Logix 1200
2	Above Ground Conduit	Rigid Aluminum, Copper free	EASCO
3	Conduit Seal Off	Copper free aluminum with removable aluminum plug sealed with flame retardant material	Crouse-Hinds Type EYD
4	Conduit Hubs	Aluminum hubs	Meyers type STA and STAG
5	Condulets	Copper free aluminum	Crouse-Hinds Mark 9 SA
6	Conduit Unions	Copper free aluminum	Crouse-Hinds type EYD
7	Condulet Expansion Unions	1005 Copper free aluminum	Crouse-Hinds type UNYLOR XJG
8	Conduit Tags	1" X 3" stainless steel	
9	Condulet Covers	Screw on sheet aluminum, gasketed	Crouse-Hinds Mark 9
10	Underground conduit	Concrete encased PVC ACH 80	Carlon
11	Liquid Tight Flexible Conduit	Non-Metallic	Thomas & Bettis type LT-38P series Electri-flex NM type B-PVC
12	Conduit and Equipment Supports	Stainless Steel	Unistrut P-1000SS B-Line
13	Flex Conduit Fittings	Non-metallic	Thomas & Bettis type LT 38P series
14	Junction Boxes	Less then 3 cubic feet	Hoffman concept series
15	Receptacle & Light Switch Boxes	Copper free, aluminum	Crouse-Hinds type FS & FD
16	Receptacle/Light Switch Coverplates	Gasketed with spring type lids	Crouse Hinds Type WLRD -1
17	Light Switches	Specification grade 120/277 rated	Hubbell 1221 series
18	Receptacles	20 amp rated polarized grounding type	Hubbell 5362
19	Surge Protection	120/240 Panel	Innovative Technology Model P-1S 120/240+

20	Surge Protection	480 Volt Wye	Innovative Technology Model P-3Y 277/480+
21	Surge Protection	480 Volt Delta	Innovative Technology Model P-480NN
22	Surge Protection	Phone Connection	Innovative Technology ITC-RJ11-95
23	Disconnect	Load break, pad lockable, NEMA 4X, stainless steel fused	Cutler Hammer, DH364 FWK (200A)
24	Ground Rods	3/4" x 10", copper clad steel	
24b	Ground Well	Cast Iron or PVC Sch. 40 not smaller than 8" round.	Advanced Lighting Technology, Inc. Ground Test well
25	Auxiliary Power Transformer	115 degree Celsius rise above 40 Celsius ambient	Westinghouse type EP
26	Automatic Transfer Switch	NEMA 1 automatic exerciser	ASCO model 940
27	Annunciator	LED type	Rochester Instruments Microalarm model AN-3196B LED
28	Manual Transfer Switch	Double throw lockable in all positions, load break	Cutler Hammer DT 364 UWK
29	Exterior Light	175 watt HPS 120 volt with photo cell	Hubble Night Watchman
30	Enclosure	NEMA 12 3 point latch	Hoffman
31	Panel Wiring	type SIS	Rome
32	Panel Light	120 volt fluorescent with quard	Hoffman, A-LF 16M48
33	Control Relays		Cutler Hammer type MR120L
34	Timing relays	ON Delay or OFF Delay settable from .05 seconds to 999 minutes, 10 amp contacts	Square D Class 9050 type JCK 70, JCK 60
35	Pilot Lights	Push to test LED type	Square D SKT 38L Westinghouse PB1GXLED
36	Switches		Cutler Hammer type VB

37	Pushbuttons	Fully guarded NEMA 4	Cutler Hammer type E22P1
38	Alternator	2 pump	Struthers Dunn A311XBXPR
39	Alternator	3 & 4 pump	ARM-120-AJE or ISO-120-ACE
40	Elapse Time Meters		G.E. type 236
41	Voltmeter	3 1/2" direct reading 600 volt rated	Yokagawa type SJ
42	Voltmeter Switch		
43	Terminal Blocks	600 Volt Rated	Westinghouse type TBA
44	Motor Moisture Sensor		
45	Motor Temperature Sensor		
46	Distribution Panel		Square D type QOB
47	Motor Starter and Overloads		Cutler Hammer Advantage with solid state overloads with metering module
48	Motor Circuit Protector		Westinghouse HMCP
49	Power Monitors	Adjustable from 380-480 VAC and adjustable time from 10-20 seconds	Time Mark model D2644
50	Splice Taps	Rated for required service	Square D Type LB
51	Ground Bus		
52	Fuse Blocks	Rated for voltage class needed	Square D Type FB
53	Floats	Float must reach 85% tilt to activate	Square D Class 9036 type LG-Sumptrol
54	Power Wire	XHHW, THW, THWN	Okonite, Rome, Cablec, Essex
55	Shielded Instrument Wire (4-20 mA)	600 volt rated 35 mil PVC jacket	Alpha, Belden, Dekoron
56	Submersible Level Transducer		Dwyer Mercoid PBLT2 or PBLTX
57	Panel Meter	4 1/2 Digit	Precision Digital, PD690
58	UPS	400 VA with failure contact	APC SU700 with alarm contact module
59	Generator		Please refer to specification noted above.

SECTION 5
CONCRETE

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SECTION 5.1: CONCRETE AND REINFORCEMENT

PART 1: GENERAL

A. DESCRIPTION

This section shall govern for the concrete used on all City of Waco work.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

1. Aggregates for Portland Cement Concrete

a. General Requirements

(1) General - Aggregates for portland cement concrete shall conform to the requirements contained below and shall be approved by the Owner prior to use. Aggregates shall be of such character that it shall be possible to produce workable concrete within the limits contained in this Specification.

(2) Tests - Test of aggregates shall be made in accordance with the applicable current ASTM standards. The tests used for aggregates are listed below:

ASTM DESIGNATIONS	
C 29	Unit Weight and Voids in Aggregates
C 33	Concrete Aggregates
C 40	Organic Impurities in Fine Aggregates for Concrete
C 88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 123	Lightweight Particles in Aggregate
C 125	Concrete and Concrete Aggregates, Definition of Terms Relating to
C 127	Specific Gravity and Absorption of Coarse Aggregate
C 128	Specific Gravity and Absorption of Fine Aggregate
C 131	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136	Sieve Analysis of Fine and Coarse Aggregates
C 142	Clay Lumps and Friable Particles in Aggregates
C 330	Lightweight Aggregates for Structural Concrete

C 535	Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 641	Staining Materials in Lightweight Concrete Aggregates
D 8	Materials for Road and Pavements, Definition of Terms Relating to
D 75	Sampling Aggregates
D 422	Particle-Size Analysis of Soils
D 4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils

b. Fine Aggregates

(1) General - Fine aggregate shall consist of natural sand, manufactured sand or a combination of the two, with or without mineral filler. The sand, or mixture of sand, comprising a single fine aggregate, shall consist of clean, hard, durable, uncoated grains and shall be essentially free from clay lumps.

(2) Deleterious Substances - The maximum permissible percentage, by weight, of deleterious substances shall not exceed the following:

Material removed by decantation	3.0%
Other deleterious substances such as coal, shale, coated grains and soft flaky particles	3.0%

An additional loss of two percent by decantation may be allowed, provided this new additional loss is material of the same quality as specified for fine aggregate or mineral filler. The fine aggregate shall be free from an excess amount of salt or alkali, and at the time of use shall be free from frozen and/or all foreign material.

(3) Tests - When tested for organic impurities, the fine aggregate shall not have a color darker than the standard color. This test shall be made in accordance with ASTM Designation C 40.

(4) Gradation - The fine aggregate shall be well graded from fine to coarse and when tested by standard laboratory sieves shall meet the following requirements:

Passing ⅜ in. sieve	100%
Passing No. 4 sieve	95 to 100%
Passing No. 8 sieve	80 to 100%
Passing No. 16 sieve	50 to 85%

Passing No. 30 sieve	25 to 65%
Passing No. 50 sieve	10 to 30%
Passing No. 100 sieve	0 to 10%
Passing No. 200 sieve	0 to 3%

The fine aggregates shall have a fineness modulus as shown in *Item A.1.b.(6), Additional Requirement, of Section 5.1 Part 2* and shall also meet the requirements of *Item A.1.b.(1), General, of Section 5.1 Part 2.*

(5) Mineral Filler - Stone dust or crushed sand may be added as a mineral filler, if so directed by the Owner. Amounts of mineral filler shall not exceed five percent of the fine aggregate to improve the workability or quality specified for fine or coarse aggregates and when tested by standard laboratory sieves shall meet the following requirements:

Passing No. 30 sieve	95 to 100%
Passing No. 100 sieve	70 to 100%

(6) Additional Requirements - For Class A, C, E and F concrete the fineness modulus as defined below for fine aggregates shall be between 2.30 and 3.10.

For Class H concrete, the fineness modulus of the fine aggregates shall be between 2.40 and 2.90.

For Class A, C, E, F and H concrete, when the fineness modulus of fine aggregate varies by more than two-tenths from the fineness modulus being used in the current design, the batch shall be redesigned before placing more concrete.

The fineness modulus of fine aggregates shall be determined by adding the sum of accumulative percentages by weight retained on the following sieves, and dividing by 100: Nos. 4, 8, 16, 30, 50 and 100.

(7) Rejection - Fine aggregates which fail to meet the requirements of these specifications may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Fine aggregates sources, from which materials with properties not meeting these specifications are delivered, may be rejected as further supply sources to the project by the Owner. Such rejection shall incur no cost to the Owner.

c. Coarse Aggregates

(1) General - Coarse aggregates shall consist of crushed stone, gravel, crushed gravel or a combination of these. Gravel and crushed gravel shall consist of clean, hard, durable particles, free from adherent coating, thin or elongated pieces, soft or disintegrated particles, dirt, organic or deleterious substances. Crushed stone shall consist of the clean, dust free product resulting from crushing of stone. There shall be no adherent coatings, clay, loam, organic or deleterious substances.

(2) Deleterious Substances - The maximum amount of deleterious substances shall not exceed the following percentage by weight:

Material removed by decantation	1.0%
Shale, slate or other similar material	1.0%
Clay lumps	0.25%
Soft fragments	3.0%
Other deleterious substances, including friable, thin, elongated or laminated pieces	3.0%
The sum of all deleterious substances, exclusive of material removed by decantation, shall not exceed by weight	5.0%

Aggregates shall be free from an excess amount of salt, alkali, vegetable matter or other objectionable matter. At the time of their use, aggregates shall be free from frozen and/or all foreign material, which may have become mixed with them in the stockpile.

(3) Tests - Coarse aggregates shall have a percent wear of not more than 45 when tested by abrasion and impact in the Los Angeles Machine, ASTM Designations C 131 and C 535.

(4) Gradation - Coarse aggregates shall be well graded in size from coarse to fine. When tested by standard laboratory methods, coarse aggregates shall meet the requirements in *Table 1, Coarse Aggregate Grading*, for percentage passing each sieve by weight.

Coarse aggregates of different characteristics, though tested and approved, shall not be mixed with other aggregates; but shall be stored, batched and weighed separately.

(5) Maximum Aggregate Size - The maximum size of aggregates for structural concrete shall not exceed three inches, and shall be reduced in size to meet the following conditions:

(a) one-sixth of the least dimension between forms of that part of the structure in which concrete is to be placed; and

(b) three-fourths of the clear space between reinforcement.

The maximum size aggregate is defined as the clear space between the sides of the smallest square openings through which 95 percent of the weight of the aggregate can be passed.

(6) Rejection - Coarse aggregates which fail to meet the requirements of these specifications may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Coarse aggregate sources, from which materials with properties not meeting these specifications are delivered, may be rejected as a further supply sources to the project by the Owner. Such rejection shall incur no cost to the Owner.

Table 1
Coarse Aggregate Grading (Percent Passing)

Grade	Nom. Size	2-1/2"	2"	1 ½	1"	3/4"	1/2"	3/8"	No. 4	No. 8
2	1 1/2"'		100	95-100		40-70		10-30	0-5	
3	1"		100	95-100		60-90	25-60		0-5	
4	3/8"						100	70-95	0-25	

2. Cement

a. General - Cement shall be either Type I or Type III of a standard brand of portland cement which shall conform to the requirements of the current Standards for Portland Cement, ASTM Designation C 150, or other applicable test methods of the ASTM.

Classes of concrete shall be in accordance with this section of the specifications, unless otherwise shown on the plans or detailed specifications.

The testing does not in any way change the penalties imposed on the Contractor for deficient strength outlined elsewhere in these specifications.

b. Volume and Weight of Bag of Cement - A bag of cement as packed by the manufacturer and weighing 94 pounds shall be considered one cubic foot.

c. Rejection - Cement may be rejected for failure to meet any of the requirements of this specification; and shall be rejected under the following specific conditions:

(1) Bulk cement which has partially set or which contains any lumps or cakes.

3. Chemical Admixtures

a. General - Unless otherwise provided in the plans or special provisions, approved types of chemical admixtures to minimize segregation, to improve workability or to reduce the amount of mixing water may be used in the rate of dosage specified by the Owner and in accordance with the manufacturer's recommendations. Tests submitted with the mix design must be performed after the addition of admixtures to the mix.

Admixtures shall be dispensed in a form by an accurate mechanical dispenser designed for convenient confirmation of the accuracy of measurement. Dispensers shall have sufficient capacity to measure at one time the full quantity required for each batch. Two or more admixtures of different types, such as a water-reducing and air-entraining admixture, may not be compatible when mixed together. Where different admixtures are used, they should be added to the batch separately unless it is known that they can be mixed together satisfactorily. Dosage of admixtures

shall not vary from the dosage order by the Owner by more than five percent. In addition:

(1) Chemical admixtures shall conform to Types A, D, F and G dosages in accordance with manufacturer's recommendations as specified by the Owner.

Water-reducing admixtures conforming to Chemical Admixtures for Concrete, ASTM Designation C 494, Types A and F, shall be used to improve quality of concrete by obtaining specified strength at lower cement content and to increase slump without increasing water-cement ratio; and may also be utilized in improving properties of concrete containing aggregates that are harsh or poorly graded.

Water-reducing, set retarding admixtures, conforming to ASTM Designation C 494, Types D and G, may be used during hot weather concrete placement, so as to keep concrete workable during the entire placing period, in order that succeeding placements may be made without development of cold joints or discontinuities in the structural unit.

(2) Owner's option: High range water-reducing admixtures, super-plasticizer conforming to ASTM Designation C 494, Types F and G, may be used to greatly reduce water content to obtain dense concrete with higher early strengths and maintain high slump or flowing concrete while maintaining low water-cement ratio for concrete that must be placed under difficult conditions such as pump or tremie methods, etc.

(3) Air-entraining admixtures shall conform to Air-Entraining Admixtures for Concrete, ASTM Designation C 260.

Dosage shall conform to recommendations of manufacturer, as specified by Owner, and determined by field-testing of concrete mixture by qualified testing personnel.

The Contractor shall secure the approval of the Owner for the particular admixture, which he proposes to incorporate into the concrete prior to actual use of the admixture. The Contractor shall furnish such information and evidence that the Owner may require in his determination of the acceptability of the proposed admixture. When the Contractor proposes to use an air-entraining admixture, which has been previously approved by the Owner, he shall submit a certification stating that the admixture is the same as that previously approved.

Any other admixtures for whatever purpose shall have the approval of the Owner prior to incorporation into the concrete mix.

b. Fly ash - An admixture conforming to the physical and chemical requirements of Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete, ASTM Designation C 618, with the exception that the LOI shall be a maximum of three percent, may be used in all classes of concrete with the approval of the Owner. The fly ash must be sampled and tested according to the frequency and methods of Fly Ash or Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete ASTM Designation C 311, for tons produced at the source. Such source shall be subjected to the approval of the Owner. Laboratory analysis shall be submitted for verification of compliance to ASTM standards and frequency of sampling and testing when requested by the Owner.

The amount of fly ash to be used per cubic yard of each class of concrete shall be established by laboratory data for each source and type of fly ash. When fly ash is used in concrete mix design, the water-cement ratio shall be based on total cementer's material. Proposed concrete mix design, with laboratory data and confirming cylinder strength, shall be submitted to the Owner for approval. The design and strength data shall be resubmitted for approval annually or when there is a change in materials or when requested by the Owner.

Alternate brands and types of fly ash may not be substituted in approved concrete mix designs.

4. Mineral Filler - Mineral filler shall consist of stone dust, crushed sand or other inert material approved by the Owner: and may be added in amounts not to exceed 10 percent of the weight of the sand or mixture of sands, to improve the workability or plasticity of the concrete mix. Such mineral filler must be of the quality specified for fine or coarse aggregate; and when tested by laboratory methods shall meet the following requirements for percentage by weight:

Retained on No. 30 sieve	0%
Retained on No. 200 sieve	0% to 35%

Where a mineral filler is used, it shall be measured by volume or weighed and batched separately.

5. Water

a. General - Water for use in concrete shall be reasonably clean and free of oil, acid, alkali, organic matter or other deleterious substances. Water, which is suitable for drinking or ordinary household uses, may be accepted for use without being tested.

b. Source - Water shall be obtained preferably from a domestic water supply. Where other source of supply is proposed, the approval of the Owner must be obtained prior to using the water.

c. Measuring Devices - The device for measuring the quantity of water shall indicate the quantity in gallons and fractions thereof. The operating mechanism shall regulate the quantity required for any given batch within one percent. The supply inlet shall be cut off automatically when the water is discharged into the mixer.

Upon approval of the Owner, the water for any one batch in the mixer may be measured in approved cans, buckets or other containers; and no more than the required amount of water shall be introduced into the mixer. The measuring devices shall be checked at the beginning of each job.

d. Tests - If the water is of questionable quality, it shall be tested in accordance with the current standard Method of Test of Quality of Water to be used in concrete, AASHTO Designation T26. Contractor will be responsible for cost of testing.

e. Rejection - Water for use with cement may be rejected for failure to meet any of the requirements of this specification.

6. Dowel Bars

a. General - Dowel bars shall be straight and smooth as shown on the plans and standard details and shall conform to the requirements of *Item A.7, Steel Reinforcement, of Section 5.1 Part 2.* The dowel bars shall be coated with asphalt paper, a PVC sleeve, or oil to the extent shown on the plans. See plans for designated coating. Bars shall be minimum grade 40 and domestically produced. Dowel bars shall also be secured to the proper line and grade as shown on the plans and standard details.

b. Dowel Caps - Caps for slip dowel bars shall be of the length shown on the plans; and shall have an internal diameter sufficient to permit the cap to freely slip over the bar. In no case shall the internal diameter exceed the bar diameter by more than 1/8 inch, and one end of the cap shall be tightly closed. The cap shall be installed to allow the bar to move not less than 1¼ inches in either direction.

7. Steel Reinforcement

a. General - Concrete reinforcement is the metal (rods or fabric) imbedded in concrete in such a manner that the reinforcement and concrete act together in resisting forces.

b. Material - Unless otherwise specified or designated on the plans, the metal for all bar reinforcement shall be one of the following:

(1) New billet steel - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, ASTM Designation A 615 (A 615M which is the metric standard), Grades 40 or 60.

(2) Axle steel - Axle-Steel Deformed and Plain Bars for Concrete Reinforcement, ASTM Designation A 617, Grade 40 or 60.

Axle steel shall not be permitted on structures and the use of axle steel shall not be permitted under the following conditions:

(a) where bending of the bar is required; or
(b) for use in railroad underpass structures.

Unless otherwise designated on the plans, all reinforcement steel bars shall be deformed in accordance with the requirements of ASTM Designations A 615, A 616 and A 617, Grade 60. Twisted bars are not considered deformed and shall not be used. The deformed bars shall provide a net sectional area at all points equivalent to that of plain square or round bars of equal nominal size.

Bars of spiral reinforcement shall be plain bars rolled from billets directly reduced from ingots and shall conform to the requirements of ASTM Designation A 615.

All reinforcement shall be domestically produced.

c. Sizes and Weights - The size and weight of reinforcing bars shall conform to the requirements of ASTM Designation A 615.

d. Bending - Reinforcement bars shall be bent cold to the shapes indicated on the plans. All bending of hard grade new billet steel shall be done in the shop. Bends shall be true to the shapes indicated; and irregularities shall be cause for rejection. Unless

otherwise shown on the plans, bends for stirrups and ties shall be made around a pin having a diameter of less than two times the minimum thickness of the bar. Other bends shall be made according to the latest code of Standard Practice of the Reinforcing Steel Institute.

e. Splicing - Splicing of bars will be in conformance with the requirements of the latest edition of ACI Manual 318. Welding of reinforcing steel is not permitted without the written approval of the Engineer. When permitted, the welding must be in compliance with the requirements of AWS-D12.1.

f. Storage - Reinforcement shall be stored above the ground surface upon skids, platforms or other supports; and shall be protected from mechanical injury and surface deterioration caused by exposure to the conditions producing rust. When placed in the work, the reinforcement shall be free from dirt, loose rust, scale, painting, oil or other foreign materials.

g. Rejection - Reinforcement may be rejected for failure to meet all of the requirements of this specification; and specifically for the following:

(i) Reinforcement exceeding the allowable variations;

(ii) Reinforcement not bent in accordance with the details;

(iii) Reinforcement with a coating of dirt, loose scale, paint, oil or other foreign substances which shall prevent bonding of the concrete and reinforcement; or

(iv) Twisted bars.

8. Steel Wire Reinforcement

a. General - The use of welded wire fabric may be used as shown on the plans or as approved.

Welded wire fabric shall be delivered to the job site in sheets. Rolls of wire fabric shall not be permitted.

The size of welded wire fabric shall be as shown on the plans.

b. Material - Wire for fabric reinforcement shall be cold-drawn from rods hot-rolled from billets and shall conform to the requirements of Cold-Drawn Steel Wire for Concrete Reinforcement, ASTM Designation A 82. Welded wire fabric shall conform to the requirements of Welded Steel Wire Fabric for Concrete Reinforcement, ASTM Designation A 185.

c. Sizes and Weights - The properties of wire fabric shall conform to the requirements of the herein stated ASTM Designations.

d. Storage - Reinforcement shall be stored above the ground surface upon skids, platforms or other supports; and shall be protected from mechanical injury and surface deterioration caused by exposure to the conditions producing rust. When placed in the work, the reinforcement shall be free from dirt, loose rust, scale, paint, oil or other foreign materials.

e. Rejection - Reinforcement may be rejected for failure to meet any of the requirements of this specification; and specifically for the following:

(i) Reinforcement exceeding the allowable variations;

(ii) Reinforcement not bent in accordance with the details;

(iii) Reinforcement with a coating of dirt, loose scale, paint, oil or other foreign substances which shall prevent bonding of the concrete and reinforcement; or

(iv) Twisted bars.

9. Joint Filler

a. General - Joint filler is the material placed in concrete pavement and concrete structures to allow for the expansion and contraction of the concrete.

b. Material - Expansion joint materials shall consist of boards, preformed fiber materials, or rebonded neoprene filler.

(1) Boards for expansion joint filler shall be of the required size, shape and type indicated on the plans or required in the specifications. Boards shall be selected stock of redwood or approved equal The boards shall be sound heartwood and shall be free from sapwood, knots, clustered birdseyes, checks and splits. Occasional sound or hollow birdseyes, when not in clusters, shall be permitted, provided the board is free from any other defects that shall impair its usefulness as a joint filler. With the exception of redwood and cypress, all boards shall have a creosote or pentachloropenal treatment of not less than six pounds per cubic foot. When oven dried at 230° Fahrenheit to a constant weight, the weight of the board per cubic foot (minus creosote) shall not be less than 20 pounds, nor more than 35 pounds.

(2) Preformed fiber materials for expansion joint filler shall be of the required size, shape and type as shown on the plans or required in the specifications. Materials shall be as follows:

(a) Preformed Bituminous Fiber Material - Preformed bituminous fiber materials shall meet the requirements of ASTM D 1751.

(b) Rebonded Neoprene Filler - Rebonded neoprene filler shall consist of ground closed-cell neoprene particles, rebonded and moulded into sheets of uniform thickness of the dimensions shown on the standard details, meeting the requirements of ASTM D 1752, Type 1. Certification that the material meets those requirements shall be furnished to the Engineer.

c. Dimensions - The thickness of the expansion joint filler shall be shown on the standard details; the width shall be not less than that shown on the standard details, providing for the top seal space.

d. Rejection - Expansion joint filler may be rejected for failure to meet any of the requirements to this specification.

10. Joint Sealing

a. Description - This Subsection shall govern the material requirements for joint sealants, backing materials and joint fillers.

b. Materials - The materials for this item shall conform to the following:

(1) Joint Sealant Materials – A Low Modulus Horizontal Sealant, with self leveling, or an approved equal.

The size shown on the plans shall be the nominal width of the sealant. The uncompressed depth of the seal shall be equal to or greater than the width.

All preformed joint sealants installed by the Contractor shall have been prequalified for compliance with the requirements. Each size and configuration of seal produced by a manufacturer must be approved by the Engineer prior to use on Department projects. For a sealant manufacturer to prequalify and obtain approval of a sealant, detailed dimensions and configuration of each size of sealant and certified test results indicating compliance with Departmental Material Specification D-9-6310 and any requirements shown on the plans and specifications shall be submitted to the Engineer.

Submission shall be done sufficiently in advance of work to allow for testing and evaluation of the material.

The Engineer will confirm by visual inspection that the sealant proposed for installation is the same size, configuration and manufacture as shown on plans. The Engineer will examine the sealant for any undue distortions, such as dissymmetry, warping, thick webs or uneven width, which are likely to impair the performance of the joint. If the magnitude of the distortions is sufficient to create doubt as to the performance of the sealant, the Engineer may direct that the sealant be replaced or that samples representing the worst of the lot be subjected to further testing to verify their performance.

(2) Backer Rods and Backing Materials - These materials shall be capable of holding the fluid sealant in open joints in place. In all cases, these materials shall be of such a type that will not bond to the sealant. The backing materials shall meet the requirements of the sealant manufacturer. They shall be compressible type materials, such as closed-cell, resilient foam or sponge rubber stock of vinyl, butyl or neoprene, or expanded polyethylene or polyurethane.

The diameter of the backer rod shall be at least 25 percent larger than the joint reservoir width.

11. Curing Materials

a. General - This specification shall govern the materials to be used in the curing of concrete. The materials when applied as elsewhere specified shall retain the moisture, present in the concrete at the time of application of curing material, within specified limits for the curing period.

b. Material - Materials for the curing of concrete shall conform to the following requirements:

(1) Membrane-Forming Compounds - The membrane curing compound shall conform to the requirements of Liquid Membrane-Forming Compounds for Curing Concrete, ASTM Designation C 309 for Type 1-D, clear or translucent with fugitive dye or Type 2, white pigmented compound, unless otherwise specified or indicated. It shall be of such nature that it shall not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete.

The compound shall produce a firm, continuous uniform moisture-impermeable film free from pinholes and shall adhere satisfactorily to the surfaces of damp concrete. It shall, when applied to the damp concrete surface at the specified rate of coverage, dry to touch in one hour and dry through in not more than four hours under normal conditions suitable for concrete operations. It shall adhere in a tenacious film

without running off or appreciably sagging. It shall not disintegrate, check, peel or crack during the required curing period.

The compound shall not peel or pick up under traffic and shall disappear from the surface of the concrete by gradual disintegration.

The compound shall be delivered to the job site in the manufacturer's original containers only, which shall be clearly labeled with the manufacturer's name, the trade name of the material and a batch number or symbol with which test samples may be correlated.

When tested in accordance with Water Retention by Concrete Curing Materials, ASTM Designation C 156, the liquid membrane-forming compound shall restrict the loss of water present in the test specimen at the time of application of the curing compound to not more than 0.55 grams per square centimeter of surface.

(2) Polyethylene Film - Polyethylene film shall be opaque pigmented white in color and shall be manufactured from virgin resin without additives or scrap. The film shall have a minimum thickness of 4 mils (0.004 inch). The permissible moisture loss from the concrete, when tested in accordance with ASTM Designation C 156, shall not exceed 0.055 grams per square centimeter of surface. The film shall be sufficiently strong and tough to permit its use under the conditions existing on paving or structural projects without being torn or otherwise rendered unfit for the use intended during the curing period. It shall be of uniform thickness throughout, free of pinholes and other blemishes.

12. Waterstops - Waterstops shall be of the type and kind designated on the plans.Care shall be taken that the waterstop is properly located and held in position during placement of concrete. For particular material, the following shall apply:

a. PVC Material - Splices of waterstop shall be performed by fusing the material, using a heat device thermostatically controlled in accordance with the manufacturer's recommendations.

b. Copper Material - Any copper sheets which are damaged under construction operations shall be repaired or replaced. Splices shall be made by lapping and soldering; or other approved methods.

B. MATERIAL TESTING

Refer to *Section 5.10, Materials Testing.*

C. EQUIPMENT

1. General - All machinery and equipment necessary for the construction of this item shall be on the project and shall be approved by the Owner as to condition before the Contractor shall be permitted to begin construction operations on which the equipment is to be used. All machinery and equipment shall be maintained in good condition to insure the completion of the work without excessive delays for repairs and replacements.

2. Field Laboratory - A field laboratory structure shall be required only when specifically required and provided for in the special provisions.

3. Planer and Templates - A subgrade planer shall be furnished and shall be operated immediately ahead of the paving operations. The planer shall be equipped with adjustable blades, which shall trim the subgrade to the exact section as shown on the plans. The planer shall be supported on wheels that travel on the side forms and shall be so constructed that the wheels are plainly visible during operations and must be heavy enough to remain on the forms at all times. The frame shall be of such strength and rigidity that should the support of the planer be transferred from the wheels to the center, there shall not be a deflection of more than ⅛".

A template shall be provided having adjustable rods projecting downward at one-foot intervals. The bottom of these rods shall be adjusted to the true cross section of the bottom of the slab when the template rests upon the side forms. The template shall be of sufficient strength and rigidity that the deflection at the center shall be no greater than ⅛" should the support be transferred to that point.

Automatic subgrade trimmer may be used, if approved by Owner, in lieu of above equipment.

4. Forms - The side forms shall be metal, of approved cross section and bracing, of a height not less than the prescribed edge thickness of the concrete section, and a minimum of 10 feet in length for each individual form. Forms shall be of ample strength and shall be provided with adequate devices for secure setting so that when in place they shall withstand the impact and vibration of equipment imposed thereupon without appreciable springing or settlement. In no case shall the base width be less than eight inches for a form eight inches or more in height. The forms shall be free from warps, bends or kinks and shall show no variation from the true plane for face or top. Each 10-form length of forms shall be provided with at least three pins for securely staking in position. Sufficient forms shall be provided for satisfactory prosecution of the work. Ten-foot metal form sections shall be used in forming curves with a 250-foot, and larger, radius. For curves with a radius of less than 250 feet, acceptable flexible metal forms or wood forms may be used upon approval by the Owner. Wood forms may be used upon approval of the Engineer.

5. Mechanical Vibratory Equipment - All concrete placed for pavement shall be consolidated by approved mechanical vibrators operated ahead of the transverse finishing machine and designed to vibrate the concrete internally and/or from the surface. Unless otherwise shown on the plans, vibrators of the surface-pan type shall be used for full-depth placement. Both type vibrators shall be furnished and may be used concurrently at the discretion of the Owner. Vibratory members shall extend across the pavement practically to, but shall not come in contact with the side forms. Mechanically operated vibrators shall be mounted in such manner as not to interfere with the transverse or longitudinal joints.

The internal-type vibrators shall be spaced at not more than 24 inches and shall be equipped with synchronized vibratory units. Separate vibratory units shall be spaced at sufficiently close intervals to provide uniform vibration and consolidation to the entire width of the pavement. The frequency in air of the internal spud-type vibratory units shall be not less than 8,000 cycles per minute and not less than 5,000 cycles per minute for tube

types. The method of operation shall be as directed by the Owner. The Contractor shall have a satisfactory tachometer available for checking the vibratory elements.

The pavement vibrators shall not be used to level or spread the concrete but shall be used only for purposes of consolidation. The vibrators shall not be operated where the surface of the concrete, as spread, is below the elevation of the finished surface of the pavement, except for the first lift of concrete where the double strike-off method of placement is employed. The vibrators shall not be operated for more than 15 seconds while the machine upon which they are installed is still.

The pan-type vibratory units shall apply the vibrating impulses directly to the surface of the concrete. The operating frequency shall not be less than 3,500 cycles, nor more than 4,200 cycles per minute in air. The Contractor shall have a satisfactory tachometer available for checking the speed of the vibratory elements.

Approved hand manipulated mechanical vibrators shall be furnished in the number required for provision of proper consolidation of the concrete along the forms, at joints and in areas not covered by mechanically controlled vibrators. These vibrators shall be sufficiently rigid to insure control of the operating position of the vibrating head.

Complete and satisfactory consolidation of the concrete pavement is the most important requirement of this specification. Cores taken as required by *Item D, Pavement Testing, of Section 3.6 Part 3* shall be carefully examined for voids, honeycombing or other evidence of incomplete consolidation. If such evidence is present, changes in the consolidation procedures and/or equipment shall be made to insure satisfactory consolidation.

6. Vibrating Screed - The mechanically vibrated screed shall be provided with a template adjusted to the crown of the concrete section. The template shall be power vibrated, adjustable in height and mounted to ride on the forms. The mechanical vibration of one of the screeds on the transverse finishing machine specified in *Item C.8, Transverse Finishing Machine, of Section 5.1, Part 2* shall be acceptable.

7. Transverse Finishing Machine - The transverse finishing machine shall be provided with two screeds accurately adjusted to the crown of the pavement, shall be power driven and mounted in a substantial frame equipped to ride on the forms. The machine shall be so designed and operated as to strike off and consolidate the concrete.

Finishing machines shall be maintained in a tight and good operating condition, accurately adjusted to the required crown and profile and free from deflection, wobble or vibration tending to affect the surface finish. Machines failing to meet these requirements shall be rejected by the Owner; and the Contractor shall provide approved equipment.

8. Miscellaneous Finishing Equipment - The Contractor shall furnish a broom of the push broom type not less than 18" in width with stiff bristles for the final surface finish of concrete base or as the Owner directs.

The Contractor shall furnish a sufficient number of bridges equipped to ride on the forms and span the pavement for finishing operations and for the installation and finishing of joints. The Contractor shall furnish, operate and maintain at least two standard 10-foot

steel straightedges and all necessary finishing and edging tools as may be required to complete the pavement in accordance with the plans and specifications.

PART 3: EXECUTION

A. CONCRETE MIX DESIGN AND CONTROL

The Owner shall monitor plant control of the concrete. Within a period of not less than 10 days prior to the start of concreting operations the Contractor shall submit to the Owner, a design of the concrete mix he proposes to use together with samples of all materials to be incorporated into the mix, a copy of the test results from the proposed mix, and a full description of the source of supply of each material component. The design of the concrete mix shall produce a concrete complying with the slump requirements and the requirements of the table "Classes of Concrete."

The dry loose volume of coarse aggregate shall not be more than $^{82}/_{100}$ths (0.82) cubic feet per cubic foot of concrete, except in cases where the voids in the coarse aggregate as determined by standard test methods exceed 48 percent of the total dry loose volume. Where voids exceed 48 percent, the dry loose volume of coarse aggregate shall not exceed $^{85}/_{100}$ths (0.85) cubic feet per cubic foot of concrete.

If the concrete fails to meet the strength requirements it shall be rejected and the mix design shall be revised.

All material samples submitted to the Owner shall be sufficiently large to permit laboratory batching for the construction of test specimens to check the adequacy of the design. There shall be no change or deviation from the proportions of the design mix or sources of supply except as hereinafter provided. No concrete may be placed on the job site until the mix design has been approved by the Owner in writing to the Contractor.

B. QUALITY OF CONCRETE

1. Consistency - In general, the consistency of concrete mixtures shall be such that:

a. The mortar shall cling to the coarse aggregate.

b. The aggregates shall not segregate in concrete when it is transported to the place of deposit.

c. The concrete, when dropped directly from the discharge chute of the mixer, shall flatten out at the center of the pile; but the edges of pile shall stand and not flow.

d. The concrete and mortar shall show no free water when removed from the mixer.

e. The concrete shall slide and not flow into place when transported in metal chutes at an angle of 30 degrees with the horizontal.

f. The surface of the finished concrete shall be free from a surface film or laitance.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When field conditions are such that additional moisture is needed for the final concrete surface finishing

operation, the required water shall be applied to the surface by fog spray only; and shall be held to a minimum amount. The concrete shall be workable, cohesive, possess satisfactory finishing qualities and be of the stiffest consistency that can be placed and vibrated into a homogeneous mass. Excessive bleeding shall be avoided. Slump requirements shall be as specified herein.

Structural Concrete	**Avg. Slump**	**Max. Slump**
(a) Cased Drilled Shafts and Thin-walled Sections (9 inches or less)	4	5
(b) Slabs, Caps, Columns, Piers, Wall Sections Over 9 inches	3	4
(c) Slip Form Paving	½	2
Underwater or Seal Concrete	5	6
Rip-rap, Curb, Gutter and Other Miscellaneous Concrete	As Specified by Owner.	

NOTE: No concrete shall be permitted with slump in excess of the maximums shown. Any concrete mix failing to meet the above consistency requirements, although meeting the slump requirements, shall be considered unsatisfactory; and the mix shall be changed to correct such unsatisfactory conditions unless otherwise specified by the Owner.

2. Other Concrete Qualities - The concrete shall be uniform and workable. The cement content, maximum allowable water cement ratio, the average and maximum slump and the strength requirements of the various classes of concrete shall conform to the requirements of the table below, and as required herein. During the progress of the work, the Owner shall cast cylinders or beams as a check on the compressive or flexural strength of the concrete actually placed.

TABLE 2 - CLASSES OF CONCRETE

Class of Concrete	Min. - Max. SX. Cement Per C.Y.	Min. Comp. Strength 28-Day psi	Min. Beam Strength 7-Day psi ****	Max. Water Cement Ratio	Coarse Aggr. No. Table 1, Coarse Agg. Grading.
A	5.0	3000	500	6.5	2-3-4
B	4.0	2000	330	8.0	2-3-4
C*	6.0	3600	600	6.0	2-3
D	3.0	1500	250	11.0	2-3-4
E	6.0	3000	500	7.0	2-3
F	6.5	4200	700	5.5	2-3
S	6.0	3600	600	5.0	2-3
H**	6.5 - 8.0	As specified on plans	N.A.	5.5	3

* Entrained Air.

** Prestressed Concrete.

**** ASTM C 293 (Center Point.)

Unless otherwise specified in the special provisions or in the plans for job site placement of concrete, a minimum of three test cylinders or beams shall be required. For small placements, tests may be made for each truck or as required by the Engineer. One cylinder or beam shall be tested at seven-day strength. Requirements shall be based on results obtained from trial batches.

The remaining cylinder or beam shall be tested at 28 days for record.

All test specimens, beams or cylinders representing tests for removal of forms and/or falsework shall be cured using the same methods; and under the same conditions as the concrete represented.

The Contractor, when required by the Owner, shall provide and maintain curing facilities for the purpose of curing test specimens, and shall provide for care and security of facilities. Provisions shall be made to maintain the water in the curing tank at temperatures between 70 °F and 90°F.

When control of concrete quality is by 28-day compressive tests, job control shall be by seven-day compressive tests, which are shown to provide the required 28-day strength, based on results from trial batches. If the required seven-day strength is not secured with the approved mix design, changes in the batch design shall be made.

C. Ready Mix

Use of ready-mixed concrete will be permitted provided the batching plant and mixer trucks meet quality requirements of the Owner and Engineer. Ready-mixed concrete, batching plant and mixer truck operation shall include the following:

1. A ticket system will be used that includes a copy for the Inspector. Ticket will have machine stamped time/date of concrete batch, a mix design designation, weight of cement, fly ash, sand and aggregates; exact nomenclature and written quantities of

admixtures and water. Any item missing or incomplete on ticket may be cause for rejection of concrete.

2. Sufficient trucks will be available to support continuous placements. The Contractor will satisfy the Engineer or designated representative that adequate standby trucks are available to support monolithic concrete placement requirements.

3. A portion of mixing water required by the mix design to produce the specified slump may be withheld and added at the job site, but only with permission of the Owner and Engineer and under the Inspector's observation. When water is added under these conditions, the concrete batch will be thoroughly mixed before any slump or strength samples are taken. Additional cement shall not be added at the job site to otherwise unacceptable mixes.

4. A metal plate(s) shall be attached in a prominent place on each truck mixer plainly showing the various uses for which it was designed. The data shall include the drum's speed of rotation for mixing and for agitating and the capacity for complete mixing and/or agitating only. A copy of the manufacturer's design, showing dimensions of blades, shall be available for inspection at the plant at all times. Accumulations of hardened concrete shall be removed to the satisfaction of the Owner.

5. The loading of the transit mixers shall not exceed capacity as shown on the manufacturer's plate attached to the mixer or 63 percent of the drum volume, whichever is the lesser volume. The loading of transit mixers to the extent of causing spill-out enroute to delivery will not be acceptable. Consistent spillage will be cause for disqualification of a supplier.

6. Excess concrete remaining in the drum after delivery and wash water after delivery shall not be dumped on the project site unless approval of the dump location is first secured from the Owner.

D. PLACING REINFORCEMENT

Unless otherwise shown on the plans, dimensions shown for reinforcement are to the centers of the bars. Reinforcement shall be placed as near as possible in the position shown on the plans. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from plan placement by more than $^{1}/_{12}$ of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars shall not vary from plan placement by more than ¼ inch. Cover of concrete to the nearest surface of steel shall meet the above requirements, but shall never be less than one inch.

For bridge slabs, the clear cover tolerance for the top mat of reinforcement shall be -0, + ½ inch.

The reinforcement shall be accurately located in the forms, and firmly held in place, before and during concrete placement, by means of bar supports, adequate in strength and number in order to prevent displacement and to keep the steel at the proper distance

from the forms. Bars shall be supported by standard bar supports with plastic tips, plastic bar supports or precast mortar or concrete blocks, when supports are in contact with removable or stay-in-place forms, as approved by the Engineer and Owner. Bright basic bar supports may be used to support reinforcing steel placed in slab overlays on concrete panels or on existing concrete slabs.

For bar supports with plastic tips, the plastic protection shall have a minimum thickness of $^{3}/_{32}$ of an inch and extend upward on the wire to a point at least ½ inch above the formwork.

All accessories such as tie wires, bar chairs, supports or clips used with epoxy coated reinforcement shall be of steel, fully coated with epoxy or plastic. Plastic supports approved by the Engineer may also be used with epoxy-coated reinforcement.

Mortar or concrete blocks shall be cast to uniform dimensions with adequate bearing area. A suitable tie wire shall be provided in each block for anchoring to the steel. The blocks shall be accurately cast to the thickness required in molds approved by the Engineer. The surface placed adjacent to the form shall be a true plane, free of surface imperfections. The blocks shall be cured by covering with wet burlap or mats for a period of 72 hours. Mortar for blocks shall contain approximately one part portland cement to three parts sand. Concrete for blocks shall contain nine sacks of portland cement per cubic yard of concrete.

Individual bar supports shall be placed in rows at three foot maximum spacing in each direction. Continuous type bar supports shall be placed at four foot maximum spacing. Continuous bar supports will be required when permanent metal deck forms are used.

The exposure of the ends of longitudinals, stirrups and spacers used to position the reinforcement in concrete pipe and precast box culverts or sewers shall not be cause for rejection.

Reinforcing steel for bridge slabs, top slabs of direct traffic culverts and the top slabs of prestressed box beams shall be tied at all intersections except that where the spacing is less than one foot in each direction, alternate intersections only need to be tied. For reinforcing steel cages for other structural members, the steel shall be tied at a sufficient number of intersections to provide a rigid cage of steel. Mats of wire fabric shall be fastened securely at the ends and edges.

Before concrete placement, all mortar, mud, dirt, etc., shall be cleaned from the reinforcement. Concrete shall not be placed until authorized by the Engineer.

If the reinforcement is not adequately supported or tied to resist settlement, floating upward, overturning of truss bars, or movement in any direction during concrete placement, concrete placement will be halted until corrective measures are taken.

E. PLACING CONCRETE

1. Weather Conditions - Concrete shall not be placed when the air temperature is below 40°F and falling, but may be placed when the air temperature is 35°F and rising; the temperature being taken in the shade, away from artificial heat; and with the further provision that concrete shall be placed only when weather conditions, in the opinion of the Owner, are suitable. The minimum temperature of all concrete at the time of placement

shall be not less than 50°F. The maximum temperature of Class C, F, H, X, Y and Z cast-in-place concrete used in bridge superstructures shall not be more than 85°F, at the time of placement. Concrete diaphragms, parapets, concrete portions of railings, curbs and sidewalks, unless monolithically placed with the slab, may not be subject to the preceding control if approved by the Owner in writing. Other portions of structures, when so noted on the plans, shall require the temperature control specified thereon.

Concrete placement shall not be permitted when impending weather conditions may result in rainfall or low temperatures, which shall impair the quality of the finished work. In case rainfall should occur after placing operations are started, the Contractor shall provide ample covering to protect the work. In case of a drop in temperature, the provisions set forth in *Item E.2, Placing Concrete Under Adverse Weather Conditions, of Section 5.1 Part 3* shall be applied.

a. Hot-Weather Placing - In addition to the requirements above concrete must also meet the requirements of ACI 305R-99.

b. Cold-Weather Placing - In addition to the requirements above concrete must also meet the requirements of ACI 306R-88.

2. Time - Concrete shall not be placed before the time of sunrise; and shall not be placed later than the time it would take to permit the finishing of the pavement during sufficient natural light.

3. General - A retarding admixture shall be used when the continuous placing method is used in the deck of continuous units. The initial set of the concrete shall be retarded sufficiently to insure that the concrete remains plastic in not less than three spans immediately preceding the one being placed. For simple spans, retardation shall be required only if necessary to complete finishing operations or as required by *Item A.3, Chemical Admixtures, of Section 5.1 Part 2*.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for finishing, the required water shall be applied to the surface by fog spray only, and shall be held to a minimum amount.

The maximum time interval between the addition of cement or mixing water to the batch and the placing of concrete in the forms shall not exceed the following:

Table 3

	Air or Concrete Temperature	**Maximum Time**
Non-agitated Concrete	80°F or above 35 to 79°F	15 minutes 30 minutes
Agitated Concrete	90°F or above 75 to 89°F 35 to 74°F	45 minutes 60 minutes 90 minutes

The use of an approved cement-dispersing agent in the concrete shall permit the extension of each of the above temperature-time maximums by 30 minutes, except that for non-agitated concrete, the maximum time shall not exceed 30 minutes.

All the unformed surfaces of slab concrete for bridge decks and the top slab of direct traffic culverts shall be protected against rapid surface drying by the use of fog sprays. Fog sprays, powered by pressure pumps and capable of covering the entire area of freshly placed concrete with a fine mist, shall be installed, ready for use prior to the start of placing operations.

On individual placements of 15 cubic yards or less, hand operated spray nozzle equipment of the stirrup pump type may be substituted for the equipment specified above.

Fogging shall be carefully controlled to prevent accumulation of standing or flowing water on the surface of the fresh concrete. Fogging shall continue, as required, through the finishing operations and shall be used as interim curing until the selected curing medium is in place, except that in lieu of continuous fogging over the entire area, that portion of the finished concrete surface which is sufficiently hardened may be covered with wet burlap. The burlap shall be kept wet until the final curing media is in place.

The Contractor shall give the Owner sufficient advance notice before starting to place concrete in any unit of the structure to permit the inspection of forms, the reinforcing steel placement and preparation for casting. No concrete shall be placed in any unit prior to the completion of the formwork, the placement of the reinforcement and approval by the Owner. Concrete mixing, placing and finishing shall be done in daylight hours, unless adequate provisions are made to light the entire site of all operations.

The sequence of placing concrete shall be as provided on the plans or in the specifications. The placing shall be so regulated that the pressures caused by the plastic concrete shall not exceed the loads used in the design of forms.

The method of handling, placing and consolidation of concrete shall minimize segregation or the displacement of the reinforcement; and shall produce a compact mass of uniform texture. Concrete shall not have a free fall or more than three feet except in the case of thin walls such as culvert walls. The spattering of forms or reinforcement bars shall be prevented if the concrete so spattered shall dry or harden before being incorporated into the mass.

Any hardened concrete spatter ahead of the plastic concrete shall promptly be removed from the work.

Each part of the forms shall be filled by depositing concrete as near its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the reinforcement bars without displacing them. Depositing large quantities at one point in the forms and running or working it along the forms shall not be allowed.

After the concrete has taken initial set, the forms shall not be jarred or any strain placed on projecting reinforcement.

Chutes, troughs, conveyors or pipes used in placing concrete shall be arranged and used so that the ingredients of the concrete shall not be separated. When steep slopes are necessary, the chutes shall be equipped with baffle boards or made in short lengths that reverse the direction of movement; or the ends of such chutes shall terminate in

vertical downspouts. Open troughs and chutes shall extend, if necessary, down inside the forms or through holes left in the forms. All chutes, troughs, conveyors and pipes shall be kept clean and free from coatings of hardened concrete by a thorough flushing with water before and after each placement. Water used for flushing shall be discharged clear of the concrete.

Concrete shall be deposited in the forms in layers of suitable depth, but not more than 36" in thickness, unless otherwise directed by Owner.

Successive layers or adjacent portions of concrete shall be placed in a sequence so that they can be vibrated into a homogeneous mass with the previously placed concrete without a cold joint. Not more than one hour shall elapse between adjacent or successive placement of concrete. Unauthorized construction joints shall be avoided by placing required portions of abutments, piers, walls or superstructure in one continuous operation. For mass placements, placements on falsework where differential setting time may include stress cracking, placement in deep girder stems, etc., an approved retarder (cement dispersing agent) in accordance with *Item A.3, Chemical Admixtures, of Section 5.1 Part 2* shall be used to control stress cracks and/or unauthorized cold joints.

Laitances or foreign matter of any kind shall not be permitted to accumulate inside the forms; and openings in forms necessary for removal of same shall be provided.

All concrete shall be well consolidated and the mortar flushed to the surface of the forms by continuous working with mechanical vibrators of an approved type. Vibrators of the type, which operate by attachment to forms or reinforcement, shall not be permitted, except that external vibration may be allowed when the forms are of steel, but shall be subject to regulation by the Owner.

At least one standby vibrator shall be provided for emergency use in addition to the ones required for placement.

For lightweight concrete, vibrators of the high-frequency type, which produce a minimum of 7,000 impulses per minute, shall be required.

The vibrators shall be applied to the concrete immediately after deposit. Prior to the beginning of work, a systematic spacing of the points of vibration shall be established to insure complete consolidation of the concrete being placed and the thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. Immersion type vibrators shall be inserted vertically, at points 18 to 30 inches apart; and slowly withdrawn.

For shallow slabs or for concrete inaccessible to vertical insertion of the vibrator, the vibrator may be inserted in a sloping horizontal position. The entire depth of each lift of concrete shall be vibrated; and the vibrator shall be allowed to penetrate several inches into the preceding lift of plastic concrete. New concrete placed against hardened concrete or against fresh concrete that is not plastic shall be thoroughly consolidated along the joint surface. The vibration shall be of sufficient duration to produce thorough consolidation; and complete embedment of reinforcement and fixtures; but shall not be done to an extent that shall cause segregation. Vibration may be supplemented by hand spading or rodding, if necessary, to insure the flushing of mortar to the surface of all forms.

Holes for anchor bolts in piers, abutments, bents or pedestals may be drilled or may be formed by the insertion of oiled wooden plugs or metal sleeves in the plastic concrete. The plugs or sleeves shall be withdrawn after the concrete has set. Formed holes shall be of such diameter to permit horizontal adjustments of the bolts. The bolts shall be set carefully in mortar in lieu of the above methods of placing. Anchor bolts may be set to exact locations in concrete when it is placed.

The placing of concrete for deck slabs shall be done from a mixing plant located off the structure. Carting or wheeling concrete batches over a completed slab shall not be permitted until the slab has aged at least four full curing days. If carts are used, timber planking shall be required for the remainder of the curing period. Carts shall be equipped with pneumatic tires. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

The storing of reinforcing or structural steel on completed roadway slabs generally shall be avoided and, when permitted, such storage shall be limited to quantities and distribution that shall not induce excessive stresses.

4. Placing Concrete Under Adverse Weather Conditions - Concrete for structures shall not be placed on frozen ground nor shall it be mixed or placed while the atmospheric temperature is below 40°F, unless adequate means are employed to heat the aggregates and water, and satisfactory provisions have been made for protecting the work.

Concrete slabs shall not be placed on frozen ground, nor shall concrete be mixed or placed when the atmospheric temperature is below 40°F or when conditions indicate that the temperature may fall to 40°F within a 24-hour period, except with the written permission of the Owner and only after such precautionary measures for the protection of the work have been taken as the Owner may direct.

Concrete shall be effectively protected from freezing or frost for a period of five days after placing. When the temperature of the air is above 85°F, an approved retarding mixture shall be required in all concrete used in superstructures, top slabs of direct traffic culverts, and cased drilled shafts.

Concrete placement shall be stopped when rainfall is sufficient to cause damage to the work.

5. Placing Concrete in Water - Concrete shall be deposited in water only when specified on the plans or with written permission of the Owner. The forms, cofferdams or caissons shall be sufficiently tight to prevent any water current passing through the space in which the concrete is being deposited. Pumping shall not be permitted while the concrete is being placed; or until it has set for at least 36 hours.

The concrete shall be placed carefully in a compact mass by means of a tremie; or other approved method that does not permit the concrete to fall through the water without adequate protection. The concrete shall not be disturbed after being deposited. Depositing shall be regulated to maintain approximately horizontal surfaces at all times.

When a tremie is used, it shall consist of a tube having a diameter of not more than 10 inches, constructed in sections having watertight connections. The tremie shall be

equipped with a device for sealing the bottom of the tube, the positive opening thereof and for the placing of the tremie through the water to the point of placement. The means of supporting the tremie shall permit the movement of the discharge over the entire surface of the work and shall permit the tremie to be lowered rapidly when necessary to choke off or retard the flow.

6. Placing Concrete in Superstructure - To insure operation and maintenance of grades and clearances, one or more passes of the screed shall be made over the section of bridge spans to be placed prior to the placement of concrete.

For transverse finishing, concrete in the superstructure shall be placed in transverse strips, beginning at the lowest end of the unit or length of spans to be placed and proceeding to the other end.

For longitudinal screeding, concrete shall be placed in longitudinal strips. Placing, preferably, shall be started at a point in the center of the section adjacent to one curb. The strip thus started shall be completed by depositing concrete uniformly in both directions toward the ends, except that for spans on a grade of 1½ percent or more, the placing shall start at the lowest end. The width of strips shall be such that the concrete therein shall remain plastic until the adjacent strip is placed.

The forms for the bottom surface of concrete slabs, girders and overhangs shall be maintained true to the required vertical alignment during the concrete placing. For convenience in checking the vertical alignment, an approved system of "tell-tales" attached to the forms shall be installed and maintained by the Contractor. They shall provide a convenient means of match-marking with reference to points set on stakes or other suitable reference points set independently of the forms and falsework for the span being placed. Unless otherwise provided, the girders, slab and curbs of deck girder spans shall be placed in one continuous operation.

The filling of girder stems ahead of placing the concrete in the slab shall be permitted, provided the slab concrete is placed in the time as specified herein. The location of construction joints and the sequence of placements of the slab on steel and prestressed concrete beams shall be as shown on the plans. Where plans do not specify a particular sequence, any logical placing sequence which shall not result in the overstressing of any of the supporting members shall be permitted subject to the approval of the Owner.

On steel truss spans the falsework under the span shall be released and the span swung free on its permanent supports before placing any concrete in the floor slab.

When the curb forms are filled, the curbs shall be brought to the correct camber and alignment, struck off and float-finished as described in *Item F, Finishing, of Section 5.1 Part 3.*

As soon as concrete is placed in a section of the slab of sufficient width to permit finishing operations, the slab shall be finished as specified in *Item F, Finishing, of Section 5.1 Part 3.* When the surface of the slab is to receive and additional wearing surface or level-up (widening), the slab shall be given a reasonably smooth float or screed finish and shall not be finished as stated above.

7. Placing Concrete in Box Culverts - In general, construction joints shall be permitted only at the points shown on the plans.

Where the top slabs and sidewalls are placed monolithically in culverts more than four feet in clear height, an interval of not less than one hour nor more than two hours shall elapse between the placing of the concrete in the walls and that in the top slab. Such interval is to allow for shrinkage in the wall concrete.

The top surface of the base slab shall be finished accurately at the proper time to provide a smooth uniform surface. The upper surface of the top slab which shall carry direct traffic shall be finished as specified in *Item F.2, Finish of Roadway Slabs, of Section 5.1 Part 2*. On a fill-type culvert, which does not carry direct traffic, the top slab shall be given a reasonably smooth finish.

8. Placing Concrete in Foundations and Substructure - Concrete shall not be placed in footings until the depth and character of the foundation has been inspected by the Owner and permission has been given to proceed.

The placing of concrete bases above seal courses shall be permitted after the caissons or cofferdams are free from water and the seal course cleaned. Any necessary pumping or bailing during the concreting operation shall be done from a suitable sump located outside the forms.

All temporary wales or braces on the inside of cofferdams or caissons shall be constructed or adjusted as the work proceeds to prevent unauthorized construction joints in bases or shafts.

When footings can be placed in dry foundation pits without the use of cofferdams or caissons, forms may be omitted, if desired by the Contractor and approved by the Owner, and the entire excavation filled with concrete to the elevation of the top of footing. Where this procedure is followed, no measurement for payment shall be made for concrete placed outside of the footing dimensions shown on the plans.

Concrete in columns shall be placed monolithically unless otherwise provided. Columns and caps and/or tie beams supported thereon may be placed in the same operation. To allow for shrinkage of the column concrete, it shall be placed to the lower level of the cap or each tie beam and placement delayed for not less than one hour nor more than two hours before proceeding.

F. FINISHING

1. Treatment and Finishing of Horizontal Surfaces, Except Roadway Slabs - All upper surfaces not covered by forms shall be struck off to grade and finished. The use of mortar topping for surfaces under this classification shall not be permitted.

After concrete has been struck off as described above, the surface shall be floated with a suitable float. Bridge sidewalks shall be given a wood float or broom finish or may be striped with a brush, as specified by the Owner. Unless otherwise specified, top of caps and piers shall be given a smooth finish with a steel trowel. Other surfaces shall be wood float finished and striped with a fine brush leaving a fine-grained texture.

2. Finish of Roadway Slabs - As soon as the concrete has been placed and vibrated in a section of a sufficient width to permit working, the surface shall be approximately leveled, struck off and screeded, carrying a slight excess of concrete ahead of the screed to insure filling of all low spots. The screed shall be designed to provide the rigidity necessary to hold true to shape and shall have sufficient adjustments to provide for the required camber. A vibrating screed may be used if it is sufficiently heavy to withstand distortion. The screeds shall be provided with a metal edge.

Longitudinal screeds shall be moved forward across the concrete with a combined longitudinal and transverse motion with ends resting on headers or template, set true to the roadway grade on the adjacent finished slab.

The surface of the concrete shall be screeded a sufficient number of times, (not less than three) and at such intervals as to produce a uniform surface, true to grade and free of voids.

Spans over 50 feet in length may be screeded in two or more sections if suitable intermediate templates are installed and if adequate equipment is provided. Unless otherwise provided, the templates shall be designed to permit early removal in order to avoid construction joints and to permit satisfactory finishing at the template site.

If necessary, the screeded surface shall be worked to a smooth finish with a long handled wood or metal float of the proper size; or hand-floated from bridges over the slab.

While the concrete is still plastic, the Contractor shall have the surface checked with a long handled 10-foot straightedge. The check shall be made with the straightedge parallel to the centerline. Each pass of the straightedge shall lap half of the preceding pass. All high spots shall be removed and all depressions over $^{1}/_{16}$" in depth shall be filled with fresh concrete and floated. The checking and floating shall be continued until the surface is true to grade and free of depressions, high spots, voids or rough spots.

Unless otherwise shown, the surface shall be given a burlap drag finish, groove finish, or a broom finish. If a burlap drag is used, it shall consist of layers of continuous burlap fabric, free of seams, dirt or hardened concrete.

The burlap drag shall be kept wet when in use. The drag shall be attached to a work bridge and drawn over the surface of the slab as necessary to obtain the desired surface texture. Work bridges shall be provided from which to perform all finishing operations.

If a grooved finish is specified, the surface shall be given a grooved steel tine finish. The grooves shall be approximately $^{1}/_{8}$ to $^{3}/_{16}$ inch deep approximately $^{1}/_{8}$ inch wide. The tines shall be randomly spaced approximately ¾ to one (1) inch apart. The grooves shall run perpendicular to the structure centerline when a transverse screed is used, and parallel to the structure centerline when a longitudinal screed is used. Areas, which receive insufficient texture depth, shall receive additional texture, when directed by the Engineer, by saw grooving in accordance with the procedure given below.

At the option of the Contractor, or when shown on the plans, the surface shall be given its final texture by saw grooving to meet the above requirements. Saw grooving may be done a minimum of four (4) days after the slab concrete has been placed. If saw grooving is done prior to the completion of curing, the curing shall be continued after sawing to provide the minimum curing time required.

Rail support holes shall be filled with concrete and finished to match to top of the slab.

The edges of slabs and all joints requiring edging shall be carefully tooled with an edger, of the radius required by the plans, at the time of the concrete begins to take its "set" and becomes non-workable. All such work shall be left smooth and true to lines.

After the final set of the concrete, the roadway surface shall be tested again with a standard 10-foot metal straightedge for irregularities; and the surface shall be corrected, if necessary, to conform to the following:

> The straightedge shall be placed parallel to the centerline of road so as to bridge any depressions and touch high spots. Ordinates measured from the face of the straightedge to the surface of the slab shall not exceed $^{1}/_{16}$ inch per foot from the nearest point of contact and the maximum ordinate shall not be greater than $^{1}/_{8}$ inch. The surface shall be corrected by grinding off the high spots as required to conform to these limits. Vertical curvature and required camber shall be taken into account when straightedging.

In all roadway slab finishing operations camber for specified vertical curvature and transverse slopes shall be provided.

For concrete slab or concrete girder spans which are cast-in-place on falsework, an additional amount of camber shall be provided to offset the initial and final deflections of the span. The additional amount of camber shall be determined from the dead-load deflection diagram shown on the plans. When dead-load deflection is not shown on the plans, the additional amount of camber shall be $^{1}/_{8}$ of an inch per 10 feet of span length, but not greater than ½ inch. For concrete girder (CG) spans the additional camber for initial and final deflections shall be ½ inch for 30-foot spans and ¾ inch for 40-foot spans.

Roadway slabs supported on prestressed concrete, steel beams or girders shall receive no additional amount of camber; except that for slabs without vertical curvature, the longitudinal camber shall be approximately ¼ inch.

Dead-load deflection shall be taken into account in the setting of headers and rail systems.

3. Stamp - The contractor shall stamp his name and the date the work was done, in legible letters on every 50 feet of concrete including curbs, curb with gutter, alleys, driveways and structures. This name shall be stamped with some kind of metal stencil with letters not less than two inches high. The design of the stamps shall be approved by the Engineer.

G. Finishing Exposed Surfaces

The type of surface finish shall be one of the types described herein and as designated on the plans. Where the plans do not specify the type of finish, a Type I Finish shall be required.

1. Type I Finish - The following areas shall require lined forms and shall receive a first and second rubbing:

The top, exterior and roadway faces of curbs; all concrete surfaces of railing, including the parapet types; the exterior vertical faces of slab spans, rigid frames, arches and box girders; the outside and bottom surfaces of fascia beams or girders (precast prestressed concrete beams excluded); the underside of overhanging slabs to the point of juncture of the supporting beam; all vertical surfaces of piers, columns, bent caps, (including the bottom sloped portions only of variable depth caps), abutments, wingwalls and retaining walls, which are exposed to view after all backfill and embankment are placed.

On slab spans and rigid frame structures, the underside of the slab shall be finished for a width of two feet in from the outer edge; but lined forms shall be required for the entire bottom surfaces.

For rigid frame structures, finishing shall be required on the inside sloping and vertical surfaces.

Culvert headwalls and wingwalls, inlets, manholes and sewer appurtenances shall receive a first rubbing only.

No rubbing shall be required on any area inside culvert barrels. Horizontal surfaces of bridge sidewalk slabs shall be finished in accordance with *tem F, Finishing, of Section 5.1 Part 3.*

2. Type 2 Finish - All concrete surfaces of railing, including parapet types; the top and roadway faces only of curbs; and wingwalls of bridges shall be given a first and second rubbing. All other surfaces described under Type I Finish shall be given a first rubbing only. Lining of forms shall be as required in a Type I Finish.

3. Type 3 Finish - All concrete surfaces of railing, including the parapet types; the top and roadway faces only of curbs; and wingwalls of bridges shall be given a first and second rubbing. All other surfaces described under Type I Finish shall not require rubbing, but shall require lining of forms.

4. Type 4 Finish - All concrete surfaces of railing, including the parapet types; the top and roadway faces of curbs; and wingwalls of bridges and culverts shall be given a first rubbing only. Form lining shall not be required. Rubbing of culvert wingwalls shall not be required, provided lined forms are used.

After all repair work and pointing has set sufficiently, the first rubbing shall be performed as follows:

All surfaces to be finished shall be wet and given a first rubbing with a carborundum stone. The rubbing shall bring the surface to a paste; and produce a smooth dense surface without pits, form marks or other irregularities. The use of cement to form a paste shall not be permitted.

Where a single rubbing is specified, the paste shall be spread uniformly, striped with a brush and allowed to take a reset, after which the surfaces shall be washed with clean water, leaving them with a neat and uniform appearance and texture. Chamfered corners shall also be rubbed.

When a second rubbing is required, striping with a brush and washing after the first rubbing shall not be required. Chamfered corners generally should not be rubbed in the first rubbing.

The second rubbing shall be performed during the process of conditioning the structure for final acceptance. The surfaces requiring finish shall be cleaned of drip marks and discolorations; and shall be given a final rubbing with a carborundum stone. The surface shall be striped neatly with a brush, and the mortar shall be allowed to take a reset, after which the surfaces shall be washed with clean water, leaving them with a neat and uniform appearance and texture.

The first rubbing shall be done immediately upon removal of the forms. Membrane curing, if used, shall be applied after the first rub has been completed. Prior to the second rubbing, any remaining curing membrane shall be removed from the surface by brushing, buffing or other satisfactory methods. Removal of the membrane shall not be required except when a second rubbing is required.

Surfaces other than those specified herein shall not require rubbing unless they are not true or have porous or honeycombed areas. When such defects occur, the areas affected shall be given a first rubbing, which shall extend over a sufficient area to blend it into the surrounding unfinished surface. This shall not be construed to require the rubbing of large adjacent unblemished areas to gain absolute uniformity of color and texture on the structure part in question. All surfaces shall be free of discolorations and should present a uniform appearance. Unsightly discoloration shall be removed prior to acceptance.

When so indicated on the plans, or with written permission of the Owner, painting of concrete surfaces in lieu of rubbing shall be permitted. When painting is permitted, all surfaces to be coated shall be prepared in the following manner:

Soon after form removal, any porous spots, honeycombed areas, untrue surfaces and lines shall be corrected. All fins, form marks, runs, drips or mortar shall be removed, leaving a smooth and uniform surface.

When preparing the completed structure for final acceptance, all grease, dirt, mortar drips and remaining curing membrane shall be removed from the pertinent surfaces after which the surfaces shall be painted with a latex-base adhesive grout.

The grout shall consist of one part latex-base adhesive, two parts white cement, two parts natural cement, two parts fine masonry sand and one part water. Mixture should have the consistency of a thick paint.

The finished surface shall have a uniform appearance and texture. Thickness of coating shall be approximately $^{1}/_{16}$ to ⅛ of an inch.

H. CURING CONCRETE

Careful attention shall be given to the proper curing of all concrete. Contractor shall inform Owner fully of the methods and procedures proposed for curing; shall provide proper equipment and material in adequate amounts; and shall have approval of the proposed method, equipment and material prior to placing concrete.

Inadequate curing facilities or lack of attention to the proper curing of concrete shall be cause for Owner to stop all construction on the job until approved curing is provided.

All concrete shall be cured for a period of four days except as noted herein.

EXCEPTIONS TO 4-DAY CURING	
Description	Required Curing
Upper Surfaces of Bridge Roadway, Median and Sidewalk Slabs, and Top Slabs of Direct Traffic Culverts	8 Curing Days

A curing day is defined as a calendar day when the ambient temperature, taken in the shade away from artificial heat, is above 50°F for at least 19 hours, or the ambient temperature is 50 degrees or less; and if satisfactory provisions are made to maintain the temperature at all surfaces of the concrete above 40°F for the entire 24 hours.

In continuous placement of concrete, the required curing period shall begin when all concrete has been placed and has attained its initial set.

The following methods are permitted for curing concrete subject to the restriction of the table in *Item H.3, Membrane Curing, of Section 5.1 Part 3* and the requirements of this specification for each method of curing.

1. Form Curing - When forms are left in contact with the concrete, other curing methods shall not be required except for cold-weather protection.

2. Water Curing - All exposed surfaces of the concrete shall be kept wet continuously for the required curing time. The water used for curing shall meet requirements for concrete mixing water as specified in *Section 5.1, Concrete and Reinforcement.*

a. Wet Mat - Cotton mats shall be used for this curing method. The mats shall not be placed in contact with the concrete until such time that damage shall not occur to the surfaces. Damp burlap blankets made from 9-ounce stock may be placed on the damp concrete surface for temporary protection prior to the application of the cotton mats. The mats may be placed dry and wetted down after placement. Mat curing, except for continuous placements, shall commence not later than three hours after finishing of the roadway slab.

The mats shall be weighted down adequately to provide continuous contact with all concrete surfaces where possible. The surfaces of the concrete shall be kept wet for the required curing time.

Surfaces, which cannot be cured by contact, shall be enclosed with mats, anchored positively to the forms, or to the ground, so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet.

b. Water Spray - This method shall be accomplished by overlapping sprays or sprinklers, so that all unformed surfaces are kept continuously wet.

c. Ponding - This method requires the covering of the surfaces with a minimum of two inches of clean granular material, kept wet at all times; or water to a minimum depth of one inch. Satisfactory provisions shall be made to provide a dam to retain the granular material or water.

3. Membrane Curing - Unless otherwise shown on the plans, Type 2 membrane curing compound may be used where permitted. Membrane shall be applied in a single, uniform coating at the rate of coverage recommended by the manufacturer and as approved by the Owner, but not less than nine gallons per 210 feet of area. Tests for acceptance shall be at this specified rate.

Membrane curing shall not be applied to dry surfaces; but shall be applied to horizontal surfaces just before free moisture has disappeared. Formed surfaces and surfaces which have been given a first rub shall be dampened and shall be moist at the time of application of the membrane.

STRUCTURE UNIT DESCRIPTION	REQUIRED		PERMITTED	
	Water for Complete Curing	Membrane for Interim Curing	Water for Complete Curing	Membrane for Interim Curing
1. Upper surfaces of bridge roadway; median, and sidewalk slabs; top slabs of direct traffic culverts; top surface of any concrete unit upon which concrete is to be placed and bonded at a later interval (stub walls, risers, etc.). Other superstructure concrete (curbs, wing-walls, parapet walls, etc.).	X			
2. Top surface of precast and/or prestressed piling.	X	X		
3. All substructure concrete, culverts, box sewers, inlets, manholes, retaining walls, riprap.			*X	*X

* Polyethylene sheeting or burlap polyethylene mats fastened to prevent outside air from entering shall be considered equivalent to water or membrane curing per this item.

When membrane is used for complete curing, the film shall remain unbroken for the minimum curing period specified. Membrane, which is damaged, shall be corrected immediately by reapplication of membrane.

4. Hot-Weather Curing - In addition to the requirements above concrete must also meet the requirements of ACI 305R-99 and ACI 308R-01 Section 2.7

5. Cold-Weather Curing - In addition to the requirements above concrete must also meet the requirements of ACI 306R-88 and ACI 308R-01 Section 2.6.

I. REMOVAL OF FORMS AND FALSEWORK

Except as herein provided, forms for vertical surfaces may be removed when the concrete has aged not less than one day for normal concrete and not less than ½ day for high-early strength concrete, provided the forms can be removed without damage to the concrete.

Forms for inside curb faces may be removed in approximately three hours, provided the concrete has set sufficiently to permit form removal without curb damage.

Weight-supporting forms and falsework for all bridge components, culverts and slabs shall remain in place a minimum of four curing days. Forms may then be removed if the concrete has attained a compressive strength of 3000 psi, as evidenced by strength tests using specimens made from the same concrete and cured under the same conditions as the portion of the structure involved. Forms for other structural components may be removed as specified by Owner. If all beams made for the purpose of form removal have been broken without attaining the required strength, forms shall remain in place for a total of 14 curing days.

The above provisions relative to form removal shall apply only to forms or parts of forms, which are so constructed as to permit removal without disturbing forms, or falsework, which are required to be left in place for a longer period on other portions of the structures.

J. DEFECTIVE WORK

Any defective work discovered after the forms have been removed shall be repaired or replaced as soon as possible. If the surface of the concrete is bulged, uneven or shows excess honeycombing or form marks, which in the opinion of the Owner cannot be repaired satisfactorily, the entire section shall be removed and replaced. In repairing honeycombed areas, all loose material shall be removed before the repair work is started. No extra compensation shall be allowed for the extra work or materials involved in repairing or replacing defective concrete.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

1. Concrete - The quantity of concrete, which constitutes the completed structure, shall be measured by the square yard, square foot, or per each of accepted work in place. The dimensions used shall be those shown on the plans or ordered in writing by the Owner

The concrete quantities, measured as provided, shall be paid for at the unit price bid, which price shall be full compensation for furnishing, hauling and mixing all concrete materials, including trial batches; placing, curing and finishing all concrete; for all grouting and joints; furnishing and placing all expansion and construction joints, except as hereinafter provided; furnishing and placing metal flashing strips and

waterstops; and for all forms and falsework, labor, tools, equipment and incidentals necessary to complete the work.

The above provision for payment for expansion joints shall not be interpreted to provide payment for cast steel or structural steel shapes and plates, used expansion joints and armored joints; or for structural steel, cast iron or cast bearing plates. Payment for these materials is provided for in *Section 6.3.A, Steel Structures*.

The preceding provisions for payment shall not be interpreted to provide payment for concrete in railing, piling, precast prestressed concrete units or other concrete items for which provision is otherwise made in the contract.

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SECTION 5.2: LIGHTWEIGHT CONCRETE

PART 1: GENERAL

A. DESCRIPTION

This item shall govern for the equipment used; for the storing, measuring and handling of materials; and for the mixing, placing, finishing and curing of lightweight concrete for bridges and other structures. The concrete shall be composed of portland cement, natural sand fine aggregate, lightweight coarse aggregate, a cement dispersing agent, and air-entraining admixture and water, proportioned and mixed as hereinafter provided.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

1. Lightweight Aggregates

a. General - Lightweight aggregates shall consist of expanded clay or shale having strong, durable particles; and conforming to the requirements of Lightweight Aggregate for Structural Concrete, ASTM Designation C 330.

b. Deleterious Substances - The maximum amount of deleterious substances shall not exceed the following percentage by weight:

Loss on ignition	5%
Clay Lumps	2%

Lightweight aggregates that, upon being subjected to the test for organic impurities, produce a color darker than the standard shall be rejected, unless it can be demonstrated that the discoloration is due to small quantities of materials not harmful to the concrete.

After a test for staining materials (ASTM Designation C 641), if the aggregates are classified as "heavy stain" or darker, a test following the chemical procedure shall be performed. If 1.5 mg or more of ferric oxide (Fe_2O_3) is found, the aggregate shall be rejected.

c. Tests - Lightweight aggregates shall have a percent of wear not more than 40 when tested according to ASTM Designation C131.

d. Gradation - The lightweight aggregate shall be well graded in size from coarse to fine; and, when tested by standard laboratory methods, shall meet the following requirements for percentage by weight:

Passing ¾ in. sieve	90 to 100%
Passing ⅜ in. sieve	20 to 55%
Passing No. 4 sieve	0 to 10%
Passing No. 8 sieve	0 to 5%

e. Additional Requirements - The natural fine aggregate shall conform to the requirements for aggregate shown in *Item A.1.b.(4), Gradation, of Section 5.1 Part 2.*

f. Rejection - Lightweight aggregates which fail to meet the requirements for these specifications may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Lightweight aggregate sources from which materials with properties not meeting these specifications are delivered may be rejected as a further supply source to the project by the Owner. Such rejection shall incur no cost to the Owner.

B. MATERIAL TESTING

Refer to *Section 5.10, Materials Testing.*

C. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. Classification and Proportions

Lightweight concrete shall be proportioned by weight in such manner as to secure a uniform and workable mix, which shall produce cured concrete of the weight and strength specified herein. Prior to mixing any concrete, which shall be used in the structure, the Contractor shall prepare trial batches, proportioned and tested in accordance with TxDOT Bulletin C-11. Additional sand may be required to improve workability of the mix.

At the option of the Contractor, natural fine aggregate may be substituted for fine lightweight aggregate, provided such substitution does not result in producing concrete that has a weight in excess of the permissible maximum specified herein.

The cement content, maximum air content and slump of the various classes of concrete, shall conform to the following table:

TABLE 4 - CLASSES OF LIGHTWEIGHT CONCRETE

Class	Min.-Max. Bags Cement per C.Y.	Min. Comp. Strength 28-Day psi	Max Slump	Air-Dried Weight Max.*	Total Air Content	Use
X	5.5 - 6.5	3000	**	110	6 - 9	General Structural
Y	5.5 - 7.0	5000	3	115	6 - 9	Prestressed Concrete
Z	5.5 - 8.0	As specified on plans	3	118	6.9	Prestressed Concrete

* Air-dried weight shall be measured after 7 days moist curing at 100% relative humidity at 73 (±2)°F (22.8 + 1.1°C) and stored for 21 days at 50 (±2) % relative humidity.

** Class X concrete shall be placed so that the average slump shall be maintained at approximately 3 inches (7.5 cm). No concrete shall be permitted with a slump in excess of 4 inches (10 cm.)

If the strength required for the class of concrete being produced is not secure with the minimum cement content specified, additional cement shall be used or other aggregates provided at the Contractor's expense.

B. QUALITY OF CONCRETE

1. Consistency - Concrete shall be of such consistency so as to insure the required workability and result in compact masses having dense, uniform surfaces. The proportions of the ingredients shall be varied only with the approval of the Owner.

In general, the consistency of lightweight concrete should be similar to that of natural aggregate concrete. Batches, which are harsh and unworkable, shall be redesigned at the Contractor's expense.

2. Other Qualities - During the progress of the work, the Owner shall cast and test cylinders to maintain a check on the compressive strength of the concrete being placed.

For prestressed lightweight concrete, one test (three-test cylinders) for each pertinent strength test required by the table in *Item A, Classifications and Proportions, of Section 5.2 Part 3* shall be required for each separate stressing line of beams, spans, piling, etc., as the case may be.

Testing and curing of cylinders shall be in accordance with *Section 5.1, Concrete and Reinforcement.*

Air content shall be checked by use of a pressure type air meter in accordance with ASTM Designation C 231.

Test for wet weight shall be made in accordance with ASTM Designation C 138.

The relationship between the air-dried weight of concrete and the wet weight of concrete shall be established by the Owner, based upon trial batches and checks made during progress of the work.

For each change in batch design weight and for each 25 cubic yards of concrete placed in the structure, two tests for weight shall be made. At any time that the average of these tests indicates a wet weight in excess of that which has been determined to produce air-dried concrete of the specified weight, the batch shall be adjusted to reduce the wet weight of concrete by the amount required.

C. MIXING

The following shall govern the mixing of lightweight concrete:

1. The cement-dispersing agent and at least $^{2}/_{3}$ of the total mixing water shall be introduced in the mixer and mixed for 15 seconds.

2. The fine and coarse aggregate shall be added and mixed for 45 seconds.

3. The cement and final water shall be added and mixing completed. The minimum mixing time shall be determined by the Owner for the concrete batch and the equipment used; but in no case shall the total mixing time be less than three minutes. Minimum mixing for concrete mixed in trucks shall be 100 revolutions of the drum.

The drum on truck mixers shall be operated at high speed while charging it with aggregate. Cement shall be introduced into the mixing drum while it is rotating at slow speed. Immediately prior to discharge of the concrete, the drum shall be rotated at high speed for 30 seconds.

D. PLACING, CURING AND FINISHING

The placing of concrete, including construction and removal of forms and falsework, curing and finishing shall be in accordance with *Section 5.1 Part 3, Execution*, except that floats used in finishing shall be metal shod.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Measurement and payment shall be in accordance with Item A.1, Concrete, of Section 5.1 Part 4.

SECTION 5.3: CONCRETE CURB AND GUTTER

PART 1: GENERAL

A. DESCRIPTION

Curb and gutter shall be constructed to the size, shape, lines and grade as shown on the plans or as directed by the Owner. Variations in size and shape may be made to fit individual special conditions.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

All materials and requirements for concrete shall conform to the requirements of *Section 5.1, Concrete and Reinforcement*.

B. MATERIAL TESTING

Refer to *Section 5.10, Materials Testing*.

C. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Excavation - Excavation shall be as provided in *Section 1.3, Unclassified Excavation*, and as shown on the plans.

2. Reinforcing Steel - All steel reinforcement shall be accurately placed as shown on the plans and held in place during progress of concreting by such effective means that it shall not be moved out of true position. All bars shall be wired at their intersections and at all laps or splices. All bars at splices shall be lapped a minimum to 40 diameters of the bar or 12 inches, whichever is greater.

All reinforcement necessary for a section of concrete shall be placed and approved by the Owner before any concrete is deposited in the section. All steel must be free from paint and oil; and all loose scale, rust, dirt and other foreign substances shall be completely removed before using.

3. Forms - All forms shall be made of wood or steel and framed, braced or staked in a substantial and approved manner so as to insure perfect alignment and grade. All forms shall be clean and shall be oiled immediately before concreting. Care shall be taken in removing forms to prevent marring or spalling of the concrete. Forms shall be a minimum of 1⅝ inches in thickness or equivalent when wooden forms are used or be a gauge that shall provide equivalent rigidity and strength when metal forms are used. Form dimensions may vary as directed by the Engineer.

All forms showing a deviation of ⅛" in 10 feet from a straight line shall be rejected.

For curves with a radius of less than 250 feet, acceptable flexible metal forms or wood forms shall be used.

4. Expansion Joints - Expansion joints shall be constructed, using expansion joint material of an approved type. Expansion joints shall be placed in the curb and gutter, at 50-foot intervals and at intersection returns and other rigid structures, or as otherwise specified by the Owner. Tooled joints shall also be placed at 10-foot intervals or matching abutting sidewalk joints and pavement joints. Expansion joints shall also be placed at all intersections with concrete driveways, curbs, buildings and other curbs and gutters. All expansion joints shall be not less than ½" in thickness, extending the full depth of the concrete; and shall be perpendicular and at right angles to the face of the curb. Any expansion material extending above the finished work shall be neatly trimmed to the surface of the finished work. The expansion joints in concrete pavement shall coincide with the expansion joints in curb and gutter and sidewalk. Longitudinal dowels, across the expansion joints in the curb and gutter, shall be required. There shall be three No. 5 round, smooth bars for dowels at each expansion joint spaced in accordance with the standard street details. The dowel shall be a minimum of 24" in length. One-half of the dowel shall be coated with asphalt and terminated with an expansion cap. The cap shall provide a minimum of 1" free expansion. Dowels shall be supported by an approved method to provide a true horizontal and longitudinal alignment.

In the event concrete pavement is to be placed in the street, the contraction (dummy) joints in the curb, gutter and/or combined curb and gutter shall be in strict alignment with the contraction (dummy) joints in the pavement, and may be marked with an approved tool to the depth designated by the Owner. If the joints are not constructed by marking; they shall be sawed at the time of sawing joints in the concrete slab and to the same depth as those in the slab. Expansion joints of the size of those in the pavement shall be placed through the curb and gutter at the point of, and in strict alignment with, expansion joints in the pavement.

All joints shall be constructed in a neat and workmanlike manner, with edges rounded, in conformity with the plans and specifications; and at location as shown on the plans or as designated by the Owner.

5. Concrete Placement - No concrete shall be placed when the air temperature is less than 35°F, unless permission to do so is granted by the Owner in writing. When such permission is granted, the Contractor shall furnish sufficient protective material and devices to enclose and protect the fresh concrete in such a way as to maintain the temperature of the air surrounding the fresh concrete at not less than 45°F for a period of at least five days.

Concrete shall be deposited so as to maintain a horizontal surface and shall be thoroughly and continuously worked into all spaces and around all reinforcement so as to form a dense voidless mass.

The course aggregate shall be worked away from contact with the forms so as to form a smooth, hard exposed concrete surface.

The concrete for curb and gutter shall preferably be placed continuously between expansion joints. If construction joints are allowed at other locations by the Owner, they shall be properly constructed with wooden bulkheads so as to completely separate adjacent concrete sections.

Curb and gutter forms must be “tapped” to minimize voids. Proper care must be exercised to ensure effective crack control joints. Any voids in curb and gutter sections shall be immediately patched with Portland cement mortar.

Integral curb, with or without gutter, when designated in the plans or specifications, shall be placed while the concrete in the base or pavement is still plastic; and shall be spaded and consolidated with the concrete slab in order that a thorough bond shall be obtained.

Integral curb, with or without gutter, shall be placed in sections equal to the adjoining concrete slab length, with expansion joints provided as specified herein.

6. Finishing - After the concrete has been struck off and while it is still plastic, the exposed surfaces shall be plastered with a ½" mortar topping. The mortar topping shall be applied with a steel "mule," or a finishing tool or method, which produces results equivalent to that obtained with the mule. All exposed surfaces shall then be floated or troweled and lightly brushed as required by the Owner to produce a smooth and uniform finish. Excess working of the surfaces shall be avoided. Excess water, laitance and inert materials shall be removed from the surfaces.

The top of all the work and the face of all curbs shall be checked for irregularities as soon as the surface is finished, using a 10-foot straightedge. The maximum distance from the straightedge to the concrete shall not exceed ¼". All variations greater than ¼" shall be immediately corrected. All honeycombed areas disclosed by removal of forms shall be immediately chipped out and patched with portland cement mortar.

7. Curing - After finishing operations are completed, the concrete surface shall be sprayed with an approved concrete curing compound. The surface of the concrete shall be kept thoroughly damp between the completion of the finishing operations and the application of the curing compound. The curing compound shall be applied under pressure, by means of a spray nozzle, at a rate not to exceed 200 square feet per gallon.

A minimum of 72 hours curing time shall be required. Should the Contractor elect to remove the forms before the minimum curing time has elapsed, he shall apply curing compound to the newly exposed vertical faces. Forms shall remain in place at least 24 hours after completion of the concrete placement for the curb and gutter.

Curb and gutter shall be cured a minimum of seven (7) days prior to the installation of base courses or shall obtain a concrete test cylinder break of 3,000 psi or a beam break of 500 psi. Curb and gutter shall be properly backfilled prior to placing base courses.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Curb and gutter shall be measured by the linear foot in place complete. Laydown curb and gutter shall also be measured by the linear foot.

The work performed and materials furnished as prescribed by this item, measured as provided in this item, shall be paid for at the contract unit prices bid for curb and gutter, which shall be full compensation for preparing the subgrade; furnishing and placing all materials, including foundation course, reinforcing steel and expansion joint material; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

SECTION 5.4: CONCRETE SIDEWALKS AND DRIVEWAY APPROACHES

PART 1: GENERAL

A. DESCRIPTION

This item shall govern the construction of barrier free access ramps, concrete sidewalk, driveways, and approaches conforming to the lines, grades, locations and designs as indicated on the plans and specifications, or as established by the Owner.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

1. General - All materials and requirements for concrete shall conform to the requirements of *Section 5.1 Concrete*.

2. Reinforcement - Driveway approaches and walk reinforcing, when required, shall be No. 3 bars on 18" centers. Sidewalk reinforcing (except in driveway approach) will be as shown on plans.

3. Slump - The placement of concrete must to comply with the specifications and ACI standards. Unless otherwise specified, concrete shall be placed at a 4” slump, plus or minus 1”. No water shall be added after the load has been slumped, inspected, and tested. Concrete should be vibrated where possible.

B. MATERIAL TESTING

Refer to *Section 5.10, Materials Testing.*

C. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. General - Concrete sidewalks shall have a minimum thickness of 4"; except that sidewalks constructed in driveway approach sections shall have a minimum thickness equal to that of driveway approach or as called by plans and specifications within the limits of the driveway approach. Standard slope for walks shall be ¼" per foot in the direction of the curb or street with a tolerance of ⅛" per foot. The construction of the driveway approach shall include the variable height radius curb in accordance with the plans and details.

At the locations shown on the plans or at locations designated by the Owner, the separate curb, integral curb or curb and gutter shall be laid down to a uniform width of not

less than the specified height of the curb from the back of the curb line for access to future driveways. The return radii and partial curb return shall be built from the face of the curb to the back of the curb lay-down.

Where a driveway approach is to be constructed at a location where there exists a separate curb and gutter, said curb and gutter shall be removed for the full width of the gutter to the nearest joint or to a sawed point at the point of radius. On concrete pavement with monolithic curb, the breakout line shall be 12" from the face of the curb line and shall be parallel to it and form a right angle with the concrete surface. The breakout line shall be a sawed groove in accordance with the requirements of *Section 6.7, Sawing.*

2. Excavation - Excavation required for the construction of sidewalks and driveways shall be to the lines and grades as established by the Owner; or as shown on the plans.

3. Fine Grading - The Contractor shall do all necessary filling, leveling and fine grading required to bring the subgrade to the exact grades specified and compacted to at least 95 percent of maximum density as determined by ASTM D 698. Moisture content shall be within minus 2 to plus 2 of optimum. Any over excavation may be repaired with compacted sand or gravel thoroughly wetted in place to the satisfaction of the Owner.

4. Forms - Forms shall be of wood or metal, of a section satisfactory to the Owner, straight, free from warp and of a depth equal to the thickness of the finished work. They shall be securely staked to line and grade and maintained in a true position during the depositing of concrete.

5. Finishing - Concrete sidewalks and driveway approaches shall be finished to a true, even surface. They shall be troweled and then brushed transversely to obtain a smooth uniform brush finish. Joint and sides shall be edged with suitable tools. Additional requirements for finishing are outlined in *Item F, Finishing, of Section 5.1 Part 3.*

6. Joints - Expansion joints for sidewalks and driveways shall be formed, using expansion joint material of an approved type and shaped to the section. Expansion joints shall be placed in the sidewalk at 50-foot intervals or as otherwise specified by the Owner. Expansion joints shall also be placed at all intersections, sidewalks with concrete driveways, curbs, formations, other sidewalks and other adjacent old concrete work. Similar material shall be placed around all obstructions protruding into or through sidewalks or driveways. All expansion joints shall be ½" in thickness. Edges of all construction and expansion joints and outer edges of all sidewalks shall be finished to approximately a ½" radius with a suitable finishing tool. Sidewalks shall be scored at intervals equal to the width of the walk with a marking tool. When sidewalk is against the curb, expansion joints and tooled grooves shall match those in the curb.

7. Curing - Sidewalks and driveways shall be cured in accordance with the requirements of *Item A.7, Curing, of Section 5.3 Part 3.*

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Measurement for sidewalks complete in place shall be by the square foot. Measurement for driveway approaches complete in place shall be by the square foot. Measurement of driveway approaches shall start at the lip of gutter and shall include the area of the curb radii. Curbs on driveways shall not be measured separately, but shall be included as a part of the driveway concrete. Concrete sidewalks and driveways shall be paid for at the contract unit price bid, which price shall be full compensation for excavating and preparing the subgrade; furnishing and placing all materials, including gravel base and expansion joint materials; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

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SECTION 5.5: DRILLED CONCRETE SHAFTS

PART 1: GENERAL

A. DESCRIPTION

This item shall govern for the construction of reinforced concrete shafts with or without bell type concrete footings. Such shafts shall be constructed in accordance with this item and in conformance with the details and governing dimensions shown on the plans.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

All concrete materials and their preparations shall be in accordance with the requirements of *Section 5.1, Concrete and Reinforcement*, and the additional requirements herein. All concrete shall be Class "A," 3,000 psi unless otherwise shown on the plans.

When casing of the shaft is required, the following shall apply:

1. The maximum size coarse aggregate shall be one and one-half (1½) inches.

2. The elapsed time from beginning of placement of concrete in the cased portion of the shaft until extraction of the casing is begun shall not exceed 30 minutes. If a cement-dispersing agent is used, this time shall not exceed one hour. If non-agitating equipment is used to haul the concrete from a central mixing plant, the elapsed time for discharge of concrete from the mixer to placement in the shaft shall not exceed 10 minutes. If a cement-dispersing agent is used, this time shall not exceed 30 minutes.

3. When the temperature of the air or concrete is above 85°F, an approved cement dispersing agent shall be required in all drilled shaft concrete. Reinforcing steel shall conform to the requirements of *Item A.7, Steel Reinforcement, of Section 5.1 Part 2.*

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Excavation - The Contractor shall do all excavation required for the shafts and bell footings, through whatever materials are encountered, and to the dimensions and elevations shown on the plans or required by the site conditions. Unless otherwise shown on the plans, all shafts shall be bored to plumb to a tolerance of 1½ inches for depths up to and including 10 feet. When bells are required, they shall be excavated so as to form a

bearing area of the size and shape shown on the plans. Shafts and bells may be excavated so as to form a bearing area of the size and shape shown on the plans.

The plans indicate the expected depths and elevations at which satisfactory bearing material shall be encountered; and this information shall be used as a basis for the contract. If satisfactory foundation materials are not encountered at plan elevations, the footings may be raised or lowered as determined by the Owner. Alterations in plan depths shall be made as judged proper to satisfactorily comply with the design requirements.

Casings shall be required for shaft excavations when such provision is necessary to prevent caving of the material or when necessary to shut off seepage water or when required by the Engineer and Owner. Casings shall be of ample strength to withstand handling stresses, the pressure of concrete and of the surrounding earth or backfill materials; and shall be watertight. The inside diameter of the casing shall not be less than the normal size of the shaft. No extra compensation shall be allowed for the concrete required to fill an oversize casing or oversize excavation.

When the drilling operation reaches a point where caving condition and/or excess ground water is encountered, no further drilling shall be allowed until a construction method is employed which shall prevent any caving that tends to make the excavation appreciably larger than the size of casings to be used. Drilling in a mud slurry without the removal of cuttings, or other construction methods which shall control the size of the excavation, shall not be permitted.

If the elevation of the top of the shaft is below ground level at the time of concrete placement, an oversize casing from ground elevation to a point below the top of the shaft shall be required to control caving of any material into the freshly placed concrete.

Any excavation for the footing bells or shafts beyond the lines required shall be backfilled with Class "A," 3,000 psi concrete at the Contractor's expense. Where casings are used, the Contractor shall be permitted to backfill around the upper portion of the casing with pea gravel or other granular material. Where a double casing is required for a portion of the shaft, no material shall be placed between the casings, but this area shall be filled with Class "A," 3,000 psi concrete.

Under normal operations when the casing is to be removed, the removal shall not be started until concrete placement is completed in the shaft. Movement of the casing for short pulls of a few inches or rotating of the casing shall be permitted. When unusual conditions warrant, the casing may be pulled in partial stages. In all cases, a sufficient head of concrete shall be maintained at all times above the bottom of the casing to overcome hydrostatic pressure. Extraction of the casing shall be at a slow, uniform rate and the full pull shall be in a truly vertical direction. If any upward movement of the concrete and/or inside the casing occurs at any time during the pulling operation, the following criteria shall govern:

a. If the upward movement is one inch or less, the casing shall be left in place. Vibration or rodding shall not be used to attempt to break the casing loose for extraction unless the entire shaft is to be replaced.

b. If the upward movement is greater than one inch, all of the material shall be removed and the entire drilled shaft operation shall be redone.

Placing of drilled shaft concrete under water shall not be done without the permission of the Owner.

Material excavated from shafts and bells and not used in the backfill around the completed bents or piers shall be disposed of as directed by the Owner. The disposal of such material shall be in such a manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other parts of the work.

At the time concrete is placed, the excavation shall be free from accumulated seepage water and all loose material shall be removed from the base area.

The Contractor shall provide suitable access and lighting for the Owner to inspect the completed foundation excavation and check the dimensions and alignment of drilled shafts and the under-reamed excavation when under-reaming is required. Any required lighting shall be by electric lights. Any mechanical equipment used in the excavations shall be operated by air or electricity. The use of gasoline-driven engines placed in the excavation for pumping or drilling shall not be permitted.

In order that the Owner may judge the adequacy of a proposed foundation, the Contractor, if requested, shall make soundings or take cores at his expense to determine the character of the supporting materials. The depth of such soundings or cores shall not be required to exceed five feet below the proposed footing grade. It is the intent of this provision that soundings shall be made or cores taken at the time the excavation in each foundation is approximately complete.

When the plans require drilled shafts in the abutments, the embankment at the bridge ends shall be made to grade as shown and thoroughly compacted, as provided in the governing specifications, prior to drilling for abutments shafts.

2. Reinforcing Steel - The reinforcing steel cage for the shaft, consisting of longitudinal bars and spiral hooping or lateral ties, shall be completely assembled and placed into the shaft as a unit. Generally, the reinforcing steel unit shall not be placed until immediately before concreting operations are to be started.

The longitudinal bars shall be tied or tack-welded to the spiral hooping at intervals not to exceed 12 inches on centers to provide a rigid unit.

For cased shafts where the reinforcing steel cage is over 30 feet in length the longitudinal bars shall be tied or tack-welded at each intersection of the spiral hooping for a distance of $^{1}/_{5}$th the depth of shaft from the bottom of the cage.

The cage of reinforcing steel shall be supported from the top by some positive method, to prevent slumping downward during extracting of the casing.

In uncased shafts, side spacer blocks of concrete shall be used at intervals along the shaft to insure concentric spacing for the entire length of shaft. In cased shafts, concrete spacer blocks shall not be used, but metal "chair" type spacers shall be placed vertically at intervals around the steel cage to insure concentric spacing inside the casing.

3. Concrete - The work shall be performed in accordance with the provisions of *Section 5.1, Concrete and Reinforcement,* and in conformance with the requirements herein.

Preferably, concrete shall be placed immediately after all excavation is complete and reinforcing steel placed.

Concrete placing shall be continuous from the beginning of placement in the shaft or footing bell to the top of shaft or to a construction joint as may be indicated on the plans. Time intervals shall be allowed for pulling casings, for placing forms and other operations necessarily carried on in sequence with the placing operations. The reinforcing steel cage shall be held vertically in some manner to restrain the steel from slumping during the concrete placement operation. Concrete shall be placed through a suitable tube to prevent segregation of concrete materials and unnecessary splashing on the reinforcing steel cage. The tube shall be made in sections to permit the discharge and raising as the placement progresses. A non-jointed pipe may be used if sufficient openings of the proper size are provided to allow for the flow of concrete into the shaft.

Whenever a casing is used, the casing shall be smooth and well oiled and shall extend sufficiently above the grade of the finished shaft to provide excess concrete to be placed for the anticipated slump due to the casing removal.

Where a casing is to be pulled, the concrete placed in casing shall be of such workability as to require no vibrating or rodding. Where a cap block or ground line strut is shown on the plans to be placed at the top of the drilled shaft, and the cap or strut is shown to be placed monolithic with the drilled shaft, a time interval shall be allowed for placing the required form and reinforcing after any necessary casing removal.

After a placement is completed, the top surface shall be cured, and any construction joint area shall be treated as prescribed in *Section 5.1, Concrete and Reinforcement.*

B. Test Holes

When shown on the plans, or when ordered by the Owner in writing, test holes shall be required to establish elevation for "belling" to determine elevation of ground water; or to determine other soil characteristics.

The diameter and depth of test hole or holes shall be as shown on the plans or as directed by the Owner.

C. Test Bells

When shown on the plans, or when ordered by the Owner in writing, the under-reaming of bells, on specified test holes, shall be required to establish the ability to under-ream in the soil strata present. The diameter and shape of the test bell shall be as shown on the plans or as directed by the Owner.

PART 4: MEASUREMENT AND PAYMENT

A. Measurement and Payment

Acceptable drilled shafts in place of the specified diameter shall be measured by the linear foot. At interior bents and piers, shafts shall be measured from a point of six inches below the ground elevation at the center of shaft unless otherwise indicated on the plans. At street grade separations and at railroad underpasses, the ground elevation shall be the completed roadway section under the structure. At stream crossings and at

railroad overpasses, the ground elevation shall be considered as the elevation existing at the time drilling begins. At abutment bents, the length of shaft shall be measured from the bottom of cap elevation.

Footing bells, constructed to the specified dimensions, or to the altered dimensions as authorized by the Owner, shall be measured by the cubic yard of concrete in the acceptable footings placed. The bell shall consist of the authorized footing volume outside the dimensions of the drilled shaft, which for the purpose of measurement shall be considered as extending to the bottom of the bell.

Test holes of the specified diameter shall be measured from the elevation of the ground at the time drilling begins, by the linear foot of acceptable test hole drilled.

Test bells of the specified diameter and shape shall be measured by each test bell acceptably under-reamed.

Drilled shafts shall be paid for at the unit price bid per linear foot of the specified diameter of "drilled shafts," measurements being made as hereinbefore outlined. Where vertical and spiral reinforcing bars from the shaft extend into footings, caps, columns or other concrete members, the cost of such reinforcing shall be included with and paid for as part of "drilled shafts."

Footing bells, constructed to the specified dimensions or to the altered dimensions as authorized by the Owner, shall be paid for at the contract unit price bid per cubic yard for "bell footing."

Test holes, of the specified diameter, shall be paid for at the contract unit price bid per linear foot for "test hole."

Test bells, of the specified diameter, shall be paid for at the contract unit price bid for each "test bell."

The foregoing unit prices shall be full compensation for making all excavations; for drilling all test holes and test bells; pumping, placing and removing any required casings; furnishing and placing all concrete and reinforcing steel; all backfilling; and furnishing all tools, labor, equipment, materials and incidentals necessary to complete the work. No extra payment shall be made for casings left in place.

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SECTION 5.6: MATERIALS TESTING

Construction Operation	Applicable Testing	Frequency of Testing
Concrete: Curb and Gutter Drive Approach Valley & Fillet Sidewalk & Wheelchair Ramps Concrete Lined Channel Cast-In-Place San. Sewer Manholes Storm Sewer Manholes Inlets Concrete Medians Reinforced Concrete Headers Concrete Steps Retaining Walls	Slump, Compressive Strength	On placements greater than 5 CY make one set of cylinders for first 25 CY and one additional set for every 75 CY thereafter. Applies to each class of concrete, each day.

SECTION 6
MISCELLANEOUS CONSTRUCTION

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SECTION 6.1: BARRIERS AND WARNING AND/OR DETOUR SIGNS

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of the basic requirements, which the Contractor must comply with, in order to assure the safety of the public, Owner's personnel and the Contractor's employees. The type and location of signs and barriers shall be provided as required in *Section 8.11, Public* Convenience and Safety, of *General Provisions*. Additional signs and/or barriers shall be erected if so directed by the Owner in writing.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Not Applicable

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. GENERAL

The amount of street space taken up by construction and maintenance work should be not more than is absolutely necessary, though this does not justify any failure to use such signs, warning devices and channelization as may be required in the roadway for public protection and guidance. The Contractor shall be held responsible for all damage to the work due to failure of barricades, signs, lights and watchmen to protect it. Whenever evidence is found of such damage, the Owner may order the damaged portion immediately removed and replaced by the Contractor at his cost and expense. The Contractor's responsibility for the maintenance of barricades, signs and lights and for providing watchmen shall not cease until the project is finally accepted by the Owner.

PART 4: MEASUREMENT AND PAYMENT

A. PAYMENT

The furnishing, placing and maintaining of barriers and warning and/or detour signs by the Contractor shall not be paid for directly but shall be considered subsidiary to the various bid items of the contract.

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SECTION 6.2: PAVEMENT MARKINGS

PART 1: GENERAL

A. DESCRIPTION

This item shall include the furnishing of all labor, equipment, materials, and the performance of all operations necessary for the application of permanent painted pavement markings on streets. The markings contractor shall use a crew experienced in the work of installing pavement markings, and in the necessary traffic control for such operations. Work zone safety during the pavement marking process is the responsibility of the pavement markings contractor. All flagging operations, vehicle-mounted arrow boards, lead and follow trucks, and construction warning devices shall be provided and used in accordance with the TMUTCD.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Traffic marking paint applied on streets shall meet the specifications of TXDOT. Specifically, the materials shall conform to TxDOT Departmental Materials Specifications D-9-8200, YPT-10 and/or WPT-10 and D-9-8290.

B. EQUIPMENT

Paint striping equipment used to place four-inch solid or broken line shall have the capability of placing a minimum of 40,000 linear feet of marking per working day. Equipment used for placing markings in widths other than four inches shall have capabilities similar to four-inch marking equipment, and shall be capable of placing linear markings up to eight inches in width in one pass.

The equipment shall be maintained in satisfactory operating condition. Four-inch marking equipment will be considered as unsatisfactorily maintained if it fails to have and average hourly placement rate of 5,000 linear feet in any five consecutive working days of seven hours or more.

The equipment shall be equipped so that one four-inch (10 cm) broken line and either one or two solid lines can be placed at the same time.

The equipment shall be equipped with an automatic cut-off device (with manual operating capabilities) to provide clean, square marking ends and to provide a method of applying broken line in a stripe-to-gap ratio of 10 to 30. The length of the stripe shall not be less than 10 feet nor longer than 10.5 feet. The total length of the stripe-gap cycle shall not be less than 39.5 feet nor longer than 40.5 feet in variance from one cycle to the next, nor shall the average total length of a cycle for a road mile of broken line exceed 40.5 feet or be less than 39.5 feet.

The equipment shall be capable of placing lines of all widths with clean edges and of uniform cross-section. Four-inch lines shall be four inches plus or minus ⅛ inch.

The equipment shall be equipped with bead dispensers, one for each paint spray gun, placed on the equipment so that beads are applied to the paint almost instantly as the marking is being placed on the roadway surface. The bead dispensers shall be designed and aligned so that beads are applied uniformly to the entire surface of the marking. The bead dispensers shall be equipped with automatic cut-off controls, synchronized with the cut-off of the marking equipment.

Paint pots or tanks shall be equipped with an agitator that will keep the paint thoroughly mixed and may be either a pressurized or non-pressurized type.

PART 3: EXECUTION

A. SURFACE CONDITIONS

It will be the responsibility of the markings contractor to assure that all surfaces are sufficiently clean prior to applying the painted markings of any material that will prevent adhesion of the paint to the roadway surface. Temporary markings are required on all streets as requiring markings as resurfacing is completed. The contractor may place permanent painted markings on overlaid streets immediately or within 24 hours to avoid this requirement. If temporary markings are used, permanent markings shall be placed within 7 calendar days. The markings contractor shall be responsible for complete removal of temporary markings. To ensure the safety of the motoring public, permanent painted markings shall be installed on the same day temporary markings are removed from a given roadway section. The markings contractor will not be allowed to paint over any temporary markings.

B. TYPES OF MARKINGS

The following marking types have been enumerated:

Type 1 - Double Yellow Solid: 4" lines
Type 2 - Double Yellow Solid/Broken: 4" lines, 10' line/30' skip
Type 3 - Single Yellow Broken: 4" line, 10' line/30' skip
Type 4 - Single White Solid: 4" line
Type 5 - Single White Broken: 4" line, 10' line/30' skip
Type 6 - Railroad Symbol and transverse pavement markings
Type 7 - Transverse: 12" lines inside painted medians/islands
Type 8 - Stop Line (White Solid): 18" lines
Type 9 - Crosswalk Line (White Solid): 6" lines
Type 10 - Painted Median (Yellow Solid): 8" lines
Type 11 - Painted Island (White or Yellow): Solid area
Type 12 - Left or Right Symbol Arrow: 8'
Type 13 - Through Symbol Arrow: 9.5'
Type 14 - Combination Through and Left/Right Symbol Arrow: 12.75'
Type 15 - Work Marking "ONLY": 8' x 5.75'

C. LANE SIZES AND LAYOUT

The markings contractor shall provide any pilot markings needed to facilitate the placement of the permanent markings specified for streets on the project. Standard lane

size shall be 12 feet. Minimum lane size is 10 feet. Maximum lane size shall be 15 feet. Combined travel and parking lane size shall be minimum 18 feet and maximum 22 feet.

Double line lane measurements shall be to the center of the space between lines. Single line lane measurements shall be made to the center of the painted line. All curb lane measurements shall be made to lip of gutter. Edge line, separating travel lane and shoulder shall be no closer than three feet to the edge of pavement.

Standard procedure for layout shall be to measure 12-foot lanes from street centerline out to each side. Continuous two-way left turn lanes shall be split on centerline. If necessary, interior lane sizes will be reduced before reducing curb lane size. Interior lane sizes, once established, shall remain constant. Any excess street width shall be added to curb lanes.

Longitudinal lines shall terminate no closer than 15 feet to the extended face of curb of crossing streets on the project street approach. The markings contractor will be required to perform lane reduction transitions to develop "teardrop" islands, and install transverse markings as necessary to produce a smoothly-transitioned, easily-driveable overall appearance.

E. Application

Paint shall be applied at a rate of not less than 15 gallons nor more than 20 gallons per mile of solid four-inch stripe. Application rate for solid eight-inch stripe shall be between 30 and 40 gallons per mile. (These rates yield wet film thicknesses from 15 to 20 mils.)

Beads shall be applied to the paint marking at a uniform rate sufficient to achieve the retro-reflective characteristics specified when observed in accordance with Test Method Tex-828-B. All markings placed shall have uniform distinctive retro-reflective characteristics. Under no circumstances shall bead application rate be less than eight pounds of beads per gallon of paint applied to the road surface.

Applied markings shall be protected from traffic until they have dried sufficiently so as not to be damaged or tracked by normal traffic movements.

F. Inspection

The City of Waco shall provide an inspector to accompany the markings contractor. The inspector shall have authority to stop work for bad weather, disputes or clarification of markings layout, if in the inspector's estimation it would be imprudent to proceed. The inspector shall have the authority to request the markings contractor to provide pilot markings in complex markings areas for the purpose of driving through and revising for smooth transition.

PART 4: MEASUREMENT AND PAYMENT

A. Measurement

Work for Permanent Painted Pavement Marking will be measured by the linear foot of the various widths. Lengths indicated on the bid proposal include gaps for 30' skips in broken lines. Gaps for intersections are not included in the lengths.

B. PAYMENT

Work performed as prescribed by this item shall be paid for at the unit price bid for "Permanent Painted Pavement Markings" per linear foot of the various widths specified, per square foot of islands, and per unit for railroad, arrow symbol and word pavement markings. This price shall be full compensation for furnishing all labor, tools, equipment, materials, and incidentals necessary to complete the work specified.

SECTION 6.3: ROADWAY ILLUMINATION ASSEMBLIES

PART 1: GENERAL

A. DESCRIPTION

This item shall govern for furnishing and installing the various types of roadway illumination assemblies shown on the plans.

The term "roadway illumination assembly" as used herein shall constitute the complete assemblage of poles, mast arms, parts, equipment and miscellaneous components, foundations, erected as shown on the plans and in accordance with these specifications, forming a complete and independent lighting unit.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. GENERAL

All materials furnished by the Contractor under this section shall be new and in accordance with the NEC.

All materials and construction methods shall be in accordance with the details shown on the plans, the requirements of this section and the pertinent requirements of the following sections:

Section 6.8, Painting.
Section 6.9, Electrical Conduit.
Item A, Metals for Structures, of Section 6.3.A Part 2.

The Contractor shall furnish six (6) sets of shop drawings of the complete assembly and the drawings shall be submitted to the Engineer for review and approval.

B. SAMPLING

Sampling of luminaires, lamps and ballasts will be in accordance with TxDOT Test Method Tex-714-I.

C. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Roadway illumination assemblies shall be fabricated and installed in accordance with the details and dimensions shown on the plans or as approved in writing by the Engineer.

Roadway illumination assemblies shall be located as shown on the plans, except that the Engineer may shift the assembly locations, within design guidelines, where necessary to secure a more desirable location or to avoid conflict with utilities. Unless otherwise shown on the plans, the Contractor shall stake and the Engineer will verify all roadway illumination assembly locations.

Erection of poles and luminaires located near any overhead or underground utilities shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning such work.

The careful erection and aligning of the roadway illumination assemblies shall be considered an essential feature of the installation of the assemblies.

Any steel part or member on which galvanizing has been damaged shall be repaired in accordance with *Item A, Metals for Structures, of Section 6.3.A Part 2.*

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

This item will be measured as each roadway illumination assembly complete in place or as stated in the bid proposal.

The work performed and materials furnished in accordance with this item and measured as provided, will be paid for at the unit price bid for "Roadway Illumination Assemblies" of the various types specified or as otherwise stated. This price shall be full compensation for furnishing, installing and testing all luminaires, ballasts, poles, lamps, foundations, anchor bolts, anchor plates (when required), internal conductors and connections; and for all labor, tools, equipment and incidentals necessary to complete the work.

SECTION 6.4: MOBILIZATION

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of the mobilization of personnel, equipment and supplies at the project site in preparation for beginning work on other contract items or other project incidentals.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Not Applicable

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Not Applicable

PART 4: MEASUREMENT AND PAYMENT

A. PAYMENT

Partial payments of the "Lump Sum" bid for mobilization will be as specified by the following. The adjusted contract amount for construction items as used below is defined as the total contract amount less the lump sum bid for mobilization.

1. When 1% of the adjusted contract amount for construction items is earned, 50% of the mobilization lump sum bid will be paid.

2. When 5% of the adjusted contract amount for construction items is earned, 75% of the mobilization lump sum bid will be paid.

3. When 10% of the adjusted contract amount for construction items is earned, 90% of the mobilization lump sum bid will be paid.

4. Upon completion of all work items, payment for the remainder of the mobilization lump sum bid will be made.

5. The lump sum bid for mobilization shall not exceed 10% of the total contract.

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SECTION 6.5: METAL BEAM GUARDRAIL

PART 1: GENERAL

A. DESCRIPTION

This item shall consist of furnishing and installing metal guard rail where indicated on the plans or as directed by the Owner. Railing shall be constructed in accordance with these specifications and as shown on the plans.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Metal railings shall be fabricated from the materials specified and shall be in accordance with these specifications and as shown on the plans and contract documents.

1. Steel Railings - Steel railings shall be fabricated for Structural Steel, ASTM A 36, steel of either 10-gauge (0.1345", nominal thickness) or 12-gauge (0.1046", nominal thickness). Minimum tensile strength of the rail element and joint, when tested in tension, parallel to the axis of the rail, shall be not less than 100,000 pounds for 10-gauge or 60,000 pounds for 12-gauge.

a. Painted Steel Railings - Painted steel rail shall meet the requirements for steel railings. Paint and painting systems shall be as specified.

b. Galvanized Steel Railings - Galvanized steel railing shall meet the requirements of Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip, ASTM Designation A 123.

2. Flexible Metal Beam Guard Railings - The rail elements shall be of the W-beam type fabricated to develop continuous beam strength and shall consist of metal plate or sheet formed into a beam as shown on the plans. The beam shall be free from warp. When tested with a straight edge or string along either edge of a 12½-foot sectional length of beam, the maximum deviation of the beam edges from the straight edged shall not exceed ½ inch at any point.

The steel for the rail elements shall conform to the requirements of AASHTO M-180. The rail shall be 10-gauge (0.1345 ± 0.008 inch) or 12-gauge (0.1046 ± 0.008 inch) as shown on the plans. Rail elements shall contain not more than 0.04 percent phosphorous nor more than 0.05 percent sulphur.

The rail element for the terminal anchor section shall be of the same materials as the rail element used throughout the project.

Unless otherwise shown on the plans, the rail element shall be galvanized in accordance with the requirements of *Item B, Galvanizing, of Section 6.8 Part 2* except that the galvanized coating shall not be less than 1.80 ounces per square foot of double exposed surface (single spot test).

3. Rejection - Any metal or material specified in this section may be rejected for failure to meet all of the provisions of this specification or for any defect causing said metal or material to be unsuitable for its intended use.

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Unless the plans call for setting in concrete, the posts shall be backfilled by thoroughly tamping the material in 4" layers. The rail elements shall be erected to produce a smooth, continuous rail paralleling the line and grade of the roadway surface or as shown on the plans. The rail elements shall be joined end-to-end by bolts and lapped in the direction of traffic in the lane adjoining the guardrail. When designated on the plans, the rail elements shall be curved before erection. Holes for special details may be field-drilled; or punched with the approval of the Owner. After erection, the timber posts shall be painted with two coats of finish paint. Steel posts and non-galvanized rail shall be painted with one prime coat of paint and two coats finish paint in accordance with *Section 6.8, Painting.*

All parts of galvanized rail elements on which the galvanizing has become scratched, chipped or otherwise damaged after erection shall be thoroughly cleaned by wire brushing the damaged area to remove all loose, cracked or bruised spelter material coating. The cleaned area shall be painted with two coats of zinc dust-zinc oxide paint conforming to the requirement of Federal Specifications MIL-P-15145.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

The railing shall be measured by the linear foot from end to end along the face of the railing including terminal sections. The price paid per linear foot for steel guard rail in place shall be full compensation for furnishing all labor, materials, tools, equipment and performing all work involved in construction of the guard rail as required by the plans and these specifications.

SECTION 6.6: RAILING

PART 1: GENERAL

A. DESCRIPTION

This item shall govern for the construction of steel, aluminum, cast iron or pipe railing, including necessary anchorages on bridges, walls or incidental structures as designated on the plans.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

All materials shall conform to the requirements of *Item A, Metals for Structures, of Section 6.3.A Part 2.* Unless otherwise indicated in the plans or specifications, pipe railing shall be standard black pipe.

Railing materials shall be stored above the ground on platforms, skids or other supports. The materials shall be kept from grease, dirt and contact with dissimilar metals. Care shall be taken at all times to avoid scratching, marring, denting, discoloring or otherwise damaging the railing. Unpacking and storing of rail members, upon arrival at the job site, shall be in accordance with manufacturer's recommendations.

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Railing shall be of size and type shown on the plans; and constructed in accordance with details shown on the plans and in conformance with the requirements herein. It shall be constructed to the alignment, grade and camber as designated on the plans. Shop fabricated railing shall be of such uniformity as to insure good joints and continuous lines after erection. Any appreciable amount of cutting, bending or filling required on erection to produce a reasonable fit shall be cause for rejection of the rail. Unless otherwise shown on the plans, rail posts shall be erected plumb, with the top rails parallel to the roadway grade indicated on the plans or to the surface of the structure on which the rail is mounted. The fabrication and erection of metal for railing shall conform to the pertinent provisions of *Section 6.3.A, Steel Structures*, and to the requirements of this specification.

Shop drawings shall be prepared and forwarded for approval in accordance with the requirements of *Section 6.3.A, Steel Structures.* Splicing of members shall be permitted only as provided by the contract plans.

Splices shall be at rail posts only. All splice locations and details shall be shown on the shop drawings.

The vertical members of the railing may be placed in the correct position and alignment at the time of placing the concrete; or oversize sleeves may be embedded in the proper location and position for subsequent installation of the railing in the sleeves. If sleeves are used, the railing shall be placed in the sleeves and set with molten sulphur compound.

Unless otherwise indicated, aluminum members shall be separated from concrete or steel by a bearing pad conforming to the requirements for preformed rubber fabric pads as described in *Section 6.3.A, Steel Structures.* The material shall be ⅛" in thickness unless otherwise specified. All welding shall conform with the recommendations of the American Welding Society. Welding of aluminum materials shall be done by an inert gas shielded electric arc welding process in which no flux is used. Torch or flame cutting of aluminum shall not be permitted.

After erection, the railing shall be painted with one prime coat and two field coats of paint conforming to the requirements of *Section 6.8, Painting.* Aluminum railing shall not require field painting. Prior to acceptance, all extrusion marks, grease, dirt and grime shall be cleaned from aluminum railing.

Steel railing shall be given one shop coat. This coating shall be of sufficient quality and coverage to protect the metal from corrosion. After erection, the railing shall be cleaned, spot painted and painted in accordance with *Section 6.8, Painting.*

If galvanized rail is used, all parts of the rail on which the galvanizing has become scratched, chipped or otherwise damaged shall be thoroughly cleaned by wire brushing the damage area to remove all loose, cracked or bruised spelter coating. The cleaned area shall be painted with two coats of zinc dust-zinc oxide paint conforming to the requirements of Federal Specifications MIL-P-15145.

Unless otherwise provided, railing shall not be placed until after the falsework for the span has been released. During construction of railing, care shall be exercised to insure proper functioning of expansion joints, if any.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Railing shall be measured as the number of linear feet of satisfactorily completed railing.

Payment shall be made at the contract price bid per linear foot for "railing," which price shall be full compensation for all pipe structural shapes, paint, labor, tools and equipment; and all incidentals necessary for the completed railing in conformity with the plans and these specifications.

SECTION 6.7: SAWING

PART 1: GENERAL

A. DESCRIPTION

This item shall apply in the removal of bituminous or concrete pavement, curb, gutter, sidewalk or driveways. This item shall also govern for the sawing of weakened plane joints (contraction joints).

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Not Applicable

B. EQUIPMENT

The saw shall be power-driven, shall be manufactured especially for the purpose of sawing concrete, shall be suitable for the work to be performed including dust control and shall be maintained in good operating condition.

Saw blades shall make a clean, smooth cut, producing a groove ⅛" to ¼" wide and to the full depth required by these specifications or as shown on the plans.

The saw, with its control devices, shall be mounted on a sturdy frame supported on rubber-tired wheels.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. General - Sawing shall be in accordance with the requirements of this item unless otherwise shown on the plans or in the special provisions.

2. Removing Pavement, Curb, Gutter, Sidewalk and/or Driveways - The edge of pavements and appurtenances shall be neatly sawed prior to the replacement of the paving. Saw cuts shall be made to a minimum depth of 2". Except for sidewalks, if a saw cut falls within three feet of a construction joint, cold joint, expansion joint or edge, the materials to be removed shall be removed to the joint or edge. For sidewalks, if a saw cut falls within 18" of a construction joint, cold joint, expansion joint or edge, the materials to be removed shall be removed to the joint or edge. The edges of pavement and appurtenances, which are damaged subsequent to sawing, shall again be saw cut to neat straight lines for the purpose of removing the damaged areas. Such saw cuts shall be parallel to the original saw cut.

Concrete sidewalk or driveway to be removed shall be neatly sawed in straight lines either parallel to the curb or at right angles to the alignment of the sidewalk. No section to be replaced shall be smaller than 30" in either length or width unless otherwise approved by the Owner.

3. Saw Cuts for Contraction Joints - Saw cuts for contraction joints shall be a minimum of ¼ the depth of the pavement.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Sawing shall not be measured for payment, but shall be considered subsidiary to the items requiring sawing

SECTION 6.8: PAINTING

PART 1: GENERAL

A. DESCRIPTION

This item shall govern for the type, quality and for the application of paint to structures. The painting of structures shall include, unless otherwise provided in the contract, the preparation of the surfaces, the application, protection and drying of the paint coatings, the protection of all traffic upon, underneath, or near the structure, the protection of all parts of the structure against disfigurement by any and all painting operations and the supplying of all tools, tackle, scaffolding, labor, workmanship, paint and materials necessary for the completion of the entire work in accordance with the plans and these specifications.

The intent of the coating design herein specified is to procure the paints in and on structures so that the durability and protective value of these designs shall be realized in service. Accordingly, the best quality materials and workmanship are implied throughout. Surface conditions and application requirements are specified with the intent to obtain full adhesion of paint to clean dry firm surfaces. This shall require careful attention to preparation of surface, to the prevention of contamination and marring of the coating during and after drying, and to uniform, skilled application.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. PAINT

Paint shall be homogeneous, free of contaminants and of a consistency suitable for the use for which it is intended. The pigment shall be finely ground and properly dispersed in the vehicle according to the requirements of the paint. This dispersion shall be of such nature that the pigment does not settle appreciably, does not cake nor thicken in the container, nor become granular nor curdled. Paint and paint materials shall be delivered to the job site in new, unopened, airtight containers, appropriately identified with the manufacturer's name, date of manufacture, type of paint or paint material, specification number and lot or batch number.

No paint shall be used until at least seven days have elapsed from the date of manufacture.

1. Paint Systems - The first coat of paint applied to an unpainted surface shall be called the prime coat. The paint applied to field connections, welds, rivets and all damaged or defectively painted or rusty areas shall be a prime coat. The paint applied over the prime coat shall be called the finish coat.

Paint materials shall conform in all respects to the requirements of the reference specifications indicated for such material in the following tables:

a. Pigments

(1) White

(a) Pure TiO_2 Rutile - Titanium Dioxide Pigments, ASTM Designation D 476, Type IV.

(b) Lead Free Zinc Yellow - Zinc Oxide, ASTM Designation D 79, either American or French process.

(2) Yellow - Zinc Yellow (Zinc Chromate) Pigments, ASTM Designation D 478.

(3) Red - Red Lead, ASTM Designation D 83.

(4) Green - Chrome Oxide Green, ASTM Designation D 263.

(5) Metallic

(a) Aluminum - Aluminum, Pigments, Powder and Paste, for Paints, ASTM Designation D 962 (leafing pigment), Type II, Class B.

Testing of aluminum paste shall conform to Aluminum Powder and Paste, Sampling and Testing, ASTM Designation D 480, except that the leafing test vehicle, described in paragraph 8, shall be composed of 30 grams of Neville LX-685-125 Resin, 20 ml of Xylol* and 80 ml of Mineral Spirits.**

** Xylol - Industrial Grade Xylene, ASTM Designation D 364.*

*** Mineral Spirits - Petroleum Spirits (Mineral Spirits), ASTM Designation D 235.*

(b) Zinc Dust - Zinc Dust (Metallic Zinc Powder), ASTM Designation D 520.

(6) Inert

(a) Talc - Magnesium Silicate Pigment, ASTM Designation D 605.

(b) Diatomaceous Silica Pigment, ASTM Designation D 604, Type A.

b. Resins

(1) Chlorinated Paraffin - MIL-C-429A, Type I or Type II.

(2) Solid Petroleum Resin -

Melting Point degrees Fahrenheit (Ring and Bell)	200 - 300
Acid Number	1 Max.
Saponification Number	2 Max.
Specific Gravity	1.0 Min.

Color - 50% solution (by weight) in Xylol* shall be no darker than #15 Gardner scale.

Compatibility - A mixture (by weight) of 14% resin, 47% OKO S-70 oil, 32% mineral spirits**, and 7% Xylol* shall show no cloud nor settling after 24 hours at 77°F.

** Xylol - shall meet Industrial Grade Xylene, ASTM Designation D 364.*

*** Mineral Spirits - shall meet Petroleum Spirits (Mineral Spirits), ASTM Designation D 235, Type IV.*

(3) Polyurethane Resin (60%)

(a) General

Type:	Oil Modified
Type Oil:	Linseed
Type Solvent:	Mineral Spirits*
% Solids:	59.9 - 61.0

(b)	**Solid Resin Basis**	**Min.**	**Max.**
	Acid Number	--	3.5
	% Nitrogen	2.3	4.0
	Free NOC	--	--
	Iodine Number of Fatty Acids	177	--
(c)	**Resin Solutions**	**Min.**	**Max.**
	% Solids	59.0	61.0
	Weight per gallon	7.0	7.8
	Modifying Resins	--	--
	Appearance:	Clear, transparent and homogeneous when examined by transmitted light.	
(d)	**50% Solid Basis**		
	Color (Gardner-Holdt)	8 max.	
	Dry Times** with:		
	Mineral Spirits*	3 mil wet film	
	SST, max.	60 minutes	
	TF, max.	120 minutes	
(e)	**Viscosity-Gardner**	**Min.**	**Max.**
	With Mineral Spirits*		
	59.0 to 61.0% Solids	Z	Z-2
	50.0% Solids	E	H
	40.0% Solids	A-3	A

**** Mineral Spirits - shall meet Petroleum Spirits (Mineral Spirits). ASTM Designation D 235, Type IV; and in addition, shall have a KB value from 3¼ to 36.***

***** Driers shall be 0.36% lead, 0.02% cobalt, 0.02% manganese, and 0.04% calcium as metal based on the resin solids present.***

(4) Vinyl-Toluene/Acrylate Copolymer

(a) General

Form: Shall be white granular powder or friable granular.

	Min.	**Max.**
Specified Gravity, 25°C	1.025	1.035
Refraction Index, 25°C	1.553	1.563
Softening Point, °C	130	140
Acid Number	--	6.1

(b) Solution Viscosity, Seconds #4

Ford Cup 77°, with Xylol	**Min.**	**Max.**
40% Non-Volatile	60	110
33_% Non-Volatile	25	55
30% Non-Volatile	14	40

(c) Film

A one mil dry film cast from a 30% solution in Xylol* shall be colorless and transparent.

In addition to the above requirements, the infrared spectra shall match the spectra on file with the Materials and Test Division of the Texas State Department of Highways and Public Transportation.

Xylol - Shall meet Industrial Grade Xylene, ASTM Designation D 364.

(5) Long Oil Alkyd (70%)

(a) General

Type:	Pure Drying Alkyd
Non-Volatile:	69 - 71%
Viscosity (Gardner 1963):	9
Volatile:	Xylol*
Acid Number Max. (Solution Basis):	4
Phthalic Anhydride:	ASTM D 563
Minimum on Non-Volatile:	24%
Type of Oil:	Soybean
% Oil on Non-Volatile Calculated:	65
Mineral Spirits** Tolerance:	1000%
Resin and/or Derivatives:	None
Phenolic Resin Modifiers:	None

(b) Compatibility - A solution containing the equivalent of 120 grams of 5 equivalent of cps chlorinated rubber, 215 grams of 70% long oil alkyd, and 225 grams of Xylol* shall be clear, transparent and show no separation after 24 hours of storage in a ¾ full test tube at +5°F. This rubber-alkyd solvent solution shall produce a clear film upon drying.

(c) 50% Solids Basis (Xylol*)

Drying Time: A 3 mil wet film at 77°F:

Dust Free	1 - 2 Hours
Tack Free	5 - 6 Hours
Hard	8 - 10 Hours

Driers***: Based on the resin solids present, all the equivalent of 0.06% cobalt (metal) and 1.0% lead (metal).

** Xylol - Shall meet Industrial Grade Xylene, ASTM Designation D 364.*

*** Mineral Spirits - Shall meet petroleum Spirits (Mineral Spirits), ASTM Designation D 235, Type IV.*

****Driers - Shall meet Liquid Paint Driers, ASTM Designation D 600.*

(6) Chlorinated Rubber - Must be approved by the Owner prior to the use of coatings in which the material is proposed for use.

Viscosity @ 25°C (20% solution with Toluene*) 4-7 cps.

** Toluene - Shall meet Industrial Grade Toluene, ASTM Designation D 362.*

Substitution in a standard formula shall not result in a viscosity variation greater than 4 KU.

c. Oils

(1) Raw Linseed Oil - ASTM Designation D 234

(2) Polymerized Linseed Oil	**Min.**	**Max.**
Acid Number	--	3.0
Iodine Number, Wijs	115	130
Saponification Number	190	199
Refractive Index, 26°C	1.483	1.491
Specific Gravity	0.955	0.965
% Solids	99.5	--

(3) Modified Linseed Oil	**Min.**	**Max.**
Acid Number	--	4.0
Iodine Number, Wijs	50	180
Saponification Number	152	172
Refractive Index, 25°C	1,500	1,508
Viscosity, Gardner	Z-3	Z-4
Specific Gravity	0.975	0.985
% Solids	99.5	--

(4) Surface Activity Oil	**Min.**	**Max.**
Cloud Point, °F	44	48
Pour Point, °F	40	44
Free Fatty Acids (as oleic)	--	2.0%
Iodine Number	60	70
Saponification Number	185	195
Flash Point, °F, COC	390	--
Fire Point, °F, COC	420	--
Color, NPA	--	--
Specific Gravity, 60°F (16°C)	0.895	0.905
Viscosity SSU, 100°F (38°C)	90	100

d. Thinners

(a) Mineral Spirits - Petroleum Spirits (Mineral Spirits), ASTM Designation D 235, Type I or IV.

(b) Xylol - Industrial Grade Xylene, ASTM Designation D 364.

(c) VM & P Naptha - VM & P Napthas, ASTM Designation D 3735, Type I.

(d) MIBK - Methyl Isobutyl Ketone, ASTM Designation D 1153.

(e) Butyl Alcohol - Secondary Butyl Alcohol, ASTM Designation D 1007.

(f) Dipentene - Federal Specifications TT-D-376c.

(g) Toluene - Industrial Grade Toluene, ASTM Designation D 362.

(h) Aromatic Naptha - SC-100	**Min.**	**Max.**
% Aromatics	95	--
Boiling Range	310	350
Kauri-Butanol Value	90	--
Specific Gravity, 25°C	0.865	8.876
Appearance	Clear, Sediment Free	

(i) Butyl Cellosolve

Appearance	Clear, Sediment Free
Color	Water White
Boiling Range	166° to 173°F
Chemical Formula	$C_4H_9OC_2H_4OH$

e. Additives and Chemicals

(1) Driers - Liquid Paint Driers, ASTM Designation D 600.

(2) Additives must be approved by the Owner prior to the use of coatings in which the additive is proposed for use.

(a) Anti-Skinning Agent

(b) Betone - N.L. Industries

(c) Thix-A-Trol "ST", N.L. Industries

(d) Stabilizer

- Thermolite 813, M & T Chemicals, Inc.
- Stanclere TM, Interstab Chemicals, Inc.

2. Traffic Paint

a. General - Paint for traffic striping and marking shall correspond with the requirements as shown in this specification or on the plans and contract documents.

b. Pigments

(1) White

(a) Pure Titanium Dioxide, Tutile, Nonchalking - Titanium Dioxide Pigments, ASTM Designation D 476, Type II.

(b) Zinc Oxide - Zinc Oxide, ASTM Designation D 79, either American process or French process.

(2) Colored

(a) Titanium Dioxide, Special, Rutile, Nonchalking

Specific Gravity	4.1 ± 0.05
Oil Absorption	18 ± 18%
Moisture	0.5% max.
Retained on #325 Mesh	0.1% max.
TiO	9.5% max.
Fe O_3	2.0 - 3.0%
pH	6.5 - 7.0
Ignition Loss	0.35% max.
Y (luminosity)	42.5 - 45.5

(b) Medium Chrome Yellow - Color and Color Characteristics: The luminance factor of the pigment shall be within the following limits when tested before and after exposure:

	Min.	Max.
Initial	53	59.0
Final	45	

In addition, the allowable change between the initial and final luminance factors shall be no more than nine units.

The initial x and y chromaticity color coordinates of the pigment shall be within the rectangle defined by the sets of coordinates shown below:

X	**Y**
0.490	0.455
0.511	0.433
0.514	0.480
0.535	0.458

Method of Test - The pigment shall be tested according to TxDOT Test Method Tex-810-B.

The formulation of the test using the pigment to be tested is as follows:

Material	**Parts by Weight**
Color Pigment	54.0
Long Oil Alkyd Resin	31.5
4% Calcium Drier	0.6
6% Cobalt Drier	0.3
Anti-Livering Agent	0.1
Anti-Skinning Agent	0.2
Mineral Spirits (2)	13.3 (3)

- Alkyd resin solution meeting Federal Specification TT-R-2660D, Type I, Class A.
- Mineral spirits meeting Petroleum Spirits (Mineral Spirits), ASTM Designation D 235, Type IV.
- The amount of mineral spirits may be varied slightly to produce the desired grinding consistency.

Number of coats: Two

(3) Inert

(a) Talc, Paint-Grade Magnesium Silicate - Shall meet Magnesium Silicate Pigment, ASTM Designation D 605.

(b) Calcium Carbonate

$CaCO_3$	Min. 97.0%
H_2O	Max. 0.4%
Specific Gravity	2.63 - 2.73
Weight retained on #325 Screen	Max. 0.75

Substitution in a formula shall not result in a viscosity variation greater than 4 KU.

(c) Calcine Kaolin (Aluminum Silicate, Anhydrous)

	Min.	**Max.**

Al_2O_3	39.5	44.0
SiO	51.0	56.5
Fe_2O_3		1.0
TiO_2		2.5
CaO + MgO		0.8
$Na_2 + K_2O$		1.2
Ignition Loss		1.0

In addition, the X-ray diffraction pattern shall match the X-ray diffraction pattern on file at the Materials and Tests Division of TxDOT.

Materials having color requirements shall be tested according to TxDOT Test Method Tex-810-B.

c. Resins

(1) Chlorinated Paraffin - Shall meet Federal Specifications MIL-C-429C, Type I.

(2) Chlorinated Rubber - Shall be similar and equal to the standard sample submitted to TxDOT by the manufacturer and approved by the Department prior to the award of contracts for use.

Viscosity @ 25°C (20% solution with Toluol*****) 17 - 22 cps.

Substitution in a formula shall not result in a viscosity variation greater than 4 KU.

**** Toluol - Industrial Grade Toluene, ASTM Designation D 362.***

(3) Traffic Paint Alkyd Resin Solution

(a) General

Type:	Pure, drying alkyd
Length:	Medium
Type Oil:	Soya, linseed or tall. No mixture of two or more oils shall be permitted.
Solvent:	Toluol, Industrial Grade Toluene, ASTM Designation D 362.
Compatibility:	A solution of one part 75% traffic alkyd and five parts toluol shall be clear.

A solution containing the equivalent of 120 grams of 20 cps chlorinated rubber, 130 grams of 75% traffic alkyd, 200 grams of methyl ethyl ketone shall be clear, transparent and show no separation after 24 hours of storage in a ¾ full test tube at 80° +/-5°F. This rubber-alkyd-solvent solution shall produce a clear film upon drying.

(b) Solid Resin Basis

Percent Phthalic Anhydrides	33 to 37
Percent Oil Acids	48 to 55
Acid Number, max.	9.0
Ash Residue, max.	0.10%

Unsaponifiable, max.	2.0%
Iodine Number of Fatty Acids, min.	115
Refractive Index of Fatty Acids, min.	1.4660
Percent Resin based on Fatty Acids (Tall Oil Alkyds), max.	1.0

(c) 45% Solids Basis*

Color: Gardner 1953 Standard - 9 max.

Drying Time: A wet film 3 mils thick shall set to touch in not more than 90 minutes.

(**Driers:** Based on the resin solids present, add the equivalent of 0.06% cobalt (metal) and 1.0% lead (metal)).

**** Toluol shall be used to reduce the resin solution to 45% solids and meet Industrial Grade Toluene, ASTM Designation D 362.***

(d) Turbidity - In addition to the above requirements, the traffic alkyd resin shall meet the following % transmittance requirements when tested according to TxDOT Test Method Tex-814-B, utilizing methyl isobutyl ketone as primary solvent, and methyl alcohol as precipitating agent.

% Transmittance	Min.	Max.
T_1	10.0%	
T_2		70.0%

Calculate volume in milliliters of precipitating agent as follows:

$$V_1 - 91x$$

where: V_1 = volume of precipitating agent required for T_1
x = grams of alkyd resin solids

and

$$V_2 = 1.398\ V_1$$

where: V_2 = additional volume of precipitating agent required for T_2.

d. Thinners

(1) Methyl Ethyl Ketone - Methyl Ethyl Ketone, ASTM Designation D 740.

(2) Aromatic Naptha

Appearance	Clear, free of sediment
Color	Water, white
Boiling Range	360°F - 415°F
Kauri Butanol Value	88 min.
Specific Gravity, 25°C	0.884 - 0.894
Flash Point, °F (TCC)	140 min.

e. Additives and Chemicals

(1) Driers - Liquid Paint Driers, ASTM Designation D 600.

(2) Additives must be approved by the Owner prior to the use of coatings in which the additive is proposed for use.

(a) Stabilizer

- Thermolite 813, M&T Chemicals, Inc.
- Stanclere TM, Interstab Chemicals, Inc.

(b) Treated Bentonite Clay

- Bentone 34, NL Industries
- Claytone 40, Southern Clay Products

3. Thermoplastic Paint - The thermoplastic traffic line paint shall conform to one of the following:

a. Specification No. 1 - Thermoplastic traffic line in paint shall be a reflectorized thermoplastic pavement striping material applied to the road surface in a molten state by mechanical means. It shall have surface application of glass beads, which, upon cooling to normal pavement temperature, shall produce an adherent reflectorized stripe of the specified thickness and width and shall be resistant to deformation by traffic. The material shall contain at least 20 percent by weight of glass beads in the white and yellow paints and at least 12 percent titanium dioxide in the white paint. The material, when applied at a temperature range of 400°F to 425°F, and a thickness of 125 mils ($^1/_8$") to 188 mils ($^3/_{16}$"), shall set to bear traffic in not more than two minutes when the air temperature is 50°F and not more than 10 minutes when the air temperature is 90°F.

b. Specification No. 2 - This type of thermoplastic paint shall consist of a free flowing reflectorized pavement striping material containing premixed glass beads which, when flame sprayed to a clean road surface, shall produce a quick-drying, adherent reflectorized stripe capable of resisting deformation by traffic. The material shall conform to No-Pick-Up Time of Traffic Paint, ASTM Designation D 711.

4. Rapid Dry Paint - Rapid dry white, yellow or black traffic paint shall dry to a condition so that there shall be no traffic pick-up in 30 seconds, and which shall be completely dry in not more than three minutes when preheated to 110°F to 180°F in proper equipment before application.

The "no traffic pick-up" time shall be determined by No-Pick-Up Time of Traffic Paint, ASTM Designation D 711.

5. Ready-Mixed Paint - Where ready-mixed paints are specified, they shall be suitable for use on either asphalt concrete or portland cement concrete.

6. Reflective Material - Reflective material shall consist of glass beads added to the surface of the final coat of paint prior to setting, so that the beads shall have proper adhesion. Special care shall be taken with rapid dry paint and thermoplastic materials.

Glass beads shall be mechanically applied at a rate of six to eight pounds of beads per gallon of paint. Glass beads shall be applied to pavement markings, curbs and crosswalks by use of a dispensing device developed for this purpose or other methods approved by the Owner.

The Owner may authorize the use of paint containing premixed glass beads. The type, gradation, quantity and quality of the premixed glass beads shall be approved prior to the manufacture of the paint. In addition to the specified premixed beads, two to three pounds of beads per gallon of paint shall be mechanically applied when the paint is applied.

If thermoplastic paint is required, glass beads may be added directly to the combined pigment, filler and resin. However, prior to setting, all thermoplastic paint surfaces shall receive an additional application of at least one pound of glass beads per gallon of paint.

All paint shall meet the requirements of the appropriate air pollution control district.

B. GALVANIZING

1. General - Zinc used for galvanizing shall be grade Prime Western conforming to Zinc (Slab Zinc), ASTM Designation B 6. Except as otherwise specified, materials shall be galvanized by the hot-dip or electro-depositing process.

2. Coating Requirements - The minimum weight of coating and other requirements shall be as shown in the following table. The weight shown is ounces per square foot of surface area. The weight of coating shall be determined in accordance with Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM Designation A 90, modified to determine the coating of each surface separately. All surfaces, when tested separately, shall meet the minimum requirements.

Material	ASTM Designation	Weight of Coating Oz./sq.ft. (Min.)
Steel product including structural shapes, tie rods, handrails, manhole steps, fence posts, braces, and miscellaneous items	A 123, Zinc (Hot-Galvanized Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip	2.00
Hardware including casting, rolled, pressed, and forged articles	A 153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware	2.00
Bolts, screws, nuts, and washers	A 153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware	1.25
Chain link fence fabric (galv. after fabrication)	A 392, Zinc-Coated Steel Chain-Link Fence fabric	1.20
CMP culverts and	A 444, Steel Sheet, Zinc-Coated (Galvanized) by the	1.00

Material	ASTM Designation	Weight of Coating Oz./sq.ft. (Min.)
underdrains	Hot-Dip Process for Culverts and Underdrains	
Steel pipe	A 120, Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses	1.80
Iron or steel wire fencing	A 116, Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric	0.80
Steel or iron sheets	A 525, General Requirements for Sheet Steel, Zinc-Coated (Galvanized) by the Hot-Dipped Process	0.63
Barbed Wire	A 121, Zinc-Coated (Galvanized) Steel Barbed Wire	0.50
Electrolier standards, 7-gauge steel and over	A 386, Zinc-Coating (Hot-Dip) on Assembled Steel Products	2.00
Electrolier standards, under 7-gauge steel	A 386, Zinc-Coating (Hot-Dip) Assembled Steel Products	1.50

3. Workmanship - The zinc coating shall adhere tenaciously to the surface of the base metal. The finished product shall be free from blisters and excess zinc; and the coating shall be even, smooth, and uniform throughout. Machine work, die work, cutting, punching, bending, welding, drilling, thread cutting, straightening, and other fabricating shall be done as far as is practicable before the galvanizing. All members, nuts, bolts, washers, etc., shall be galvanized before a structural unit is assembled. All uncoated spots or damaged coatings shall be cause for rejection.

Products that are warped or distorted to the extent of impairment for the use intended shall be rejected.

4. Repair of Damaged Zinc Coating - Zinc coating, which has been field or shop cut, burned by welding, abraded, or otherwise damaged to such extent as to expose the base metal, shall be repaired and recoated by one of the following methods:

a. Hot-Dip Process - The damaged areas shall be thoroughly stripped and cleaned, and a coating of zinc shall then be applied by the hot-dip process.

b. Metallizing Process - The damaged area shall be thoroughly cleaned by blasting with sharp sand or steel grit. The blasted area shall lap the undamaged zinc coating at least ½".

Zinc wire containing not less than 99.98 percent zinc shall be used in the metallizing operation. A zinc coating shall be applied to the damaged area with a metallizing gun to a thickness of not less than 0.005" on the damaged area, and shall taper to zero thickness at the edge of the blasted undamaged section.

c. Zinc Rich Paint - The damaged area shall be thoroughly cleaned by wire brushing and all traces of welding flux and loose or cracked zinc coating removed prior to painting. The cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirement of Military Specifications MIL-P-15145. The paint shall be properly compounded with a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

Small areas may be repaired by coating them with such proprietary materials as galvicon or galvalloy or an approved equal.

C. ALUMINIZING

1. General - Paint shall be homogeneous, free of contaminants, and of a consistency suitable for the use of which it is specified. The pigment shall be finely ground and properly dispersed in the vehicle according to the requirements of the paint; and this dispersion shall be of such nature that the pigment does not settle appreciably, does not cake nor thicken in the container, nor become granular nor curdled. Paint and paint materials shall be delivered to the job site in new, unopened, airtight containers, appropriately identified with the manufacturer's name, date of manufacture, type of paint or paint material, specification number and lot or batch number.

No paint shall be used until at least seven days have elapsed from the date of manufacture.

2. Coating Requirements - All steel shall be painted with one shop or prime coat and with not less than two field coats unless otherwise specified or shown on the plans.

a. Shop Coat (Prime Coat) - The shop or prime coat of paint for metal shall be a red lead paint and shall conform to the specification for red lead and paint made therefrom, Red Lead, ASTM Designation D 83. The shop coat shall be touched up in the field as work progresses.

The paint shall be factory-mixed. As an alternative, the pigment shall be furnished in the form of red paste.

b. Field Coats - The field coats shall be aluminum paint and shall conform to the specification for paint, described in *Item A.1.a.(5).(a), Aluminum, of Section 6.8 Part 2*. The first field coat shall be tinted with four to six ounces of Prussian blue or chrome green

paste per gallon of paint as specified in AASHTO M69 to permit detection of incomplete application for ease in inspection.

3. Workmanship - The coating shall adhere tenaciously to the surface of the base metal. The finished product shall be free from blisters and excess paint and the coating shall be even, smooth and uniform throughout. Machine work, die work, cutting, punching, bending, welding, drilling, threadcutting, straightening and other fabricating shall be done as far as is practicable before a structural unit is assembled. All uncoated spots or damaged coatings shall be cause for rejection.

Products that are warped or distorted to the extent of impairment for the use intended shall be rejected.

4. Repair of Coating - Coating which has been field or shop cut, burned by welding, abraded, or otherwise damaged to such extent as to expose the base metal, shall be repaired and recoated as required by the Owner.

B. TESTING AND CERTIFICATION

All paint and paint materials shall be sampled and tested prior to use. All tests shall be conducted in accordance with the methods specified by ASTM or methods set forth in Federal Standard 141. In the absence of any such methods, other suitable methods may be designed and utilized by the Owner.

Lots or batches of paint of proprietary brand, which have been previously sampled and tested and approved as conforming with these specifications, may be used without further testing, if permitted by the Owner. For the purpose of these specifications, proprietary brands of paint and paint materials are construed to mean those conforming to the requirements of these specifications, which are produced for distribution through regular wholesale and retail outlets.

The Contractor shall, upon request, deliver to the Owner certified copies of the manufacturer's test report. The test report shall indicate the name of the manufacturer, type of material, date of manufacture, quantity, specification number, manufacturer's lot or batch number and results of the required tests. The test report shall be signed by an authorized representative of the manufacturer. The certified test reports and the testing required in connection therewith shall be at no cost to the Owner.

1. Galvanizing - Test coupons for determining the quantity and quality of galvanizing shall be of such size and shall be wired to the materials to be galvanized before immersion so as to represent the amount of coating deposited on the finished product.

Nondestructive tests for uniformity of coating may be made by the Owner with a magnetic instrument in accordance with Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods, ASTM Designation E 376.

C. REJECTION

Raw materials and finished products, which fail to meet all requirements of these specifications, shall be subject to rejection. Final acceptance or rejection shall be based on results of tests on samples of raw materials and finishes taken during production, and upon tests made on finishes as soon as practicable after their arrival at the shipping destination. Approval of materials, as a result of preliminary testing prior to manufacture into finished coatings, shall not be binding upon final approval or rejection. The judgment of the Owner shall be final in all questions relative to conformance with the provisions of these specifications.

D. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Descaling, Cleaning and Preparation of Surface - Throughout paint application, including shop and field painting, no paint shall be applied over a surface which evidences a loose or scaly condition. Every effort shall be made by means of the most effective and practical methods to remove all loose mill scale, rust, dirt, oil and grease, as well as all other foreign surfaces which would be deleterious to the procurement of the firm paint coating. The original cleaning and preparation of the surface necessarily must be done at the fabricating plant before application of the shop coat; but the same general requirements for painting over a clean, firm surface shall be applicable to all coats.

The Owner shall look for evidence of faulty surface preparation preceding the shop coat by close inspection of the surface directly prior to application of first field coat; likewise, between first and second field coats. This careful inspection directly in advance of paint application may disclose not only loose, scaly conditions on the surface as a result of faulty preparation, but also failure of the paint to harden because of contamination and changes which might have taken place beneath the paint film as a result of rusting and loosening of mill scale after paint has been applied.

Therefore, whenever the Owner has the slightest doubt as to the firm condition of the surface at any time throughout the application of any coats, he shall be expected to explore underneath the surface of any paint coats already applied so as to uncover evidence of infirmity and to direct remedial measures. Any effective methods of removal of rust, scale and dirt, such as through the use of sandblast, hand or rotating metal brushes, scrapers, chisels, hammers or other effective means shall be acceptable. Undesirable contaminants, which are not allowed to be present on the surface directly prior to paint application and which shall prevent proper hardening and adhesion of the paint film, are grease, oil, oily grime and moisture. Condensed moisture shall be avoided; and other grease-like contaminants shall be removed with solvents, applied with clean rags in such a manner that the oily substance is actually removed and not simply diluted or spread out over a greater area. Particular attention shall be given to the cleaning of fillets, riveted

areas, rivet heads, bolt heads, nuts, washers, drilled or punched holes and welds where loose mill scale, rust, oil and flux are likely to be present.

Unless cleaning is to be done by sandblasting, all weld areas shall be flushed thoroughly with clean water before painting so as to remove any alkaline residue. The flushed surface shall be allowed to become thoroughly dry before paint application.

2. Weather Conditions and Dryness of Surface - Paint shall not be applied to any surface where moisture is present and discernible to the eye. Paint shall not be applied at air temperatures below 40°F nor when there is a likelihood of change in weather conditions within two hours after application, which would result in air temperatures below 40°F or depositing of moisture in the form of rain. Paint shall not be applied when, in the Owner's opinion, impending weather conditions might result in injury to fresh paint.

3. Number of Coats and Color - Except for surfaces hereinafter specified or otherwise provided for on the plans, all structural steel shall be painted with one shop coat of primer, one field coat primer and two field coats of paint as specified on plans. The paint shall be omitted from the surface of structural steel, which shall be in contact with concrete in the finished structure. At the time concrete is placed, such surfaces of structural steel shall be free from dirt, scale, rust, paint, oil or other foreign material.

4. Stirring, Mixing and Care of Paints - All mixed paints shall be made ready for use through reincorporating settled pigment by means of thorough stirring, boxing and straining so that the paint is in its original homogeneous form, free from large agglomerates and skins greater than ¼ millimeter in diameter. Paint in mixing pots shall be kept tightly covered when not in use so as to reduce volatile losses and skinning. Paint always shall be in a complete mixed condition when filled into painter's pots, and this filling always shall be through a strainer of 20-mesh cloth or wire or finer. Paint from the painter's pots shall be concentrated tightly into covered mixing pots at the end of the day; shall at no time during application contain skins or large agglomerates; and the interior sides of pots shall be periodically cleaned free of soft skins which might cling to brushes.

5. Thinning - At temperatures above 70°F, all of the paints herein specified for use, when freshly opened from sealed containers and thoroughly stirred, are of normal consistency suitable for good brush application without thinning. At temperatures below 70°F, the consistency may be heavy enough to require some thinning for proper brush application. Adjustments of paint consistency shall be accomplished by heating in hot water or on steam radiators. Adjustments of paint consistency by thinning so as to meet any and all conditions shall be done only at the discretion of the Owner and only after procuring his specific permission. The general rule which shall be applied for thinning paints shall be that the full hiding coat can be applied so as to thoroughly obscure the surface being painted, whether bare metal or undercoat, without sags and runs. Proper use of paints should remove the necessity for thinning because of evaporated volatiles as a result of allowing the paints to stand in uncovered containers.

6. Brush Application - Painting shall be done by workers skilled in the craft of structural metal painting. Good workmanship by skilled workers is evidenced by the following outstanding features: all crevices, sharp angles, etc., are first traced; the entire surface is then coated without attempt to "layoff" the paint in one direction; lastly, runs from crevices are picked up and the paint is laid off in one direction so as to leave a uniform film free from runs, sags or brush marks caused by not "feathering" or blending one lap into another. Brushes preferably shall be round or oval in shape; but if flat brushes are used, they shall not exceed 4" in width; brushes should be springy and not flabby. Brushes shall not be permitted to become seedy from skins.

7. Spray Application - The equipment used for spray painting shall meet the approval of the Owner and shall have adequate provisions for separation of moisture from the airstreams in contact with the paint. Before thinning for spray application is permitted by the Owner, he shall make sure that at least 50 psi air pressure is present at the gun; that the gun is not clogged with dried or semi-dried paint; and that the spray gun is adequate for the work and has a proper spray head for application of paints used. A spray gun correctly held is approximately 8" from and always perpendicular to the surface being painted. The good painter shall steadily move the gun through a deliberate pattern that permits overlapping of the previous pass by 50 percent and at a speed that shall produce a full uniform coat. Overspray shall be held to a minimum.

If spray application is used, workers shall be adequately protected with respirators; and provisions shall be made to prevent infliction of harm upon all other humans and/or animals, which might be exposed to the fumes or might eat food upon which the fumes have deposited. This warning shall absolve the Owner from blame in the event of harm to persons or property from the named cause, and full responsibility for any such harm shall rest upon the Contractor.

8. Shop Coat - It shall be mandatory to apply the shop coat by brushing or rolling, unless the surfaces to be painted are cleaned by sandblasting, in which case spray application of the shop coat shall be permitted. When all fabrication work is completed and has been tentatively accepted as such, all surfaces not painted before assembling shall be cleaned as provided in *Item A.1, Descaling, Cleaning, and Preparation of Surface, of Section 6.8 Part 3* and painted with one coat of primer. Pieces shall not be loaded for shipment until thoroughly dry. No painting shall be done after loading material on cars. Erection marks for the field identification of members shall be painted on previously painted surfaces. The top of the top flange of stringers shall not be painted. Machine finished surfaces shall be coated as soon as practicable after being accepted.

Surfaces of iron and steel castings milled for the purpose of removing scale, scabs, fins, blisters or other surface deformations shall generally be given the shop coat of paint.

All metal surfaces which shall be within 2" of field welds shall be coated with linseed oil in advance of the application of shop coat paint and left bare of paint until field welding has been completed. The shop coat shall be applied as uniformly as possible by brushing with the intent of securing an average wet film thickness of 3.5 mils (0.0035 inch) or 468

square feet of surface per gallon of paint. The corresponding dry film thickness shall be 2.1 mils (0.0021 inch).

Portions of structures entailing difficult application of the field coats after erection may be completely painted before assembling or erection at the discretion of the Owner.

9. Field Cleaning and Spot Painting - When the erection work is complete, including straightening of bent metal, etc., the shop-coated surface shall be restored in a serviceable condition acceptable to the Owner by means of preparation of surface as outlined in *Item A.1, Descaling, Cleaning, and Preparation of Surface, of Section 6.8 Part 3*; and smoothing and touching up marred places in the shop coat film with primer. Field welds, heads of field rivets and bolts and any other surfaces to be painted, which have not yet been shop coated, shall be painted with primer.

The coating of linseed oil specified in *Item A.8, Shop Coat, of Section 6.8 Part 3* shall be thoroughly removed, as directed for removal of grease and oil in *Item A.1, Descaling, Cleaning, and Preparation of Surface, of Section 6.8 Part 3* immediately prior to erection.

10. First Field Coat - When field cleaning and restoration of shop coat has been completed and all shop coat is thoroughly dry, the first field coat of primer may be applied. Finished surfaces intended for sliding contact shall be given a coat of approved graphite grease immediately prior to being placed in the structure. Graphite grease shall be composed of dry graphite flakes mixed with sufficient light grease or heavy oil so as to form a thick paste suitable for the purpose. Field coats shall not be required on the bottom surface of shoe castings or bearing plates in direct contact with concrete nor on the top surfaces of beams, girders, etc., on which a concrete slab is to be placed in direct contact. The first field coat shall be applied as uniformly as possible, either by spraying, rolling, brushing, or a combination of these with the intent of securing an average wet film thickness of 3.5 mils (0.0035 inch).

11. Finish Coats - When the first field coat, including all touched-up marred places, has thoroughly hardened, the finishing coats of finish paint may be applied. After application of the finishing field coat, the painted portion of the structure shall present a uniform color and appearance throughout.

The finish paint coat shall be applied as uniformly as possible by spraying, rolling or brushing, with the intent of securing an average dry film thickness of 1.5 mils (0.0015") for each coat of paint applied.

12. Removal of Paint Improperly Applied - All paint which has been improperly applied and fails to dry and harden properly, or to adhere tightly to underlying metal or other paint film, or does not evidence a normal, workmanlike appearance in conformance with the intent of these specifications, shall be remedied or thoroughly removed and replaced at the expense of the Contractor. When the final field coat does not have a uniform color and appearance throughout the structure, it shall be corrected by the use of whatever additional coats are necessary. Removal of freshly applied paint, which has not

yet set, shall be effected with the use of solvents. Removal of dried paint films shall be effected either by means of sandblasting or scraping, meeting the approval of the Owner.

The Contractor shall protect pedestrian, vehicular and other traffic in the vicinity; and also all portions of the structures not intended to receive paint, against damage or disfigurement by spatters or splashes of paint or paint materials.

B. Cleaning and Painting Existing Structures

All structural steel to be painted shall be cleaned thoroughly in accordance with *Item A.1, Descaling, Cleaning, and Preparation of Surface, of Section 6.8 Part 3* to prepare the surfaces to receive new paint. Rust spots shall be cleaned to bare metal. The steel shall be spot painted with primer in accordance with *Item A.9, Field Cleaning and Spot Painting, of Section 6.8 Part 3* prior to application of paint to the entire surface unless otherwise specified. After the cleaning and spot-paint have dried thoroughly, the application of two field coats of paint shall be applied. Paints and their application shall conform to the pertinent articles of this specification.

PART 4: MEASUREMENT AND PAYMENT

A. Measurement and Payment

Unless otherwise provided in the plans and special provisions, painting shall not be measured for payment, nor shall payment be made as a separate contract item. The cost thereof shall be included in the contract pay items as are provided for the item to be painted; which prices shall be the total compensation for cleaning, spot painting, for application of paint, and for furnishing all labor, equipment, material, scaffolding, protection of traffic, tools and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

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SECTION 6.9: ELECTRICAL CONDUIT

PART 1: GENERAL

A. DESCRIPTION

This item shall govern the furnishing and installation of conduit of the size and at the locations as indicated on the plans.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. GENERAL REQUIREMENTS FOR ELECTRICAL COMPONENTS

1. General - The material shall provide complete and operative electrical installations as well as that necessary to interface and operate with all other materials as designated. Unless otherwise indicated in the plans or contract specifications, electrical components shall meet the requirements specified herein.

2. Drawings - Drawings are not intended to and do not show all materials such as junction boxes, outlet boxes, conduit fittings and similar components. Even though such material components may not be specifically mentioned in the specifications, nor shown on the drawings, nor shown on the drawings, nor noted on shop drawings, if they are necessary to make a complete installation, they shall be included in the materials required under these specifications.

3. Codes and Standards - All electrical material and tests shall be in conformity with the applicable current standard rules, regulations and specifications of the following authorities:

a. National Board of Fire Underwriters (NBFU), National Fire Protection Association (NFPA), and National Electric Code (NEC)
b. National Electrical Manufacturers Association (NEMA)
c. Institute of Electrical and Electronic Engineers (IEEE)
d. Insulated Power Cable Engineers Association (IPCEA)
e. American National Standards Institute (ANSI)
f. National Electrical Contractors Association (NECA)
g. Association Edison Illuminating Companies (AEIC)
h. National Bureau of Standards (NBS)(National Electrical Safety Code)
i. Rural Electrification Administration (REA)
j. Such other codes and standards as specified on the plans or in the contract specifications.

4. General Material - All material shall be new unless otherwise specified. All materials of a type for which the Underwriters' Laboratories have established a standard shall be listed by the Underwriters' Laboratories, Inc., and shall bear its label.

5. Rejection - Any material provided in this section may be rejected for failure to meet all of the provisions of these specifications or for any defect causing said material to be unsuitable for its intended use.

B. MATERIALS

All electrical component materials provided shall be in accordance with the plans, special provisions, contract documents, and these specifications.

1. Luminaries - Luminaries shall be as shown on the plans and special provisions of the specifications. Lamps, housings, reflectors, mountings, ballasts, and other required items shall be provided to present a complete operable unit.

2. Electroliers - Poles, arms and bases to provide support for the electric lamps shall be as shown on the plans and presented in the special provisions, contract documents, and these specifications.

3. Conduit

a. Plastic Conduit - All plastic conduits shall be schedule 40, rigid, high impact polyvinylchloride, conforming to Federal Specification W-C-1094 and Underwriters' Laboratories, Inc., Standard UL-651.

b. Rigid Steel Conduit - All rigid steel galvanized conduits shall be hot-dipped galvanized inside and out, and shall conform in all respects to Federal Specification WW-C-581d, ANSI C80.1 and Underwriters' Laboratories specifications. The conduit shall be protected by a chromic acid rinse.

c. Flexible Conduit - All flexible conduits shall be American Metal Hose with a neoprene jacket and Appleton Sealtite fittings, or other approved equals.

d. Indoor Cable Tray - Tray shall be constructed of pregalvanized steel and shall meet the requirements of NEMA Standard VE1 and NEC Article 318. The tray shall be furnished complete with the necessary splices, connections, supports, end plates, and other accessories as required.

e. Underground Trench Duct - The trench duct shall consist of precast concrete framing members, side sections, and removable cover sections assembled to form a completely enclosed trench, except with open earth bottom having a 4" bedding of sand. Trench shall be constructed so its top is even with finished grade.

The trench shall be of width shown on the plans x 24" deep inside. The precast sides of the trench shall be held in place by the pressure of the external earth backfill.

Precast trench members shall utilize 3000 psi or greater high early strength concrete. Members shall be cured for a period of at least 14 days.

Manufacturer's noncorrosive metal cable clips shall be furnished to support ground wire and control cables on each framing member. Manufacturer's precut ½" thick asbestos cement board supported by special slot in framing member for segregation of voltages shall be furnished.

Entrance into buildings from the trench duct shall be by means of aluminum cable risers furnished by the manufacturer of the trench duct. Lids shall be field notched to fit and the necessary support hardware for side mounting shall be furnished by the manufacturer.

Where road crossings are indicated on the plans, they shall consist of precast road crossing modules, 5'-0" long and designed for H-20 load capacity. Modules shall be furnished with steel covers and shall be of a width as indicated on the plans.

4. Wire - Copper wire shall conform to the applicable portions of Soft or Annealed Copper Wire, ASTM B 3 and Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft, ASTM B 8. Wire sizes shall be based on American Wire Gauge (AWG) Conductors, hard, medium-hard, or soft; ASTM Designation B 3 and B 8, respectively.

Multiple-circuit conductors shall be of a size indicated on the plans. Insulation for such conductors shall be standard THW-grade polyvinyl chloride and conforming to the applicable provisions of Poly (Vinyl Chloride) Insulation for Wire and Cable, 60°C Operation and Poly (Vinyl Chloride) Insulation for Wire and Cable, 75°C Operation, ASTM Designation D 2219 and 2220, respectively.

5. Rejection - Electrical component materials specified in this section may be rejected for failure to meet all of the provisions of this specification as for any defect causing such materials to be unsuitable for their intended use.

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Prior to the installation of conduit, the Owner shall be notified so that a representative be present to inspect the installation of the conduit. Failure to contact the Owner shall constitute grounds for rejecting conduit, which has been installed without the presence of a representative of the Owner.

All conduits shall be placed in accordance with lines and grade, details and dimensions as shown on the plans, or as directed by the Owner. All ends of pipe shall be reamed to remove burrs. All splicing of conduit shall be done by using standard couplings manufactured for this purpose. All bare ends of conduit for future connections by others shall be capped with standard conduit caps. The location of ends of all conduit for future electrical circuits in structures shall be marked by a "E" at least 3" high, cut into the face of curb, gutter or wall directly above the conduit.

All conduits shall be placed a minimum of 12" below the bottom of the improved pavement section and in no case shall be less than 24" below finished grade. Installation under existing pavements may be accomplished by jacking, tunneling or drilling. Conduit shall extend 12" behind back of curb unless otherwise called for on the plans.

Conduit in medians shall be placed in the median at a depth of 18" to 30" or as shown on the plans. Where pull boxes or junction boxes are required in medians, which are to be surfaced, they shall be installed by the Contractor at the location and grade as shown on the plans or as directed by the Owner.

Unless otherwise specified in the special provisions or on the plans, all pull-boxes shall be furnished by the Contractor. All necessary fittings for proper installation of conduit in the pull-box shall be furnished and installed by the Contractor. Where it is required that pull-boxes be installed, the conduit shall be fitted with standard 90° ell fittings to enter the pull-box from the bottom. A nipple shall be attached to the ell of sufficient length so that the distance from the top of the pull box to the end of the nipple shall be 8".

A No. 9 galvanized pull wire or approved material shall be placed in all conduits; and prior to the placement of paving, the wire shall be moved back and forth to insure that the conduit is free from obstructions. Before final acceptance of the conduit work, this method of checking shall again be incorporated to insure that the paving operations have not rendered the conduit useless. It shall be the Contractor's responsibility to remove and replace all damaged conduit at his own expense.

Conduit bends, except factory bends, shall have a radius of not less than seven times the inside diameter of the conduit. Where factory bends are not used, conduit shall be bent, without crimping or flattening, using a portable hydraulic pipe bender. The radius of the pipe shall conform to the dimensions shown on the plans; if not designated on the plans, the longest radius practicable shall be used.

Conduit locations shown on the plans are for bidding purposes only and may be changed with permission of the Owner to avoid underground obstacles. The Contractor shall furnish and install conduit to an electrical service point to be determined by the Owner prior to the beginning of any construction.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Conduit of the size specified on the plans shall be measured by the linear foot (M) along the main line of conduit. Fittings shall not be measured directly but shall be considered subsidiary to this item.

Conduit, as measured in this item, shall be paid for at the unit price bid for "conduit" of the size specified, which prices shall be full compensation for furnishing and installing all conduit, for all excavation, for all gravel backfill, for furnishing and installing all fittings, for furnishing and installing pull-boxes and for all labor, materials, tools, equipment and incidentals necessary to complete the work.

SECTION 6.10: RIPRAP

PART 1: GENERAL

A. DESCRIPTION

This section shall cover work consisting of riprap or reinforced concrete slope protection; all complete in-place in conformity with the lines, grades and details shown on the plans and in accordance with these specifications. Riprap shall be used for slope, bank and ditch bottom protection; and for erosion control at the ends of pipes and structures; and at other designated locations.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

Riprap or stone masonry shall consist of either natural stone or broken portland cement concrete.

1. Material and Dimensions

a. General - Natural stone for riprap shall consist of fieldstone or rough unhewn quarry stone as nearly uniform in section as is practicable. The natural stone shall be dense, resistant to the action of air and water, and suitable in all other respects for the purpose intended. The stone used for common mortar riprap may consist of broken-up concrete removed under contract or obtained from other approved sources. Broken concrete shall be as nearly uniform in section as practicable.

Materials for concrete, grout and mortar shall conform to the requirements of these specifications. Concrete shall be of the class shown on the plans. Mortar and grout required for the several types of riprap shall consist of one part of portland cement and three parts of sand, thoroughly mixed with water. Mortar shall have a consistency such that it can be handled easily and spread by trowel. Grout shall have a consistency such that it shall flow into and completely fill all joints.

Bar reinforcement shall conform to the requirements of the *Item A.7, Steel Reinforcement, of Section 5.1 Part 2.*

Wire reinforcement shall consist of welded fabric meeting the requirements of ASTM Designation A-185.

Premolded expansion joint material shall conform to the requirements of *Section 5.1, Concrete and Reinforcement.*

Individual riprap material shall have a minimum thickness of 4", and minimum surface dimensions of 12" by 24". Smaller fragments may be used only to fill the voids between the above minimum size of riprap materials.

b. Field Stone and Quarry Stone - Dry Riprap, Type A and Type B: Unless otherwise specified, all stones used in these types of riprap shall weigh between 50 and 150 pounds each, and at least 60 percent of the stones shall weigh more than 100 pounds each. The stones shall be placed in a single layer with close joints. The upright axis of the

stones shall make an angle of approximately 90 degrees with the embankment slope. The courses shall be placed from the bottom of the embankment upwardly, the larger stones being placed in the lower courses. Open joints shall be filled with spalls. Stones that project more than the allowable amount in the finished work shall be replaced, embedded deeper or chipped. Dry riprap Type B differs from dry riprap Type A only in that a toe wall of concrete, having dimensions and reinforcement as shown on the plans, shall be used.

Dry Riprap, Type C and Type D: Stones having one broad flat surface shall be used when possible, this surface being placed on a horizontal earth bed prepared for it and so placed as to overlap the underlying course, the intent being to secure a lapped or "shingled" surface.

Fifty percent of the mass shall be of stones weighing between 100 and 150 each. These stones shall be placed first and arranged roughly so as to be in close contact. The spaces between the large stones then shall be filled with stones of suitable size so placed as to leave the surface evenly stepped, conforming to the contour required, and capable of shedding water to the maximum degree practicable.

Dry Riprap Type D differs from dry riprap Type C only in that a toe wall of concrete, having dimensions and reinforcement as shown on the plans, shall be used.

Stone Riprap for Foundation Protection: Stones for foundation protection shall range in weight up to 300 pounds each, unless otherwise specified or shown on the plans; and shall be graded and so placed as to produce a minimum of voids. The top six inches shall be of graded smaller stones and shall be grouted, the grout and grouting to be in conformity with the requirements and methods outlined for grouted riprap, Type A and Type B.

c. Grouted Riprap - Grouted Riprap, Type A and Type B: Stones used in these types of riprap shall weigh between 40 and 150 pounds each. The stones shall be placed in the same manner as specified above for dry riprap Type A and Type B, with care being taken to prevent earth or sand from filling the spaces between the stones. After the stones are in place, the stones shall be wetted thoroughly and the spaces between the stones shall be completely filled with grout. The surface of the riprap shall be swept with a stiff broom after grouting.

No riprap shall be grouted in freezing weather. The work shall be protected from the sun and kept moist for at least three days after grouting. Grouted riprap Type B shall have a concrete toe wall as specified for dry riprap, Type B.

d. Mortar Riprap - Mortar Riprap: Stones for this purpose shall be fairly large and flat-surfaced, laid with a true and even surface and a minimum of voids. Fifty percent of the mass shall be of broad flat stones weighing between 100 to 150 pounds each, placed with the flat surface uppermost and parallel to the slope. The spaces between the larger stones shall be filled with stones of suitable size, leaving the surface smooth, reasonably tight and conforming to the contour required.

Before placing mortar, the stones shall be wetted thoroughly. As each of the larger stones is placed, it shall be surrounded by fresh mortar; and adjacent stones shall be shoved into contact. After the larger stones are in place, all of the spaces or openings between them shall be filled with mortar and the smaller stones then placed by shoving them into position, forcing excess mortar to the surface and insuring that each stone is

carefully and firmly embedded laterally. All excess mortar thusly forced up shall be spread uniformly to completely fill all surface voids. All surface joints then shall be pointed up roughly, either with flush joints or with shallow, smooth raked joints.

Common Dry Riprap and Common Mortar: The stones for this type shall be not less than one third of a cubic foot in volume and not less than 4" in length dimensions. The width of the stones shall not be less than twice the thickness.

2. Rejection - Materials, which fail to meet the requirements of these specifications, may be rejected by the Owner. Such rejection shall incur no cost to the Owner.

Materials sources from which materials with properties not meeting these specifications are delivered may be rejected as further supply sources to the project by the Owner. Such rejection shall incur no cost to the Owner.

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

The slopes and other areas to be protected shall be compacted and dressed to the line and grade shown on the plans prior to the placing of riprap. Broken concrete or stones may be used for any of the construction listed below.

1. Dry Riprap - The stones shall be placed in a single layer with close joints. The upright axis of the stones shall make an angle of approximately 90° with the embankment slope. The courses shall be placed upwardly from the bottom of embankment, the larger stones being placed in the lower courses. Open joints shall be filled with spalls. Stones that project more than the allowable amount in the finished work shall be replaced, embedded deeper or chipped. Dry riprap Type B differs from dry riprap Type A only in that a toe wall of concrete, having dimensions and reinforcement as shown on the plans, shall be used.

Dry Riprap, Type C and Type D. Stones having one broad flat surface shall be used when possible, this surface being placed on a horizontal earth bed prepared for it and so placed as to overlap the underlying course, the intent being to secure a lapped or "shingled" surface. These stones shall be placed first and roughly arranged in close contact. The spaces between the large stones then shall be filled with stone of suitable size so placed as to leave the surface evenly stepped, conforming to the contour required, and capable of shedding water to the maximum degree practicable. Dry riprap Type D differs from Dry riprap Type C only in that a toe wall of concrete, having dimensions and reinforcement as shown on the plans, shall be used.

2. Grouted Riprap, Type A and Type B - The stones shall be placed in the same manner as specified in *Item A.1, Dry Riprap, of Section 6.10 Part 3*, Type A and Type B, with care being taken to prevent earth or sand from filling the spaces between the stones.

After the stones are in place, the stones shall be wetted thoroughly, and the spaces between the stones shall be completely filled with grout. The surface of the riprap shall be swept with a stiff broom after grouting. No riprap shall be grouted in freezing weather. The work shall be protected from the sun and kept moist for at least three days after grouting. Grouted riprap Type B shall have a concrete toe wall as specified for dry riprap Type B.

3. Mortar Riprap - Stone for this purpose shall be fairly large and flat-surfaced, laid with a true and even surface and a minimum of voids. Broad flat stones shall be placed with the flat surface uppermost and parallel to the slope. The largest stones shall be placed near the base of the slope. The spaces between the larger stones shall be filled with stone of suitable size, leaving the surface smooth, reasonably tight, and conforming to the contour required.

Before placing mortar, the stones shall be wetted thoroughly. As each of the larger stones is placed, it shall be surrounded by fresh mortar; and adjacent stones shall be shoved into contact. After the larger stones are in place, all of the spaces or openings between them shall be filled with mortar; and the smaller stones then placed by shoving them into position, forcing excess mortar to the surface and insuring that each stone is carefully and firmly embedded laterally. All excess mortar forced up shall be spread uniformly to completely fill all surface voids. All surface joints then shall be pointed up roughly either with flush joints or with shallow, smooth-raked joints.

Common Dry-Riprap and Common Mortar. Prior to placing the stones, a suitable bed shall be excavated for the course or layer. The base course or layer of stone shall be bedded well into the ground with their edges in contact. Each succeeding course or layer shall be well bedded into the placed on even contact with its preceding course or layer. The finished surface shall present an even, tight surface to line and grades of typical sections.

Sufficient mortar shall be used to fill completely all voids in the layers of stone; and surface shall be swept with a stiff broom. Grout may be used in lieu of mortar. Spalls and small stones used to fill open joints and voids shall be driven to a tight fit.

4. Concrete Riprap - Concrete for riprap shall be placed in accordance with the details and to the dimensions shown on the plans or as established by the Owner. Unless otherwise shown by a note on the plans, concrete riprap shall be reinforced, using wire or bar reinforcement.

The class of concrete shall be specified on the plans and shall be in accordance with *Section 5.1, Concrete and Reinforcement*. Reinforcement shall be properly supported throughout placement of concrete.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Riprap shall be measured for payment either in square feet of the specified minimum thickness or in cubic yards, based on the dimensions shown on the plans or on revised dimensions, where changes are ordered or approved by the Owner or by ton of

material in place. Riprap shall be paid for at the contract unit price complete in place, as provided in the proposal and contract. The contract unit price shall be the total compensation for preparing the subgrade, including excavation; for furnishing and placing all materials; for furnishing, placing, shaping and tamping backfill; for disposal of all surplus materials; and for all labor, tools, equipment and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

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SECTION 6.11: GABION STRUCTURE

PART 1: GENERAL

A. DESCRIPTION

This item shall govern the construction and assembly of gabion structures conforming to the lines, grades, locations and designs as indicated on the plans and specifications, or as established by the Owner. Gabions shall be used for slope or bank protection and erosion control on open channels.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

1. Gabions - Gabions shall consist of uniform hexagonal wire mesh woven in triple twist pattern with openings fabricated in such a manner as to be nonraveling and designed to provide the required flexibility and strength.

The perimeter edges of the twisted wire mesh shall be woven around a reinforcing wire in a manner designed to prevent slippage, and the edges of the mesh shall be securely selvedged. All corners shall be reinforced by heavier wire.

Gabions shall be so fabricated that the sides, ends, lid, base, and diaphragms can be readily assembled at the construction site into rectangular baskets with a minimum thickness of one foot. Where the length of the gabion exceeds one and one-half times its horizontal width, the gabion shall be divided by diaphragms of the same mesh and gauge, as the body of the gabion into equal cells whose length does not exceed the horizontal width. Diaphragms shall be secured in the proper position on the base section.

All dimensions are subject to tolerance limit of five percent.

Wire shall conform to the following requirements in accordance with Federal Specifications QQW-461-G Class 3 - Finish 5 - Soft.

Wire for Fabric (diam)	3.00 mm ± 2.5%
Wire for Selvedges and Corners (diam)	3.90 mm ± 2.5%
Wire for Binding and Connecting (diam)	2.20 mm ± 2.5%
Tensile Strength (psi)	60,000 - 75,000
Elongation (percent) (not less than)	12%
Weight of zinc coating for all wire	0.80 oz/sq ft

2. Stone - The stone shall be graded from three to eight inches and meet the requirements of *Item A.3, Pipe Bedding Material for Water and Sanitary Sewer Mains, of Section 4.2 Part 2.*

3. Rejection - Gabions may be rejected for failure to meet any of the requirements of this specification.

B. EQUIPMENT
Not Applicable

PART 3: EXECUTION

A. GABION BASKET ASSEMBLY

1. Gabion baskets are assembled by unfolding the baskets on a hard surface and stamping out all kinks. Fold up the front, back, and end panels and fasten together with the projecting heavy gauge wire by twisting it around the selvedge wire two complete turns. Fold the diaphragms up and secure in the same manner. All edges and diaphragms to sides are now laced together in the following manner: Cut a length of lacing wire approximately 5 feet long, secure the wire at one end by looping and twisting together, then proceed lacing with a double loop (made at the same point) approximately every 4" to 5" apart pulling the basket pieces tightly together. Secure the end of the wire by again looping and twisting.

2. Gabion baskets shall then be placed in position empty and shall be tied together each to its neighbor along all contacting edges in order to form a continuous connecting structural unit. Tying shall be in the same manner as that used to assemble baskets and shall produce a joint that is as strong as the body of the mesh.

B. GABION BASKET PLACEMENT

Gabions 3 feet high that are to be placed in a straight row are to be stretched in the following manner before being tied to the adjacent gabions. Tie together approximately 100 feet of gabion baskets end to end. Secure one end of the row by tying to gabions already filled or fill the end gabion with stone and then stretch baskets sufficiently to remove kinks. While maintaining tension, tie the row of baskets to its neighbor and then fill with stone.

C. GABION STONE PLACEMENT

When the assembled empty gabion baskets have been installed, the gabion stone shall then be placed in the following manner. The gabion baskets may be filled by machine with sufficient additional handwork to accomplish a maximum density and a minimum amount of voids. Vertical outside surfaces shall be placed by hand with large select stone in order to achieve the best appearance. Baskets are to be filled in 12" layers in order to install a looped inner tie wire in each cell connecting to front and back faces every 12" of vertical height in any unsupported face. Individual cells may not be filled more than one foot above any adjacent cell unless looped inner tie wires run in both directions.

D. GABION BASKET CLOSURE

When each gabion basket has been filled to its maximum, which is approximately 1½" higher than the sides, and the surface leveled with a minimum amount of voids, the

lids shall be pried down and over with a bar until the edge of the lid and edge of the basket are together. The heavy projecting wire on the lid shall be twisted around the heavy wire on the sides two complete turns and the lid shall then be tied to the edges and tops of diaphragms in the same manner as the baskets are assembled so that the finished joint is as strong as the body of the mesh. The lids of the gabion baskets shall also be tied together, each to its neighbor along all connecting edges to insure the formation of a continuous connecting structural unit. Special attention shall be given that all projecting sharp ends of wire are turned in.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Gabions shall be measured for payment either in square feet of the specified minimum thickness or in cubic yards based on the dimensions shown on the plans or on revised dimensions, where changes are ordered or approved by the Owner or by ton of material in place. Gabions shall be paid for at the contract unit price complete in place, as provided in the proposal and contract. The contract unit price shall be the total compensation for preparing the subgrade, including excavation; for furnishing, placing and assembling all materials; for furnishing, placing, shaping and tamping backfill; for disposal of all surplus materials; and for all labor, tools, equipment and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

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SECTION 6.12: GEOTEXTILES

PART 1: GENERAL

A. DESCRIPTION

Geotextiles are woven or nonwoven fabrics, which can be used for subsurface drainage, erosion control and soil stabilization applications. The fabric shall provide a permeable layer, and tensile reinforcement, while retaining the soil matrix.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

The fabric shall be inert to commonly encountered chemicals and hydrocarbons. It shall be mildew and rot resistant, insect and rodent resistant, and conform to the latest revision of the following standards:

DESIGNATION	TOPIC	PAVEMENT (Minimum)	EMBEDMENT (Minimum)
ASTM D 1682	Grab Tensile Strength	115 lbs.	80 lbs.
ASTM D 1682	Grab Tensile Elongation	20%	20%
ASTM D 751	Burst Strength (Diaphragm Meth)	375 psi	200 psi
ASTM D 2263	Trapezoid Tear Strength	100 lbs.	40 lbs.
ASTM D 1682	Modulus (Load at 10% Elongation)	105 lbs.	105 lbs.
AATCC-30*	Mildew, Rot Resistance (Strength Retention)	100%	100%
ASTM D 422	Equivalent Opening Size (U.S. Standard Sieve)	70-100	30-100

***American Association of Textile Chemists and Colorists.**

B. CERTIFICATION

The manufacturer, if requested by the Owner, shall provide documents setting forth the name and manufacturer, the chemical composition of the filaments or yarns, ant test values of the properties of the geotextile. The manufacturer must certify that the material meets or exceeds these specifications

C. REJECTION

Geotextile may be rejected for failure to meet any of the requirements of this specification.

D. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Not Applicable

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Not Applicable

SECTION 6.13: WOOD PRODUCTS

PART 1: GENERAL

A. DESCRIPTION

This item shall govern the use and constraints of wood products as indicated on the plans and specifications, or as established by the Owner.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. LUMBER AND TIMBER

1. General - Structural lumber or timber shall be of the kinds and grades indicated on the plans or set forth in the contract documents. Proper allowance for shrinkage shall be made where it is necessary to meet exact dimensions shown on the drawings. In general, all lumber and timber shall conform to American Lumber Standards established by the various lumber associations, in cooperation with the National Bureau of Standards.

2. Grades - Sheeting in tunnels and flooring for foundations shall be equal in quality to No. 1 dimension. Sheeting and shoring shall be equal in quality to No. 1 dimension. Bracing shall be equal in quality to No. 1 small timbers. All lumber shall be grade marked.

3. Sizes - The plans show the nominal sizes, but actual sizes shall conform to American Lumber Standards.

4. Treatment with Preservatives - All preservatives used to treat lumber and timber shall comply with the applicable standards contained in the Manual of Recommended Practice of the American Wood Preservers' Association (AWPA). Wood shall be conditioned, seasoned, prepared and treated by pressure process in accordance with the applicable standards contained in the AWPA Manual.

Wood preservatives shall be either creosote, oilborne, or waterborne as defined by the American Wood Preservers' Institute. Creosote preservatives may be creosote or creosote/coal-tar solutions. Oilborne preservatives may be pentachlorophenol, copper-8-quinolinolate, or tributyl-tin oxide. Waterborne preservatives shall be acid copper chromate (AAC), ammoniacal copper arsenate (ACA), chromated zinc chloride (CZC), or fluor-chrome-arsenate-phenol (FACP). The amount of preservative used shall be in accordance with the recommendations of the American Wood Preservers' Institute for the use intended.

5. Rejection - Lumber and timber may be rejected for failure to meet all of the requirements of this specification.

B. PLYWOOD

1. General - Plywood shall be manufactured and graded in accordance with the rules of the American Plywood Association and the latest Product Standard for Construction and Industrial Plywood of the National Bureau of Standards.

2. Grades - All plywood shall be engineering grade "B-B" exterior or better.

3. Grade Marking - Each sheet of plywood shall bear the official stamp of a quality control agency stating the grade of the sheet.

4. Rejection - Plywood may be rejected for failure to meet all of the requirements of this specification.

PART 3: EXECUTION

A. CONSTRUCTION METHODS

Not Applicable

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Not Applicable

SECTION 7
STRUCTURES

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SECTION 7.1: General

7.1.A Structural Excavation

PART 1: GENERAL

A. DESCRIPTION

Structural excavation shall consist of the removal of material for the construction of foundations for bridges, retaining walls, headwalls for culverts, or other structures; and other excavation designated on the plans or in these specifications or in the special provisions as structural excavation; and the subsequent backfill of these same structures.

Structural backfill shall consist of furnishing material, if necessary, and placing and compacting backfill material around structures to the line designated on the plans and/or as specified or directed by Owner.

Structural excavation and structural backfill shall include the furnishing of all materials and equipment; the construction or installation of all cofferdams and other facilities which may be necessary to perform the excavations and place and compact the backfill; and the subsequent removal of such facilities, except where they are required or permitted by the plans or specifications to remain in place.

B. COFFERDAMS

Cofferdams for foundation construction shall be carried well below the bottom of the footings and shall be well braced and reasonably watertight. The interior dimensions of cofferdams shall provide sufficient clearance inside the walls for constructing forms and driving piles and to permit pumping outside the forms.

If, in the judgement of the Contractor, the clearance provided on the plans between the outside line of the footing and any pile or interior wall or surface is not sufficient to permit the driving of piles or building of forms, he may provide such necessary clearance structuring the cofferdam sufficiently large to provide such clearance as he may deem necessary. Any such enlargement in excess of one foot outside the dimensions of the footing as shown on the plans shall be considered as being for the sole purpose of expediting the work of the Contractor and such excavation and backfill shall be at the Contractor's expense.

Cofferdams which are tilted or moved out of position by any cause during the process of sinking shall be plumbed or enlarged so as to provide the necessary clearance and proper pier location and such work shall be at the Contractor's expense.

In streams or tidal waters at a time of probable flood, cofferdam walls shall be vented at low water elevation to insure equal hydrostatic head both inside and outside of the cofferdam during the period or pouring and settings of seals.

No shoring shall be permitted in cofferdams, which shall induce stress, shock or vibration in the permanent structure.

When permitted by the Owner, cross struts or bracing may extend through foundation concrete. Struts or bracing shall be removed and the resulting space filled with concrete of the same mix as that specified for the surrounding concrete.

For substructure work, the Contractor shall submit drawings showing his proposed method of cofferdam construction and other details left open to his choice or not fully shown on the plans. The type and clearance of cofferdams, insofar as such details affect the character of the finished work, shall be subject to the approval of the Owner, but other details of design shall be left to the Contractor who shall be responsible for the successful construction of the work. The drawings shall be submitted at least 30 days in advance of the time the Contractor begins construction of the cofferdams.

After completion of the substructure, the cofferdams with all sheeting and bracing shall be removed at least two feet below the level of the stream bed, by the Contractor at his expense, and such removal shall be performed in a manner that shall not disturb or mar the finished concrete or masonry.

PART 2: PRODUCT

A. MATERIALS

Not Applicable

B. EQUIPMENT

Not Applicable

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. **Excavation -** Excavation shall include the following:

a. When concrete or masonry footings are to rest upon rock, the rock shall be removed to a depth sufficient to expose sound rock. The rock shall be roughly leveled off or cut to approximate horizontal and vertical steps, and shall be roughened. When concrete or masonry footings are to rest on an excavated surface other than rock, care shall be taken not to disturb the bottom of the excavation; and the final removal of the foundation material to grade shall not be made until just before the concrete or masonry is placed.

b. Excavated material required to be used for backfill may be deposited by the Contractor in storage piles at points convenient for rehandling of the material during the backfilling operations. The location of storage piles shall, however, be subject to the approval of the Owner, who may require that the survey centerline of the structure and the transverse or hub line of any unit of the structure be kept free of any obstruction.

c. Excavated material required to be wasted shall be disposed of as directed by the Owner, and the disposal shall be in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other part of the work.

d. For all single and multiple box culverts, pipe culverts and pipe arch culverts, where the soil encountered at established footing grade is a quicksand, muck or similar unstable material, the following procedure shall be used unless other methods are called for on the plans.

All unstable soil shall be removed below the bottom of the culvert. Such excavation shall be carried at least one foot beyond the horizontal limits of the surface on all sides. All unstable soil so removed shall be replaced with suitable stable material,

placed in uniform layers of suitable depth for compaction as directed by the Owner. Each layer shall be wetted, if necessary; and compacted by rolling or tamping as required to provide a stable foundation for the structure.

e. When the material encountered at footing grade of a culvert is found to be partially rock, or incompressible materials, and partially a soil or material that is compressible, but otherwise satisfactory for the foundation, the incompressible material shall be removed for a depth of six inches below the footing grade and backfilled with a material similar to the compressible foundation used for the rest of the structure.

f. When the material encountered at footing grade of a bridge bent or pier is found to be partially of rock or incompressible material, and partially of a compressible material, the foundation shall not be placed until the Owner has inspected the footing and authorized such changes found necessary to provide an adequate foundation.

2. Backfill - No backfill shall be permitted to be placed except in the presence of the Owner. Structural backfill shall not be placed until the structure footings or other portions of the structure or facility have been inspected by the Owner and approved for backfilling. As soon as practicable all spaces excavated under this item and not occupied by the permanent structure shall be backfilled, except that no backfill shall be placed against any abutment or retaining wall until such structure has been in place at least seven days or until required strength has been obtained. No backfill shall be placed adjacent to box culverts until the top slab has been in place at least four days or as directed by the Engineer. When called for on the plans special backfill material, such as pit run gravel, shall be placed at the locations and in the manner called for on the plans. All other backfill material shall be earth, free of any appreciable amount of stone or gravel particles more than four inches in greatest dimension, large or frozen lumps, wood or other extraneous material, and shall be of such gradation as to permit thorough compaction as required by the Owner.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Measurement for payment when payment is provided in the special provisions shall be for material excavated within the limits shown on the plans or as directed by the Owner. Unless otherwise provided in the special provisions or proposals, no payment shall be made for structural excavation or backfill as such, the cost thereof under normal circumstances being considered as included in the price bid for the construction or installation of the items to which such excavation or backfill pertain. Payment shall be made only when provided for in the special provisions or proposal. When provided for, payment for work performed under this specification shall be made at the unit price bid per cubic yard for unclassified structural excavation which price shall be full compensation for all excavation and backfill and for all materials, labor, tools and incidentals necessary to complete the work.

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7.1.B: Driving Piling

PART 1: GENERAL

A. DESCRIPTION

This specification shall govern for the equipment to be furnished in order to perform the methods to be followed in the driving of piling.

The requirements herein are minimum. Strict compliance with these minimum requirements shall not relieve the Contractor of the responsibility for adopting whatever additional provisions may be necessary to insure the successful completion of the work.

B. SUBMITTALS

PART 2: PRODUCT

A. MATERIALS

1. Timber Piles

a. General - This item shall govern the furnishing of untreated or treated timber piling of the type and in accordance with the lines, spacing and dimensions indicated by the plan or contract documents. The lengths of piling to be furnished shall be as shown on the plans or as determined by the Owner from the results of driving test piling, if test piling are required in the contract.

b. Quality - Untreated piling may be of any species of durable timber, which shall satisfactorily stand driving. Treated piling shall consist of southern pine or Douglas fir impregnated with a preservative of such quality and process as shown on the plans and/or as specified in *Section 6.13 Wood Products*. Piling shall conform to Round Timber Piles, ASTM Designation D 25 for Class B piles and the requirements contained herein. Piling shall be cut from sound live trees free from any defects such as decay, red heart, ring shakes, unsound or loose knots, numerous knots, or holes, knots in clusters, groups of single knots, twist of grain exceeding one-half of the circumference in any 20-foot length, and other defects which may impair utility, strength or durability. Piling which have been scored for turpentine may be accepted, provided the scar does not exceed 36 inches, and provided the scoring is of recent date, showing the scar to be entirely sound and free from insect damage. Any defects, which would be more injurious than the maximum allowable knot, shall not be permitted.

All knots shall be trimmed close to the body of the pile. Sound knots shall be permitted, provided they are not in clusters. A knot cluster is the grouping of two or more knots together as a unit with the fibers of the wood deflected around the entire unit. A group of single knots is not a knot cluster. A single knot is one occurring by itself with the fibers of the wood in which it occurs deflected around it. The diameter of a sound knot shall not be greater than one-third of the minimum diameter of the pile at the section where it occurs, and shall not exceed 4". The diameter of the knot shall be measured at right angles to the length of the pile. The sum of widths of all knots in any one-foot length of piling shall not exceed twice the width of the maximum allowable knot for that section of pile.

Piling which show excessive checking or splitting before or after treatment and prior to driving shall be rejected. Checked piling, on which the checks are not judged excessive, shall have the checks completely filled with hot tar pitch before being driven and after driving if necessary. Excessive splitting or checking shall be gauged as follows:

(1) A large check or split at the butt of pile which shall permit a number of 10 B&S (diameter 0.102 inches) wire to be extended three feet into the body of the pile.

(2) Checking and splitting of such size that at any point along the pile two checks or splits occur into which a No. 10 wire may be inserted for a depth of more than $^{7}/_{8}$". Shakes smaller than one-third of the diameter of the pile may be permitted, provided the location and proximity of other defects do not affect the utility of the pile.

Piling shall average not less than six annual rings per inch; and, in addition, one-third or more summer-wood measured over the third, fourth, and fifth inches from the center of the pile along a radial line. Where there are less than six annual rings per inch, piling may be accepted if there is an average of one-half or more summerwood. Density shall be determined on butt ends of piling. Untreated piles shall have as little sapwood as possible; and, when used in exposed work, the diameter of the heartwood shall be not less than $^{8}/_{10}$ths of the actual diameter of the pile at the butt. Treated piles, preferably, shall have as much sapwood as possible. In southern pine, the sapwood thickness shall be not less than 1½"; and in Douglas fir, not less than 1" at the butt end. The outer three annual rings of all piling shall be free from compression wood.

Piling shall be peeled of bark, including the inner skin, soon after cutting so that the piling are smooth and clean. Care shall be taken to remove as little sapwood as possible; and it should not be injured by unnecessary axe cuts. All of the rough bark and at least 80 percent of the inner bark shall be removed. In no case shall any piece of inner bark be over ¾" in width or 8" in length, and there shall be at least 1" of clean cut surface between any two strips of inner bark. Machine trimming shall be kept to a practicable minimum of the piling surface; and in no case shall be more than ¼", except at knot whorls. The circumference at any point between the knot whorls shall not be reduced by more than 1".

Whenever there is any sign of decay visible in untreated timber, the material shall be rejected. In any case where the condition of timber is doubtful, and in all cases of air-seasoned material, the Owner shall require a section 2" thick, or more, to be cut from the butt and tip. Evidence of decay, such as softness, or brownish discoloration, even though there are no definite areas of breakdown in the wood fibers, shall be sufficient cause for rejection.

When air seasoning is utilized, great care should be exercised in the examination of the piling during the seasoning to protect such from conditions conducive to deterioration. Piling should be cut preferably during the winter season; and the maximum air-seasoning period shall be limited to 120 days except by special permission of the Owner. Storage yards should be kept free of vegetation, standing pools of water and debris harboring fungi. Proper stacking and protection practices shall be followed to reduce possible contamination of the piling while it is seasoning. Necessary records shall

be kept by marking suitably the seasoning stacks to facilitate inspection as to time of seasoning. Pretreated stock shall not be acceptable to the Owner except in emergencies.

c. Dimensional Requirements - Piling shall be furnished cut to the lengths shown on the plans or specified by the Owner. Variation of 6" from the ordered length shall be allowed, but the average length in any shipment shall be equal to, or greater than, the specified lengths. The supplier shall stencil size and length on the butt end of each piling with numerals at least 1" high. Tips and butts shall be cut at right angles to the axis of piling.

The minimum diameter of round piling at a section 4' from the butt, measured under the bark, shall be as follows:

Length of Piling	Minimum Diameter 4' from Butt
40' and under	12"
Over 40'	13"

The minimum diameter of the tip shall be as follows:

Length of Piling	Minimum Diameter of Tip
20' and under	9"
21' to 44'	8"
Over 45'	7"

The maximum diameter of the butt shall be 18" unless otherwise specified. When a tree is not exactly round, the diameter shall be determined either by measuring the circumference and dividing by 3.14, or by taking the average of the maximum and minimum diameters at the location specified.

Piling shall be butt cut from the main body of the tree and shall be cut above the ground swell with a gradual taper from the point of butt measurement to the tip. Any localized deviation from straightness in a 5' section or less shall be classified as short crook. The deviation of a line drawn from the center of the pile above the bend to the center of the pile below the bend shall not exceed 2" in such a section. Piling may have a sweep in one plane in one direction, provided that a straight line from the center of the tip to the center of the butt does not deviate from the centerline of the pile at any point more than one percent of the length, and in no case shall it fall outside the body of the pile. Piling may have sweeps in two planes (double sweep), or sweeps in two directions in one plane (reverse bend or sweep), provided that the line applied as above does not deviate from the centerline of the pile by more than one-fourth the diameter of the pile at the point of greatest deviation; and provided further that the reversal or change in direction is within the middle half of the length.

d. Rejection - Any timber piling not conforming to these specifications and applicable provisions of other sections shall be rejected. Any defect causing it to be unsuitable for its intended use shall be cause for rejection of the piling.

2. Steel Piles

a. General - This item shall govern for the furnishing of steel piling of section and sheet piling, in place of the type and weight, and in the locations shown on the plans and the contract specifications and in these specifications.

Steel piles furnished under this specification shall consist of structural steel shapes that fulfill the requirements prescribed for such material in Structural Steel, ASTM Designation A 36 and shall conform to the details and dimensions indicated by the drawings and specifications relating directly thereto.

Splices in steel piles shall be made by a full penetration butt weld of the entire cross section. Case shall be taken to properly align adjacent sections so that the axis of the pile shall be straight. The number of splices in the length of the pile shall be limited to three. Splices in the top 10' of the piles shall not be permitted. The locations of pile lugs, when used, shall be performed by qualified welding operators in accordance with AWS Specifications.

b. Manufacturing Requirements - Material for steel piles shall not be made by acid bessemer process.

Steel sheet piling shall consist of standard interlocking sheet pile sections having positive interlocks in both longitudinal and transverse directions, which are continuous throughout the entire length of the piece.

c. Rejection - Any steel piling not conforming to these specifications and applicable provisions of other sections shall be rejected. Any defect causing it to be unsuitable for its intended use shall be cause for rejection of the piling.

3. Concrete Piles

a. General - This item shall govern for the furnishing of concrete piles in place, size and in the locations shown on the plans. The types of concrete piles covered by these specifications are precast piles, metal shell concrete piles and prestressed concrete piles. Portland cement concrete and reinforcing steel shall conform to the provisions *Section 5.1, Concrete and Reinforcement.* Compressive strength tests for concrete shall be performed in accordance with Making and Curing Concrete Test Specimens in the Field, ASTM Designation C 31.

b. Precast Piles - The following shall govern for precast piling in addition to the applicable requirements of *Section 7.2.B, Concrete Structures*:

The form foundation shall be unyielding. Timber sills or joints, when used, shall be wide enough and spaced sufficiently close to support the weight of the concrete without settlement and prevent sagging of the bottom forms.

Piling to be turned over for removal of a single unit steel form shall be cast on a 6" thick (minimum) sand bed placed on an unyielding foundation. The sand bed shall be kept clean and free of all coarse aggregates, extraneous concrete or other hard material.

Timber from bottom and side forms shall not be less than ¾" in thickness after surfacing; and lined with an approved material such as hardboard, plywood or equal. Lining shall not be required for piling completely hidden from view in the finished structure. Forms may also be constructed of plywood of ½" minimum thickness. Clear spacing of supporting studs or joists shall not exceed 30 times the actual lumber or plywood

thickness. Face-ply grain of plywood forms shall be laid parallel to the length of the pile. All forms shall be built and maintained reasonably mortar tight.

When metal forms are used, they shall conform to the requirements of *Section 7.2.B, Concrete Structures,* except that corners may be filleted or rounded.

All square piling corners shall have a 1" chamfer unless otherwise provided.

Reused forms shall be oiled and their accuracy of shape, rigidity, strength and smoothness shall be maintained.

Before reuse, warped and bulged lumber must be properly sized and reconditioned.

Forms shall be accessible for placing and vibrating the concrete.

Piling may be turned over for removal of a single unit steel from after the concrete strength reaches 400 psi minimum as evidenced by test beams made and cured under the same conditions as the piling. Curing shall be resumed upon removal of the forms.

Side forms may be removed at the discretion of the Contractor any time after the concrete has reached sufficient strength to prevent physical damage to the surface, provided curing is not interrupted for more than 30 minutes; and the pile is not moved on its supports until the minimum curing period has elapsed.

Reinforcement shall be accurately placed and rigidly supported as required by *Item A.7, Steel Reinforcement, of Section 5.1 Part 2.*

Concrete shall be placed continuously in each pile. Special care shall be taken to avoid cold joints. Approved types of mechanical vibrators shall be used to thoroughly consolidate the concrete without displacing the reinforcing steel.

Due to the close spacing of reinforcement in the pile tip, special care shall be taken to avoid accumulation of large sizes of aggregates in this area. Large particles shall be moved as required to insure complete filling of the space between bars and to avoid honeycomb in the interior of the pile.

As soon as a pile is completed and the top surface is finished as specified herein, it shall be covered with wet cotton mats which shall remain in place until the side forms are removed. Upon their removal, the entire pile or bed of piling, including the ends, shall be covered with wet cotton mats or wet earth; or submerged by ponding. This condition shall be maintained throughout the curing period.

While removing side forms and placing curing material, the piling surfaces shall be kept covered and wet to the greatest extent practicable; but in no case shall they be permitted to become dry. It is the intent of this provision not only to keep the piling wet, but also to provide for covering them in order to maintain constant curing conditions, which shall gradually and uniformly dispel the heat from the hydration process. The minimum curing period shall be six days and until the concrete has a minimum flexural strength of 600 psi, or a minimum compressive strength of 3600 psi, tested in accordance with TxDOT Bulletin C-11 and cured in the casting bed under the same conditions as the piling. The piling may be driven after curing is completed.

The top surface of all piling shall be struck off and finished with a wood float, bringing grout to the surface to cover the aggregates and present a reasonably smooth

appearance. Form marks, small corner fins and discolorations need not be removed, unless the piling is to be exposed to view.

The methods of handling and storing piling shall minimize the danger of fracture by impact or undue bending stresses. Any broken or cracked piling shall be cause of immediate review and correction of the conditions causing failure. The use of chain slings shall not be permitted. After the curing and strength requirements are met, the piling may be removed to a storage area where they shall be stored above ground on adequate blocking that shall prevent undue stresses.

The maximum sweep (curvature along the axis of the pile) shall not exceed $^1/_8$".

The head of the pile shall not be out of square by more than $^1/_8$".

Small damaged or honeycombed areas, which are purely surface in nature (not over 1" deep), may be repaired. Damage or honeycomb in excess of this shall be tentatively rejected, but shall be subject to structural review.

When piling are cast with internal voids, the position of the void shall be within plus or minus ½".

Piling cracked in the process of curing, handling and driving shall be subject to the following provisions:

(1) Piling which have cracks showing severe spalling or sufficient opening to indicate the reinforcement has been permanently distorted shall be rejected if the cracks occur in a portion, which shall be below ground after driving.

(2) Piling with cracks as described in the above paragraph, which shall be located above ground when driving is completed, may be used, provided the Contractor shall cut the piling back to the crack and rebuild it to grade. No additional payment shall be made for this buildup.

(3) Piling with cracks that show spalling but are closed sufficiently to indicate no permanent distortion of the reinforcement may be used if the Contractor shall seal the area over the crack with an approved epoxy waterproofing material. Cracks $^1/_{32}$" or greater in width shall have a V-formed $^1/_8$" in width and depth prior to application of the waterproofing.

The waterproofing shall be applied in the crack and over an area not less than 1" each side. If, during driving, cracks develop in the portion, which shall be below ground, driving operations shall be stopped and the required waterproofing applied before driving continues.

(4) Fine hair cracks or surface checks, which, as determined by the Owner, do not extend to the plane of the nearest reinforcing steel, shall not require extra treatment and shall not be cause for rejection unless they are numerous and extensive.

(5) A tendon breakage, which may occur, shall be analyzed in accordance with *Section 7.2.D, Prestressing*.

(6) All replacement or repairs specified herein, and other replacements due to faulty materials or construction methods, shall be made at the Contractor's expense.

Buildups shall be made in accordance with the details shown on the plans.

Welding of reinforcing steel shall conform to *Item O, Welding, of Section 7.3.A Part 3.*

The pile ends shall be cut back, leaving the steel exposed. The final cut of the concrete shall be normal to the longitudinal axis, and any damage shall be remedied by further cut back. The buildup form shall be placed, care being taken to prevent leakage along the pile. The buildup shall be of class "C" concrete. Just prior to placing the concrete, the top of the pile shall be wetted thoroughly and covered with a thin coating of cement grout.

If no further driving is required, form removal and curing shall conform to requirements for concrete columns in *Section 7.2.B, Concrete Structures.*

Where additional driving is required, the buildup portion shall be water cured for six curing days.

c. Metal Shell Piles - This item shall govern for the furnishing of metal shell piling in place, fabricated, reinforced and filled with concrete in accordance with these specifications and plans, of the type and size shown on the plans, and in the location as required by the plans.

Metal shell piling may be of any of the sections and of the minimum thickness or gauge indicated on the plans. The entire metal shell shall form an integral watertight unit. The show or point shall be tightly fastened to the shell and adequately welded or otherwise connected to prevent the entrance of water. The shell shall be of sufficient strength to resist the earth pressure after being driven and shall retain its original form free from harmful distortions after it and adjacent shells in the bent or pier have been driven.

Metal in the shell shall conform to *Item A of Section 7.3.A Part 2.* All concrete materials and their preparation and placing shall be in accordance with the requirements of *Section 7.2.B, Concrete Structures,* and the *Section 5.1, Concrete and Reinforcement,* except that the use of a tremie shall not be required. All concrete shall be class "A" unless otherwise shown on the plans. Reinforcement shall conform to the requirements of *Item A.7, Steel Reinforcement, of Section 5.1 Part 2.* The sizes and dimensions of reinforcing steel shall be as shown on the plans. Welding shall be done in accordance with *Item O, Welding, of Section 7.3.A Part 3.* The required sizes and dimensions of the metal piping shall be as shown on the plans.

The methods of handling shall be such that they shall not result in damage to the piling. Piling to be stored shall be placed on skids to prevent contact with the ground. A sufficient number of skids shall be used to prevent deflection in the stored piling. The stored piling shall be kept clean and fully drained at all times.

After the metal shell has been driven to the approximate penetration and bearing resistance to satisfy the design requirement, it shall be cut off or built up as necessary to bring the top of the shell to plan grade. Cut-offs shall be made with a cutting torch or other acceptable methods, which shall give the desired result of a smooth, level end of shell at the proper elevation. Buildups shall be made by welding on a section of shell in such manner as to develop fully the section of the shell and give a smooth, watertight joint.

Where the top of the pile is appreciably deformed or otherwise damaged below cut-off level, the damaged portion shall be cut of and replaced with a new section spliced in place. No additional compensation shall be allowed for this work and material.

Test piling, generally, shall not be required except where load tests are to be made. Where required, test piling shall be furnished and driven at locations as shown on the plans or as directed by the Owner, and shall conform to the requirements herein provided for metal shell piling. In general, test piling shall be made a part of the completed work and shall be cut of or built up to grade elevations as necessary. The Contractor shall be given the option of driving test piling for his own information in estimating the length of piling, even though they are not required or indicated on the plans.

Load tests shall be required when called for on the plans or contract specifications. When required bearing resistance, as computed by the proper formula, cannot be attained at or near the depth of penetration indicated on plans, the Owner may require load tests on one or more piles as necessary to establish the actual bearing capacities of the piling and to develop a modified bearing resistance formula.

The length of a metal shell pile may be built up in sections either before or during the driving operation. The minimum length of a section measured between splices shall be 5'. Only one splice shall be permitted in that portion of a pile exposed above ground line or normal water line.

Care shall be taken to properly align the sections to be spliced to insure a straight axis, and the sections shall be welded together in a manner that shall fully develop the section of the shell and also form a watertight joint.

After all driving and splicing are completed, the shell shall be free of buckles, water and other foreign matter and shall be of the required shape and dimensions before filling with concrete. The Contractor shall provide equipment and facilities necessary for the proper inspection of the shells. Any broken, improperly driven, or otherwise defective shell shall be removed and replaced at the Contractor's expense.

The concrete shall be placed in a continuous operation from tip to butt. Care shall be taken to prevent segregation in depositing concrete, and special devices shall be used if necessary. No concrete shall be placed in the piling in any bent or footing until all driving of piling in that bent or footing has been completed. The tops of shells shall be kept covered after driving until the concrete has been placed.

Metal shell piling shall be reinforced when and as indicated on the plans. Care shall be taken to hold the reinforcement to true position in the shell when placing concrete. Concrete blocks or other suitable devices shall be used to prevent the displacement of the core reinforcing.

All surfaces of metal shells which shall be exposed to view in the completed structure shall be cleaned and painted in accordance with *Section 7.8, Painting,* and in compliance with the following additional requirements:

Metal shell piling shall not be painted prior to driving. After driving and placing concrete in the metal shell, all exposed portions of the metal shell pile shall be

cleaned and painted in accordance with *Section 7.8, Painting.* Painting shall extend to a point 1' below the finished ground line unless pile is standing in water, in which case, paint shall extend to the low water line. Earth removed for this painting shall be replaced after paint has hardened.

d. Prestressed Concrete Piles - This item shall govern for the furnishing of prestressing along with the pertinent requirements of *Section 7.2.C, Prestressed Concrete for Structures,* and *Section 7.2.D, Prestressing*. This includes the design,mixing, placing, curing and quality of concrete construction and removal of forms, submission of prestressing details and plant facilities plans, tensioning and release of stress to the concrete and inspection facilities.

For prestressed piling, concrete shall be of the class shown on the plans.

4. Rejection - Any concrete piling not conforming to these specifications and applicable provisions of other sections shall be rejected. Any defect causing it to be unsuitable for its intended use shall be cause for rejection of the piling.

B. EQUIPMENT

The driving of piling shall be done with power hammers (steam or diesel). When specified on the plans, gravity hammers shall be permitted. Either steam or compressed air may be used as the operation medium for steam hammers.

Steam hammers shall be furnished with boiler or air compressor capacity at least equal to that specified by the manufacturers of the hammers to be used. The boiler or compressor shall be equipped with an accurate pressure gauge at all times.

Diesel hammers, which have an enclosed ram, shall be equipped with a gauge and charts, which shall evaluate the equivalent energy actually being produced under any driving condition.

The valve mechanism and other parts of all power hammers shall be maintained in first-class condition so that the length of stroke and number of blows per minute for which the hammer is designed shall be obtained.

Power hammers shall be operated at not less than 80 percent of the manufacturer's rated capacity.

The driving equipment for steel sheet piling shall be of such size as required to drive the piling to the required depths with no damage to the piling. The equipment shall be equipped with a head suitable to the shape of the sheet pile.

When gravity (drop) hammers are used, the height of drop shall be regulated to avoid injury to the piling and in no case shall exceed the maximum drop shown in the table below. The Contractor shall furnish the Owner with a certified scale weight of the hammer to be used.

TABLE - SIZE OF DRIVING EQUIPMENT

Type Piling	Type Hammer	Min. Energy (Foot-Pounds)*	Weight Hammer or Ram (Power Hammer) Min. / Max.	Max. "H" in Feet
Timber	GRAVITY POWER	6000	2000 lb to 3000 lb	15
Steel H and Metal Shell	GRAVITY Required bearing under 30 tons 30-37 tons Over 37 tons POWER	250 x R or 2½ x Wp Whichever is larger	2000 lb to 5000 lb 2500 lb to 5000 lb 3000 lb to 5000 lb Open end diesel 2000 lb	15 15 15
Concrete ALL SIZES	GRAVITY		½ Wp but not less than 3000 lb	
15" OR SMALLER	POWER Single acting or open end diesel Double acting or enclosed ram diesel	10,000 but not less than one ft-lb per Wp 8000 but not less than one ft-lb per lb of Wp	Open end diesel 2000 lb	
16" OR LARGER	POWER Single action or open end diesel Double acting or enclosed ram diesel	15,000 but not less than one ft-lb per lb or Wp 12,000 but not less than one ft-lb per lb of Wp	Open end diesel 2700 lb	

*R = Design load in tons.
Wp = Weight of piling in pounds.
(The size of the hammer shall comply with Table above.)

Concrete piling shall not be subject to excessive tensile stresses due to the combination of a particular hammer with the given soil conditions. When such damage occurs, the Contractor shall make such changes necessary to provide undamaged piling in place.

If such damage occurs, the Owner may require:

1. Reduced energy delivered to the piling. This may be reduced stroke, change in cushioning, or a lighter ram.

2. Equivalent energy but with heavier or lighter ram with different stroke.

3. Smaller hammer for the easier initial driving.

4. Pilot holes or jetting equipment.

Where test piling or test loads are required, the hammer used in driving all other piling shall be of the same type and size as the hammer used in driving the test piling.

Pile drivers shall be equipped with heads which are constructed in such manner as to afford freedom of movement of the hammer and which provide adequate support to the pile during driving. The vertical axis of the leads and hammer shall coincide with the vertical axis of the pile.

Except where piling are driven through water, the leads shall be of sufficient length that a follower shall not be necessary. Where a follower is required for the driving of piling under water, one piling out of every 10 shall be of sufficient length that a follower is not required. This piling shall be driven as a test piling for proper correlation of the follower-driven piling in the group.

PART 3: EXECUTION

A. General

Unless otherwise shown on the plans, the embankment at bridge ends shall be made to grade and thoroughly compacted as provided in the governing specifications prior to the driving of abutment piling. Foundation piling shall not be driven until after the excavation is approximately complete.

All piling raised during the process of driving adjacent piling shall be driven again. Broken, split or misplaced piling shall be withdrawn and properly replaced or corrected as directed by the Owner based on design analysis.

B. Tolerance for Driving

Piling shall be driven to the vertical or batter line indicated. The allowable variation from the plan alignment shall not exceed four inches in any direction. If the center of gravity of a pile group varies by more than three inches from the center of gravity determined from plan location, a structural analysis shall be required to see if the group shall be acceptable.

The minimum concrete cover for piling in footings shall be five inches, and the pile shall be in such position to permit proper placement and cover of reinforcing steel.

C. Protection of Pile Heads

A structural steel driving head suitable for the type and size of pile being driven shall be used. Wood cushion blocks shall be used as necessary to prevent damage to the pile. Rope mat, belting or similar cushioning material may be used in addition to wood cushion blocks. Cushion blocks shall be changed as necessary to prevent damage to the pile.

D. Penetration

The length of piling shown on the plans is the length, which is estimated to give the required bearing and is for estimating purposes only.

Piling shall be driven to the "minimum penetration" shown on the plans and to such greater depths required to obtain the specified bearing resistance. Where the plans indicate a "required penetration" into a particular stratum, this penetration into the strata shall be required although the strata may be found at a higher or lower elevation than is indicated on the plans.

Where no specific information is shown on the plans as to penetration, and where test piling are not required, the pile lengths shown shall be considered as the "plan penetration"; shall be driven to this approximate elevation; and to such greater depths required to obtain the specified bearing resistance.

When the specified penetration cannot be obtained without over-driving of the piling, pilot holes or jetting may be required. (Driving after the computed bearing resistance has reached twice the design load or when there is damage to the pile shall be considered over-driving of concrete piling.)

E. BEARING RESISTANCE

The bearing resistance of all piling shall be determined by the following formulas:

For gravity hammers:

$$p = \frac{2WH}{S + 1.0}$$

When the energy delivered (W x H) by the gravity hammer is 24,000 foot-pounds or greater, and the penetration does not exceed ¼th inch per blow for the last 40 blows delivered (without increasing), the bearing resistance shall be determined by:

$$p = \frac{2WH}{3S} \times N$$

For single-acting hammers:

$$p = \frac{2WH}{S + 0.1}$$

For double-acting hammers:

$$p = \frac{2E}{S + 0.1}$$

p = Bearing resistance in pounds.
S = Average penetration in inches per blow for the last 20 blows. (40 blows for special formula for gravity hammer.)
W = Weight of ram in pounds.

H = Height of fall of ram in feet.
N = Ratio of weight of ram to the weight of the pile. N shall not be used when greater than 1.
E = Manufacturer's rated energy in foot-pounds (for double-acting steam hammers).
E = The equivalent energy in foot-pounds, determined by gauge attached to the hammer taken during the period when the average penetration in inches per blow is determined. (For enclosed ram diesel hammer.) The maximum value of E to be used shall not exceed that shown as follows:

When rating diesel hammers for energy to determine compliance with the requirements of the table on page 9 of this section, the height of fall of the ram of the single-acting (open end) hammer shall be seven feet. The maximum energy rating allowed for the double-acting (enclosed ram) hammer shall be:

Link Belt 312 - 15,000 foot-pounds
Link Belt 520 - 26,000 foot-pounds

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT

Items specified in this section to be paid for as separate contract pay items shall be measured for payment as indicated in the following:

1. Timber Piling - Timber piling, treated or untreated, furnished in lengths specified on the plans or approved by the Owner and driven in accordance with these specifications, shall be measured for payment by the linear foot complete in place after cut-offs and build-ups have been made.

Cut-offs shall be measured for payment by the linear foot. The pay length of cut-off for each pile shall be determined by deducting the length of accepted pile in place, after cut-off has been made, from the "approved length" of the pile, except that no measurement shall be made of cut-offs necessitated by brooming, splitting or other injuries arising from careless or improper driving. No cut-off shall be measured on any pile, which is spliced and built-up. Splices for build-ups shall be measured for payment as a unit. Each test pile shall be measured for payment as a unit.

2. Steel Piling - Steel H piling shall be measured for payment in linear feet of acceptable piling in place after all cut-offs and build-ups have been made. For those piles specified to be driven to a "minimum penetration," no measurement shall be made on that portion of piling below the elevation at which the penetration and bearing requirements were first obtained.

Steel sheet piling shall be measured for payment by the square foot of acceptable piling in place. Sheet piling driven below the elevation required by the plans or as directed by the Owner shall not be measured for payment.

3. Precast Concrete Piling - Precast concrete piling shall be measured for payment by the linear foot of acceptable piling in place after all cut-offs and build-ups have been made, to which measurement shall be added two feet for each authorized build-up made, other than those made necessary by improper casting, handling or driving of piling.

Cut-offs shall be measured for payment by the linear foot. The pay length of cut-off for each pile shall be determined by deducting the length of the accepted pile in place, after cut-off has been made, from the "approved length" of the pile, except that no measurement shall be made of cut-offs necessitated by damage arising from careless or improper driving. No cut-off shall be measured on any pile, which is spliced and built-up.

When the Contractor chooses to cast piling to extra length to eliminate protrusion of reinforcing steel, such extra length shall not be measured for payment as either piling or cut-offs.

When piling, other than required test piling, are driven to depths greater than required to the meet the specified penetration and bearing requirements, no measurements shall be made on that portion of piling below the elevation at which penetration and bearing requirements were first obtained. Portions of test piling, directed by the Owner to be driven below the level at which penetration and bearing were first obtained, shall be measured for payment.

B. PAYMENT

All items specified in this section shall be paid for as indicated below. The work performed and material furnished as prescribed herein, measured as provided under "method of measurement," shall be paid for at the contract unit price.

1. Timber Piling - Timber piling shall be paid for at the contract unit price per linear foot for "treated timber piling" or "untreated timber piling," as the case may be.

Cut-offs for treated or untreated timber piling measured as previously provided shall be paid for by the linear foot at one-half the contract unit price respectively for "treated timber piling" or for "untreated timber piling."

Splices for build-ups for timber piling shall be paid for each at four times the contract unit price for timber piling. This shall not include any allowance for the length of piling used in the build-up as same is measured and paid for as timber piling as provided elsewhere.

Test piling shall be paid for at the contract unit price for each timber test piling.

The foregoing unit prices shall be full compensation for furnishing all materials, tools, labor, equipment, jetting, pilot holes, alignment holes and incidentals necessary to complete the work.

2. Steel Piling - Steel H piling shall be paid for at the contract unit price per linear foot for "steel H piling," or "steel H test piling," as the case may be, of the specified size and weight. Steel sheet piling shall be paid for at the contract unit price per square foot for "sheet piling" of the specified weight and size required. No direct payment shall be made for cut-offs, pile heads, concrete collars, painting or for excavation and backfill required in placing the collars and in the painting of portions of piling below ground line; such items

shall be considered as incidental work, and the cost thereof shall be included in such contract pay items as are provided in the proposal and contract.

Splices for steel H piling shall be paid for each at two times the contract unit price for steel H piling of the size and weight on which the splice is made, except that no payment shall be made for any splice on any pile whose actual length left in place, after all cut-offs, splices or build-ups have been made, is not greater than the length shown on the plans or directed by the Owner; nor shall payment be made for more than one splice on any one pile.

No payment shall be made for cut-off or build-up of sheet piling. The foregoing unit prices shall be full compensation for furnishing all materials, tools, labor, equipment, jetting, pilot holes, alignment holes and incidentals necessary to complete the work.

3. Precast Concrete Piling - Concrete piling shall be paid for at the contract unit price per linear foot for the specified size of precast concrete piling.

Cut-off shall be paid for at one-half the contract unit price per linear foot for precast concrete piling. Where cutbacks are made below grade for the purpose of making build-ups, payment for same shall be included in the allowance for build-ups.

A partial allowance shall be made for materials and for precast piling (cast, but not driven) in accordance with the provisions of *Part II, Section 7.3*.

The foregoing unit prices shall be full compensation for furnishing all materials, tools, labor, equipment, jetting, pilot holes, alignment holes and incidentals necessary to complete the work.

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SECTION 7.2: Concrete

7.2.A Drilled Shaft Foundations

PART 1: GENERAL

A. DESCRIPTION

This item shall govern for the construction of foundations consisting of reinforced concrete shafts with or without bell type concrete footings. Such foundations shall be constructed in accordance with this item and in conformance with the details and governing dimensions shown on the plans.

B. SUBMITTALS

PART 2: PRODUCT

A. MATERIALS

All concrete materials and their preparations shall be in accordance with the requirements of *Section 5.1, Concrete*, and the additional requirements herein. All concrete shall be Class "A," 3,000 psi unless otherwise shown on the plans.

When casing of the shaft is required, the following shall apply:

1. The maximum size coarse aggregate shall be one and one-half (1½) inches.

2. The elapsed time from beginning of placement of concrete in the cased portion of the shaft until extraction of the casing is begun shall not exceed 30 minutes. If a cement-dispersing agent is used, this time shall not exceed one hour. If non-agitating equipment is used to haul the concrete from a central mixing plant, the elapsed time for discharge of concrete from the mixer to placement in the shaft shall not exceed 10 minutes. If a cement-dispersing agent is used, this time shall not exceed 30 minutes.

3. When the temperature of the air or concrete is above 85 F, an approved cement dispersing agent shall be required in all drilled shaft concrete. Reinforcing steel shall conform to the requirements of *Item A.7, Steel Reinforcement, of Section 5.1 Part 2.*

B. EQUIPMENT

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. Excavation - The Contractor shall do all excavation required for the shafts and bell footings, through whatever materials are encountered, and to the dimensions and elevations shown on the plans or required by the site conditions. Unless otherwise shown on the plans, all shafts shall be bored to plumb to a tolerance of 1½ inches for depths up to and including 10 feet. When bells are required, they shall be excavated so as to form a

bearing area of the size and shape shown on the plans. Shafts and bells may be excavated so as to form a bearing area of the size and shape shown on the plans.

The plans indicate the expected depths and elevations at which satisfactory bearing material shall be encountered; and this information shall be used as a basis for the contract. If satisfactory foundation materials are not encountered at plan elevations, the footings may be raised or lowered as determined by the Owner. Alterations in plan depths shall be made as judged proper to satisfactorily comply with the design requirements.

Casings shall be required for shaft excavations when such provision is necessary to prevent caving of the material or when necessary to shut off seepage water. Casings shall be of ample strength to withstand handling stresses, the pressure of concrete and of the surrounding earth or backfill materials; and shall be watertight. The inside diameter of the casing shall not be less than the normal size of the shaft. No extra compensation shall be allowed for the concrete required to fill an oversize casing or oversize excavation.

When the drilling operation reaches a point where caving condition and/or excess ground water is encountered, no further drilling shall be allowed until a construction method is employed which shall prevent any caving that tends to make the excavation appreciably larger than the size of casings to be used. Drilling in a mud slurry without the removal of cuttings, or other construction methods which shall control the size of the excavation, shall not be permitted.

If the elevation of the top of the shaft is below ground level at the time of concrete placement, an oversize casing from ground elevation to a point below the top of the shaft shall be required to control caving of any material into the freshly placed concrete.

Any excavation for the footing bells or shafts beyond the lines required shall be backfilled with Class "A," 3,000 psi concrete at the Contractor's expense. Where casings are used, the Contractor shall be permitted to backfill around the upper portion of the casing with pea gravel or other granular material. Where a double casing is required for a portion of the shaft, no material shall be placed between the casings, but this area shall be filled with Class "A," 3,000 psi concrete.

Under normal operations when the casing is to be removed, the removal shall not be started until concrete placement is completed in the shaft. Movement of the casing for short pulls of a few inches or rotating of the casing shall be permitted. When unusual conditions warrant, the casing may be pulled in partial stages. In all cases, a sufficient head of concrete shall be maintained at all times above the bottom of the casing to overcome hydrostatic pressure. Extraction of the casing shall be at a slow, uniform rate and the full pull shall be in a truly vertical direction. If any upward movement of the concrete and/or inside the casing occurs at any time during the pulling operation, the following criteria shall govern:

a. If the upward movement is one inch or less, the casing shall be left in place. Vibration or rodding shall not be used to attempt to break the casing loose for extraction unless the entire shaft is to be replaced.

b. If the upward movement is greater than one inch, all of the material shall be removed and the entire drilled shaft operation shall be redone.

Placing of drilled shaft concrete under water shall not be done without the permission of the Owner.

Material excavated from shafts and bells and not used in the backfill around the completed bents or piers shall be disposed of as directed by the Owner. The disposal of such material shall be in such a manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other parts of the work.

At the time concrete is placed, the excavation shall be free from accumulated seepage water and all loose material shall be removed from the base area.

The Contractor shall provide suitable access and lighting for the Owner to inspect the completed foundation excavation and check the dimensions and alignment of drilled shafts and the under-reamed excavation when under-reaming is required. Any required lighting shall be by electric lights. Any mechanical equipment used in the excavations shall be operated by air or electricity. The use of gasoline-driven engines placed in the excavation for pumping or drilling shall not be permitted.

In order that the Owner may judge the adequacy of a proposed foundation, the Contractor, if requested, shall make soundings or take cores at his expense to determine the character of the supporting materials. The depth of such soundings or cores shall not be required to exceed five feet below the proposed footing grade. It is the intent of this provision that soundings shall be made or cores taken at the time the excavation in each foundation is approximately complete.

When the plans require drilled shafts in the abutments, the embankment at the bridge ends shall be made to grade as shown and thoroughly compacted, as provided in the governing specifications, prior to drilling for abutments shafts.

2. Reinforcing Steel - The reinforcing steel cage for the shaft, consisting of longitudinal bars and spiral hooping or lateral ties, shall be completely assembled and placed into the shaft as a unit. Generally, the reinforcing steel unit shall not be placed until immediately before concreting operations are to be started.

The longitudinal bars shall be tied or tack-welded to the spiral hooping at intervals not to exceed 12 inches on centers to provide a rigid unit.

For cased shafts where the reinforcing steel cage is over 30 feet in length the longitudinal bars shall be tied or tack-welded at each intersection of the spiral hooping for a distance of $^{1}/_{5}$th the depth of shaft from the bottom of the cage.

The cage of reinforcing steel shall be supported from the top by some positive method, to prevent slumping downward during extracting of the casing.

In uncased shafts, side spacer blocks of concrete shall be used at intervals along the shaft to insure concentric spacing for the entire length of shaft. In cased shafts, concrete spacer blocks shall not be used, but metal "chair" type spacers shall be placed vertically at intervals around the steel cage to insure concentric spacing inside the casing.

3. Concrete - The work shall be performed in accordance with the provisions of *Section 7.2.B, Concrete Structures,* and in conformance with the requirements herein.

Preferably, concrete shall be placed immediately after all excavation is complete and reinforcing steel placed.

Concrete placing shall be continuous from the beginning of placement in the shaft or footing bell to the top of shaft or to a construction joint as may be indicated on the plans. Time intervals shall be allowed for pulling casings, for placing forms and other operations necessarily carried on in sequence with the placing operations. The reinforcing steel cage shall be held vertically in some manner to restrain the steel from slumping during the concrete placement operation. Concrete shall be placed through a suitable tube to prevent segregation of concrete materials and unnecessary splashing on the reinforcing steel cage. The tube shall be made in sections to permit the discharge and raising as the placement progresses. A non-jointed pipe may be used if sufficient openings of the proper size are provided to allow for the flow of concrete into the shaft.

Whenever a casing is used, the casing shall be smooth and well oiled and shall extend sufficiently above the grade of the finished shaft to provide excess concrete to be placed for the anticipated slump due to the casing removal.

Where a casing is to be pulled, the concrete placed in casing shall be of such workability as to require no vibrating or rodding. Where a cap block or ground line strut is shown on the plans to be placed at the top of the drilled shaft, and the cap or strut is shown to be placed monolithic with the drilled shaft, a time interval shall be allowed for placing the required form and reinforcing after any necessary casing removal.

After a placement is completed, the top surface shall be cured, and any construction joint area shall be treated as prescribed in *Section 7.2.B, Concrete Structures.*

B. TEST HOLES

When shown on the plans, or when ordered by the Owner in writing, test holes shall be required to establish elevation for "belling" to determine elevation of ground water; or to determine other soil characteristics.

The diameter and depth of test hole or holes shall be as shown on the plans or as directed by the Owner.

C. TEST BELLS

When shown on the plans, or when ordered by the Owner in writing, the under-reaming of bells, on specified test holes, shall be required to establish the ability to under-ream in the soil strata present. The diameter and shape of the test bell shall be as shown on the plans or as directed by the Owner.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

Acceptable drilled shafts in place of the specified diameter shall be measured by the linear foot. At interior bents and piers, shafts shall be measured from a point of six inches below the ground elevation at the center of shaft unless otherwise indicated on the plans. At street grade separations and at railroad underpasses, the ground elevation shall be the completed roadway section under the structure. At stream crossings and at railroad overpasses, the ground elevation shall be considered as the elevation existing at

the time drilling begins. At abutment bents, the length of shaft shall be measured from the bottom of cap elevation.

Footing bells, constructed to the specified dimensions, or to the altered dimensions as authorized by the Owner, shall be measured by the cubic yard of concrete in the acceptable footings placed. The bell shall consist of the authorized footing volume outside the dimensions of the drilled shaft, which for the purpose of measurement shall be considered as extending to the bottom of the bell.

Test holes of the specified diameter shall be measured from the elevation of the ground at the time drilling begins, by the linear foot of acceptable test hole drilled.

Test bells of the specified diameter and shape shall be measured by each test bell acceptably under-reamed.

Drilled shafts shall be paid for at the unit price bid per linear foot of the specified diameter of "drilled shafts," measurements being made as hereinbefore outlined. Where vertical and spiral reinforcing bars from the shaft extend into footings, caps, columns or other concrete members, the cost of such reinforcing shall be included with and paid for as part of "drilled shafts."

Payment shall include the following:

1. Payment for individual completed shaft lengths, up to and including five feet in excess of the maximum plan length shaft as defined herein, shall be made at the unit price bid per linear foot of the specified diameter of "drilled shafts."

2. Payment for that portion of individual completed shaft length in excess of five feet and up to and including 15 feet more than the maximum plan length shaft as defined herein, shall be made at a unit price equal to 115 percent of the unit price bid per linear foot of the specified diameter of "drilled shafts."

3. Payment for individual completed shaft lengths, over 15 feet in excess of the maximum plan length shafts as defined herein, shall be in accordance with one of the following methods as determined by the Owner:

a. Method "A" - By unit prices agreed on in writing by the Owner before said extra work is commenced, subject to all other conditions of the contract.

b. Method "B" - By lump sum price agreed on in writing by the Owner and the Contractor before said extra work is commenced, subject to all other conditions of the contract.

Footing bells, constructed to the specified dimensions or to the altered dimensions as authorized by the Owner, shall be paid for at the contract unit price bid per cubic yard for "bell footing."

Test holes, of the specified diameter, shall be paid for at the contract unit price bid per linear foot for "test hole."

Test bells, of the specified diameter, shall be paid for at the contract unit price bid for each "test bell."

The foregoing unit prices shall be full compensation for making all excavations; for drilling all test holes and test bells; pumping, placing and removing any required casings; furnishing and placing all concrete and reinforcing steel; all backfilling; and furnishing all tools, labor, equipment, materials and incidentals necessary to complete the work. No extra payment shall be made for casings left in place.

7.2.B Concrete Structures

PART 1: GENERAL

A. DESCRIPTION

This specification shall govern for the construction of all types of structures involving the use of structural concrete except where the requirements of this section are not applicable. All concrete structures shall be constructed in accordance with the design requirements and with the details shown on the plans; in conformity with the pertinent provisions of other applicable sections of the specifications; and in conformity with the requirements herein provided.

B. SUBMITTALS

PART 2: PRODUCT

A. MATERIALS

Materials used in the performance of the work herein specified shall conform to the requirements of the applicable sections of these specifications and the concrete shall conform to the requirements of *Section 5.1, Concrete and Reinforcement*, or *Section 5.2, Lightweight Concrete.*

B. EQUIPMENT

PART 3: EXECUTION

A. General Requirements

Before starting work, the Contractor shall inform the Owner fully of the methods of construction he proposes to follow and the amount and character of equipment he proposes to use; the adequacy of which shall be subject to the approval of the Owner. Plans for forms and falsework, for concrete piers and concrete superstructure spans over 20 feet in length, and for all widening details shall be submitted to the Owner for review and approval. Similar plans shall be submitted for other units of the structure if requested by the Owner. The plans shall be prepared on standard 24 inches by 36 inches sheets. They shall show all essential details of the proposed forms, falsework and bracing so that a structural analysis may be made. Six sets of such plans shall be required. The Owner may require a structural analysis of forms, falsework and bracing by a Professional Engineer registered in the State of Texas.

Concurrence on the part of the Owner in any proposed construction methods, approval of equipment or approval of form and falsework plans does not relieve the Contractor of the responsibility for the safety or correctness of his methods and adequacy of his equipment; or from carrying out the work in full accordance with the contract.

Unless otherwise provided, the following requirements shall govern for the time sequence in which construction operations may be carried on and for the opening of completed structures to traffic:

No superstructure members, forms, falsework or erection equipment shall be placed on the substructure, before the substructure concrete has attained a 500 psi flexural strength or comparable strength in compression, if required by the Owner.

The use of completed portions of a structure for storage of materials shall not be permitted until all curing requirements for the particular part of the structure have been met.

Forms for wall or columns shall not be erected on concrete footings until the concrete in the footing has cured at least two days. Concrete may be placed in the wall or column as soon as the forms and reinforcing steel placement are approved.

The support of tie beam and/or cap forms by falsework placed on previously placed tie beams is permissible, provided such supporting beams have attained 500 psi flexural strength; curing requirements completed; and are properly supported to eliminate stresses not provided for in the design.

Structures shall not be opened to construction traffic or to the traveling public until authorized by the Owner. Authorization may be given after the last slab of concrete has been in place at least 14 days or concrete has attained a minimum of 90% of required compression strength for light construction traffic not to exceed a ¾-ton vehicle to pass over the structure.

Authorization may be given after the last slab concrete has been in place at least 30 days for normal construction traffic and to the traveling public. Construction vehicles with a minimum of three axles may be operated across structures if the total gross load does not exceed 51,000. Because of possible damage to the new structures, care shall be exercised to reduce impact on the new structures by limiting the speed of such vehicles to 10 miles per hour or less.

Where a detour is not readily available or is not economically feasible, and an occasional crossing of a structure with overweight construction equipment such as a concrete paving machine is necessary, the Owner may permit such crossing after a structural analysis is made giving consideration to the dimensions of the equipment axle spacings and axle loads.

Unless otherwise shown on the plans, the placement of roadway slabs may be by the sequence shown on the plans, using a longitudinal screed or a self-propelled transverse mechanical finishing machine, or by continuous placement using a transverse mechanical finishing machine only. The screed shall be adequately supported on a header or rail system, which shall have sufficient stability to withstand the longitudinal or lateral thrust of the equipment. Supports for a transverse finishing machine shall be installed so that they may be removed without damage to the slab. Bond between the removal supports and the concrete shall be prevented in a manner acceptable to the Owner. Portions of the rail support system, which remain embedded in the slab, shall not project above the upper mat of reinforcing steel. Attachment of the rail support system by welding to I-beams or girders shall be permitted subject to the following requirements:

1. Welds shall be parallel to the web of the member. Circular or transverse welds shall not be permitted.

2. Welds shall not be permitted on the tension flange of the members in that area where the stress exceeds 75 percent of the allowable stress.

3. Welds shall be made with low-hydrogen electrodes.

4. Welding shall be done by a certified welder, subject to test welds.

5. Certification papers will be provided prior to beginning any work.

B. DRAINS

Weep hole drains and roadway drains shall be installed and constructed as shown on the plans in the designated locations.

When the concrete is not formed at the weep hole location, a sheet of building paper shall be placed over the gravel to prevent the entrance of concrete into the pocket during operations.

C. JOINTS

1. Expansion Joints - Expansion joints and devices to provide for expansion and contraction shall be constructed where and as indicated herein or on the plans.

The bearing area under the expansion ends of concrete slabs, prestressed concrete beams, girders and slab and girder spans shall be given a steel trowel finish. These areas shall be finished to the exact grades required. The material used in separate expansion surfaces shall be that shown on the plans and shall be placed carefully so that concrete or mortar cannot be subsequently worked around or under the material.

Immediately after the removal of forms and again where necessary after surface finishing, all projecting concrete shall be removed along exposed edges in order to secure full effectiveness of the expansion joints.

2. Construction Joints - The joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set shall be deemed a construction joint. When concrete is to be placed monolithically, the term monolithic shall be interpreted to mean that the manner and sequence of concrete placing shall be such that construction joints shall not be created.

Construction joints shall be of the type and at the locations shown on the plans. Additional joints shall not be permitted without written authorization from the Owner. Any additional construction joints shall have details equivalent to those shown on the plans for joints in similar locations.

Unless otherwise provided, construction joints shall be square and normal to the forms. Bulkheads shall be provided in the forms for all joints except horizontal joints.

Construction joints requiring the use of joint sealing material shall be as detailed on the plans. The material shall be specified on the plans without reference to joint type.

The top surface of a concrete placement which terminates at a horizontal construction joint shall have the surface roughened thoroughly as soon as practicable after

the concrete has attained initial set. The surfaces at bulkheads shall be roughened as soon as the forms are removed.

Before joining plastic concrete to concrete that has already set, the surface of the concrete in place shall be free from all loose material, laitances, dirt or foreign matter; shall be washed, scrubbed clean and drenched thoroughly with water until saturated; and shall be kept moist until the plastic concrete has been placed. Immediately prior to the placing of additional concrete, all forms shall be drawn tight against the existing concrete and the existing joint surface shall be flushed with a coating of grout mixed in the proportions of one part of cement to two parts of sand.

D. FALSEWORK

All falsework shall be designed and constructed to safely carry the maximum anticipated loads and to provide the necessary rigidity. Details of falsework construction shall be subject to review and approval by the Owner in accordance with the provisions of *Item E, Forms, of Section 7.2.B Part 3*. When the falsework is no longer required, it shall be removed. Falsework piling shall be pulled or cut off a minimum of six inches below finished ground level. Falsework and piling in a stream or lake shall be removed completely to a point specified by the Owner to prevent any obstruction to the waterway.

E. FORMS

1. General - Forms shall be of suitable material and of a type, size, shape, quality and strength to insure construction as designed. The forms shall be true to line and grade, mortar tight and sufficiently rigid to resist deflection during placing of the concrete. The responsibilities for the adequacy shall rest with the Contractor. All dirt, chips, sawdust, nails and other foreign matter shall be completely removed from forms before any concrete is deposited therein. The surfaces of forms shall be smooth and free from irregularities, dents sags and holes that would deface the finished surfaces. Forms previously used shall be thoroughly cleaned of all dirt, mortar and foreign matter before being reused. Before concrete is placed in forms, all inside surfaces of the forms shall be thoroughly treated with an approved releasing agent, which shall leave no objectionable film on the surface of the forms that can be absorbed by the concrete. Care shall be exercised that no releasing agent is deposited on previously placed concrete, reinforcement or embedded metal items.

Forms for all surfaces that shall not be completely enclosed or hidden below the permanent surface of the ground shall be made of surfaced lumber; or material, which shall provide a surface at least equal to surfaced lumber or plywood. Any lumber or material, which becomes badly checked or warped, prior to placing concrete, shall not be used.

Forms for all exposed surfaces of bridges, viaducts, over-crossings and similar structures shall be constructed of plywood or an approved equal. Plywood for forms shall be exterior type, of the grade "Concrete-Form Exterior," conforming to the specifications of the U.S. Department of Commerce, National Bureau of Standards, Commercial Standards, latest edition. Plywood shall be furnished and placed in 48" widths and in uniform lengths of not less than 96", except where the dimension of the member formed is

less than the specified panel dimension. Plywood shall be placed with the grain of the outer plies in the direction of the span. Where plywood is attached directly to the studs or joists, the panels shall not be less than $^5/_8$" thick; and the studs or joists shall be spaced not more than 12" center to center. Plywood form panels otherwise conforming to the requirements specified herein; may be used with a continuous backing of ¾" sheeting. All form panels shall be placed in a neat, symmetrical pattern with the horizontal joints level and continuous. All joints shall be filled with an approved quick-setting compound and finished flush with the interior of the form.

Forms for round columns exposed to view shall be of steel, except that other materials shall be allowed with written permission of the Owner.

Forming plans shall be submitted for approval subject to the requirements of *Item A, General Requirements, of Section 7.2.B Part 3*. Forms shall be designed for the pressure exerted by a liquid weighing 150 pounds per cubic foot. The rate of placing the concrete shall be taken into consideration in determining the depth of the equivalent liquid. An additional live load of 50 pounds per square foot shall be allowed on horizontal surfaces. The maximum unit stresses shall not exceed 125% of the allowable stresses used by TxDOT for the design of structures.

2. Molding - Molding specified for chamfer strips and other uses shall be made of redwood, cypress or white pine materials of such grade that shall not split when nailed and which can be maintained to a true line without warping. The molding shall be mill-cut and dressed on all surfaces.

3. Form Ties and Spreaders - Metal form ties of an approved type or an approved substitute shall be used to hold forms in place. Pipe spreaders shall not be permitted. Metal and wooden spreaders, which are separate from the forms, shall be entirely removed as the concrete is being placed. All metal ties, wire or other appliances used inside the forms to hold them in correct alignment shall be removed to a depth of at least ½" from the surface of the concrete. Burning off of rods, bolts or ties shall not be permitted. The cavities produced shall be carefully cleaned and completely filled with retempered sand-cement mortar mixed in proportions of one to three; and the concrete shall be left smooth and even.

4. Form Supports for Overhanging Slabs - Form supports which transmit a horizontal force to a steel girder or beam or to a prestressed concrete beam shall be permitted, but shall not be used unless a structural analysis has been made of the effect on the girder or beam and approval is granted by the Owner.

Holes in steel members for support of overhanging brackets may be punched or drilled full size or may be torch cut to ¼ of an inch under size and reamed full size as provided for in *Section 7.3.A, Steel Structures.* In no case shall the holes be burned full size. All such holes must be approved by the Owner in writing prior to punching, drilling or burning. Holes shall be left open unless specified on the plans to be filled with a button head bolt. In no case shall the holes be filled by welding.

F. PLACING REINFORCEMENT

Placing Reinforcement is outlined in *Item D, Placing Reinforcement, of Section 5.1 Part 3.*

G. PLACING CONCRETE

Placing Reinforcement is outlined in *Item E, Placing Concrete, of Section 5.1 Part 3.*

H. FINISHING

Placing Reinforcement is outlined in *Item F, Finishing, of Section 5.1 Part 3.*

I. REMOVAL OF FORMS AND FALSEWORK

Removal of forms and falsework is outlined in *Item I, Removal of Forms and Falsework, of Section 5.1 Part 3.*

J. DEFECTIVE WORK

Defective work is outlined in *Item J, Defective Work, of Section 5.1 Part 3*.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

No direct measurement or payment shall be made for the work to be done or the equipment to be furnished under this item, but it shall be considered subsidiary to the particular items required by the plans and the contract.

7.2.C Prestressed Concrete for Structures

Part 1: General

A. Description

This item shall govern for the complete construction, prestressing and erection of precast prestressed concrete structures, in accordance with the plans.

B. Submittals

PART 2: PRODUCT

A. Materials

Materials for concrete shall be in accordance with *Section 5.1, Concrete and Reinforcement*, and/or *Section 5.2, Lightweight Concrete.* Materials for prestressing shall be in accordance with *Section 7.2.D, Prestressing*. Reinforcing steel, not prestressed, shall be in accordance with *Item A.7, Steel Reinforcement, of Section 5.1 Part 2.* Structural steel bearing plates, fittings, etc., shall be in accordance with *Section 7.3.A, Steel Structures.* Bearing pads shall be in accordance with TxDOT Standard Specifications for Construction of Highways, Streets, Bridges, Item 434, or newest revision and with special specifications contained in the contract.

The values which govern for minimum concrete strengths during different phases of construction shall be as shown on the plans; or as shown on approved shop drawings.

For Class H, Y and Z concrete, the control of the concrete shall be by compressive tests of cylinders and not be flexural tests. Two tests (6 cylinders) shall be made for each pertinent strength test required. For determining "release strength" of prestressed concrete members, a test shall be defined as the average of the breaking strength of two cylinders.

Test cylinders for Class H, Y and Z concrete shall be required for each separate stressing line of beams, spans, members, piling, etc., as the case may be.

All test specimens, beams or cylinders representing test for removal of forms and/or falsework and Class H, Y and Z concrete for "tension release" shall be cured under the same conditions and be subjected to the same curing materials and to the same weather conditions as the concrete represented.

"Design strength" cylinders for acceptance of prestressed concrete members shall be cured with the member which the cylinders represent until release of stress or until partial tensioning strength is obtained, after which these cylinders shall be cured for the remainder of the test period in a curing tank.

Provisions shall be made to maintain the water in the curing tank at temperatures between 70 and 90°F. The cost of all materials used in the test specimens and the cost of providing and maintaining curing facilities shall be included in the unit price bid for the various prestressed concrete members.

B. Equipment

PART 3: EXECUTION

A. General

The method of construction and of prestressing shall be as shown on the project plans and on the approved shop drawings. Prior to beginning the casting of prestressed members, the Contractor shall give the Owner ample notice and to the location of the casting site and the date on which work shall begin so that arrangements may be made for inspection.

An inspection laboratory shall be furnished if required by the Owner. Shop plans showing the following information shall be submitted for approval. Three copies of each shall be supplied.

1. **Erection Layout -** An erection layout sheet showing information for field erection. (Location, type member, erection mark of member, bearing pads, etc.).

2. **Fabrication Details -** Complete information necessary for fabrication not shown on contract plans. (Member lengths, type, skew angle, dimensions for diaphragm holes, neoprene pad sizes, bevels and erection devices, inserts to be used in forming, etc.).

3. **Method of Handling and Transporting -** Method of transporting to the job site, including points of support, blocking used, tie down points, amount of cantilever, etc.

4. **Facilities Plan -** Prior to pretensioning of members, the producer shall submit a drawing showing the complete facilities to be used for stressing, including details of the pulling head, anchor plates, jacks, hold-downs, etc., with dimensions and thickness of plates, bolts, etc., and types of materials used. This shall be sufficient detail to allow accurate calculation of stresses in the stressing equipment and anchorages. Detailed drawings shall be submitted and approval of the system given prior to casting of beams.

5. **Prestressing Details -** For post-tensioned members, pre-tensioned members with draped strands, for special and modified designs, for job site fabrication, and for cast-in-place members, the Contractor shall submit to the Owner detailed fabrication plans showing details of the member and forms, devices for holding prestress steel in place, method and details of prestressing the steel together with anticipated elongations and jack pressures; and all other features of proposed fabrication. Calculations may be included at the Contractor's option; or required at the Owner's request where necessary to justify the system and method of prestressing to be used.

6. **Corrected "As-Built" Shop Plans -** At the completion of the job, corrected "as-built" shop plans shall be submitted, to be incorporated as a part of the final plans of the project

B. Construction Methods

Prestressing shall be in accordance with *Section 7.2.D, Prestressing*.

Reinforcing steel shall be fabricated and placed in accordance with the plans; and as required herein.

The construction of forms and the placing, curing and finishing of concrete shall be in accordance with the provisions contained herein and pertinent notes shown on the plans.

1. Forms - All forms for precast prestressed concrete construction shall be constructed of steel, unless otherwise noted on the plans. Forms shall be constructed of sufficient thickness, with adequate bracing and stiffeners; so anchored as to withstand the forces due to placement of concrete; and shall be maintained mortar-tight. Accurate alignment of the forms shall be maintained throughout the entire casting operation.

The grade and alignment of forms shall be checked each time the forms are set.

Metal forms shall be free from paint, rust, grease or other foreign materials, which might cling to or discolor the prestressed member. All forms shall be cleaned thoroughly prior to each casting operation. Wood forms, if allowed, shall conform to requirement of *Section 6.13 Wood Products*.

External bracing for side forms shall be used to maintain the shape and dimensions of the prestressed member as shown on the plans within the tolerances specified in *Subsection E Workmanship and Tolerance* of this section. Internal bracing and holding devices in forms shall not be permitted if such would remain in the finished prestressed member.

The soffit for casting prestressed concrete members shall be so constructed and maintained to provide not more than ¼ inch variation in any 50-foot length of the bed from the theoretical plane of the bottom of the member.

All joints in the forms shall be smooth and mortar-tight to avoid irregular finishes or blemishes on the prestressed concrete member. Plugging of holes and slots or other repairs of forms shall be done in such a manner as to produce a smooth and even finish of the prestressed concrete member.

Forms for internal voids in prestressed concrete piling shall be anchored securely to prevent movement or misalignment during the placing of concrete.

In forming internal voids with a mandrel, if approved by the Owner in writing, special attention shall be given to maintaining the correct position and alignment of the mandrel throughout the entire casting operation.

The facing of all forms shall be treated with oil or coated with other satisfactory materials prior to placing of concrete. The oil or other materials used for this purpose shall be consistency and composition as to facilitate form removal and not discolor or otherwise be injurious to the concrete surface.

All forms shall be constructed to facilitate removal without damage to the concrete. At the Contractor's option, forms for prestressed concrete piling may be constructed with a ⅛ inch draft to permit ease of removal.

2. Placing Concrete - All concrete shall be placed during daylight hours unless the fabrication plant or site is provided with an adequate lighting system approved by the Owner in writing.

The method and manner of placing concrete shall be such as to avoid segregation or separation of the aggregate or displacement of the reinforcing steel and/or prestressed tendons. Concrete shall be deposited as nearly as possible in its final position in the forms. Depositing large quantities of concrete at one location in the forms and running or working it along the forms shall not be permitted. Special attention shall be directed toward working the coarse aggregate back from the face of the concrete and to forcing the concrete under and around the prestressed tendons and reinforcing steel.

Concrete may be placed in one lift. At the Contractor's option, concrete may be placed in multiple continuous horizontal layers in forms for precast prestressed concrete beams. In such instance, the thickness of the first layer shall be such that the surface of the concrete shall be slightly above the top of the bottom flange fillet. The beam forms shall be completely filled by the second layer which shall be placed prior to any initial set of the first layer. No more than one hour shall elapse between the placing of the successive layers.

Concrete shall be placed in one continuous horizontal layer in forms for precast prestressed concrete piling and precast prestressed concrete slab units.

Concrete shall not be placed at outdoor casting beds during inclement weather or when impending weather conditions may result in rainfall or low temperature during the casting operation which might impair the quality of the finished member. In case rainfall should occur after placing operations are underway, the Contractor shall provide adequate covering to protect all exposed concrete. The completion of a member which is in progress shall be permitted, provided adequate provisions are made to prevent damage to the concrete.

a. Placing Concrete in Cold Weather - When precast prestressed concrete members are produced in a fabricating plant which has adequate provisions to protect the concrete when placed in the forms and which has approved steam curing facilities, concrete may be placed under any low temperature conditions, provided:

(1) The temperature of the concrete is not less than 50°F nor more than 90°F when placed in the forms.

(2) The framework and covering are placed and heat is provided for the concrete and forms within one hour after the concrete is placed in the forms. This shall not be construed to be one hour after the last concrete is placed; but that no concrete shall remain unprotected and unheated for longer than one hour.

(3) The steam heat shall keep the air surrounding the concrete between 50°F and 90°F for a minimum of two hours prior to beginning the temperature rise which is required for steam curing.

(4) The temperature of the concrete shall not be less than 50°F at any time after all ingredients are added and mixing commences.

For fabricating plants which do not provide facilities necessary to accomplish the preceding provisions and for job site precast, prestressed members, concrete may be placed when the atmospheric temperature is 35 °F or greater. The temperature of the concrete at the time of placement in the forms shall not be less than 50°F nor more than 90°F. The concrete shall not be placed in contact with any materials having a temperature less than 32°F or any material coated with frost.

Aggregates shall be free from ice, frost and frozen lumps. When required, in order to produce the minimum temperature specified above, the aggregate and/or the water shall be heated uniformly, in accordance with the following:

Water shall be heated to a temperature not to exceed 180°F and/or the aggregate shall be heated to a temperature not to exceed 150°F. The heating apparatuses shall be capable of heating the mass of aggregate uniformly and preclude the occurrence of hot spots, which shall burn the material. The temperature of the mixture of the aggregates and water shall be between 50°F and 90°F before introduction of the cement.

All concrete in precast prestressed concrete members shall be effectively protected to maintain the temperature of the concrete at all surfaces above 50 °F for the required total curing time as specified in *Section 7.2.E Precast Concrete Units*. Protection shall consist of providing additional covering and, if necessary, supplementing such covering with artificial heating. When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating equipment and covering material shall be on hand ready for use before permission is granted by the Owner in writing to begin placement of concrete.

b. Placing Concrete in Hot Weather - When concrete is to be placed during hot weather, the concrete shall be placed in the forms without the addition of more water to the concrete than required by the design (slump consistency); and the concrete shall be finished properly without adding water to the surface. Control of the initial set of the concrete and lengthening the time for finishing operations under adverse wind, humidity and hot weather conditions may be accomplished with the use of an approved cement dispersing agent.

The maximum time interval between the addition of mixing water and//or cement to the batch and the placing of concrete in the forms shall not exceed the following:

	Air or Concrete Temperature (Whichever is Higher)	**Maximum Time (Addition of Water or Cement) To Placing in Forms**
Non-agitated Concrete	80°F or above 35 to 79°F	15 minutes 30 minutes
Agitated Concrete	90°F or above 75 to 89°F 35 to 74°F	45 minutes 60 minutes 90 minutes

The use of an approved cement-dispersing agent in the concrete shall permit the extension of each of the above temperature-time maximums by 30 minutes; except that for non-agitated concrete the maximum time shall not exceed 30 minutes.

Under conditions of extreme temperature, wind or humidity when the specified temperature-time maximums are excessive, the Owner may require the use of an approved cement-dispersing agent or may suspend concrete placing operations if quality concrete is not being placed.

3. Vibration of Concrete - All concrete in precast, prestressed concrete members shall be compacted and the mortar flushed to the surface of the forms by continuous working with approved high-frequency mechanical vibrators operating at a minimum of 7,000 impulses per minute. Use of external vibrators in conjunction with internal vibrators shall be permitted.

At least one standby vibrator shall be provided for emergency use to avoid delays in vibrating due to breakdowns.

The vibrators shall be applied to the concrete immediately after deposit and shall be moved throughout the mass, thoroughly working the concrete around the reinforcement, and into the corners and angles of the forms until it has been reduced to a plastic mass. When the concrete is placed in more than one layer, the vibrator shall be operated so that it shall penetrate the layer of concrete placed previously. The vibration shall be of sufficient duration to accomplish thorough compaction and complete embedment of the reinforcing steel and prestressed tendons, but shall not be done to such extent as to result in segregation. Vibration shall be supplemented by hand spading, if necessary, to insure the flushing of mortar to the surface of all forms.

4. Finishing of Concrete - Top surfaces of prestressed concrete members against which cast-in-place concrete shall be placed later shall be rough floated with a wooden float to bring grout to the surface and cover all aggregate. At the time of initial set, laitances shall be removed by brushing to provide a rough finish. Sound concrete shall not be removed nor the aggregate loosened. Fresh concrete from exposed reinforcing steel shall be removed.

Erection holes (lifting eyes, form anchors, etc.) in exterior beams shall be filled with mortar and the surface given a first surface rubbing to blend the area into the surrounding surface. Holes in interior beams need not be filled unless steel is exposed. Erection or fabrication holes in the bottoms of all beams shall be filled with non-staining, non-shrink mortar in a manner which shall preclude subsequent reopening of the holes.

The exterior surfaces of exterior prestressed concrete beams shall be made uniform in color and texture by brushing, buffing, partial rubbing (to blend imperfections), sandblasting (80-mesh material) or other means necessary to make the surface uniform in appearance, but not necessarily to yield the same color or rubbed texture of the surrounding non-prestressed concrete in the final structure.

When permitted by notes on the plans, or with written permission of the Owner, the exterior surfaces of the exterior prestressed concrete beams may be painted with a latex-base adhesive grout.

The coating shall be approximately ⅛ inch in thickness and shall be applied after slab concrete is placed and all runs, drips and mortar have been removed from the surface of the beam.

5. Curing of Concrete - Careful attention shall be given to the proper curing of prestressed concrete members. The Contractor shall inform the Owner regarding the methods and procedures proposed for curing; shall provide the proper equipment and necessary materials; and shall have approval in writing by the Owner of such methods, equipment and materials prior to placing concrete in the forms.

Inadequate curing facilities or lack of attention to the proper curing of prestressed concrete shall be cause for the Owner to stop all construction on the job until approved curing is provided. Inadequate curing may be cause for rejection of the member.

Side forms may be removed at the discretion of the Contractor at any time after the concrete has reached sufficient strength to prevent physical damage to the member. Removal of the forms shall be done in such a manner that curing is not interrupted on any member by more than 30 minutes. Cracks caused by form restriction shall be cause for rejection of the affected member.

All approved concrete members shall be cured continuously, except as provided for form removal, until the concrete strength as indicated by the compressive tests of cylinders cured with the members have reached the strength designated on the plans. Prestressed concrete piling shall be steam-cured or water-cured for an additional three curing days after release of tension. All other prestressed concrete members, except piling, shall be protected from freezing and shall be covered to prevent rapid drying for a period of 72 hours after release of tension.

Curing shall be commenced prior to the formation of surface shrinkage cracks, but in no case longer than one hour after the concrete has been placed in the forms.

A curing day is defined as calendar day when the temperature, taken in the shade away from artificial heat, is above 50°F for least 19 hours; or a colder day if satisfactory provisions are made to maintain the temperature at all surfaces of the concrete above 50°F for the entire 24 hours.

All prestressed concrete members shall be steam-cured or water-cured except that membrane curing may be used as interim curing on the top surface of precast prestressed concrete piling.

a. Water Curing - Water curing shall conform to the requirements of Item I.2, Water Curing, of Section 7.2.B Part 3.

b. Elevated Temperature Curing - Curing by elevated temperature methods shall be permitted as follows:

(1) Steam Curing - (Steam curing is defined as use of steam above 90°F for curing of concrete). When steam curing of prestressed concrete is provided, all surfaces of the concrete shall be at a temperature not to exceed 150°F.

Sufficient moisture shall be provided inside the curing jacket so that all surfaces of the concrete are wet. If the temperature inside the curing jacket exceeds the limitations shown below, the concrete shall not be accepted.

151 to 160°F for 60 minutes
161 to 170°F for 30 minutes
171 to 180°F for 15 minutes
Over 180°F - NONE

An unobstructed air space of not less than six inches shall be provided between all surfaces of the prestressed concrete member and the curing jacket. Steam outlets shall be positioned so that curing steam is not applied directly on the concrete or reinforcing steel and tendons.

Steam curing shall not commence until the concrete has been in place for two hours. During the application of steam, the temperature inside the curing jacket should be raised uniformly at a rate not to exceed 40°F per hour. Temperature decrease at the end of the curing operation shall not exceed the same rate.

(2) Alternate Methods - Other methods of elevated temperature curing may be permitted by the Owner, provided that temperature maximums, rate of temperature variation, humidity control, etc., are in accordance with the requirements of steam curing. Permission shall be obtained from the Owner in writing for any alternate method.

(3) Protection - Members shall remain protected until the difference between the temperature inside the jacket and the temperature of the outside air is 25°F or less.

The location of steam lines, location of control points for discharge of steam into the curing jacket and the number and type of openings for steam distribution within the curing jacket shall be arranged in such manner that temperature variation between any points in the enclosure shall not exceed 20°F.

C. Handling and Erection

Fabrication and erection plans shall indicate the method of handling and erecting prestressed members. An adequate factor of safety shall be included in all calculations for handling and erection to preclude overstressing any part of the member due to dynamic forces or impact.

Prestressed concrete beams shall be maintained in an upright position at all times and shall be picked up and supported near the end of the beams only and in such a way as to prevent torsional stress in the beam. Beams may be lifted with the lifting devices as approved on the shop plans or by other methods approved by the Owner in writing.

No prestressed concrete structural member shall be moved from the casting yard until all requirements for tensioning, curing and strength have been attained. The strength of a prestressed member shall be considered adequate after curing and tensioning requirements are fulfilled if the design strength compressive cylinders indicate that the required design strength has been attained.

D. Defects and Breakage

If any prestressing tendon or portion thereof is broken prior to placing concrete in the member, it shall be replaced with a satisfactory unit properly prestressed. The breaking of one wire of a seven-wire strand in a unit during concrete placing operations shall be subject to a structural review prior to acceptance.

Fine hair cracks or checks on the surface of the member which, as determined by the Owner, do not extend to the plane of the nearest reinforcement, shall not be cause for

rejection unless such cracks are so numerous and extensive as to indicate inadequate curing, in which case the members shall be rejected. Diagonal cracks on the vertical surfaces, which indicate damage from torsion shall be subject to a structural review prior to acceptance. Vertical and horizontal cracks which are $^{1}/_{16}$ inch or less in width and which tend to close upon release of stress are acceptable. Cracks in excess of this are subject to review prior to acceptance. Cracks, which extend into the plane of reinforcing steel and/or prestressed tendons and are acceptable otherwise shall be repaired by sealing with a latex-base adhesive grout or with epoxy.

All replacements as herein specified as well as all other replacements due to faulty materials or construction methods shall be made at the Contractor's expense.

E. WORKMANSHIP AND TOLERANCE

1. Prestressed Beams, Girders, Spans and Box-Type Beams - Requirements shall include the following:

a. Variation from shop plan lengths: plus or minus one inch.

b. Variation from plan height, box-type beams: plus or minus ¼ inch. Others: plus or minus ½ inch.

c. Maximum deviation of ¼ inch per 10 feet of length. Box-type beams ¾ inch total deviation.

d. Out-of-square (vertical or horizontal) or deviation from plane skew angle: maximum ⅛ inch per foot of dimension.

e. Bearings - Requirements include:

(1) Out-of-perpendicular with vertical axis: maximum $^{1}/_{16}$ inch.

(2) Honeycomb in bottom soffit of beams at the bearing shall not exceed 15 percent of the bearing area (width x length). No tendons shall be exposed and the maximum depth of honeycomb shall not exceed one inch. Honeycomb shall be chipped out to sound concrete and repaired satisfactorily prior to acceptance.

f. Form Fit-Up - Where sections of forms are to be butt-jointed, an offset of $^{1}/_{16}$ inch for flat surfaces and ⅛ inch for corners and bends shall be permitted.

2. Repair - Small areas of honeycomb which are purely surface in nature (not over one inch) may be repaired. Honeycomb extending to the plane of the prestressed strands shall be rejected tentatively, subject to structural review prior to acceptance.
Variations greater than specified above shall be cause for rejection.

3. Steel - Reinforcing steel shall not project above the top of the member more than ½ inch nor less than ¾ inch from plan dimension. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from plan placement by more than ¼ inch or $^{1}/_{12}$ of the spacing between bars, whichever is greater. In the plane of the steel perpendicular to the nearest surface of concrete, bars shall not vary from plan placement by more than ¼ inch.

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PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT

Precast prestressed concrete beams or girders of the type specified, cast and stressed, as required on the plans, shall be measured by the linear foot complete in place.

Precast, prestressed concrete spans of the size and type specified, cast and stressed, as required by the plans, shall be measured as each prestressed span, complete in place.

Other precast, prestressed members of the type and size specified, cast and stressed, as required by the plans, may be measured by the linear foot or by each member as the case may be and as noted on the plans.

Cast-in-place structures (or structures where the Contractor has the option of casting-in-place) shall be measured in accordance with the provisions of *Section 7.2.D, Prestressing*.

B. PAYMENT

Precast, prestressed concrete beams or girders shall be paid for at the unit price bid per linear foot for "prestressed concrete beams" of the type specified.

Precast prestressed concrete spans shall be paid for at the unit price bid for each "prestressed concrete span."

Other prestressed concrete members shall be paid for at the unit price bid per linear foot for "prestressed concrete members" (specify name and type) as the case may be.

A partial allowance shall be made for materials and for precast or prestressed concrete members "cast, but not erected" in accordance with the provisions in *Item A, Measurement and Payment, of Section 7.2.B Part 4.*

The above prices shall be full compensation for constructing the member; furnishing and tensioning prestressed steel; furnishing and placing reinforcing steel, conduit and attached bearing plates, etc., for same; grouting holes; and for all bars, anchorage plates, and other appurtenances which become an integral part of the precast structure and for any special treatment of end anchorages and shoes as indicated on the plans; and shall be full compensation for furnishing all materials, tools, equipment, labor and incidentals necessary to fabricate, transport and erect the members in the structure as indicated on the plans.

7.2.D Prestressing

PART 1: GENERAL

A. DESCRIPTION

This item shall govern for the furnishing, storing and handling of materials for prestressing; and for the prestressing of structural units except as otherwise shown on the plans.

B. SUBMITTALS

Not Applicable

PART 2: PRODUCT

A. MATERIALS

1. Concrete - All concrete shall conform to the provisions of *Section 5.1, Concrete and Reinforcement*, and/or *Section 5.2, Lightweight Concrete.* Cast-in-place concrete shall further conform to *Section 7.2.B, Concrete Structures.*

2. Grout - The recommended composition of grout for post-tensioning tendons shall be:

94 pounds	Portland Cement: Type II
1 pound	Admixture: Interplast C as manufactured by Sika Chemical Company, or Intrusion Aid as manufactured by Concrete Chemicals Company, or an approved equal.
5½ gallons max.	Water

50 pounds maximum of fly ash with a maximum carbon content of eight percent may be added to the above mixture if desired.

Other mixtures of equal or better strength, workability and freedom from corrosive elements may be approved by the Owner.

3. Reinforcing Steel - Reinforcing steel, not prestressed, shall conform to *Item A.7, Steel Reinforcement, of Section 5.1 Part 2.*

4. Structural Steel - Structural steel bearing plates, fittings, etc. shall conform to *Section 7.3.A, Steel Structures*.

5. Prestressing Steel

a. Post-Tension Method - Alternate types of prestressing tendons and systems may be used as provided for on the plans. End anchorages tendon couplers or

connections shall develop at least 95 percent of the required ultimate strength of the tendon, based upon the gross area and the required minimum unit strength. Certification of the above by the manufacturer shall be required. Friction-type anchorage shall not be permitted when coated tendons are used.

Anchorages which depend upon both friction and mechanical interlocking such as serrated wedges and threaded nuts shall be permitted for coated tendons, subject to the following tests to be performed at the manufacturer's expense by a commercial laboratory approved by the Owner:

Static Test - Anchorage shall develop at least 95 percent of the required breaking strength of the tendon with a minimum elongation of three percent.

Dynamic Test - Anchorage shall withstand 500,000 cycles from 60 to 70 percent of the required breaking strength of the tendon without failure or slippage. Tendon and anchorage shall be lubricated for this test.

Bearing and shim plates shall be structural steel in accordance with the provisions of *Section 7.3.A, Steel Structures.*

As used herein, "tendon" shall be defined as any single prestressing element used to apply prestressed forces to the member. For post-tensioned construction this shall be each group of wires, each group of seven-wire strands, with each large diameter strand or each bar having common end anchorage.

All tendons shall be identified by heat number, or reel in the case of seven-wire strand; and tagged for identification purposes. Anchorage assemblies shall be identified in a like manner. The Contractor shall furnish, free of additional charge, one representative specimen of each size of tendon from each 10 tons of each heat. For seven-wire strand, one specimen shall be furnished from each reel up to a lot of three reels or from each third reel for lots of four or more reels. These specimens are to be obtained at the casting yard or at the tendon fabrication plant. Each specimen shall be four feet in length.

When required by the Owner, the Contractor shall furnish, free of charge, two specimens of each size of prestressing unit of the selected type, with end fittings attached, for tensile tests to be performed by the Owner. These specimens shall be five feet in clear length measured between ends of fittings. If the results of the test indicate the necessity of check tests, additional specimens shall be furnished without additional cost.

When testing as a complete unit is not required, the tendon shall be tested and specimens submitted as specified above.

Tendons shall be grouted or coated as shown on the plans. Tendons and conduit for grouted tendons and all anchorage devices shall be free of lubricant, oil, loose rust and other deleterious materials at the time of placing in the member. The Owner may prohibit the use of components, which show excessive signs of oxidation or weathering.

(1) Steel Wire - Parallel steel wire shall conform to ASTM Designation A 421. Type BA shall be used for "button" anchorages and Type WA shall be used for "wedge" anchorages.

(2) Manufactured Steel Twisted Wire Strand (Large Diameter Strand) - Unless otherwise specified on the plans, strand shall not be galvanized. The

minimum ultimate strength shall be 220,000 pounds psi based upon the gross section of the tendon.

The minimum ultimate elongation over a gate length of 10 inches shall be three percent. After tendons are fabricated, such shall be prestretched at sufficient stress and for sufficient length of time to equalize the stress in all wires and to reduce creep to a minimum.

When required, tendons shall be shipped to the job site with end fittings attached and encased in the flexible metal conduit described elsewhere in these specifications.

(3) Prestressing Bars - The minimum ultimate tensile strength based on the gross section of the bar shall be 145,000 psi. The minimum ultimate elongation in 20-bar diameters shall be four percent. Each bar shall be proof loaded by the manufacturer to 90% of its required ultimate strength. If splices are allowed, test reports showing complete chemical analysis of the bar and of the splicing device shall be submitted for approval prior to their use. If splices are used, tensile specimens submitted shall develop 95% of the required ultimate strength, when tested with a two-degree cold bend in the bar at the root of the thread or at the end of the splicing device.

(4) Manufactured Steel Seven-Wired Strand - Wires, strands or bars with greater ultimate strength but otherwise produced and tested in accordance with ASTM Designation A 21, ASTM Designation A 416 and the requirements of this specification, shall be permitted, provided the physical properties as outlined in the applicable specification are shown on the shop drawings.

b. Pretension Method - As used herein, "tendon" shall be defined as "any single prestressing element used to apply prestressed forces to the concrete." For pretensioned construction, this shall be each strand of straight wire.

(1) Steel Wire - The requirements for steel wire shall be the same as the requirements for steel wire for the post-tensioned method as specified above.

(2) Manufactured Steel Seven-Wire Strand - Seven-wire strand shall conform to the requirements of ASTM Designation A 416. The Contractor shall furnish, free of charge, a representative sample of each size of wire or strand from each reel up to a lot of three. In lots of four reels or more, one sample shall be furnished from each third reel or fraction thereof. Each sample shall be four feet in length.

(3) Prestressing Bars - Bars shall not be allowed in the pretension method.

6. Bearing Pads - Bearing pads shall conform to the requirements of TxDOT Standard Specifications for Construction of Highways, Streets, Bridges, Item 434, or newest revision.

7. Conduit - The conduit to enclose grouted post-tensioned tendons shall be mortar tight, galvanized flexible interlocked metal conduit having a minimum wall thickness of $^{1}/_{100}$ of an inch. The Contractor shall furnish manufacturer's data certifying that the conduit is capable of withstanding a crushing force of 600 pounds per square foot. The inside area of conduit shall be at least twice the area of the enclosed prestressing steel.

The conduit shall be increased in size near the ends to allow movement of the anchorage devices.

8. Coating - Tendons not requiring grouting shall be completely coated with a nonvolatile, low friction mineral oil base grease with a rust preventing additive having a relative uniform viscosity under temperature ranges of 20°F to 120°F. A protective sheathing shall be provided around the tendon consisting of a waterproof material capable of maintaining the tendon tightly bundled and containing the lubricant. Torn tendon wrapping need not be repaired if less than six inches in length; and grease is prominent on tendon.

B. EQUIPMENT

When required to post-tension cast-in-place units, the Contractor shall furnish a compression testing machine, meeting the requirements of ASTM Designation C 59. In lieu of the above, and with written permission of the Owner, the Contractor may provide the facilities of an acceptable commercial laboratory for the testing of cylinders for "tensioning strength" or "partial tensioning strength."

PART 3: EXECUTION

A. CONSTRUCTION METHODS

1. General - The following paragraphs are primarily intended to apply to the prestressing of concrete structures. However, the methods of tensioning and other requirements where applicable shall apply to the prestressing of any type of structure or member, subject to special requirements on the plans.

Calculations of anticipated losses, spacings, clearances, etc. shall be in accordance with the latest AASHTO Standard Specification for Highway Bridges, unless otherwise shown on the plans.

Prior to stressing, the Contractor shall furnish the Owner certified copies of load calibration curves on all jacks and gauge systems to be used in the work. Stressing systems shall be recalibrated when required by the Owner.

2. Post-Tensioning - When grouted tendons are to be deflected, the metal conduit shall be set low enough to offset the eccentric position of the tendons or bars in the conduit after stressing. Unless otherwise specified, the location of the prestressing units with respect to the member being prestressed as shown on the plans shall be construed to be the final location after stressing. The prestressing details to be furnished by the Contractor shall show the offsets from the bottom of slab or beam to the bottom of conduit, taking into account the position of the prestressing steel within the conduit. The conduit shall be supported at intervals of not more than five feet unless otherwise shown on the plans and shall be securely fastened to prevent displacement during placement of concrete. The Contractor shall submit details of his proposed method of supporting the conduit for approval. Unless otherwise shown on the plans, the allowable tolerance for vertical positioning of the tendon shall be plus or minus ¼ of an inch.

Grouted tendons shall be equipped with fittings for injection of grout and ports to vent entrapped air. Grout ports shall be required at the far end of the tendon and at the high points of the tendon profile when there is more than six inches variation in the vertical position of the conduit. Tendon with less than six-inch vertical variation shall have grout ports at the far end at intervals between the far end and injection end not to exceed 100 feet. Grout ports shall consist of ½ inch minimum diameter galvanized metal pipe with caps or other arrangements having a minimum port diameter of ½ inch as approved by the Owner.

The tops of the grout ports shall be set approximately ½ inch below the finished surface of the concrete. Recesses caused by the grout ports in the concrete surfaces shall be filled with mortar and finished as directed upon completion of grouting. If end anchorages permit, tendons may be inserted in the member after placing of the concrete. In all cases, the flexible metal conduit previously described shall be used. If tendons are to be inserted later, a stiffening bar shall be placed inside the metal conduit prior to placing of concrete. Positive means of holding the conduit in its correct position shall be provided in all cases and shall be indicated on the working drawings submitted to the Owner for approval.

After the concrete has reached a compressive strength equal to the "partial tensioning strength" as specified on the plans, and to be as indicated by compressive cylinder tests, the members may be partially prestressed for the purpose of removal of members from the casting bed to a curing area, provided satisfactory provision is made to bring all stressing units (including units stressed for handling) up to full required stress at the time of final stressing. The units to be stressed and the amount and pattern of the stressing for the partial prestressing shall be submitted with the prestressing details and approved by the Owner.

The Contractor shall furnish hydraulic jacks for stressing the steel. These jacks shall be of a type suitable for the purpose and shall be equipped with gauges graduated to read directly to one percent of the total load applied and calibrated to measure accurately the stress induced in the steel. In all methods of tensioning, the stress induced in the prestressed steel shall be measured by elongation of the steel and checked by gauge pressure. The result shall be within five percent of each other.

Suitable means shall be provided for measuring the elongation of the steel to the nearest $^{1}/_{16}$ of an inch. In the event of apparent discrepancies of more than five percent between stresses indicated by elongation and gauge pressure, the entire operation shall be checked carefully and the source of error determined and corrected before proceeding further. When both ends of tendons are being pulled simultaneously, the final elongation at either end shall be within five percent of the calculated elongation for that particular end. If one or both ends differ more than the five percent mentioned in the preceding, the tensioning operation shall be partially or totally repeated until the required tolerances are obtained.

The temporary overload force, when required, and the post-tensioning force as shown on the plans, may be applied when the concrete has reached a compressive strength equal to the "tensioning strength." These forces may be applied to one or both ends of the tendon as necessary to reduce friction. The temporary overload force shall be

held for a period of two minutes before reducing to the post-tensioning force required. The sequence of post-tensioning the units shall be such as to prevent overstressing the member by vertical or lateral bending at any time; and shall be so indicated on the prestressing details submitted to the Owner for approval.

A test for "partial tensioning strength" and "tensioning strength" shall be defined as the average breaking strength of two cylinders.

The following is the general tensioning procedure. The prestressing details to be submitted by the Contractor shall reflect the same general tensioning procedure modified for each particular installation.

a. The tendons shall be tensioned in the sequence designated in the prestressing details.

b. Initial tensioning to take the slack out of the tendons shall be 10 percent of the maximum tensioning load, unless otherwise shown on the prestressing details.

c. After the initial tensioning, the tendons shall be reference marked to determine elongation.

d. After tensioning to overcome friction, the tension should be reduced to that required to set the anchorage. With friction type anchorages, it shall be necessary to check the required elongation after the tendons have been released in order to insure that the required elongation is obtained after the anchors have set. If the resulting elongation after anchorage set is outside the tolerances required, the entire tensioning operation shall be repeated until the necessary requirements are met.

e. After stressing and anchoring all tendons and upon the Owner's approval, projecting tendons shall be trimmed as shown on the approved prestressing details.

f. For grouted tendons, the conduits shall be grouted within 48 hours after the completion of the tensioning operation, unless delayed by permission of Owner. Grout must be pumped toward an open vent. Grout shall be pumped continuously under moderate pressure at one end of the conduit until all entrapped air is forced out of the open vents downstream from the grout pump. The open vents shall be closed as soon as grout issues in a steady stream. After all grout ports have been closed, the pressure shall be increased to a minimum of 75 psi and held at this pressure for approximately 15 seconds. The grouting entrance port is then closed.

Unless otherwise shown on the plans, lightweight concrete prestressed units shall be stressed with a temporary force equal to 125 percent of the final prestress force and maintained for a period of 45 days. The temporary force shall be applied when the concrete has aged a minimum of 10 days, and when the test cylinders indicate the "tensioning strength" has been attained. At the end of the period specified, all the individual post-tensioning units shall be restressed to the correct final prestress force.

3. Pretensioning - All tendons to be prestressed in a group shall be brought to a uniform initial tension of 1,000 pounds, plus or minus 50 pounds per tendon prior to being given their full pretensioning. Initial tension greater than that specified herein may be used when designated and approved on the shop drawings. The uniform tension shall be measured by some suitable means, such as a dynamometer, so that its amount can be used as a check against elongation computed and measured.

After this initial stressing, the group shall be stressed to a total tension as required by the plans by means of hydraulic jacks equipped with gauges graduated to read directly to one percent of the total load to be applied, and calibrated to measure accurately the stress induced in the steel. The induced stress shall be measured by elongation of the tendons and checked by gauge pressure. The results shall be within five percent of each other.

Means shall be provided for measuring the elongation to an accuracy of $^{1}/_{16}$ of an inch. In the event of apparent discrepancies of more than five percent between stresses indicated by gauge pressure and elongation, the entire operation shall be checked carefully and the source of error determined and corrected before proceeding further. Where a combination of straight and deflected tendons is used, the stress indicated by total elongation shall not vary by more than five percent from that indicated by gauge pressure. Measurements on individual deflected tendons to establish differential stresses at different points in the beam shall be averaged at a cross section of the beam and the averages shall be within five percent of the computed elongation. No individual tendon shall vary from the computed elongation by more than 10 percent at any measured cross section.

Independent references shall be established adjacent to each anchorage to indicate any yielding or slippage that may occur between the time of initial stressing and final release of the tendons.

With the tendons stressed to full tension as prescribed above and all other reinforcing in place, the concrete shall be cast to lengths necessary to provide the lengths required by the plans, after shrinkage and elastic shortening have occurred.

After strength requirements are attained, the tension in the tendons shall be gradually and simultaneously released and the tendons cut off as required, using a sequence to minimize shock and reduce premature tendon breakage.

When elevated temperature curing is used, the release of stress shall be prior to the beginning of temperature reduction. Members shall remain protected until there is a differential of temperature inside the curing jacket and air temperature of not more than 25°F.

At the ends of members, the tendon ends and a minimum area of one inch around each tendon shall be coated with approximately a 10 mil coating of a commercial grade of epoxy.

When draped tendons are used, positive external hold downs may be required to offset the vertical forces in the beam at the time of stress release.

4. Combined Pretensioning and Post-Tensioning - Where plans call for a combination of pretensioning and post-tensioning, all of the requirements of both the pretensioning and post-tensioning shall apply, in this order, and the requirements shall overlap as necessary to fulfill the intent of this specification.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT

Measurement shall include the following:

1. All precast concrete members either pretensioned, post-tensioned, or combined pre- and post-tensioned, shall be measured and paid for as specified in *Item A, Measurement of Section 7.2.C Part 4.*

2. Cast-in-place prestressed concrete structures and units shall be measured as follows:

a. Concrete, non-prestressed reinforcing steel and structural steel (except bearing and anchorage devices integrally a part of the post-tensioning system) shall be measured by the cubic yard or by the pound in accordance with the applicable specifications for these items. Grout and ducts for post-tensioning shall not be measured, but shall be considered subsidiary to this item.

b. The prestressing steel required and the work involved in the prestressing of the cast-in-place structures or units shall not be measured, but shall be considered as one unit for "prestressing" each different structure type or unit as itemized on the plans and in the proposal.

B. PAYMENT

Payment for the work and all materials for prestressing of cast-in-place members as specified above shall be made at the lump-sum price bid for "prestressing."

The preceding payment shall be full compensation for furnishing all prestressing steel, all materials, fabrication, transportation, erection, prestressing and for furnishing all metal encasing ducts, grout fittings, anchorage bearing plates and all tools, labor and incidentals necessary to complete the work.

7.2.E Precast Concrete Units

Part 1: General

A. Description

This item shall govern for the materials used and for constructing, furnishing and placing precast concrete units at the locations shown, and in accordance with the details shown on the plans. Unless otherwise shown on the plans, the Contractor shall have the option of furnishing cast-in-place, precast (formed) or precast (machine-made) concrete units.

B. Submittals

PART 2: PRODUCT

A. Materials

Unless otherwise shown on the plans, concrete for cast-in-place and precast formed concrete units shall be Class "A" conforming to the requirements of *Section 5.1, Concrete and Reinforcement*, except that Class "C" concrete shall be required when a unit is used with monolithic pipe sewer construction.

Concrete for precast machine-made units shall meet the requirements of ASTM Designation C 76, Sections: Reinforced Concrete, Cement, Aggregate, Mixture and Concrete Test Requirements for Concrete, and shall have a minimum 28-day compressive strength of 4,000 psi. Vibrating equipment used in making concrete test cylinders must be approved by the Engineer.

Concrete strength tests required for each run will be based on the average strength of two cylinders tested at either 7, 14, or 28 days. When compression tests are requested earlier than 28 days, the minimum number of test cylinders required shall be as follows:

6 cylinders when the first test is at 7 days;
4 cylinders when the first test is at 14 days;
2 cylinders when the first test is at 28 days.

When the design strength for a run is attained by either the 7- or 14- day tests, further tests for that run will not be required.

Failure to attain design strength by the 28-day test will result in rejection of the run represented by the tests.

During the production of the precast machine-made units, at least one test (2 cylinders) shall be made to represent each group of 10 complete units, or fraction thereof, of each continuous run of production but not more than one test for each type and each size unit will be required in a single day. A continuous run of production may extend over a weekend shutdown in production, however, a shutdown for 5 days or more will not be considered a continuous run.

Steel Reinforcement shall conform to the requirements of *Item A.7, Steel Reinforcement, of Section 5.1 Part 2,* and the details shown on the plans. A positive means of holding the steel cages in place throughout production of the concrete units shall be provided and shall be subject to approval of the concrete units shall be provided and shall be subject to approval of the Engineer. Welding of steel reinforcement will not be

permitted unless specifically shown on the plan details and shall conform to the requirements of *Item O, Welding, of Section 7.3.A Part 3.* The maximum variation in the position of the reinforcement shall be plus or minus 10% of the wall thickness or plus or minus one half inch, whichever is lesser. In no case, however, shall the cover over the reinforcement be less than shown on the plans.

B. EQUIPMENT

PART 3: EXECUTION

A. GENERAL

Cast-in-place and precast (formed) concrete units shall conform to the requirements of *Section 7.2.B, Concrete Structures, Section 5.1, Concrete and Reinforcement*, and ASTM Designation C 857, Minimum Structural Design Loading for Underground Precast Concrete Utility Structures, and C 858, Underground Precast Concrete Utility Structures, as applicable. Concrete units shall be of the various types shown on the plans and designated by letters or by numbers to indicate the particular design of each. Each type shall be constructed in accordance with the details shown on the plans, or approved by the Engineer, to the depth required by the profiles and schedules given.

B. FORMS, PRECAST MACHINE-MADE CONCRETE UNITS

Forms for precast machine-made concrete units shall be made of steel and comply with the requirements of the *Section 7.2.B, Concrete Structures.*

The thickness of form metal shall be as required to maintain the true shape without warping or bulging. All bolt and rivet heads on the facing sides shall be countersunk. Clamps, pins or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or which line up improperly shall not be used. Metal shall be kept free from rust, grease or other foreign materials. Metal forms shall be welded except that these will not require lining unless specifically noted on the plan.

C. CASTING TOLERANCES

Allowable casting tolerances for concrete units shall not vary more than one-fourth of an inch, plus or minus, from the dimensions and configuration shown on the plans. Thickness in excess of that required shall not be cause for rejection provided that such excess thickness does not interfere with proper jointing or operation as determined by the Engineer.

D. MARKING

The following information shall be clearly marked on each section of precast unit prior to leaving the casting yard:

1. The date of manufacture.

2. The name or trademark or the manufacturer.

E. STORAGE AND SHIPMENT

Precast units shall be stored on level blocking in a manner acceptable to the Engineer. No loads shall be placed on them until design strength is reached. Shipment of acceptable units may be made when the 28-day strength requirements have been met.

F. REJECTION

Precast units may be rejected for nonconformity with any part of these specifications and also for any of the following reasons:

1. Fractures or cracks passing through the shell, except for a single end crack that does not exceed the depth of the joint.

2. Surface defects indicating honeycombed or open texture.

3. Damaged or misshaped ends, where such damage would prevent making a satisfactory joint.

All rejected units shall be so marked by the Engineer and shall be replaced by the Contractor with acceptable ones meeting the requirements herein. Rejected units shall be removed immediately from the site of work.

G. REPAIRS

Occasional imperfections in manufacture or accidental injury during handling may be repaired and will be acceptable if, in the opinion of the Engineer, the repairs are sound, properly finished and cured, and the repaired units conform with the requirements of this specification.

H. CONSTRUCTION METHODS

All excavation shall be in accordance with the requirements of *Section 7.1.A, Structural Excavation,* or *Section 4.2, Excavation and Backfill.*

Precast concrete units shall be bedded on foundations of firm and stable material accurately shaped to conform to their bases.

The Contractor shall provide adequate means to lift and place the concrete units. Lifting holes may be formed during production, or punched through the fresh concrete immediately after stripping forms; however, care shall be taken not to damage the unit by spalling large areas. All lifting holes shall be repaired as outlined herein.

Connections to new or existing structures shall be made in accordance with details shown on the plans. Jointing material shall be in accordance with *Part II Subsection A.5, Pipes of Section 4.7, Reinforced Concrete Culvert, Storm Drain, Pipe and Box Section,* or as specified on the plans.

Frames, grates, rings and covers, when required by the plans for use in a concrete unit, shall be installed in accordance with *Item A of Section 7.3.A Part 2.*

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT

Precast and cast-in-place units of each size and type, satisfactorily completed in accordance with the plans and specifications, will be measured by each concrete unit completed to the stage of construction required by the plans.

Excavation and backfill, unless otherwise noted on the plans, will be measured as required by *Section 7.1.A, Structural Excavation,* or *Section 4.2, Excavation and Backfill.* as appropriate.

B. PAYMENT

Payment for precast concrete units of the types shown on the plans, complete, in place, and in accordance with this specification as measured above, shall be made at the unit bid price for each type specified. Unless otherwise provided for in the special provisions or proposal, payment for work performed under this specification shall be full compensation for furnishing, transporting, and placing all concrete, steel reinforcement, brick, mortar, castings for shaping of bed, jointing to new or existing structures, and all other materials, tools, equipment, labor, and incidentals necessary to perform the work prescribed above.

Excavation and backfill, unless otherwise provided in the special provisions or proposals, shall be paid for as appropriate under *Section 7.1.A, Structural Excavation,* or *Section 4.2, Excavation and Backfill.*

SECTION 7.3: Steel

7.3.A Steel Structures

PART 1: GENERAL

A. DESCRIPTION

This specification shall govern for the fabrication and erection of structural steel and other metals (except reinforcing steel), which are used for steel structures or steel portions of structures.

B. SUBMITTALS

PART 2: PRODUCT

A. METALS FOR STRUCTURES

1. Structural Steel

a. General - Unless otherwise indicated in the plans or specifications, structural steel shall meet the requirements specified herein.

b. Carbon Steel - Carbon steel shall meet the requirements of Structural Steel, ASTM Designation A 36.

c. Copper-Bearing Structural Steel - Where copper-bearing structural steel is specified, the steel shall contain not less than 0.2% copper.

d. High-Strength Low-Alloy Steel - High-strength low-alloy steel shall meet the requirements of High-Strength Low-Alloy Structural Steel with 50 ksi Minimum Yield Point to 4" Thick, ASTM Designation A 588.

The producer shall make and report one impact test from the thickest material in each lot furnished. This test shall be longitudinal Charpy V-notch at + 40°F meeting the requirements of Mechanical Testing of Steel Products, ASTM Designation A 370, Paragraph 23.

Prior to furnishing A 588 steel, the producer may furnish to the Owner impact test data on previously produced steel from the mill from which the steel is to be furnished. The tests shall represent the range of plate thickness and shape sizes required by the project. The data shall indicate that longitudinal Charpy V-notch values of at least 15 foot-pounds at plus 40°F are consistently obtained. If this data is satisfactory, impact test data shall still be required, but shall be for informational purposes only and shall not be used for acceptance or rejection of the steel.

If prequalified data is not submitted, or the data submitted is not acceptable, impact data required shall be used for acceptance or rejection of steel. In this case, 95% of the tests shall indicate values of not less than 25 foot-pounds at plus 40°F.

A lot, for purposes of impact testing, shall consist of 50 tons or fraction thereof of finished material from a single heat which is rolled in the same mill and is the same grade, type of product (plate, bar, wide flange, I, H, angle, etc.), and which is within one of the following thickness classifications:

Differing not more than $^{3}/_{8}$" in thickness, if the thickness of the lot does not exceed 2".

Differing not more than one inch in thickness when the least thickness in the lot exceeds 2".

The governing thickness for wide flange, I, H, and T sections shall be average thickness of the flange. Test specimens for shapes shall be taken at a point one-third the distance from the outer edge of the flange or leg to the web or heel of the section.

e. Rejection - Structural steel specified in this section may be rejected for failure to meet all of the provisions of this specification, or for any defect causing it to be unsuitable for its intended use.

2. Rivets

a. General - Unless otherwise indicated on the plans or contact documents, rivets shall meet the requirements specified herein.

b. High-Strength Structural Steel Rivets - High-strength structural steel rivets shall meet the requirements of Steel Structural Rivets, ASTM Designation A 502, Grade 2.

c. Structural Steel Rivets - Structural steel rivets shall meet the requirements of Steel Structural Rivets, ASTM Designation A 502, Grade 1.

d. Rejection - Any material specified in this section may be rejected for failure to meet all of the provisions of this specification or for any defect causing said material to be unsuitable for its intended use.

3. Bolts – See *7.3.B Structural Bolting.*

4. Forgings

a. General - Unless otherwise indicated in the plans or contract specifications, forgings shall meet the requirements as specified herein.

b. Carbon Steel Forgings - Carbon steel forgings shall meet the requirements of Steel Forgings, Carbon and Alloy, for General Industrial Use, ASTM Designation A 668, Class B.

Heat-treated forgings shall meet the requirements of ASTM Designation A 668, Class F.

Alloy-steel forgings shall meet the requirements of ASTM Designation A 668, Class G.

c. Rejection - Any metal or material specified in this section may be rejected for failure to meet all of the provisions of this specification or for any defect causing said material to be unsuitable for its intended use.

5. Castings

a. General - Steel and iron castings shall meet the requirements specified herein and on the plans and contract documents.

b. Steel Castings

(1) High-Strength Steel Castings - High-strength steel castings shall meet the requirements of High-Strength Steel Castings for Structural Purposes, ASTM A 148, Grade as specified.

(2) Mild Steel Castings - Mild steel castings shall meet the requirements of Mild- to Medium-Strength Carbon-Steel Castings for General Application, ASTM Designation A 27, Grade as specified.

c. Iron Castings

(1) Material - Casting shall conform to the following ASTM Designation as applicable:

MATERIAL	ASTM	GRADE
Gray Iron Castings Gray Iron Castings for Valves, Flanges, and Pipe Fittings	A 48 A 126	Class 25 Minimum Class B

(2) Workmanship - All casting shall be true to pattern in form and dimension, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting strength and value for the service intended. Angles shall be filleted, and arrises shall be sharp and true.

(3) Coatings - Castings shall be coated with hot or cold applied tar as appropriate.

(4) Railings and Posts - Fittings and castings for steel pipe shall be of malleable iron or cast steel and shall meet the requirements of Malleable Iron Castings, ASTM Designation A 47, Grade 35018, or Mild- to Medium-Strength Carbon-Steel Castings for General Application, ASTM Designation A 27, Grade 70-36. All fittings and castings shall be galvanized, and the galvanizing shall meet the requirements of Zinc Coating (Hot-Dip) on Iron and Steel Hardware, ASTM Designation A 153.

(5) Rockers and Bearing Plates - Rockers and bearing plates shall be cast iron of the type and grade indicated on the plans and contract documents.

d. Rejection - Any metal or material specified in this section may be rejected for failure to meet all of the provisions of this specification or for any defect causing said metal or material to be unusable for its intended use.

6. Bronze Castings and Sheet Copper

a. General - Bronze castings and sheet copper shall meet the requirements specified herein and as shown on the plans and contract documents.

b. Expansion and Bearing Plates - Bronze bearing and expansion plates shall meet the requirements of Bronze Castings for Bridges and Turntables, ASTM Designation B 22, Alloy B.

c. Ornamental Tablets and Miscellaneous Castings - Ornamental tablets and miscellaneous castings shall meet the requirements of Copper Alloys and Castings for General Applications, ASTM Designation B 584.

d. Copper - Sheet copper shall meet the requirements of Copper, Sheet, Strip, Plate, and Rolled Bar, ASTM Designation B 152.

e. Rejection - Any metal or material specified in this section may be rejected for failure to meet all of the provisions of this specification or for any defect causing it to be unsuitable for its intended use.

7. Metal Railings

a. General - Metal railings shall be fabricated from the materials specified and shall be in accordance with these specifications and as shown on the plans and contract documents.

b. Steel Railings - Steel railings shall be fabricated for Structural Steel, ASTM A 36, steel of either 10-gauge or 12-gauge. Minimum tensile strength of the rail element and joint, when tested in tension, parallel to the axis of the rail, shall be not less than 100,000 pounds for 10-gauge or 60,000 pounds for 12-gauge.

(1) Painted Steel Railings - Painted steel rail shall meet the requirements for steel railings. Paint and painting systems shall be as specified.

(2) Galvanized Steel Railings - Galvanized steel railing shall meet the requirements of Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip, ASTM Designation A 123.

c. Flexible Metal Beam Guard Railings - The rail elements shall be of the W-beam type fabricated to develop continuous beam strength and shall consist of metal plate or sheet formed into a beam as shown on the plans. The beam shall be free from warp. When tested with a straight edge or string along either edge of a 12½-foot sectional length of beam, the maximum deviation of the beam edges from the straight edged shall not exceed ½ inch at any point.

The steel for the rail elements shall conform to the requirements of AASHTO M-180. The rail shall be 10-gauge or 12-gauge as shown on the plans. Rail elements shall contain not more than 0.04 percent phosphorous nor more than 0.05 percent sulphur.

The rail element for the terminal anchor section shall be of the same materials as the rail element used throughout the project.

Unless otherwise shown on the plans, the rail element shall be galvanized in accordance with the requirements of *Item B, Galvanizing, of Section 6.8 Part 2*, except that the galvanized coating shall not be less than 1.80 ounces per square foot of double exposed surface (single spot test).

d. Rejection - Any metal or material specified in this section may be rejected for failure to meet all of the provisions of this specification or for any defect causing said metal or material to be unsuitable for its intended use.

8. Miscellaneous Metals

a. General - Miscellaneous metals shall meet the requirements of these specifications and as shown on the plans and contract documents.

b. Wrought Iron - Wrought iron plates, rolled wrought iron shapes and bars, and welded wrought iron pipe shall meet the applicable ASTM requirements. Pipe shall be standard galvanized unless otherwise shown on the plans.

c. Rejection - Any metal or material specified in this section may be rejected for failure to meet all of the provisions of this specification, or for any defect causing said metal or material to be unsuitable for its intended use.

9. Storing Materials - All materials shall be handled in such manner that no injury shall result. Material to be stored shall be placed on skids above the ground and shall be kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns, shall be supported on skids placed closely enough to prevent excessive deflection.

B. EQUIPMENT

PART 3: EXECUTION

A. SHOP DRAWINGS

Unless otherwise provided on the plans, the Contractor shall prepare and submit detailed shop drawings for each detail of the general plans requiring the use of structural steel, forgings, wrought iron, castings or bearings. Camber and erection diagrams shall be required. The drawings shall be prepared on sheets 24 x 36 inches.

All shop drawings shall be checked by the fabricator before being submitted for approval by the Owner. The Contractor shall furnish to the Owner as many prints of the drawings as are necessary for carrying out the work.

The Contractor shall be responsible for the correctness and completeness of the drawings and for shop-fit and field connections, even though the drawings have been approved by the Owner.

When required by the plans or special provisions, the Contractor shall furnish to the Owner, before formal acceptance of the work, detailed drawings of the structure as built. Inasmuch as the drawings shall be retained by the Owner as permanent records, they must be in the form of printable transparencies of a quality satisfactory to the Owner.

B. NOTICE OF BEGINNING WORK

The Contractor shall give the Owner ample notice of the beginning of work in the shop so that inspection may be provided. No work shall be performed in the shop before the Owner has authorized fabrication. Any purchases of material prior to fabrication authorization shall be at the Contractor's risk.

C. INSPECTION

An inspector or other authorized representative of the Owner may examine the metals and metal items to be fabricated in the shop and may exercise constant surveillance over the work during its progress, with full power to reject all materials or workmanship not conforming to the plans and specification.

The Contractor shall give the Owner five days' minimum advance notice before commencement of the fabricating operations to permit ample time for the inspection of the materials.

The Owner shall be furnished complete copies of mill reports prior to commencing fabrication. The Contractor shall furnish ample means and assistance for sampling all materials. Arrangements shall be made for the Owner to have free access at all times to any portion of the workshops where work is being done under these specifications.

No fabricating, machining, cutting, welding, assembling or painting shall be done except with the knowledge of the Owner. Any work done otherwise shall be subject to rejection.

The acceptance of any material or finished member by the Owner shall not be a bar to subsequent rejection if it is later found to be defective. Rejected material and workmanship shall be promptly repaired or replaced by the Contractor.

Samples of materials, except castings, shall be cut from stock designated by the Owner or shall be selected from items furnished. Gray iron, steel and bronze castings shall be cast with test coupons.

Payment for structural steel shall not be made until shipping invoices indicating total weight of material used have been received and checked by the Owner.

D. WORKMANSHIP

Workmanship and finish shall be equal to the best general practice in modern steel fabricating shops.

Rolling tolerances for rolled shapes, plates and bars shall conform to the requirements of ASTM Designation A 6.

Before being laid out or worked, rolled material shall be straight. If straightening is necessary, it shall be done by methods approved by the Owner. Kinks and bends in the material shall be cause for rejection. Heat shrinking of low alloy structural steels shall not be permitted.

If straightening is necessary in the field, only methods approved by the Owner shall be used.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting and chipping shall be done carefully and accurately. Torch cut corners shall have a radius of 1" minimum.

Undercut gusset plates shall not be accepted. All sharp corners and edges that are marred, cut or roughened in handling or erection, shall be slightly rounded by grinding or other suitable means.

E. RIVETED AND BOLTED STRUCTURES

Unless prohibited by the plans, high-strength bolts may be used where rivets are designated. In these specifications where reference is made to pitch, edge distance, preparation of holes, etc., for rivets, the same criteria shall govern for high-strength bolts. Pitch and edge distance not shown on the plans shall be in accordance with AASHTO Standard Specifications for Highway Bridges.

F. HOLES FOR BOLTS OR RIVETS

Holes shall be either punched full size; punched and reamed; or drilled. The finished hole shall be $^{1}/_{16}$ inch larger than the nominal diameter of the rivet.

Holes punched full size shall have all burrs and sharp edges removed. The diameter of the die shall not exceed that of the punch by more than $^{3}/_{32}$ inch. Holes shall be as follows:

(1) Holes for shop rivets shall be subpunched, or subdrilled at the fabricator's option, ¼ inch less in diameter than that of the finished holes; and shall be reamed to size with the parts assembled, with the following exceptions:

(a) Holes in material thicker than ⅞ inch shall not be punched; however, at the fabricator's option, they may be subdrilled to the diameter specified for subpunching or may be drilled full size with the parts assembled, provided that the parts are adequately bolted or clamped together.

(b) Holes in rolled beams and plate girders, including stiffeners and active fillers at bearing points, may be subpunched ⅛ inch (less in diameter than that of the finished holes; and reamed to size (after assembly) in material not thicker than the nominal diameter of the rivet less ⅛ inch.

(2) Holes in material not more than ⅞ inch thick for rivets which do not transfer stress caused by external vertical loading, may be punched full size or, at the fabricator's option, may be subpunched ⅛ inch less in diameter than the finished holes and reamed to size after assembly. This applies to holes for stitch rivets, lateral, longitudinal or sway bracing and their connecting material, lacing stay plates, diaphragms which do not transfer shear or stress, inactive fillers and stiffeners not at bearing points. However, holes through assembled material shall not pass through both reamed plies and plies punched full size unless the reamed holes have been subpunched for the fabricator's convenience, or the assembled material is not over five plies thick, of which the main material consists of not more than three plies.

(3) Holes for field rivets shall be subpunched or subdrilled at the fabricator's option, ¼ inch less in diameter than that of the finished holes; and shall be reamed to size through steel templates with hardened steel bushings, with the following exceptions:

(a) Field splices in plate girders and in the chords of trusses shall be reamed with the members assembled. Other field connections may be reamed with the members assembled, at the fabricator's option. Chord splices or truss members shall, in all cases, be reamed or drilled with at least three abutting sections assembled and with milled ends of compression chords in full bearing.

(b) Assemblies, such as floor systems to girders, complete trusses, rolled beam spans connected by diaphragms and portals to trusses shall be reamed with the members assembled, if so indicated on the plans; or otherwise at the fabricator's option.

(c) Field connections of lateral, longitudinal or sway bracing shall conform to the requirements of holes for shop rivets.

(d) Holes in Material thicker than ⅞ inch shall not be punched, but shall be subdrilled to the diameter specified for subpunching; or drilled full size with parts assembled.

The accuracy of the punching shall be such that for any group of holes when assembled, 75% shall admit a rod equal to the diameter of the cold rivet at right angles to the plane of the connection. Otherwise, the holes shall be reamed. When the extent of the reaming is such that the holes cannot be properly filled or accurately adjusted after reaming, the faulty member shall be discarded and replaced.

Mispunched members shall not be corrected by welding without the approval of the Owner.

G. REAMED WORK

Reaming work shall be done after the pieces forming a built-up member are assembled and so firmly bolted together that the surfaces are in close contact. Burrs and sharp edges of each reamed hole under both rivet heads shall be removed with a counter-sinking tool making $^{1}/_{16}$ inch fillets. The pieces shall be taken apart before riveting, if necessary, and any shavings removed. If it is necessary to take the members apart for shipping or handling, the pieces reamed together shall be so marked that they may be reassembled in the same position. Reamed parts shall not be interchanged.

H. DRILLED HOLES

Drilled holes shall be $^{1}/_{16}$ inch larger than the nominal diameter of the rivet. Burrs and sharp edges of each drilled hole under both rivet heads shall be removed with a counter-sinking tool making a $^{1}/_{16}$ inch fillet. Burrs on the outside surfaces shall be removed. If members are drilled while assembled, the parts shall be held securely together while the drilling is being done.

Drilled holes shall be drilled to finish size while all of the thicknesses of metal are assembled; or subdrilled and reamed as required for punch-and-reamed holes.

Holes shall be clean cut, without torn or ragged edges. Holes that must be enlarged to admit rivets shall be reamed. Drilling shall be done accurately.

I. ASSEMBLING STEEL

Steel parts shall be assembled in the shop or in the field in accordance with the following:

1. Shop Work - At the time of assembling, riveting, bolting or welding, steel surfaces in contact for shop or field connection shall be thoroughly cleaned of rust, loose mill scale, dirt, grease or other material foreign to the steel. No paint shall be applied to contact surfaces prior to riveting, bolting or welding.

Riveted or bolted trusses, continuous plate girder and I-beam spans, skew portals, skew connections, rigid frames, bents and towers shall be completely assembled in the shop and accurately adjusted to line and camber and holes for field connections; and shall be drilled or reamed while assembled. Holes for other field connections, except those in lateral, longitudinal and sway bracing, shall be drilled or reamed in the shop with connecting parts assembled; or drilled or reamed to a metal template with hardened bushings, without assembling.

Long span truss work shall be assembled in lengths of not less than three abutting panels, the members adjusted for line and camber; and holes for field connections drilled

or reamed while assembled. Field riveted or bolted joints for welded girders shall be completely assembled with the members adjusted for line and camber and prepared to fit for welding. All machinery shall be completely assembled. All bearings shall be fitted to the specified clearances and alignment. Gear reductions and all line gear shall have gear center distances set and the gears properly match-marked.

2. Field Work - 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 part shall be bent, broken or otherwise damaged. Hammering which shall injure or distort the members shall not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled, unless erected on blocking so placed as to give the trusses proper camber. The blocking shall be left in place until the tension chord splices are fully riveted or bolted and all other truss connections pinned and bolted. Rivets or bolts in splices of butt joints of compression members and rivets or bolts in railing shall not be driven or torqued until the span has been erected in place, temporarily bolted and the member is supporting its own weight. Splices and field connections shall have ½ of the holes filled with bolts and cylindrical erection pins (half bolts and half pins) before riveting or bolting.

Splices and connections carrying traffic during erection shall have ¾ of the holes so filled.

Fitting-up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be $^{1}/_{32}$ inch larger.

The drifting done during assembling shall be only such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the rivets, they shall be reamed.

Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match-marked; and a diagram showing such marks shall be furnished to the Owner.

J. RIVETING

Shop and field riveting shall conform to the following provisions.

1. Shop Work - Rivets shall be heated uniformly to a light cherry-red color and shall be driven while hot. Rivets, when heated and ready for driving, shall be free from slag, scale and other adhering matter. When driven, they shall completely fill the holes.

The heads shall be of approved shape, full size, neatly formed, concentric with the shank, free from fins and in full contact with the surface of the member.

Loose, burred or otherwise defective rivets shall be replaced. In removing rivets, care shall be taken not to injure the adjacent metal. Caulking or recupping shall not be permitted.

Rivets shall be driven by direct-acting riveters where practicable. If rivets are driven with a pneumatic hammer, a pneumatic bucker shall be used if practicable.

2. Field Work - Pneumatic hammers shall be used for field riveting. Connections shall be accurately and securely fitted up before the rivets are driven. Drifting shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the

metal. Unfair holes shall be reamed or drilled. Rivets shall be heated uniformly to a light cherry-red color and shall be driven when hot. They shall not be overheated or burned. Rivet heads shall be full and symmetrical, concentric with the shank; and shall have full bearing all around. They shall not be smaller than the heads of shop rivets. Rivets shall be tight and shall grip the connected parts securely together. Cup-faced dollies, with heads fitted closely to insure good bearing, shall be used. Sufficient air compressor capacity shall be maintained to keep the air pressure at 100 pounds psi at the hammer. Caulking or recupping shall not be permitted. In removing the rivets, the surrounding metal shall not be injured. The removal of loose or defective rivets by flame cutting shall not be permitted, except upon written permission of the Owner.

K. BOLTED CONNECTIONS

When high-strength bolts are required or permitted, the bolts shall be in conformance with *Item A, Materials, of Section 7.3.A Part 2,* and with *Section 7.3.B, Structural Bolting.*

L. JOINTS AND CONNECTIONS

1. Edge Planing - Sheared edges of plates more than ⅝ inch in thickness and carrying calculated stress shall be planed to a depth of ¼ inch.

2. Facing of Bearing Surfaces - Surfaces of bearing and base plates and other metal bearing surfaces that are to come in contact with each other, with ground concrete surfaces or with asbestos sheet packing, shall be finish-machined flat to within $^{1}/_{32}$ inch tolerance in 12 inches and to within $^{1}/_{16}$ inch tolerance overall. Surfaces of bearing and base plates and other metal bearing surfaces that are to come in contact with preformed fabric pads, elastomeric and elastic bearing pads, or portland cement grout, shall be finished-machine flat to within $^{3}/_{16}$ inch tolerance overall.

At the option of the Contractor, steel slabs, where not in contact with other metal bearing surfaces, may be heat-straightened in lieu of machining, provided the above tolerances are met.

3. Abutting Joints - When shown on the plans, abutting joints shall be faced and brought to an even bearing. Where joints are not faced, the opening shall not exceed ¼ inch (6 mm).

4. End Connection Angles - Floor beams, stringers and girders having end connection angles shall be built to exact length back-to-back of connection angles. If end connections are faced, the finished thickness of the angle shall be not less than that shown on the detail drawings.

5. Web Plates - In girders having no cover plates and which are not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than ⅛ inch below at any point.

6. Fit of Stiffeners - End stiffener angles of girders and stiffener angles intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flange angles. All fillers under stiffener angles shall fit sufficiently tight to exclude water after being painted.

7. Pin and Bolted Connections - Pilot and driving nuts shall be used in driving pins. Pins shall be so driven that the members shall take full bearing on them. In field assembling, the pin nuts on pin connections and the bolts on bolted connections shall be screwed up tight and the threads, except when high-strength bolts are used, burred at the face of the nuts with a pointed tool.

8. Pins and Rollers - Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth and free from flaws. The final surface shall be produced by a finishing cut.

Pins and rollers more than seven inches in diameter shall be forged and annealed.

In pins larger than nine inches in diameter, the forging shall be permitted to cool to a temperature below the critical range cooling; and a hole not less than two inches in diameter shall be bored full length along the axis of the pin before being annealed.

Pin holes in structural members shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other unless otherwise required. The final surface shall be produced by a finishing cut.

The distance outside-to-outside of holes in tension members and inside-to-inside of holes in compression shall not vary from that specified more than $^{1}/_{32}$ inch. Holes in built-up members shall be bored after riveting, bolting or welding is completed.

The diameter of the pin hole shall not exceed that of the pin by more than $^{1}/_{50}$ inch for pins five inches or less in diameter; or $^{1}/_{32}$ inch for larger pins.

9. Screw Threads - Threads shall make close fits in the nuts and shall be Unified Standard Series conforming to USASI B1.1-1960.

M. Bearings and Anchorage

Anchor bolts shall be either headed bolts, installed with or without pipe sleeves; or swedge bolts installed in drilled holes, as detailed on the plans. The anchor bolts shall be carefully installed to permit true positioning of the bearing assemblies.

When anchor bolts are installed in pipe sleeves, the pipes shall be completely filled with grout at the time the grout pads are constructed or at the time the bearing assemblies on masonry plates are placed.

Swedge bolts installed in holes shall be either sulphured-in or grouted-in as shown on the plans.

All bearing assemblies shall be set level and to the elevations shown on the plans. Adjustments in the horizontal positions of bearing assemblies shall be made for temperature as directed by the Owner.

In conformance with the details shown on the plans, masonry plates and the bearing plates of bearing assemblies shall be set on ground concrete surfaces, on preformed fabric pads or on grout pads.

Grout to be placed below masonry plates or bearing plates of the bearing assemblies and in anchor bolt sleeves shall consist, by volume, of one part portland cement and three parts clean concrete sand. Concrete areas to be in contact with the grout shall be cleaned of all loose or foreign matter that would in any way prevent bond between plates and the concrete surfaces and shall be kept thoroughly saturated with water for a period of not less than 24 hours immediately prior to placing the grout. The grout shall completely fill the anchor bolt sleeves and shall be tightly packed under the masonry or bearing plates to provide full bearing.

After placing, all exposed surfaces of the grout pads shall be kept covered with a heavy thickness of burlap saturated with water for a period of three days. All improperly cured or otherwise defective grout shall be removed and replaced at the Contractor's expense.

Immediately before setting bearing assemblies or masonry plates directly on ground concrete surfaces, the Contractor shall thoroughly clean the surfaces of the concrete and the metal to be in contact and shall apply a thick coating of red lead paste to contact areas to provide full bedding of the metal in the red lead paste.

Preformed fabric pads shall be furnished and installed at the locations and in accordance with the details shown on the plans.

The preformed fabric pads shall be composed of multiple layers of eight-ounce cotton duck impregnated and bound with high quality natural rubber or of equivalent and equally suitable materials compressed such as to produce the specified thickness, after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 10,000 psi without extrusion or detrimental reduction in thickness.

N. Expansion and Rotation Assemblies

Before leaving the shop or foundry, the rockers or roller nests shall be completely assembled with the bearing plates for checking and approval by the Owner.

O. Welding

All welding shall conform to the requirements of the "Standard Specifications for Welded Highway and Railway Bridges" of the American Welding Society, the requirements of these specifications and the special provisions.

Inspection of welding made to control the quality of welds and workmanship shall be performed in accordance with the requirements of the AWS. All welding shall be subject to radiographic and other non-destructive testing which shall be performed without charge to the Contractor; except that if a weld is shown to be defective, all costs involved in reinspection shall be borne by the Contractor.

Weld metal shall be sound throughout except that very small gas pockets and small inclusions of oxide or slag may be permitted if well dispersed and if none exceeds $^{1}/_{16}$ inch

in greatest dimension; and provided further that the sum of the greatest dimension of all such defects in any square inchof weld area does not exceed $^{3}/_{8}$ inch.

All welding shall be performed in such a manner that the Brinnell hardness of the weld metal and heat-affected zone is within the following limits:

Minimum Brinnell Hardness =
(Minimum specified tensile strength of parent metal/500) + 50
Maximum Brinnell Hardness =
(Maximum specified or tested tensile strength of parent metal/500) + 50

All welding of structural steel (ASTM Designation A 36, A 242 and A 441) shall be performed by either the submerged or gas-shielded arc process, or with low-hydrogen electrodes. Low-hydrogen electrodes for welding low-alloy steels shall conform to the requirement of the Federal Specifications for Electrodes (mineral covered, low hydrogen) for Welding Medium and High Tensile Steels, MIL-E-18038 (Ships). All welding of low-alloy structural steel shall be qualified by procedure tests before fabrication is commenced.

Low-hydrogen electrodes shall be stored for holding in an approved low-hydrogen oven at a temperature of from 300 to 400°F to control the moisture in the coating on the electrode.

Low-hydrogen electrodes which have been removed from their moisture-proof containers shall be stored in an approved oven at a temperature of from 300 to 400°F after rebaking.

Areas contiguous to welding operations shall be preheated to a minimum temperature of 300°F when necessary to prevent distortion or weld cracking. Preheating to a temperature in excess of 400°F shall not be required.

Unless otherwise shown on the plans or specified, bearing assemblies that are to be machined after welding shall be stress-relieved by heat treatment before machining, in accordance with AWS Specifications.

Portions of members in bearing assemblies or in direct bearing shall be straightened, planed or otherwise corrected after fabrication as necessary to provide full bearing on bearing assemblies or bearing areas on level bearing plates.

Where the end of a stiffener plate is shown "tight-fit" on the plans, the end of the plate shall be so fitted that it bears on the beam flange with at least point bearing. Local clearances between the end of the plate and flange shall not exceed $^{1}/_{16}$ inch.

Unless otherwise shown on the plans or specified, erection bolts required for welded splices or welded connections may be left in place, and the ends of all such erections bolts which project beyond the nut shall be burned off flush with the face of the nut. Where the bolt does not project, the end of the bolt and nut shall be tack welded to prevent loosening of the nut. Burning off projecting bolt ends and tack welding shall be performed prior to painting.

P. SHOP PAINTING

The application of shop paint shall conform to the requirements of *Section 6.8, Painting.* Surfaces to be in contact after shop riveting is completed shall be cleaned but not painted.

Q. MARKING AND SHIPPING

All structural members shall be marked in accordance with the erection diagram. The markings shall be over the painted surface and in no case shall shop paint be left off in order to preserve markings on unpainted steel. Match-marks shall be made with paint in addition to the requirements of *Item V, Paint and Paintings, of Section 6.3.A Part 3* and *Section 6.8, Painting.* Members weighing more than three tons shall have the weight marked thereon. Bolts and rivets of one length and diameter, and loose nuts or washers of each size, shall be packed separately. Pins, small parts and small packages of bolts, rivets, 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 package.

Anchor bolts, washers and other anchorage or grillage materials shall be shipped in time to suit the requirements of the masonry construction. The loading, transportation, unloading and storing of structural material shall be conducted so that the metal shall be kept clean and free from injury.

R. METHODS AND EQUIPMENT

Before starting work, the Contractor shall inform the Owner fully as to the method of erection he proposes to follow and as to the amount and character of the equipment he proposes to use; the adequacy of which shall be subject to the approval of the Owner. The approval of the Owner shall not be considered as relieving the Contractor of the responsibility for the safety or adequacy of his methods or equipment or from carrying out the work in full accordance with the plans and specifications. No work shall be done without the sanction of the Owner.

The Contractor shall prepare and submit erection plans for the erection of plate girders (riveted, bolted or welded), trusses and for all railroad underpass structures. Field erection plans for I-beam units shall not be required unless specified on the plans. The plans shall be completed in all details of procedure, sequence of work, equipment to be used, etc., so that a check can be made of the adequacy of the proposed erection procedure.

Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together while riveting shall not be permitted. The Contractor shall provide the falsework and all tools, machinery and appliances including drift pins and fitting-up bolts necessary for the expeditious handling of the work. Drift pins sufficient to fill at least ¼ of the field holes for main connections shall be provided.

S. FALSEWORK

The falsework shall be properly designed for the loads to be supported and shall be constructed substantially and maintained. The Contractor shall prepare and submit plans for falsework to the Owner for approval.

The falsework plans shall be complete in all details of members, connections equipment, etc., so that a structural check can be made of the falsework.

Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.

T. GRADING DECK ON CONTINUOUS UNITS

Forms shall not be erected or concrete placed until after all welding, bolting or riveting is complete, the unit positioned and bearing properly set.

An accurate measurement shall be made of the elevation of girder or beam flanges at all grading control points as shown on the plans. Subsequent grading of forms and placing and finishing of concrete shall be governed by these measurements only, taking into account the dead load deflection of the slab and rail as shown on the dead load deflection diagram.

U. MISFITS

Corrections of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets shall be considered a legitimate part of the operation. Any error in shop work which prevents the proper assembling and fitting-up of parts by the moderate use of drift pins or a moderate amount of reaming and slight chipping or cutting shall be reported immediately to the Owner. His approval of the method of correction shall be reported immediately to the Owner. His approval of the method of correction shall be obtained. The correction shall be made in the presence of the Owner, who shall check the material. Such work is to be done at the entire expense of the Contractor.

V. PAINT AND PAINTING

Unless otherwise provided, the application of field paints shall conform to the requirements of *Section 6.8, Painting.*

For railroad structures, which require that the steel be erected and assembled on falsework and moved into place as a unit, all field paint, except the final coat, shall be applied to the steel while on the falsework and prior to moving into final position. Those surfaces which are inaccessible for painting in the final position shall have the final paint coat applied prior to move-in. Touch-up of paint which is damaged due to move-in to final position shall be done, and the final field coat applied.

PART 4: MEASUREMENT AND PAYMENT

A. MEASUREMENT AND PAYMENT

No direct compensation shall be made for "steel structures." Measurement and payment for quantities for structural metal, concrete, reinforcement, railing and other proposal items, which constitute the completed and accepted structures, shall be made in accordance with the provisions of pertinent specifications.

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7.3.B Structural Bolting

PART 1: GENERAL

A. DESCRIPTION

This item shall govern for the materials to be used and for the method of installation of high-strength bolts used in structural joints.

Unless otherwise specified on the plans, high-strength bolts may be used in lieu of rivets.

B. SUBMITTALS

PART 2: PRODUCT

A. MATERIALS

1. General - Bolts shall be of the type and size specified on the plans and shall be furnished with suitable nuts and washers where required.

2. Unfinished Bolts - Unfinished bolts shall meet the requirements of Carbon Steel Externally Threaded Standard Fasteners, ASTM Designation A 307, Grade A.

3. High-Strength Bolts - High-strength bolts shall meet the requirements of High-Strength Bolts for Structural Steel Joints, ASTM Designation A 325.

4. Anchor Bolts - Unless otherwise specified, plain and threaded bars used for anchorage purposes shall meet the requirements of Structural Steel, ASTM A 36 or Steel Bars, Carbon, Merchant Quality, Mechanical Properties, A 663, Grade 65. Headed bolts and nuts shall meet the requirements of Carbon Steel Externally Threaded Standard Fasteners, ASTM A 307, Grade A. Anchor bolts shall not be galvanized unless otherwise noted on the drawings.

A mill test report or certification shall be required indicating that the material meets these requirements. When heat-treated material is specified or required, the test report for certification shall include the necessary certification relative to the heat-treating process.

5. Rejection - Any material specified in this section may be rejected for failure to meet all of the provisions of this specification or for any defect causing said material to be unsuitable for its intended use.

B. EQUIPMENT

PART 3: EXECUTION

A. GENERAL

General requirements shall include the following:

1. Surfaces of bolted parts in contact with the bolt head and nut shall not have a slope of more than 1:20 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. Holes shall be punched, subpunched and reamed or drilled as required by *Section 7.3.A, Steel Structures.* Holes shall be of a nominal diameter not more than $^{1}/_{16}$ inch in excess of the nominal bolt diameter. Field erection and fit-up of joints and splices shall conform to the requirements of *Section 7.3.A, Steel Structures.*

2. When assembled, all joint surfaces, including those adjacent to the washers, shall be free of dirt, rust, loose scale, burrs and other defects that would prevent solid seating of the parts.

3. Contact surfaces shall be free of oil, paint, lacquer or galvanizing.

The values in the table below allow for manufacturing tolerances; provide for the inclusion of either one or two flat circular washers; and the use of either a heavy or finished nut, with adequate "stick-through" at the end on the bolt. For each required beveled washer, add an additional ⅛ inch.

TABLE - GRIP DETERMINATION

DETERMINATION OF GRIP: To determine the required hexagon head bolt length the value shown in the following table shall be added to the grip, i.e. (the total thickness of all connected material, exclusive of washers).

Bolt Size, in.:	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
To determine required bolt length add to grip*, in.	$^{13}/_{16}$	$1^{1}/_{16}$	$1^{3}/_{16}$	$1^{5}/_{16}$	$1^{9}/_{16}$	$1^{13}/_{16}$	$1^{13}/_{16}$	$2^{1}/_{16}$	$2^{1}/_{16}$

*The total length of bolts shall be adjusted to the next ¼ inch increment up to five inches in length and to the next ½ inch increment for lengths over five inches.

To determine the required length of interference-body bolts, the value shown in table above, less ⅛ inch shall be added to the grip.

B. INSTALLATION

Installation shall include the following:

1. Bolts shall be installed with a hardened washer under the nut or bolt head, whichever is the element turned in tightening. A hardened washer shall also be used under the head of regular semi-finished hexagon bolts and under finished hexagon nuts, even when these are not the elements turned in tightening. The washer may be omitted under the head of heavy semi-finished hexagon bolts; interference-body bolts; and under heavy semi-finished hexagon nuts, when these are not the elements turned.

2. All fasteners shall be tightened to give at least the required minimum bolt tension values shown in the table below on completion of the joint.

TABLE - BOLT TENSION									
Bolt Size, in.:	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
Required Minimum Bolt Tensions*, lbs.	12,050	19,200	28,400	39,250	51,500	56,450	71,700	85,450	103,950

*Equal to the proof load of bolt given in ASTM Designation A 325.

3. Tightening shall be done by one of the following methods:
- **a.** The Turn-of-the-Nut Method
- **b.** The Calibrated-Power Wrench Method.

C. CONSTRUCTION

1. Pre-tightening - Prior to actual tightening of the bolts, the following procedure shall be followed:

a. A minimum of 20% of the holes at a connection point shall be filled with erection pins to "fair-up" all holes.

b. Install bolts in all remaining holes.

c. Tighten a minimum of 20% of the bolts, following a pattern of progression from the center, or most rigid part of the joint toward the free edges, making sure that all plies of the metal in the connection are properly fitted and in contact.

d. Mark those bolts used for fit-up bolts.

e. Tighten all the remaining bolts the required amount, then remove the erection pins.

f. Fill the remaining holes with bolts; and loosen all bolts used for fit-up.

g. Tighten the rest of the bolts by the required amount.

2. Turn-of-the-Nut Method - This method indicates the following:

a. Tighten all bolts used as fit-up bolts to a "snug-tight" condition. (A snug-tight condition is indicated by the wrench when it ceases to spin and just begins to impact, or with a spud wrench by tightening with slight pressure.)

b. Tighten the nuts by the amount specified in the following table:

TABLE - TURNS FOR SPECIFIED GRIP

Bolt Diameter In Inches	From Snug-Tight Rotate Nut* ½ - ¾ Turn for Grips
¾	Up to 5 Inches
⅞	Up to 5 Inches
1	Up to 8 Inches
1⅛	Up to 8 Inches
1¼	Up to 8 Inches

**Permissible tolerance: ¼ turn over, nothing under.*

Impact wrenches shall be of adequate capacity and sufficiently supplied with air to perform the required tightening in approximately 10 seconds.

c. Tightening crew to mark finished work with identifying symbol.

d. Inspector mark accepted work.

3. Calibrated-Power Wrench Method - When calibrated wrenches are used to provide the bolt tension specified in Bolt Tension Table, their setting shall be such as to induce a bolt tension slightly in excess of the value shown. The nut shall be matched-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks shall be made by the operator with a keel, crayon or spot of paint, after the bolts have been brought up to snug-tight.

A torque wrench shall be used to check bolts for tightness when the calibrated-power wrench method is used. The following procedure shall be used to calibrate the torque wrench:

One bolt of the type, size and condition of thread as those to be inspected, shall be tightened with the impact wrench, in a device capable of measuring actual bolt tension, to the required minimum bolt tension required in Bolt Tension Table.

In this tightened condition, the inspector's torque wrench shall be used to rotate the nut slowly in the tightening direction to just move the nut. The amount required to move the unit shall be used for the inspection torque. (Use the average of the three torque values).

When inspecting the bolts installed in the structure, the torque wrench shall be used to tighten the nut; and the torque read just as the nut is set in motion.

Readings higher than the required minimum tension required shall not be cause for rejection. Bolts giving values lower than the required value shall be removed and replaced.

One or two bolts of each size in every connection and a minimum of 10% of the bolts in large connections shall be checked. If one or more bolts in a connection are below the required value, all the bolts shall be reimpacted with the calibrated-power wrench.

When the calibrated-power wrench body type of bolt is allowed and used, setting shall be such as to induce a bolt tension slightly in excess of the value shown. The wrenches shall be calibrated by tightening not less than three typical bolts of each size from the lot to be installed, in a device capable of indicating actual bolt tension.

Power wrenches shall be adjusted to stall out or cut out completely at the selected tension.

When using calibrated wrenches to install bolts, the operator should return to "touch-up" bolts previously tightened, until all bolts are tightened to the prescribed tension.

Impact wrenches shall be of adequate capacity and sufficiently supplied with air to perform the required tightening in approximately 10 seconds.

D. Inspection

The Owner shall approve the procedures for calibration of wrenches and installation of bolts. The inspector shall further observe the field installation to determine that these procedures are followed.

Bolts, nuts and washers are normally shipped with a light residual coating of oil. This coating is not detrimental to friction-type connections and need not be removed. Heavy coatings of oil shall be removed. Bolts tightened by the turn-of-the-nut method shall have the outer face of the nut marked along with the end of the bolt with permanent felt markers in order to determine the amount of turn. Close inspection shall be made to insure that the bolts are a tight fit; and that there is no movement of the rivet-type head in the tightening operation. When the calibrated-wrench method of tightening is used, the Contractor shall furnish the calibration equipment (Skidmore Wilhelm bolt calibrator or equal).

For the turn-of-the-nut method, the Contractor shall not be required to furnish equipment or make tests for establishing bolt tension. Such tests, if required, shall be performed by the Owner. However, the Contractor shall not be relieved of the responsibility for retightening bolts in case that tests indicate the required tension is not being obtained.

PART 4: MEASUREMENT AND PAYMENT

A. Measurement and Payment

No direct compensation shall be made for the installation of bolts. Payment shall be subsidiary to the pertinent item requiring the use of high-strength bolts.

SECTION 8
TRAFFIC

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SECTION 8.1: ANTIQUE/SHOEBOX LIGHT AND ASSOCIATED ITEMS

A. LIGHTING POLES AND FIXTURES

The lighting poles furnished for mounting luminaries shall be free from imperfections and present a pleasing appearance when plumbed and secured to the foundation. The finished pole shall have a smooth uniform finish free from pits, scratches, blisters or other defects. Each shoebox style pole shall have a removable pole cap. The mounting height shall be as specified per pole type. All fixtures shall not require individual photocells or photocell sockets. All poles shall not have factory installed fuse holders, but shall have external fuse holders installed at the base of each pole. All Antique light poles and fixtures shall have powder coat paint finish.

ANTIQUE DECORATIVE POLE AND FIXTURE

The antique light pole and fixture manufacture and part number:

Manufacture: Antique Street Lighting Co.
Pole Part Number: #PI C17 14A DGRH
Fixture Part Number: #A25 W INC MOG ACT 120 DGRH
Color Code: Powder coat paint color DGRH = # RAL 6012 (Black Green)
Lamp: Street Smart #130022 (240V) Day White

SHOE BOX AREA LIGHTING POLE AND FIXTURE

The shoebox type light pole and fixture manufacture part number:

Pole Manufacture: KW Pole
Pole Part Number: Single Head Pole #SSP30-6.0-7-BRZ DM10BC
Double Head Pole #SSP30-6.0-7-BRZ DM2180BC

Fixture Manufacture: EMCO
Fixture Part Number: #LED Ready fixture is not currently available.
Lamp Part Number: Street Smart #SKU 190011 150 WATT 5-7K

OR

Pole Manufacture: Lithonia Lighting
Pole Part Number: Single Head Pole # SSP30 6G DM19 DDB
Double Head Pole #SSP30 6G DM28 DDB

Fixture Manufacture: Lithonia Lighting
Fixture Part Number: #KVF2 400M SR3FL L/E L/ARM L/LP Q99
Lamp Part Number: Street Smart #SKU 190011 150 WATT 5-7K

B. ANCHOR BOLTS

Four high strength 1" steel anchor bolts shall be furnished with each pole. Anchor bolts shall be fabricated from a good commercial quality hot rolled carbon steel bar with minimum yield strength of 50,000 psi. Each anchor bolt shall be threaded at the top and fitted with double nuts and washers. The other end of the bolt shall have an "L" bend. The anchor bolts shall be of sufficient length and diameter to develop the full strength of the shaft. The threaded end of the bolt shall be galvanized a minimum length of 8" from the threaded end with a minimum threaded length of 6". **All necessary anchor bolts and templates for setting anchor bolts shall be furnished immediately after award of the contract, regardless of delivery schedules of the poles**. Additional hardware shall be provided and may be delivered with the poles.

C. PHOTOELECTRIC CONTROL

The photoelectric cells shall be twist plug in type Precision brand to match fixture or contactor voltage.

D. ELECTRICAL SERVICE EQUIPMENT

Electrical service equipment shall include, but not be limited to; metered service/disconnect or contactor enclosure. All enclosures housing electrical equipment shall be rain-tight, include a padlock handle, and designed for outdoor installation in accordance with NEMA standards. The lighting installations shall comply with the applicable provisions of the National Electrical Safety Code and National Electric Manufacturers Association specifications. A standalone, pedestal type combination metered service/disconnect/contactor control panel shall be used. The pedestal type meter service may be mounted to a concrete pad, although a pre cast polymer pad base is recommended. Power requirements desired should be 480Volt single phase. If not available, a lesser voltage may be acceptable if approved by City staff. Each service point shall include individual circuit breakers and photocell controlled contactor(s), and a HOA switch for control of the lighting circuit(s). Meter services shall require a no fee electrical permit and be inspected by City of Waco Inspection Services. Electric meter, application for service will be made by City staff. The color of the electrical service equipment shall be manufactures standard light or mint green.

Recommended, Oncor Approved, Service Pedestals are Milbank brand:

CP3B1110VASP	120/240V 1P 3W	100A
CP3B12519A22SP	208/120V 3P 4W	100A
CP3B1141FA22SP	480/277V 1P 3W	100A

Recommended Service Pedestal Base is Quazite brand:
PB25251212500

E. WIRE

All electrical wire shall be stranded copper conductor. Earth ground shall be stranded copper conductor with green insulation. All wire shall be of adequate size to accommodate lighting load. All splices shall be made inside the pole.

F. CONCRETE

Concrete for standard foundations shall be a 1-2-4 mix with minimum compressive strength of 2500 psi at 28 days. Concrete shall set a minimum of 72 hours prior to erection of lighting standards. All foundations shall be finished with grout as to provide a pleasing appearance.

G. FOUNDATION BASE

All foundation bases shall be (24) twenty-four inches in diameter. Top of bases shall extend (6) six inches above grade. Top of foundation shall have a 1" chamfer. Steel rebar shall be used to for concrete reinforcement throughout the entire base.

For area lighting poles in excess of (18) eighteen feet in height, bases shall extend a minimum of (6) six feet below grade.

For decorative poles not to exceed (18) eighteen feet, bases shall extend a minimum of (3) three feet below grade.

Exception: For parking lot installations, all bases shall be (30) thirty inches in diameter and extend a minimum of (36) thirty-six inches above grade. Below grade specifications shall remain as stated above.

H. FUSE HOLDERS AND FUSES

In-line fuse holders Elastimold or Buchanan, Style D65 (double fuse) with Bussman FNM-type fuses, of the appropriate amperage shall be installed at the base of each pole inside the hand hole. Fusing in fixture shall not be allowed.

I. CABLE CONNECTIONS AND SPLICES

Cable connections and splices shall be made inside the pole with split bolt connectors and insulated with #23 3M rubber tape, or approved equal then wrapped with #88 3M vinyl tape, or approved equal. No splices may be made outside the pole other than inside the service/disconnect or contactor enclosure.

J. GROUND RODS

Ground rods shall be installed in each pole foundation and at the point of service disconnect. The ground rods shall be minimum 8' x 5/8" copper-clad. All ground rods at pole foundations shall be installed in the concrete foundation and at an angle as to penetrate the soil on the side of the foundation. A minimum of 4" and a maximum of 6" of ground rod shall extend above the top of the concrete foundation finished grade. Installations outside the foundation are not acceptable.

K. EQUIPMENT GROUNDING

All poles, ground rods, electric service and associated equipment shall be bonded by means of a copper grounding conductor. Grounding of poles by means of anchor bolts shall not be permitted. Pole grounding shall be accomplished by means of a grounding lug; screw etc. attached to the pole.

L. GROUND (JUNCTION) BOXES

Electrical, in ground, non-conductive junction boxes with bolt down removable lids shall be utilized. Lids shall be permanently marked on the top "Electrical"

Recommended boxes are Quazite brand:

#PC1212BA12	Size 12" x 12"
#PC1324BA12	Size 13" x 24"
#PC1730BA12	Size 17" x 30"

SECTION 8.2: TRAFFIC SIGNAL MAST-ARM POLES

PART 1: GENERAL

A. DESCRIPTION

These specifications are intended to describe the physical features and minimum design and serviceability requirements for traffic signal mast-arm poles.

All component parts, materials and craftsmanship of the mast-arm poles shall be of high quality, conforming to the acceptable design standards of good engineering practices.

All Structural components shall conform to ASTM-A123 standards.

All Hardware components shall conform to ASTM-A153 standards.

B. SUBMITTALS

Not Applicable

PART 2: PHYSICAL FEATURES

A. MATERIALS AND CONSTRUCTION

1. All poles as supplied must conform to the detailed drawings and specifications as to height, and general design. All castings shall be clean and smooth with all details well defined for true to pattern. Poles shall consist of:

a. A round tapered steel shaft complete with shoe base, anchor bolts and nuts, hand hole, pole top, pole plate and miscellaneous fittings.

b. b. A round tapered steel traffic arm assembly complete with miscellaneous fittings. Arm to be complete with provisions for attachment to shaft.

2. The shaft shall be made from one length of best grade hot rolled, basic open hearth steel sheet of not less than #7 manufacturer's standard gauge for use with mast-arms 20 feet and shorter, #3 gauge for use with mast-arms 25 feet and longer. Only one longitudinal weld, and no transverse welds shall be permitted in the fabrication of the shaft. The shaft shall be formed, welded, and longitudinally cold-rolled under sufficient pressure to flatten the weld, form a round tapered tube, and improve the physical characteristics of the metal to insure a minimum yield strength of 55,000 psi. Flange plates of thickness specified on the plan sheet and dimension chart shall be welded to the pole at the specified location(s) near the top for the attachment of the signal mast-arm and the luminaire arm (when specified). The flange plates shall be supported with side plates tangent to the pole and gusset plates both top and bottom. The entire flange plate assembly shall be welded as specified in the plan sheets. The flange plates shall have a deburred 2 ½" diameter wiring hole and four tapped holes for high tensile bolts. A "J" hook wire support shall be welded near the top of the shaft. The cast pole top shall be secured in place with set screws. A hand hole with dimensions as shown on the plan sheets complete with reinforcing frame, cover and bolt on terminal block shall be provided in the shaft 12 inches above the base to facilitate wiring. The reinforcing hand hole assembly shall be a Pelco #AP-1086 with a Pelco #AP-1074 Hardware Kit. Sufficient space inside the compartment between the cover and terminal strip for 12-gauge wires if all terminals are used with 2 or more wires on each terminal shall be provided. The terminal blocks shall be two each, Pelco #SE-0317, 30 AMP 600 Volt, closed back, 12 position, 12-14

AWG or approved equal. The height of the mast-arm standard shaft shall be such that the point of attachment of all mast-arm mounted signal heads shall be eighteen feet above foundation level. Luminaire mast-arms, when specified shall not be less than thirty or more than thirty-two feet above the foundation level. Hand holes shall also be provided on the opposite side of the pole from and in line with each luminaire and signal arm. Each hand hole shall be constructed as shown on the plan sheet with a minimum 4" x 6" opening, reinforcing frame and cover.

3. A fabricated steel base shall be constructed with an opening of a size and shape to receive the shaft and shall be welded to the end of shaft by continuous electric welds. The base and welds shall be such as to develop the full strength of the adjacent shaft section. The base shall be provided with 4 slotted holes to receive anchor bolts. The slotted boltholes shall be ½" larger than the specified anchor bolt diameter. The base anchorage section shall be completely enclosed by a removable base cover.

4. Four high strength steel anchor bolts shall be furnished with each pole. Each anchor bolt shall be threaded at the top and fitted with double nuts and washers. The other end of the bolt shall have an "L" bend. The anchor bolts shall be of sufficient length and diameter to develop the full strength of the shaft. The threaded end of the bolt shall be galvanized a minimum length of 8" from the threaded end with a minimum threaded length of 6". All necessary anchor bolts and templates for setting anchor bolts shall be furnished immediately after issue of Purchase order, regardless of delivery schedules of the poles. Additional hardware shall be provided and may be delivered with the standards. All couplings in the pole shall have galvanized screw in plugs installed prior to delivery.

5. The mast-arm shall be made of only one length of best grade hot rolled basic open-hearth steel sheet of not less than #7 manufacturer's standard gauge. Only one longitudinal weld, and no transverse welds shall be permitted in the fabrication of the mast-arm. After being formed and welded, the mast-arm shall then be longitudinally cold rolled under sufficient pressure to flatten the weld, form a round tapered tube and increase its physical characteristics so that the metal will have a guaranteed minimum yield strength of 55,000 psi. A flange plate of the thickness specified on the plan sheet and dimension chart shall be welded to the large end of the arm by two continuous electric arc welds, one being on the outside of the plate, adjacent to the arm tube, and the other one on the inside at the end of the tubular cross section. This flange plate shall have four holes for high tensile bolts, which shall match the four tapped holes in the mounting plate on the pole shaft. The arm shall be furnished with provisions for signal attachment as detailed on plan sheets. Galvanized screw in plugs shall be installed in all couplings prior to delivery. Signal mast-arm spread shall be as specified by quantity in the bid form.

6. One galvanized saddle clamp for mounting each signal head shall be provided with the mast-arms. See detail sheets.

7. Luminaire arms shall be provided for combination traffic and lighting poles only. The luminaire mast-arm shall be secured to the pole by a flange plate connection. The flange plate shall be welded to the large end of the arm in the same fashion as described

for the signal mast-arm. The flange plate shall have four holes for high tensile bolts, which shall match the four tapped holes in the mounting plate on the pole shaft. All burrs and sharp edges shall be removed to provide a smooth wiring raceway. The arm shall be 11 ga. minimum steel with an appearance and dimensions as shown on the plan sheets. Luminaire mast-arm spread shall be ten feet in all cases.

8. One Full base cover (4-piece) fabricated from Korad covered ABS plastic shall be provide with each pole shaft. Pelco #PB-5501, #PB-5502, or #PB-5503 or approved equal. Color shall be natural gray.

9. All materials, including hardware and the top 9" of the anchor bolts shall be furnished with a hot dip galvanized finish. All threads shall be free of slag and excess zinc from the galvanizing process so that all bolts and nuts fit together smoothly and easily. It shall not be necessary to retap or rethread any galvanized items in order to assemble the various parts of the mast-arm signal standards. It shall be possible to remove plugs installed in couplings without the use of excessive force, special tools, or heat to break loose the plug from its fully seated position.

B. DESIGN

1. The mast-arm poles, generally, shall conform to the attached drawings and specifications charts thereon. Mast-arm pole shafts shall vary in size in accordance with these charts and the types of standards specified in bid form. Specific design data listed below for each basic category of mast-arm length shall be considered as minimum requirement for completely assembled mast-arm standards without over stress or failure.

2. Design data for signal mast-arm from 15 feet through 50 feet in length.
- **a.)** Maximum weight of signal head = 135 lbs.
- **b.)** Maximum projected area of signal head and back plate = 16 sq. feet.
- **c.)** All traffic signal, sign and luminaire support structures shall be designed in accordance with the AASHTO STANDARD SPECIFICATIONS FOR STRUCTURAL SUPPORTS FOR HIGHWAY SIGNS, LUMINAIRES AND TRAFFIC SIGNALS 1994 80 mph wind zone.

3. All material shall be of the best quality and workmanship. The manufacturer may be required to furnish satisfactory evidence of his ability to supply material in accordance with the plans and specifications.

4. Octagonal shaped mast-arm traffic signal poles are not acceptable.

5. Poles with truss type arms and/or clamp-on arms will not be considered.

6. Concrete poles shall not be considered.

POLE TYPE 1
MINIMUM DESIGN REQUIREMENTS FOR TRAFFIC SIGNAL MAST-ARM POLE

Pole Ref. #	Fin.	Shaft Len.	Mast-Arm Span	Shaft Size	Mast-Arm Size "L"	P1	P2	Arm Connection Bolt Size	Pole Base B.C.	S	F	P	T	U	W	X	Y	Anchor Bolt Size
A	Galv.	20'	15'	7E - 11.0" x 8.20" x 20.00'	7E - 5.50" x 3.36" x 15.25'	1.50"	1.50"	1.25" x 3.0"	15.0"	15.625"	10.625"	5.5"	1.25"	3.50"	1.50"	6.5"	14.0"	1.25" x 48.0" x 4.0'
B	Galv.	20'	20'	7E - 11.0" x 8.20" x 20.00'	7E - 6.50" x 3.63" x 20.50'	1.50"	1.50"	1.25" x 3.0"	15.0"	15.625"	10.625"	5.5"	1.25"	3.50"	1.50"	6.5"	14.0"	1.25" x 48.0" x 4.0'
C	Galv.	20'	25'	3E - 12.0" x 9.20" x 20.00'	7E - 7.50" x 4.00" x 25.00'	1.50"	1.50"	1.25" x 3.5"	16.0"	17.000"	11.312"	7.5"	1.50"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'
D	Galv.	20'	30'	3E - 12.0" x 9.20" x 20.00'	7E - 8.00" x 3.80" x 30.00'	1.50"	1.50"	1.25" x 3.5"	16.0"	17.000"	11.312"	7.5"	1.50"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'
E	Galv.	20'	35'	3E - 12.0" x 9.20" x 20.00'	3E - 9.00" x 4.10 x 35.00'	1.50"	1.50"	1.25" x 3.5"	16.0"	17.000"	11.312"	7.5"	1.50"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'
F	Galv.	20'	40'	3E - 12.0" x 9.20" x 20.00'	3E - 9.50" x 3.90" x 40.00'	1.50"	1.50"	1.25" x 3.5"	16.0"	17.000"	11.312"	7.5"	1.50"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'
G	Galv.	20'	45'	3E - 13.0" x 10.20" x 20.00'	3E - 10.0" x 7.80" x 15.75' 7E - 8.44" x 4.10" x 31.00'	1.75"	1.75"	1.50" x 4.0"	17.0"	18.500"	12.063"	7.5"	1.50"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'
H	Galv.	20'	50'	3E - 13.75" x 10.70" x 20.00'	3E - 11.0"x7.64"x 24.00' 7E - 8.28"x 4.40" x 27.75'	1.75"	1.75"	1.50" x 4.0"	18.0"	18.5"		7.5"	1.5"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'

POLE TYPE 2
MINIMUM DESIGN REQUIREMENTS FOR TRAFFIC SIGNAL MAST-ARM POLES WITH LUMINAIRE ARMS

Pole Ref. #	Fin.	Shaft Len.	Mast-Arm Span	Shaft Size	Mast-Arm Size "L"	P1	P2	Arm Connection Bolt Size	Pole Base B.C.	S	F	P	T	U	W	X	Y	Size of Anchor Bolts	L	Lum. Arm B.C.	Lum. Arm Size
I	Galv.	31.5'	15'	7E - 11.0" x 6.59" x 31.50'	7E - 5.50" x 3.36" x 15.25'	1.50"	1.50"	1.25" x 3.0"	15.0"	15.625"	10.625"	5.5"	1.25"	3.50"	1.50"	6.5"	14.0"	1.25" x 48.0" x 4.0'	4.75"	6.75"	11E-3.80"x2.40"x 10'
J	Galv.	31.5'	20'	7E - 11.0" x 6.59" x 31.50'	7E - 6.50" x 3.63" x 20.50'	1.50"	1.50"	1.25" x 3.0"	15.0"	15.625"	10.625"	5.5"	1.25"	3.50"	1.50"	6.5"	14.0"	1.25" x 48.0" x 4.0'	4.75"	6.75"	11E-3.80"x2.40"x 10'
K	Galv.	31.5'	25'	3E - 12.0" x 7.59" x 31.50'	7E - 7.50" x 4.00" x 25.00'	1.50"	1.50"	1.25" x 3.5"	16.0"	17.000"	11.312"	7.5"	1.50"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'	4.75"	6.75"	11E-3.80"x2.40"x 10'
L	Galv.	31.5'	30'	3E - 12.0" x 7.59" x 31.50'	7E - 8.00" x 3.80" x 30.00'	1.50"	1.50"	1.25" x 3.5"	16.0"	17.000"	11.312"	7.5"	1.50"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'	4.75"	6.75"	11E-3.80"x2.40"x 10'
M	Galv.	31.5'	35'	3E - 12.0" x 7.59" x 31.50'	3E - 9.00" x 4.10 x 35.00'	1.50"	1.50"	1.25" x 3.5"	16.0"	17.000"	11.312"	7.5"	1.50"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'	4.75"	6.75"	11E-3.80"x2.40"x 10'
N	Galv.	31.5'	40'	3E - 12.0" x 7.59" x 31.50'	3E - 9.50" x 4.10" x 40.00'	1.50"	1.50"	1.25" x 3.5"	16.0"	17.000"	11.312"	7.5"	1.50"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'	4.75"	6.75"	11E-3.80"x2.40"x 10'
O	Galv.	31.5'	45'	3E - 13.0" x 8.59" x 31.50'	3E - 10.0" x 7.80" x 15.75' 7E - 8.44" x 4.10" x 31.00'	1.75"	1.75"	1.50" x 4.0"	17.0"	18.500"	12.063"	7.5"	1.50"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'	4.75"	6.75"	11E-3.80"x2.40"x 10'
P	Galv.	31.5'	50'	3E - 13.75" x 9.09" x 31.50"'	3E - 11.0"x7.64"x 24.00' 7E - 8.28"x 4.40" x 27.75'	1.75"	1.75"	1.50" x 4.0"	18.0"	18.500"		7.5"	1.50"	4.00"	2.00"	6.5"	14.0"	1.75" x 90.0" x 6.0'	4.75"	6.75"	11E-3.80"x2.40"x 10'

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SECTION 8.3: STREET LIGHTING POLES

PART 1: GENERAL

A. DESCRIPTION

These specifications are intended to describe the physical features and minimum design and serviceability requirements for traffic signal mast-arm poles.

All component parts, materials and craftsmanship of the mast-arm poles shall be of high quality, conforming to the acceptable design standards of good engineering practices.

All Structural components shall conform to ASTM-A123 standards.

All Hardware components shall conform to ASTM-A153 standards.

B. SUBMITTALS

Not Applicable

PART 2: PHYSICAL FEATURES

A. MATERIALS AND CONSTRUCTION

1. Physical Features - All street lighting poles supplied, generally, shall conform to the attached drawings and specifications charts. Pole shafts shall be capable of attaching to and supporting any of the three specified luminaire arm lengths specified. Specific design data listed shall be considered as minimum requirement for completely assembled street lighting poles without over stress or failure. Poles shall consist of:

a.) A round tapered steel shaft complete with shoe base, anchor bolts and nuts, hand hole, pole top, pole plate and miscellaneous fittings.

b.) A round tapered steel luminaire arm assembly complete with miscellaneous fittings. Arm to be complete with provisions for attachments.

PART 2: SPECIFICATIONS

A. LIGHTING POLES

The lighting poles furnished for mounting luminaries shall be free from imperfections and present a pleasing appearance when plumbed and secured to the foundation. The pole shaft shall be capable of supporting a static load of 150 pounds. The finished pole shall have a smooth uniform finish free from pits, scratches, blisters or other defects. Each pole shall have a removable pole top. The mounting height shall be 35 feet plus or minus one foot above the level of the roadway.

B. POLE SHAFT

The pole shaft shall be of one-piece design fabricated from United States standard 11 Ga. coil stock. It shall be weldable grade hot rolled commercial steel with guaranteed yield strength of 48,000 psi after fabrication. The pole shall be cylindrical in shape with a uniform taper of approximately 0.14 inches of diameter per foot of length. An oval hand hole with dimensions of 4" x 6-1/2" inside opening welded to the pole shaft shall be provided. The hand hole shall be located 90 to the luminaire arm. A bolt secured steel cover shall be provided for each hand hole. A nut holder welded to the interior vertical side of the hand hole shall include a ½" 13 UNC hex head nut for grounding.

C. ANCHOR BASE

The anchor base shall be fabricated from a structural quality hot rolled carbon steel plate with minimum yield strength of 36,000 psi. The base plate shall telescope the pole shaft and be circumferentially welded top and bottom. The base shall be provided with 1-1/2" slotted boltholes to accommodate a ½" variation in the specified bolt circle. The bolt circle shall be 12.5" all cases, unless otherwise specified.

D. FULL BASE COVER

The base cover (2-piece) shall be fabricated from United States standard 14 Ga. (0.0747") commercial quality carbon steel. The cover shall be secured with two (2) hex head screws. The cover shall be designed so that all corners and edges, vertical and horizontal are rounded with a minimum radius of one inch. Aluminum covers of the same design shall be accepted.

E. LUMINAIRE ARM

The luminaire arms shall consist of 11ga. Minimum steel tubing with guaranteed minimum yield strength of 36,000 psi. With an appearance and dimensions as shown on the plan sheets. The finish for pole, arm and accessories shall be hot dipped galvanized.

The luminaire mast-arm shall be secured to the pole by a flange plate connection. The flange plate shall be welded to the large end of the arm by two continuous arc welds, one being on the outside of the plate adjacent to the arm tube, and the other one on the inside at the end of the tubular cross section. The flange plate shall have a deburred 2" wiring hole and four holes for high tensile bolts, which shall match the four tapped holes in the mounting plate on the pole shaft. All burrs and sharp edges shall be removed to provide a smooth wiring raceway.

Luminaire arms will be six (6) feet, ten (10) feet and fifteen (15) feet in length or as specified.

F. ANCHOR BOLTS

Four high strength 1" steel anchor bolts shall be furnished with each pole. Anchor bolts shall be fabricated from a good commercial quality hot rolled carbon steel bar with minimum yield strength of 50,000 psi. Each anchor bolt shall be threaded at the top and fitted with double nuts and washers. The other end of the bolt shall have an "L" bend. The anchor bolts shall be of sufficient length and diameter to develop the full strength of the shaft. The threaded end of the bolt shall be galvanized a minimum length of 8" from the threaded end with a minimum threaded length of 6". All necessary anchor bolts and templates for setting anchor bolts shall be furnished immediately after award of the contract, regardless of delivery schedules of the poles. Additional hardware shall be provided and may be delivered with the poles.

G. DRAWINGS

A complete set of shop drawings shall be furnished with the bids at the time of bid opening for evaluation of the proposed equipment.

MINIMUM DESIGN REQUIREMENTS FOR LUMINAIRE POLES AND ARMS

Pole Type	Fin.	Mount Height	Arm Span	Shaft Size	Lum. Arm Size “L”	P3	P4	Bolt Size	B.C.	S	F	P	T	U	W	Size of Anchor Bolts
Q	Galv.	35'	6'S	11E 9.0" x 4.30" x 33.5'	11E 3.63" x 2.4" x 6.0'	1.0"	1.0"	0.75" x 2.5"	12.5"	13.8"	8.83"	5.5"	1.25"	3.75"	1.5"	1.00" x 36.0" x 4.0'
R	Galv.	35'	10'S	11E 9.0" x 4.30" x 33.5'	11E 3.80" x 2.4" x 10.0'	1.0"	1.0"	0.75" x 2.5"	12.5"	13.8"	8.83"	5.5"	1.25"	3.75"	1.5"	1.00" x 36.0" x 4.0'
S	Galv.	35'	15'S	11E 9.0" x 4.30" x 33.5'	11E 4.60" x 2.4" x 15.0'	1.0"	1.0"	0.75" x 2.5"	12.5"	13.8"	8.83"	5.5"	1.25"	3.75"	1.5"	1.00" x 36.0" x 4.0'
T	Galv.	35'	6'T	11E 9.0" x 4.30" x 33.5'	11E 3.63" x 2.4" x 6.0'	1.0"	1.0"	0.75" x 2.5"	12.5"	13.8"	8.83"	5.5"	1.25"	3.75"	1.5"	1.00" x 36.0" x 4.0'
U	Galv.	35'	10'T	11E 9.0" x 4.30" x 33.5'	11E 3.80" x 2.4" x 10.0'	1.0"	1.0"	0.75" x 2.5"	12.5"	13.8"	8.83"	5.5"	1.25"	3.75"	1.5"	1.00" x 36.0" x 4.0'
V	Galv.	35'	15'T	11E 9.0" x 4.30" x 33.5'	11E 4.60" x 2.4" x 15.0'	1.0"	1.0"	0.75" x 2.5"	12.5"	13.8"	8.83"	5.5"	1.25"	3.75"	1.5"	1.00" x 36.0" x 4.0'

S = Single Luminaire Arm T = Twin luminaire arms

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SECTION 8.4: POWDER COATING OVER GALVANIZED STEEL SURFACES

PART 1: GENERAL

The powder coat finish standardly consists of a Urethane, Triglycidyl Isocyanurate (TGIC) Polyester Powder.

PART 2: SURFACE PREPARATION AND POWDER COATING

A. The exterior steel surface is blast cleaned to Steel Structures Painting Council Surface Preparation Specification No. 7 (SSPC-SP7) requirements of utilizing cast steel abrasives.

B. Prior to the powder application, the zinc-coated substrate is preheated to a maximum temperature of 450°F for a minimum of one (1) hour.

C. Then all exterior surfaces are cleaned and coated with a Urethane or Triglycidly Isocyanurate (TGIC) Polyester Powder to a minimum dry film thickness (DFT) of 2.0 mils (0.002”).

D. The powder coating is electrostatically applied and then cured in a gas fired convection oven at a temperature range of 350°F - 400°F.

E. The thermosetting powder resin provides both intercoat as well as substrate fusion adhesion that meets 5A or 5B classification of ASTM D3359.

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SECTION 8.5: TRAFFIC SIGNAL INSTALLATION SPECIFICATIONS

PART 1: GENERAL

It is the intent of these plans and specifications to provide for the complete construction of a fully operational traffic signal(s). These plans and specifications call for City of Waco supplied items and CONTRACTOR supplied items and all labor necessary to complete the project. Any items required, but omitted are the responsibility of the CONTRACTOR.

All construction shall be subject to the inspection and approval of the City Traffic Engineer, Inspectors of the City of Waco, and Inspectors of the Texas Department of Transportation (TxDOT).

The Standard Specifications of Construction of Highways, Streets, and Bridges as adopted by the TxDOT, March 1, 1993 shall govern the construction of this project, unless a City of Waco Specification is provided.

In the event of a conflict of the specifications, the City of Waco shall determine which specification shall govern for a particular circumstance.

PART 2: SPECIFICATION DOCUMENTS:

Item -1 City of Waco Specifications for Traffic Signal Design Criteria

Item -2 City of Waco Working Drawings for New Traffic Signal Installation and Removal of Existing Traffic Signal Equipment at the intersection of MLK & Elm.

Item -3 City of Waco Working Drawings for New Traffic Signal Installation and Removal of Existing Traffic Signal Equipment at the intersection of MLK & Taylor.

Item -4 City of Waco Working Drawings for New Traffic Signal Installation and Removal of Existing Traffic Signal Equipment at the intersection of 19th & College.

Item -5 City of Waco Working Drawings for New Traffic Signal Installation and Removal of Existing Traffic Signal Equipment at the intersection of Washington & 7th.

THE TRAFFIC SIGNAL INSTALLATION CONSISTS OF THE FOLLOWING PRINCIPAL ITEMS:

Items Furnished By City of Waco For Traffic Signal Installation

- Controller, Cabinet, MMU, Detectors and all plug-ins.
- Spread Spectrum Radio, Antenna, Coax, Power supply, Coax Connectors.
- Traffic & Pedestrian Signal Heads with LED's.
- Poles, Anchor Bolts.
- Traffic and Pedestrian Signal Head Mounting Hardware.
- Pedestrian push buttons.
- Ground Rods.
- Pedestal Type Service w/Disconnect, breakers and Quazite mounting base.
- Quazite Ground Boxes.
- All Signs and mounting hardware & roadway markings.
- Opticom devices except field cable.
- VIVDS (Video Image Vehicle Detection System)– Iteris, including cable
- Street light fixtures, lamps and photocells.

Items Furnished By Signal Contractor For Traffic Signal Installation

- Labor for complete Traffic Signal installation.
- All wire not listed above.
- Conduits, Conduit fittings, PVC glue.
- Concrete and reinforcing steel.
- Forms and forming tube.
- Barricading, Work Zone and Signal Construction Signing.
- Cleanup and removal of spoils.
- Miscellaneous items such as: wire labels, connectors, tape, banding material
- Demolition and removal of existing signal poles, foundations, and junction boxes if specified.

A. The CONTRACTOR shall also furnish and install all other items not listed above which are needed to provide the complete traffic signal installation as called for in the plans and specifications.
B. City supplied items are in stock and are stored at the City Traffic Shop and Pole Yard.

PART 3: NOTES

The CONTRACTOR shall notify the City of Waco Traffic Services Division at one of the contact numbers listed below at least one week prior to starting work on this project.

The CONTRACTOR will be allowed to work on this project only during daylight hours (7 AM to 5 PM Monday - Friday). Between 7 AM and 8 AM, only work off of the roadway which does not disrupt traffic can be performed.

The CONTRACTOR shall clean up and remove from work area all loose material resulting from the contract operations each day before work is suspended.

Any obstructions to existing drainage due to the contractor's operations will be removed by the CONTRACTOR as required by the City at the CONTRACTOR's entire expense.

Any existing pavement, curbs, sidewalks, and driveways damaged or removed during construction shall be replaced by the CONTRACTOR to the City of Waco's Standards or TxDot Standards, which ever pertains to the situation.

The CONTRACTOR shall restore the construction area to original condition prior to final inspection.

After signal construction has been completed, the signal shall operate in a flashing mode for a minimum of 3 days to include one weekday, Saturday and Sunday (as directed by the City) prior to the beginning of the test period for the full signal operation.

Unless directed by the City, the signal shall be placed in full operation between 9:00 a.m. - 12:00 (noon) on Monday, Tuesday, Wednesday, or Thursday only.

A. City Signal Inspector

The City Signal Inspector, for the purposes of these specifications, is designated as the Signal Operations Supervisor or his designated representative.

B. Signal Turn On Procedure and Test Period

The CONTRACTOR shall notify the City Signal Inspector or the City of Waco Traffic Services Division at one of the contact numbers listed below approximately 48 hours in advance of the planned turn-on. The City Signal Inspector shall be present when the signals are placed in operation. Once the permanent signals have been installed and placed in operation, they shall operate continuously for a minimum of 30 calendar days in a satisfactory manner. Equipment failures during these 30 days will cause the test period to start over.

C. Conduit

All conduits under roadways shall be bored in accordance with TxDOT requirements and a minimum of 24 inches below grade.

Underground conduit for cable shall be Schedule 40 Electrical PVC. All couplings and connections shall be tight and water proof. All conduits shall have bell end caps.

Conduit to be placed under existing pavement shall be placed at a minimum depth of 24 inches below the pavement surface.

All conduits placed under natural ground may be trenched and buried; however the CONTRACTOR shall backfill, compact, and restore trenched area to the original conditions and match existing surface conditions to the density of adjacent area.

D. Signal Heads

All signal heads shall be covered with burlap or other approved material from the time of installation until the signal is placed in operation.

All indications to be 12" polycarbonate with 5" ABS molded backplates and tunnel visors.

All signal heads shall be pipe nipple mounted horizontally on mast arms and vertically on poles.

All signal heads shall be mounted in front of the mast arm or pole.

LED signal lamps shall be used for all signal indications (RED, RED ARROW, YELLOW, YELLOW ARROW, GREEN, and GREEN ARROW) as shown on the plans.

LED signal lamps shall be used for the Pedestrian Signal Lamp (Symbolic) indications as shown on the plans.

E. LOOPS

If specified, inductance loop detectors shall be XHHW #14 loop duct, imbedded in saw cuts located and dimensioned as indicated on plans. Loop lead-in shall be placed in conduit as shown in the standard signal construction details.

F. VIVDS (VIDEO IMAGE VEHICLE DETECTION SYSTEM)

If specified, VIVDS (Video Image Vehicle Detection System) shall be installed and programmed to detect vehicles in locations as indicated on plans. Field adjustments or modifications may be made on an as needed basis prior to approval by the City Signal Inspector.

G. WIRING

Extra cable length shall be included in each run to provide adequate slack, as determined by the City, at each ground box or foundation. There should be at least 2 feet of extra cable length per ground box. All cables and wires shall be identified at end terminations.

The City Signal Inspector shall approve proposed cable splicing methods prior to construction. City color-coding specifications shall be followed. The City Signal Inspector shall approve any variance from the specified color code chart prior to construction. All terminations shall be made to terminal block, if provided, in the pole bases and cabinet. No splices shall be allowed in ground boxes except for loop-to-loop lead-in wire.

H. FOUNDATIONS

The dimensions shown on the plans for location of signal foundations, conduit, and other items shall be placed as indicated, but may be varied to meet local conditions. All pole foundation locations shall be field verified and any adjustments approved by the City Signal Inspector prior to construction. The CONTRACTOR shall notify the City Signal Inspector or the City of Waco Traffic Services Division at one of the contact numbers listed below at least 48 hours before placing concrete. Class “A” 3000-psi concrete shall be used as a minimum. Cylinders will be made for testing by City personnel. Concrete cylinders shall meet or exceed a minimum compressive strength of 3000 psi at 28 days after pouring. Failure to meet this minimum will require replacement of the foundation at the CONTRACTOR’s expense.

No mast arm poles shall be placed on the foundations until concrete has reached a compressive strength of 3000 psi at 7 days minimum.

All foundations shall be finished with grout to provide a pleasing appearance.

I. GROUND BOX

All ground boxes, not located in sidewalk or parking lot areas (natural areas), shall have a minimum 6" concrete apron completely around the box, and flush with the top, for support and stability purposes.

J. EXISTING UTILITIES

The exact location of the underground utilities is not certain. The CONTACTOR shall be responsible for contacting the City of Waco and other utility companies for exact location prior to drilling for foundations, trenching, boring, and any other work that might interfere with or damage present utilities. Locations of some of these utilities can be determined by calling Digtess. No additional payment will be made for relocation of any foundations due to utilities conflicts.

Texas State Law, Article 1436C, makes unlawful the operation of equipment or machines within 10 feet of any overhead electrical line unless danger against contact with high voltage overhead lines has been effectively guarded against pursuant to the provisions of the article. When construction operations require working near an overhead electrical line, the CONTRACTOR shall contact the owner/operator of the overhead electrical line to make adequate arrangements and to take necessary safety precautions to ensure that all laws, electrical line owner/operator requirements and standard industry safety practices are met.

K. ELECTRICAL SERVICE

The City will request electrical service with Oncor Electric and the City's service provider. The CONTRACTOR shall pay for all fees charged by Oncor Electric required to install the new service.

CONTRACTOR will secure a no-fee electrical permit for electrical service with the City of Waco Inspection Services. Inspection Services will inspect electrical service work. All electrical services shall meet current NEC requirements.

L. DEMOLITION & REMOVAL OF EXISTING TRAFFIC SIGNAL

As specified in working drawings, signal poles and associated equipment on said poles shall be removed and delivered to City Pole yard. Existing control cabinets shall be returned to the City Traffic Shop. All foundations and anchor bolts shall be reduce to 6" below grade and covered with fill dirt. Existing junction boxes shall be removed and filled with dirt. Existing underground wiring and conduit shall be reduced to 6" below grade and remain. All ends shall be disconnected.

M. INSPECTION

All other inspections will be performed by City of Waco Traffic Services. All work, specified equipment, materials, and construction methods are subject to inspection. Any items deemed substandard by the inspector shall be removed and properly replaced at the CONTRACTOR's entire expense.

N. REFERENCES

References to manufacturer's trade name or catalog numbers are for the purpose of identification only. The CONTRACTOR will be permitted to furnish like materials of other manufacturers provided they are of equal or better quality and comply with the specifications for this project and are approved by the City.

O. CONTRACTOR'S RESPONSIBILITY FOR THE WORK

The CONTRACTOR shall be responsible for all installations until accepted by the City as required by the general provisions and requirements. Should 'knock downs' occur, the CONTRACTOR shall be responsible for all labor to reinstall said equipment at no additional costs. If new equipment is required, as determined by the City, the City shall provide replacement equipment at no additional cost.

P. HANDLING OF TRAFFIC

The CONTRACTOR shall provide all necessary standard construction warning signs, barricades, drums, or other traffic handling devices as required by the traffic control plan or the Manual on Uniform Traffic Control Devices (MUTCD, part VI, latest edition) and be consistent with TxDot barricade, construction, and traffic control plan standards.

Roads and streets shall be kept open to traffic at all times. The CONTRACTOR shall, unless otherwise directed by the City, arrange the installation of loop detectors or other work in the roadway so as to close only one lane of a roadway at a time. All construction operations shall be conducted to provide the least possible interference to traffic as provided in the specifications and/or as directed by the City.

The CONTRACTOR shall arrange the installation of signals, poles, and conduit so as to permit the continuous movement of the traffic in both directions at all times. A pre-construction conference with City staff shall outline intersection construction phases.

SECTION 8.6: TRAFFIC SIGNAL DESIGN CRITERIA CABINET & CABINET ACCESSORIES

Controller: Eagle #EPAC3608M42 w/"D" harness #EPAC 31008
Conflict Monitor: EDI #SSM-12LE-PR w/ data port
Load Switches: EDI #510 or PDC #SSS-86
Flasher: EDI #810 or PDC #SSF-86
Detectors: U. S. Traffic - Detector Systems single channel #919ATX-SS
Spread Spectrum Radio: Microwave Data Systems "TransNet 900" – 115K Baud Rate, w/ wiring harness for Eagle EPAC Controller and 3 Amp power supply.
Spread Spectrum Antenna: 890-960Mhz - 10db gain Yagi
SSR Polyphaser: Edco #CXHFN
Cabinet: U.S. Traffic, City of Waco Spec. #CO-010328-07. P-44 Wide, white exterior.
Preemption: 3M Opticom two position card rack w/ "green sense" harnesses.
Ped Isolation. Board: U. S. Traffic #8050-100059.1
Flash Transfer Relay 20A @ 120V DPDT 120VAC U.S. Traffic #001736

OTHER SIGNAL COMPONENTS

Signal Heads: Eagle or Peek. See City of Waco Spec. Federal yellow poly with Pelco ABS vacuum formed backplates. Minimum two (2) through signals, one (1) overhead and one (1) lower right. (Additional overhead signals desired if arm allows). Protected left turns require all arrow indications.
Pedestrian Head: U.S. Traffic/Peek - ICC #4302A-FY. See City of Waco Spec.
Pedestrian Signal Mount: U.S. Traffic/Peek –ICC #4805-FY. See City of Waco Spec.
LED Lenses-Signals: See City of Waco Spec. All colors. Shall have TxDot failsafe circuit with external inline fuses.
LED Lenses-Peds: See City of Waco Spec. Single lense unit required for "Hand/Man" Symbols w/ count down timer.
Luminaire Lighting: GE. 250 Watt, HPSV Cobra Head – full cutoff. See City of Waco Spec. (Required on all signal mast arm poles, if design allows).
Luminaire Photo Cell: Precision 120V.
Signal Mount Hardware: Pelco, two point pipe nipple mounting. Finish shall be bright zinc dichromate for steel hardware and alodine 1200 or equivalent finish for cast aluminum hardware. See City of Waco Spec.
Pedestrian Push Button: Pelco #SE-2005-08-P29 ADA federal yellow
SSR Antenna Mount: Pelco # SP-3051-TX
Signal Poles: Union Metal or Valmont. See City of Waco Spec. (Union Metal, Valmont have approved City of Waco Spec. on file).

Junction Boxes: Quazite: Lid engraved with the word "ELECTRIC"

- #PC1212BA12 Size 12" x 12"
- #PC1324BA12 Size 13" x 24"
- #PC1730BA12 Size 17" x 30"

Conduit: Schedule 40 grey electrical.

Service: Under ground 240 volt, single phase with 70 Amp 2-circuit disconnect, 30 Amp single pole breakers. W/ Milbank #U8567-0 meter pedestal and Quazite #PB10140507B31 Meter Pad Box.

Cable/Wire: See City of Waco Wiring Code:

- #6 THHN Stranded Copper Black
- #6 THHN Stranded Copper White
- 3-Pair Shielded (Belden 9773 or equal) loop lead-in.
- IMSA 20-1, 12-4 Stranded Copper (equipment grounding and street lights).
- IMSA 20-1, 12-5 Stranded Copper (individual ped/signal wiring in poles to terminal blocks.)
- IMSA 20-1, 12-7 Stranded Copper (pedestrian signals. 1 run per corner) (end of arm traffic signals).
- IMSA 20-1, 12-16 Stranded Copper (traffic signals. 1 run per corner).
- LMR-400 Coax (for spread spectrum radio)

Loop Detection: See City of Waco Spec. for wire, sealant and installation requirements.

Video Detection: VIVDS (Video Image Vehicle Detection System)– Iteris, including cable

Concrete: 5 sack mix minimum.

Signs:

- Left Turn:
  Protected: R10-5
  Protected/Permissive: R10-12
- Pedestrian Push button: R10-4b
- Street Name: See City of Waco Spec. Shall be mounted on signal arm with Astro bracket.
- Wind foil sign blank 24" x 30" shall be installed, using sign brackets, horizontally as close as possible to the signal head at the of each signal arm.

Grounding: All signal poles, cabinet, service and related equipment shall have individual ground rods 95/8" x 8' minimum) installed within the foundation(s). All ground rods shall be bonded to the equipment and connected by means of the green conductor within the cable specified: IMSA 20-1, 12-4.

SECTION 8.7: PAVEMENT MARKINGS & ROADWAY SIGNAGE

PART 1: GENERAL REQUIREMENTS

This section includes the primary specifications for the installation of permanent signage or application of permanent markings along a city street. All signs installed within the city's rights-of-way shall be mounted on a breakaway style support system to ensure NCHRP 350 compliance. Section D details the current practices used by the city on a daily basis. Any pavement surface shall be clean and dry prior to pavement marking application. It is the responsibility of the Contractor or the contractor's designee for ensuring the pavement surface is clean and dry prior to installing markings.

PART 2: TYPE OF MARKINGS AND SIGNS:

The signs and markings will typically be those as authorized in the MUTCD handbook and typically used along state highways in Texas. There may be some minor changes for specific applications. Contractor should contact Norman Hogue, P.E. with City of Waco Traffic Services for specifics for this project at (254) 750-6638.

A. MATERIALS:

1. Thermoplastic Markings

Permanent markings shall be of the TxDOT standard thermoplastic materials (DMS 8220) with either TxDOT Type II or Type III glass surface beads (DMS 8290) applied at an application rate to provide uniform distribution of beads across the surface of the stripe, with a 40 to 60% bead embedment. All existing markings including longitudinal and transverse, as well as all legends, shall be applied according to existing street layout prior to street surface treatment. All turn bays should be 4" solid white, unless noted in section H or plans. A minimum binder thickness of 90 mils (excluding glass surface beads) shall be maintained for all thermoplastic materials on hot-mix asphalt and concrete surfaces. On open graded seal-coats, a minimum binder thickness of 100 mils (excluding glass beads) shall be maintained for all thermoplastic materials. All markings shall have one-way or two-way reflective raised pavement markers installed at the specified spacing in subsection 4 or plans. Thermoplastic markings installed on concrete shall conform to the standard TxDOT specifications for Sealer for Type I markings.

2. Waterborne Paint Markings

In some cases, waterborne paint may be used in lieu of thermoplastic markings. Such cases will be identified on an individual project basis or on an engineering set of plans. In general, these types of markings are only used on low-volume roads with adequate lighting or for temporary markings between surface repair and major street rehabilitation projects. All waterborne paint shall be of the TxDOT standard thermoplastic materials (DMS-8200) and contain one of the following acrylic binders: Rohm & Haas Fastrack HD-21 or Dow DT-400.

3. Roadway Signage

All signs installed within the city's rights-of-way shall be in conformance with the current MUTCD standards. All sign blanks shall be an aluminum blank with a minimum of thickness of 0.080 inches, radius corners at all edges (1:16 ratio of corner radius to largest side; i.e. a 24" x 36" sign would have a 2.25" radius), and standard predrilled 7/16-inch holes as indicated in subsection iv below. Each finished sign shall include the appropriate standardized sign legend (see TxDOT Standard Highway Signs Manual) with a minimum type IV grade sign sheeting on each appropriate sign face (ASTM Spec. No. D4956), except for R7 series and R8-1 to R8-8 series No Parking signs which must have a minimum type II grade sign sheeting on each appropriate sign face (ASTM Spec. No. D4956).

a.) **Standard Drive Rivet --** A 3/8-inch aluminum shell/steel core drive rivet with a rivet shell: 5052 Aluminum Alloy, pin: 1008 steel, Zinc Plate, Chromate Plus Sealer. The grip shall be a nominal 0.188-inch in a 3/8-inch hole. Weight is equal to 2.25 lbs/C.

b.) **Standard Corner Bolt --** A 5/16-inch medium corner bolt, meeting material ASTM A-307 and finish ASTM B695 class 25.

c.) **Standard Nut for Corner Bo**lt **--** A 5/16-inch serrated flanged nut, meeting material ASTM A-194 and finish ASTM B695 class 25. Weight is equal to 1.26 lbs/C.

d.) **Standard Hole Layout for Sign Blanks --** The standard predrilled layout for holes should be along both the horizontal and vertical axis of each sign with 7/16-inch holes. The holes should be located as indicated in the following tables.

Diamond-Shaped Blanks	
Size	**Number of Holes Required and Spacing**
24 in.	2 holes, 12 in. from center on each diagonal line
30 in.	2 holes, 15 in. from center on each diagonal line
36 in.	2 holes, 18 in. from center on each diagonal line
48 in.	2 holes, 24 in. from center on each diagonal line, 1 hole at center
Square-Shaped Blanks	
Up to 36 in.	2 holes, 3 in. from edge in center of opposite sides
36 in., 48 in.	2 holes, 6 in. from edge in center of opposite sides
Note: Drill all diamond and square shaped blanks for use as either type.	
Rectangular-Shaped Blanks	
Up to 48 in. x 12--15 in.	4 holes, 1-½ in. from the edge in the center of each side
Up to 48 in. x 18--24 in.	4 holes, 3 in. from the edge in the center of each side, 1 hole at center
48 in. x 36 in.	4 holes, 6 in. from the edge in center of each side, 1 hole at center
Over 48 in. x 12 in.	4 holes, 1/6 horizontal dimension from edge at 1-½ in. from top and bottom edges
Over 48 in. x 24 in.	4 holes, 1/6 horizontal dimension from edge at 3 in. from top and bottom edges
Over 48 in. x over 36 in.	4 holes, 1/6 horizontal dimension from edge at 6 in. from top and bottom edges

Octagonal Sign Blanks	
24 in., 30 in.	2 holes, 3 in. from edge on vertical center line
36 in.	2 holes, 3 in. from edge on vertical center line, 1 hole at center
Triangular Sign Blanks (with point down)	
30 in.	2 holes on vertical center line, spaced 3 in. and 21 in. from top
36 in.	2 holes on vertical center line, spaced 4 in. and 24 in. from top
48 in.	3 holes on vertical center line, spaced 4 in., 19 in., and 34 in. from top
Circular Sign Blanks	
30 in.	2 holes on vertical center line, spaced 12 in. from center
36 in.	2 holes on vertical center line, spaced 15 in. from center
Isosceles Triangular Sign Blanks (with point to the right)	
30 in. x 40 in. x 40 in.	2 holes, each 12 in. from left edge, 7.5 in. from horizontal center line
36 in. x 48 in. x 48 in.	2 holes, each 15 in. from left edge, 9 in. from horizontal center line
Pentagon Sign Blanks (with point up)	
24 in.	2 holes on vertical centerline, spaced 3 in. and 21 in. from bottom edge
30 in.	2 holes on vertical centerline, spaced 3 in. and 24 in. from bottom edge
36 in.	2 holes on vertical centerline, spaced 3 in. and 27 in. from bottom edge

4. Reflective Raised Pavement Markers

THE PLACEMENT OF RPMS SHALL BE IN ACCORDANCE WITH LAYOUT RECOMMENDATION PUT FORTH BY THE FEDERAL HIGHWAY ADMINISTRATION (FHWA) IN FHWA 97-157, AND ACCEPTED CITY OF WACO STANDARD PRACTICES. RPMS SHALL BE INSTALLED AT THE FOLLOWING SPACING:

e.) On a two-lane, two-way road supplement:

1. Double solid yellow centerline with RPMs placed between the lines on 40’ centers.

2. Solid with broken yellow centerline (indicating passing in one direction) with RPMs placed between broken lines on 80’ centers.

3. Broken yellow centerline (indicating passing in both directions) with RPMs placed between broken lines on 80’ centers.

f.) Supplement continuous left-turn lane with RPMs on 80’ centers on the inside of the lane, and 40’ centers on the outside of the laneline.

g.) Supplement solid left or right turn bays with RPMs on 10' centers. For acceleration lanes use 20' centers.

h.) Supplement 8" or 12" solid white/yellow transverse markings in gore areas with RPMs on 20' centers unless directly differently in section H. Install one per transverse marking if solid white, and two per transverse marking if solid yellow on each end.

RPMs placed besides solid lines shall have a lateral offset of 2 to 3 inches, and should not be placed over longitudinal or transverse joints of the pavement surface. They should be placed so that the RPM face is perpendicular to a line parallel to the roadway striping.

5. Sign Post Installation:

Currently, the City of Waco primarily utilizes a three-part square post system with a splice to ensure NCHRP 350 compliance. The standard sign post anchor is a 2" x 2" x 3' perforated square tube (12 gauge U.S.S., ASTM designation A570, grade 50) installed in a native ground area with a maximum of 6" protruding from the finished grade. A standard splice unit is a 1-¾" x 1- ¾" x 1' perforated steel tube (14 gauge U.S.S, ASTM designation A570, grade 50) installed with a minimum of 60% of the length telescoped within the installed post anchor. The splice is affixed to the sign anchor with a minimum of (1) standard 3/8-inch steel rivet (see section C.3.a) and (1) standard 5/16-inch steel corner bolt with a 5/15-inch serrated flanged nut (see section C.3.b & c). The sign post is a 2" x 2" perforated square tube (12 gauge U.S.S., ASTM designation A570, grade 50) with sufficient length to ensure the minimum clearance from the bottom of the sign to the ground (7 ft. if a single sign assembly, 6 ft. for a multiple sign assembly). Note that the measured ground elevation is the height of the nearest pavement edge. Along rural roadway sections, assembly height may be as low as 5 feet, provided lateral clearance is available (see MUTCD). The sign post is affixed to the splice & sign anchor with a minimum of (1) standard 3/8-inch steel rivet (see section C.i) and (1) standard 5/16-inch steel corner bolt with a 5/15-inch serrated flanged nut (see section C.ii & C.iii).

6. Special Provisions:

Temporary markings shall be installed during street work and removed after permanent markings are installed. Contractor will be responsible for removing tabs. Temporary tabs may be provided by the City of Waco. Reflective tabs may be used as temporary markings, and should be offset six inches to one foot from the existing marking layout to allow permanent striping to be applied without covering the tabs. Permanent striping shall not be installed over tabs.

SECTION 9
WATER AND WASTEWATER ELECTRICAL

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SECTION 9.1: ELECTRICAL GENERAL INFORMATION

PART 1 GENERAL

1.01 GENERAL NOTE

A. This Section of the Specifications together with the drawings and other applicable sections of the Specifications, including requirements of the Instruction to Bidders, Contract Agreement, General Conditions, Supplementary General Conditions and Special Conditions comprise the Electrical portion of the work.

1.02 SCOPE OF THE WORK

A. The work contemplated under this Section includes the furnishing of all supervision, labor, materials, tools, transportation, services, etc., required for the complete installation and operation of the electrical work as shown on the drawings and as specified herein. The work shall specifically include, but is not necessarily limited to, the following items:

1. Electrical service to Lift Station.

2. Main disconnect and surge protection.

3. Scada System Components including RTU and radio antenna.

4. Switchrack with main disconnect, surge protection, manual transfer switch, power panel and pump control panel.

5. Power, lighting, grounding, instrumentation and controls for the Lift Station.

6. Connection to equipment furnished by the others including the lift station manufacturer.

7. All other work shown on the Drawings or required by the Specifications.

8. Testing all of the electrical, instrumentation and controls installation.

1.03 PLANS AND DRAWINGS

A. The drawings indicate the general layout of the complete electrical systems and show arrangements of feeders, outlets, lighting fixtures, disconnect switches, panelboards and other work. The Contractor shall field verify scale dimensions since actual locations, distances and levels are to be governed by actual field conditions.

B. The Contractor shall also check all other plans to avoid possible conflicts. Discrepancies shown on different plans or between plans and actual field conditions shall be brought to the attention of the Owner promptly for resolution.

1.04 SUBMITTALS

A. As soon as practicable after the official award of the Contract, the Contractor shall submit seven manufacture data sheets/brochures, shop drawings, wiring diagrams, on the following items:

9. Area lighting fixture and pole.

10. Main disconnect.

11. Manual transfer switch.

12. Power panel

13. Pump control panel.

14. Scada System components.

15. Surge suppressors.

16. Wiring devices.

17. Conduit and fittings.

18. Switchrack.

B. All drawings shall be identified as to intended use. Any information not applicable to the project shall be crossed out to clarify what is actually being furnished. Submittals shall be in strict compliance with Section 01300 of these Specifications.

1.05 QUALITY ASSURANCE

A. Materials and Substitutions: The materials and equipment supplied shall be new and of the best quality used in this type work. Where materials, equipment, apparatus or other products are specified by brand name, manufacturer type or catalog number, such designation is to establish standards of quality and style and shall be the basis of the bid. The Contractor shall submit any substitutions to the Architect/Engineer for consideration. In making such submittal, the Contractor shall bear the responsibility and all costs for any changes in the

design necessitated by use of the substitution. All materials shall conform to NEMA or ANSI Standards, or both, where applicable.

B. All materials shall also bear the Underwriters Laboratory label where such is available for the particular type product furnished. All materials shall be of domestic (U.S.A.) manufacture.

C. Workmanship: Workmanship shall be of the highest grade throughout and in accordance with the best standard practice.

1.06 CODES AND PERMITS

A. All work shall be performed and all materials shall be in accordance with the National Electrical Code and all applicable Federal, State and local codes, regulations and ordinances. The Contractor shall, at his own expense, arrange for and obtain all necessary permits, inspections and approval by proper authorities in local jurisdiction of such work. All costs in obtaining such fees shall be borne by the Contractor.

1.07 TEMPORARY SERVICES

A. The Contractor shall arrange for, furnish, install and maintain temporary electrical service at site as required and remove the same after construction is completed. All temporary services shall be installed in accordance with OSHA Standards.

1.08 RELATION TO OTHER WORK

A. The electrical work shall be coordinated with the work of all associated trades and shall be installed in such a manner as to avoid conflicts with piping, structures and equipment being furnished or installed by other trades.

1.09 CONNECTION TO EQUIPMENT FURNISHED BY OTHERS

A. All items of equipment furnished by others shall be completely connected. Outlets have been shown on the drawings for this purpose, but Contractor shall verify the exact location before roughing in conduit and installing the outlets. Outlets shall be located in such a manner that the equipment can be connected with as short a piece of conduit or cord as possible and the space around the equipment will not be obstructed.

1.10 TESTS

A. The installation shall be tested by the Contractor after all wiring is completed and connected, ready for the attachment of fixtures and equipment and again when fixtures and equipment have been connected, ready for use. The resistance between conductors and between each conductor and ground shall conform to the National Electrical Code requirements. All defective materials and workmanship disclosed as a result of these tests shall be corrected prior to acceptance. Any delay resulting from defective materials and workmanship does not relieve the Contractor of his responsibility under the contract.

B. Testing shall comply with sections 16950 and 16951.

1.11 RECORDS FOR OWNER

A. Keep a set of Drawings on the job, noting daily all changes made in these Drawings in connection with the final installation and turn over a clean, neatly marked set of sepia reproducible Drawings showing "as-installed" work to the Engineer for subsequent transmittal to the Owner. Accurately locate all underground utilities and services and systems and dimension on the "as-built" Drawings. Contractor shall maintain a set of "blue-line" prints in the Field or shall maintain a set of "blue-line" prints in the Field Office for the sole purpose of recording "installed" conditions.

B. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, prepared in a neat brochure or packet folder and turn over to the Engineer for review, and subsequent delivery to the Owner:

1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.

2. Operating and maintenance manuals prepared in accordance with the General Conditions.

3. Approved wiring diagrams and control diagrams representing "as-built" conditions.

4. Copies of approved Shop Drawings.

5. Any and all other data and/or Drawings required during construction.
6. Repair parts lists of all major items and equipment including name, address and telephone number of local supplier or agent.

7. Submit all of the above data to the Engineer for approval at such time as the Contractor asks for his last estimate.

1.12 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Prepare complete sets of operating and maintenance manuals for each item of equipment. Conform to the requirements of all contract documents. Include all certified Shop Drawings.

B. In addition to the above, provide the services of a competent technician acceptable to the Engineer to instruct a representative of the Owner in the complete and detailed operation of all equipment and systems. Provide these instructions for a period of sufficient duration to fully accomplish the desired results. Upon completion of these instructions, a letter of release will be required, acknowledged by the Owner, stating the dates of instruction and the personnel to who instructions were given. The Contractor is responsible for proper maintenance until the instructions have been given to the Owner's maintenance personnel and the letter of release acknowledged.

C. Provide additional diagrams, operating instructions, etc., as specified hereinafter in the other sections of these Specifications.

1.13 MATERIAL AND EQUIPMENT SCHEDULES

A. Refer to both Drawings and Specifications for schedules. Where reference is made to items "scheduled on Drawings", or "scheduled in Specifications", same shall include schedules contained in both the Drawings and Specifications. The Contractor's attention is directed to the various Specification Sections and Drawings for schedules.

1.14 FINAL INSPECTION

A. Personally conduct a careful inspection trip as a whole, assuring that the work on the project is ready for final acceptance, before calling upon the Engineer to make a final inspection.

B. In order not to delay final acceptance of the work, have all necessary bonds, guarantees, receipts, affidavits, etc., called for in the various articles of this Specification, prepared and signed in advance, together with a letter of transmittal, listing each paper included, and deliver the same to the Engineer at or before the time of final inspection. Check over each bond, receipt, etc., before preparing same for submission to see that the terms check with the requirements of the Specifications.

C. The final inspection will be made jointly by the Engineer and the Owner.

1.15 GUARANTEE

A. Guarantee, for a period of one year, the electrical work installed to be free from defects of workmanship and material, and furnish and pay for all labor and materials required to fulfill this guarantee. The guarantee period shall begin with the date of occupancy and use of the systems.

PART 2 PRODUCTS

2.01 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

A. Storage at Site: Do not receive material or equipment at the job site until there is suitable space provided to properly store and protect equipment from rust, drip, humidity and dust damage.Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of start-up or other overload conditions.

B. Conformance to Agency Requirements: Where materials or equipment is specified to be approved, listed or labeled by the Underwriters' Laboratories, Inc., or labeled, constructed and/or tested in accordance with the standards of NEMA and ANSI, the Contractor shall submit proof that the items furnished under this Section of the Specifications conform to such requirements. The label of the U.L., Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements.

C. Manufacturer's Nameplates: Provide each major component of equipment with the manufacturer's name, address and catalog number on a stainless steel plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

D. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the structures and to the work of all trades. Visit the premises and become thoroughly familiar with all details of the work and working conditions. Verify all dimensions in the field, and advise the Engineer of any discrepancy before performing any work. Make all adjustments to the work required in order to facilitate a coordinated installation at no additional cost to the Owner or the Engineer.

Submit additional data as requested by the Engineer on items designated in each section or as requested by the Engineer following award of contract.

2.02 IDENTIFICATION AND LABELING

A. Clearly mark all items of equipment using engraved nameplates as hereinafter specified. Use 3 ply laminated plastic nameplates, a minimum of 3/32" thick, with white letters on black background. Use Roman Gothic letters of a size that is legible and appropriate to the application (3/16" minimum). Attach nameplates with a minimum of two (2) brass or stainless steel screws. Rivets or adhesives are not acceptable.

B. Electrical equipment to be identified includes: all switchgear, distribution panels, transformers, motor control centers, panelboards, disconnect switches, starters, contactors, time switches, control panels, etc.

C. Give voltage characteristics on nameplates on distribution panels, motor control centers and panelboards.

Example: PANEL LV
120/208V, 3 PH, 4 W

Individual circuit breakers in distribution panels, individual units in motor control centers, individual disconnecting means, and individual motor starters, shall have nameplates describing the load served.

D. Provide blank nameplates mounted on each spare or bussed space in motor control centers, and on each spare or space in distribution panels.

E. Branch circuit panelboards shall have neatly typed circuit directories behind clear plastic. Identify circuits by room numbers or floor areas. Room numbers shall be those finally selected by the Owner, not necessarily those given on contract drawings. Spares and spaces shall be indicated with erasable pencil, not typed.

F. Provide identification strips for all terminal blocks, marked in compliance with the applicable Plans. Identify wiring at the terminal block to match the same.

G. All power wiring (120 VAC and above) shall be color coded per City of Austin standard color code.

H. Identify all lights, switches, pushbuttons and other devices on the control panel and all relays and other devices inside the panel with nameplates complying with this Section.

PART 3 EXECUTION

3.01 MANUFACTURER'S RECOMMENDATIONS

A. Follow the manufacturer's published directions in the delivery, storage, protection, installation, and wiring of all equipment and material. Promptly notify the Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturers' directions, and obtain the Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturers' directions or such instructions from the Engineer, he shall bear all costs arising in connection with the deficiencies.

3.02 SPACE AND EQUIPMENT ARRANGEMENT

A. The size of electrical equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers will be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space allotted. Fabrication drawings shall be prepared when required to indicate a suitable arrangement.

B. Install all equipment in a manner to permit access to all surfaces.

3.03 PROTECTION

A. At all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This includes erection of temporary shelters and supports where required to adequately protect any items stores from the weather, the ground and the surrounding work; cribbing of any items above the floor of the construction; and covering of items in the incomplete building with tarpaulins or other protective covering; installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. Take particular care not to damage other construction in performing work. Cover all finished floors, step treads and finished surfaces to prevent any damage by workmen or their tools and equipment during the construction of the building.

3.04 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

A. Wire all interconnecting wiring for the installation of power. Unless otherwise noted, provide all disconnect switches as required for proper operation, as indicated on the drawings, and required by applicable code.

B. Provide complete wiring diagrams indicating power wiring and interlock wiring. Submit diagrams to the Engineer for review within fifteen (15) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control drawings, not a series of manufacturer's individual diagrams.

C. Note that the electrical design and drawings are based on the equipment scheduled and indicated on the drawings, and should any mechanical equipment requiring changes to the electrical design be furnished, the required electrical changes shall be made at no cost to the Owner, Architect or Engineer.

3.05 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc., resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.

B. Methods of Cutting: Make openings cut through concrete and masonry with masonry saws and/or core drills and at such locations acceptable to the Engineer. Do not use impact-type equipment except where specifically acceptable to the Engineer. Core drill openings in precast concrete slabs exact size.

Restore all openings to "as new" condition under the appropriate Specification Section for the materials involved, and match remaining surrounding materials and/or finishes.

C. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Provide adequate supports during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Engineer.

D. Plaster: All mechanical work in areas containing plaster shall be complete prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.

E. Special Note: Do not undertake any cutting, coring or excavating which will weaken the structure.

3.06 COOPERATION AND CLEANUP

A. Cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, properly store all tools, equipment and materials and clean all debris from the job. Upon the completion of the job, immediately remove all tools, equipment, andy surplus materials and all debris caused by the work.

3.07 CLEANING AND PAINTING

A. Paint all equipment, conduit, etc., furnished and installed in exposed areas. Comply with Specification on painting.

B. Equipment is to be delivered to the job with suitable factory protective finish and painted, after installation, a color hereinafter specified.

C. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible during the painting operation.

D. Electrical switchgear, disconnect switches, panelboards, contactors, etc., with suitable factory applied finished shall not be repainted. Where factory applied finishes are damaged in transit, storage or installation, or before final acceptance, they shall be restored to factory-fresh condition by competent refinishers using a spray process and factory-furnished paint to match.

3.08 OBSTRUCTIONS

A. The Drawings indicate certain information pertaining to surface and sub-surface obstructions which have been taken from Owner's drawings. This information is not guaranteed, however, as to accuracy of location of complete information.

B. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies and other interested parties that all available information has been provided, and verify locations given.

C. Should obstruction be encountered whether shown or not, alter routing of new work, re-route existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown on the Drawings.

D. Where obstructions encountered are beyond the scope of work shown or specified in this project, refer the matter to the Owner's representative, and a cost differential proposal will be agreed upon before the added work is undertaken.

SECTION 9.2: INCOMING LINE PROTECTION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work performed under this Section consists of providing all labor, material, tools, equipment and related items required to furnish, install and place into operation incoming line protection

.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Submittals

B. Section 16010 - Electrical General Provisions

C. Section 16450 - Grounding

D. Section 16165 - Cabinets and Enclosures

1.03 REFERENCE STANDARDS

A. NEC

B. OSHA

C. ANSI

D. IEEE

E. NEMA

F. UL

1.04 ACCEPTABLE MANUFACTURERS

A. Surge Protector

1. MCG Electronics.

2. Innovative Technologies.

3. Engineer Approved Equal

1.05 SUBMITTALS

A. Each submittal shall be in accordance with the requirements of Section 01300.

B. Each submittal shall include but is not limited to the following:

1. Manufacturer's name and model number.

2. Catalog cut sheet applicable to the specific unit proposed.

3. Specifications applicable to the specific unit proposed.

C. Submit O & M Manuals in accordance with Section 01300. Include certified shop drawings.

PART 2 PRODUCTS

2.01 SURGE PROTECTION

A. Surge protection shall be installed on the incoming line to provide protection against lightning strikes and switching surges that could otherwise damage electrical and electronic equipment.

B. Surge protection shall be MCG Electronics Co. Model 120 LS, or approved equal, having the following features:

1. Fast clamp response of less than five seconds.

2. Fused protection elements within the protection module to provide backup protection of the module.

3. Protection modules that can be removed and replaced when damaged.

4. LED that will indicate when the module needs replacement.

5. LED's both internally and front panel mounted for diagnostics.

6. Remote alarm capabilities.

C. Furnish surge protection with low impedance lead cable, MCG Electronics Micro Z, or approved equal.

2.02 ENCLOSURE

A. Furnish surge protection in a NEMA 4X SS enclosure with fused disconnect switch or circuit breaker.

PART 3 EXECUTION

3.01 DELIVERY AND STORAGE

A. Delivery. Prepare equipment for shipment to job site.

B. Storage and Handling at Job Site. The CONTRACTOR shall store and handle all equipment at the job site, while such materials are awaiting installation, in conformation with the following:

C. Store equipment in an area protected from weather, moisture or possible damage.

D. Do not store materials directly on the ground.

E. Handle items to prevent damage to interior or exterior surfaces.

3.02 INSTALLATION

A. Install and test equipment in accordance with manufacturer's recommendations.

B. Keep leads to a minimum. Do not exceed 24”.

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SECTION 9.1: CONDUIT SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work performed under this Section consists of providing all labor, material, tools, equipment and related items required to furnish, and install all of the following conduit systems:

1. Heavy wall galvanized steel conduit
2. Rigid aluminum conduit.
3. Nonmetallic rigid polyvinyl chloride (PVC)
4. Flexible conduit
5. PVC-coated heavy wall rigid steel conduit

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: Section 01300

B. Electrical General Information: Section 16010

C. Wire and Cable: Section 16120

D. Boxes and Fittings: Section 16130

E. Grounding: Section 16450

1.03 REFERENCE STANDARDS

A. ANSI/ANSI C80.1 - Specification for Zinc-Coated Rigid Steel Conduit.

B. ANSI/ANSI C80.3 - Specification for Zinc-Coated Electrical Metallic Tubing.

C. ANSI/ANSI C80.4 - Specification for Fittings for Rigid Metal Conduit and Electrical Metallic Tubing.

D. ANSI/UL 1 - Safety Standard for Flexible Metal Conduit.

E. ANSI/UL 5 - Safety Standard for Surface Metal Raceways and Fittings.

F. ANSI/UL 651 - Safety Standard for Rigid Nonmetallic Conduit.

G. ANSI/UL 797 - Electrical Metallic Tubing.

H. ANSI/UL 870 - Safety Standard for Wireways, Auxiliary Gutters and Associated Fittings.

I. UL 360 - Liquid-tight Flexible Steel Conduit.

J. UL 467 - Electrical Grounding and Bonding Equipment.

K. UL 1242 - Intermediate Metal Conduit.

L. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80) and Fittings.

M. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

N. UL 6 - Rigid Metal Electrical Conduit.

O. National Electrical Code as adopted by the authority having jurisdiction.

P. FS WW-C-566 - Specification for Flexible Metal Conduit.

Q. FS W-C-582 - Conduit, Raceway, Metal and Fitting; Surface.

R. FS WWC-581 - Rigid Metallic Conduit

1.04 ACCEPTABLE MANUFACTURERS

A. Allied Tube and Conduit

B. Triangle

C. Wheatland

D. ENGINEER Approved Equal

1.05 SUBMITTALS

A. The submittal shall comply with the requirements of Section 01300.

B. The submittal shall include the following:

1. Conduit manufacturer's name as used on this project.
2. Conduit type and technical specifications.
3. Couplings and fittings.
4. Complete technical description of conduit coatings where applicable.

PART 2 PRODUCTS

2.01 HEAVY WALL GALVANIZED STEEL CONDUIT

A. Heavy wall galvanized steel conduit shall be hot dipped galvanized steel. All couplings and fittings will conform to this requirement.

2.02 POLYVINYL CHLORIDE (PVC) CONDUIT

A. Nonmetallic rigid polyvinyl chloride shall be type EPC-40-PVC where installed underground.

2.03 PVC COATED CONDUIT

A. Heavy wall galvanized steel conduit per 2.01 A with factory applied 40 mil thick coat of PVC. With PVC coated couplings.

2.04 FLEXIBLE CONDUIT

A. Flexible conduit shall be flexible steel with liquid tight jacket. Appleton Type ST, or equal.

2.05 RIGID ALUMINUM CONDUIT

A. Rigid aluminum conduit shall be copper free aluminum, standard weight with fittings and couplings of the same material.

PART 3 EXECUTION

3.01 DELIVERY AND STORAGE

A. Storage and Handling at Job Site. The CONTRACTOR shall store and handle all conduit at the job site, while such materials are awaiting installation, in conformance with the following:

1. Store conduit and accessories in an area protected from weather, moisture or possible damage.

2. Do not store materials directly on the ground.

3.02 HEAVY WALL RIGID GALVANIZED STEEL CONDUIT

A. Heavy wall rigid galvanized steel conduit shall be used for all conduits installed above ground unless otherwise noted**.** In the alternative, conduit and fittings may be copper free aluminum where installed above ground. Note that rigid aluminum conduit and fittings may be used for aboveground work in lieu of galvanized steel conduit.

B. No trade size shall be smaller than 3/4-inch.

C. A conduit's ends shall be cut square with a saw and reamed. Threads shall be cut to effect full thread joint engagement. No running threads are permitted.

D. Pull boxes shall be installed in appropriate intervals for long conduit runs.

E. Exposed rigid conduit shall be installed parallel to structural members and surfaces and multiple runs in the same direction shall be parallel with symmetrical bends.

F. All conduits shall be installed clear of structural openings.

H. Every necessary measure shall be taken to prevent the entry of dirt, stones, trash or water in the conduit system.

I. Future conduits shall be capped with threaded cap if exposed, or terminated in equipment or by galvanized couplings plugged flush with the structural surfaces if concealed. Provide all future conduits with a 0.125 inch nylon fish cord pull string.

J. Where drawings indicate future equipment, the concealed portions of conduits shall be provided unless shown otherwise on the drawings.

K. Minimum separation of twelve inches shall be maintained between hot pipes and electrical conduits.

M. Where conduits penetrate lift station wetwell, seal the open space between the conduit and wall with an approved waterproofing sealant.

N. Conduits 1-inch or less may be installed between reinforcing steel in concrete walls and slabs and if there is only 1 layer of reinforcing steel in slabs, the conduits shall be placed under the reinforcement, unless otherwise directed by the structural Engineer.

O. Structural members and reinforcing steel shall not be cut, burned or damaged in any way. Holes cut through existing floors and walls shall be neatly repaired with zinc-coated pipe rings placed on conduits at entry points.

P. For above ground runs of conduits space supports not more than 5 feet apart and install with the runs parallel or perpendicular to walls and structural members. Use right angle turns and symmetrical bends. Do not use diagonal runs except to avoid two 90 degree bends. Do not locate conduit so as to reduce the strength of structural members. Install supports within 24” of each fitting, bend or outlet box.

R. Support and secure groups of conduits on wall hangers using toggle bolts in hollow masonry, expansion bolts in concrete or solid masonry, machine screws on metal surfaces and wood screws on wood construction. Space conduits from mounting surfaces using conduit clampbacks. Provide plastic sleeves for conduits passing through masonry or concrete. Single conduits shall be supported by one-hole malleable clamps.

S. Where rigid conduits enter sheet metal boxes, secure with lock nuts and bushings.

T. Enter outside electrical enclosures from the bottom, unless shown otherwise on the Plans. Terminate conduit connections to exterior sheet metal cabinets and enclosures with Myers Scru-Tite, or equal, hubs.

3.03 POLYVINYL CHLORIDE (PVC) CONDUIT

A. Schedule 40 PVC conduits shall be installed underground. All penetrations out of ground shall be made with PVC coated galvanized steel elbows.

B. No PVC conduit shall be used in any location where it is exposed to direct sunlight, extreme heat, or within the building.

3.04 FLEXIBLE CONDUIT

A. Use flexible conduit to connect to motors, solenoid valves, transformers and any other equipment subject to vibration.

B. Maximum length not to exceed 18 inches.

3.05 PVC-COATED CONDUIT

A. Follow applicable specifications for above ground and underground rigid conduits.

B. Install with any special tools recommended by the manufacturer in the manner recommended. Do not use tools which will mar the PVC coating.

C. Patch any small nicks or abrasions in the PVC coating immediately upon discovery of the same. Replace any sections which, in the opinion of the Engineer, are badly damaged. Use touch up compound recommended by the conduit manufacturer.

D. Use only PVC-coated fittings and supports.

3.06 UNDERGROUND INSTALLATION

A. Bury underground conduit a minimum of 24 inches below grade, unless indicated otherwise.

B. Provide a minimum of 3" of separation between conduits or 7-1/2" on center, whichever is greater.

C. CONTRACTOR shall be responsible for excavating, draining, trenching, backfilling and removing excess earth in connection with installation of underground conduit.

D. Waterproof all underground conduit joints in accordance with the manufacturer's recommendation.

E. Provide sand bedding under the conduit and a sand cover over the top of the conduits. Place compacted backfill over the sand layer. The backfill shall be free of any rocks and debris larger than 1/2" measured in any direction.

F. Backfilling shall be done in such a manner that voids will be minimized. Excess soil shall be piled on top and shall be well tamped. All rock and debris shall be removed from the site.

G. Install a warning tape the entire length of each conduit run. Locate tape 12 inches above the conduits. Tape is to be 4 mil polyethylene, 6 inches wide, with metallic lining and clear polyethylene backing, with the legend "CAUTION ELECTRIC LINE BURIED BELOW." Seton Style No. 6ELE, or approved equal.

H. Provide a red colored concrete encasement where indicated or otherwise required. Concrete to be 3000 psi/28 day strength per ASTM 039-44. Add a red admixture "Sonabrite Red" by L. Sonneborn Sons, Inc., or equal, to the concrete at a rate of 5 pounds per 94 pound sack of cement or 16 pounds per cubic yard of concrete. Coloring shall be added while the concrete is still on the truck.

I. Stagger joints in concrete encasement a minimum of 6 inches vertically.

J. Use approved separators and chairs installed a maximum of 4 feet on centers. Securely anchor conduit to prevent movement during concrete placement.

K. Make transition from PVC to rigid galvanized steel conduit where conduit leaves the ground. Transitions shall consist of a PVC-to-rigid galvanized steel adapter and a 90 degree PVC-coated rigid galvanized steel bend. Continue coating for a minimum 6 inches above grade unless otherwise specified.

SECTION 9.4: WIRE AND CABLE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work performed under this Section consists of providing labor, material, tools, equipment and related items required to furnish, install and place into operation all wire and cable systems.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: Section 01300

B. Electrical General Provisions: Section 16010

C. Conduits: Section 16110

D. Grounding: Section 16450

E. Mechanical: Division 15

1.03 REFERENCE STANDARDS

A. ANSI/UL 83 - Thermoplastic-insulated Wires

B. ICEA S-61-402 (NEMA WC5) - Thermoplastic Wire and Cable for the Transmission and Distribution of Electrical Energy.

C. National Electrical Code

1.04 ACCEPTABLE MANUFACTURERS

A. Building Wire - Okonite, Cablec, Rome, Essex or Engineer Approved Equal

B. Instrument Wire - Alpha, Belden, Dekoron or Engineer Approved Equal.

1.05 SUBMITTALS

A. The submittals shall be made in complete conformance with Section 01300, and the following:

1. Furnish technical specifications and factory and field test reports.

1.06 DELIVERY

A. Deliver wire and cable in unbroken packages bearing UL and manufacturers' labels and showing date of manufacture and maximum allowable voltage.

PART 2 PRODUCTS

2.01 600 VOLT INSULATION

A. Unless otherwise noted, power and/or control cable shall be single conductor, soft drawn, annealed copper, with type THWN/THHN or XHHW-2 insulation, 90°C in dry locations and wet locations. Note however that the ampacity for 75°C wire as tabulated in the National Electrical Code shall be used throughout in determining proper wire size.

2.02 INSTRUMENT WIRE

A. Twisted pair 18 AWG copper conductors (7 strand, Class B); 15 mil 105 deg. C PVC primary insulation rated not less than 300 volts; color coded; 1.25 mil aluminum Mylar tape shield; 18 gauge, 7 strand tinned copper drain wire; 35 mil FR PVC jacket.

PART 3 EXECUTION

3.01 WIRE AND CABLE RATED 600 VOLTS AND BELOW

A. Color coded wire shall be used on 600 volts and below.

B. An equipment grounding wire run in conduit shall have an identifying green covering. Ground conductor shall be sized per NEC 250-94 and 250-95. Minimum service ground shall be #6 AWG.

C. A green 600 volt conductor used for grounding purposes with single conductor cables of higher voltage requirements will be permitted.

D. Conductor terminations, No. 8 AWG and smaller, shall be made with pressure connected lugs, Buchanan "Termend" or equal. Conductor terminations, larger than No. 8 AWG, shall be made with solderless, compression type copper terminals equivalent to Burndy type YA-L. Compression shall be made with a die set that will make a circumferential crimp. Wire strands shall be thoroughly cleaned before lug is applied.

E. Bolted connections for electrical conductors, without noncorrosive surfaces, shall be thoroughly cleaned and tinned or covered with a light film of commercial paste to prevent oxidation.

F. Where mechanical assistance is used for pulling conductors, a wire pulling compound, Polywater J, or equal, having inert qualities that do not harm the wire insulation or covering

shall be applied to the conductors before they are pulled into raceways. Interior of all raceways shall be free from grease, filings or foreign matter before conductors are pulled.

G. No wire smaller than No. 12 shall be installed, except as furnished with standard packaged equipment, or specified herein, for low voltage control systems, or fixture wiring. No. 14 may be used for control wiring where adequately protected by properly sized fuses.

H. All wiring, except in special cases, shall be run in conduits or raceways. No wire shall be installed until the conduit system is completed and the construction work has progressed beyond the stage where the wire may be damaged.

I. Where the capacity of a single feeder is so great as to require parallel conductors in more than 1 conduit, each conduit must contain the same number and length of conductors in all phases (legs) of the feeder, including any neutral conductors.

J. In circuits of 600 volts and below, control wiring may be pulled in the same conduit with the power wiring if the control wiring is rated for the same voltage as the power wiring and if the conduit size is adequate. Generally, motors 30 HP and larger shall have separate conduit systems for the motor leads and control wiring. Under no circumstance shall circuits above 600 volts and those below 600 volts be pulled in the same conduit, or the same cable tray without a metal barrier between.

K. Wiring shall be continuous between outlets. Keep splices to a minimum. Splice only in accessible junction boxes. Make splices to carry full capacity of conductors without perceptible temperature rise. Do not pull splices into conduit.

L. Wiring shall be tagged with Brady Wire Markers, or equal, at panel- boards, with suitable numbers for use in identification. All control wiring shall be tagged likewise.

M. One conductor of each lighting circuit shall be identified, and the identified conductor shall be connected to the screw shell of the lamp socket.

N. No more than three (3) lighting circuits shall be installed in any conduit for 4 wire, 3 phase systems, or two (2) circuits for 3 wire single phase systems. Each of the circuits shall be of a different phase.

O. Identify all wires in accordance with Section 16010.

P. Perform continuity tests on all power and control circuit conductors using an ohmmeter and megohmeter. Verify proper phasing connections.

Q. Do not exceed the manufacturers recommended pulling tension when installing wiring.

3.02 INSTRUMENTATION WIRING

A. Physically separate analog signals from control and power wiring. Use separate conduit for each.

B. Run 24 and 48 Vdc in separate conduits from 115 VAC wiring.

C. Neatly arrange wiring with terminations located directly opposite the terminals. Leave wire loops not less than 6 inches long in each outlet box. Tape frayed terminals and exposed wire.

D. Ground shields at only one end of each cable run. Shields shall be continuous throughout the run. Provide jumpers at terminals blocks to ensure continuity.

E. Provide Brady, or equal, wire markers to identify each wire at both the terminal block and the device, i.e., at both ends.

F. Color code as follows:

Line and load circuits AC or DC power - Black
AC control circuits - Red
DC control circuits - Blue
Interlock control circuits on the panel energized from an external source - Yellow
Equipment grounding conductors - Green
Neutral conductor - White

SECTION 9.5: BOXES AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work performed under this Section consists of providing all labor, material, tools, equipment and related items required to furnish, and install all junction boxes, pull boxes, outlet boxes and ceiling boxes.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: Section 01300

B. Electrical General Provisions: Section 16010

C. Conduits: Section 16110

D. Grounding: Section 16450

1.03 REFERENCE STANDARDS

A. ANSI/NEMA OS1 - Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports.

B. ANSI/NEMA OS2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. ANSI/UL 514 - Electrical Outlet Boxes and Fittings.

E. ANSI/NEMA FB-1 - Fittings and Supports for Conduit and Cable Assemblies.

F. FS W-C-582 - Conduit, Raceway, Metal and Fitting, Surface.

G. NEMA TC3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

H. ANSI/UL5 - Safety Standards for Surface Metal Raceways and Fittings.

I. National Electrical Code.

1.04 ACCEPTABLE MANUFACTURERS

A. Galvanized Boxes and Gutters

1. Circle AW

2. Universal

3. AMF

4. Hoffman

5. Engineer Approved Equal

B. Cast Iron Boxes and Fittings

1. O-Z/Gedney Company

2. Appleton Electric

3. Crouse-Hinds

4. Engineer Approved Equal

C. PVC Boxes and Fittings

1. Carlon

2. Engineer Approved Equal

PART 2 PRODUCTS

2.01 MATERIALS

A. Pull and junction boxes for shall be Nema 4X, 316 SS sized according to the requirements of the National Electrical Code. The junction box installed in the wetwell shall be Type 316 Stainless Steel with corrosion resistant terminal blocks.

B. The Contractor shall size all pull and junction boxes in accordance with the requirements of the National Electrical Code.

C. Use standard threaded type couplings and connectors, galvanized outside and inside by hot dipping. Do not use setscrew type connectors.

D. For rigid bushings 1.25 inch and larger, use the insulating type. Use double locknuts and bushings on smaller conduits. Use O.Z. Type BLG grounding bushings at panel boards, motor control centers and control panel entries for conduits 1.25 inch and larger.

E. Use galvanized malleable iron conduit clamps and supports appropriately sized for each application. Use conduit clampbacks to provide air space between the conduit and the surface to which it is mounted.

F. Use threaded malleable iron conduit fittings with gasketed cover for rigid steel. Crouse Hinds Obround Series, or equal.

G. Device or utility boxes shall be of unit construction of a size required for the number of switches or outlets required. No sectional device boxes will be permitted.

H. All boxes in exposed conduit runs shall be Crouse Hinds Type FS or FD, as applicable, or approved equal, with threaded conduit entries.

I. Do not use switch boxes as junction boxes.

J. Coordinate final location of boxes with other trades to avoid any conflicts.

K. Support boxes independently of conduit.

L. Coordinate location of boxes to avoid conflicts with architectural and mechanical construction.

M. Align wall-mounted outlet boxes for switches, thermostats and similar devices.

N. Provide cast outlet boxes in exterior locations and wet locations.

O. Outlet boxes for switches shall be mounted at a height of 4'-0" from the floor except as otherwise noted.

P. Outlet boxes for receptacles shall be located 1'- 3" from the floor unless otherwise noted.

Q. Mounting height shall be as measured from finished floor to centerline of coverplate.

PART 3 EXECUTION

3.01 DELIVERY AND STORAGE

A. Delivery. Prepare boxes, fittings, and accessories for shipment.

B. Storage and Handling at Job Site. The Contractor shall store and handle all boxes and fittings at the job site, while such materials are awaiting installation, in conformance with the following:

1. Store boxes, fittings, and accessories in an area protected from weather, moisture or possible damage.

2. Do not store material directly on the ground.

3.02 INSTALLATION

A. All outlet boxes shall be mounted with suitable fasteners and they shall contain the proper knockouts. On sheet metal boxes, all unused knockouts shall remain closed. Outlet or utility boxes concealed in construction shall be firmly secured in place, set true, square and flush with the finished surface for the correct application of cover plates or other devices.

SECTION 9.6: PANELBOARDS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work performed under this Section consists of providing all labor, material, tools, equipment and related items required to furnish, install, and place into operation all lighting and power distribution panelboards either in their own enclosures or installed in other equipment such as motor control centers.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: Section 16010.

B. Electrical General Information: 16010.

C. Grounding: 16450.

D. Low Voltage Motor Control Center: 16921.

1.03 REFERENCE STANDARDS

A. NEMA PB-1

B. ANSI

C. NEC

D. OSHA

E. Federal Spec W-P-115A, Type 1, Class 1

F. Federal Spec W-C-375A, WS 865 (Breakers & Switches)

G. Underwriters UL67, UL50

1.04 ACCEPTABLE MANUFACTURERS

A. Cutler Hammer Corporation.

B. General Electric Company

C. Square D Company

D. Engineer Approved Equal

1.05 SUBMITTALS

A. Make submittals in accordance with Section 16010.

B. Include the following:

1. Manufacturers' catalog number.
2. Size of main lugs, main circuit breaker and main bus.
3. Size, type and quantity of circuit breakers. Include panel schedule for each panel.
4. Type of bus material.
5. Voltage rating, e.g. 120/208 VAC, 3 phase, 4 wire.
6. Characteristic trip curve of largest circuit breaker plotted on 5 cycle log-log paper.
7. Other data sufficient to substantiate that the materials conform to the requirements of this section.

C. Submit O&M Manuals in accordance with Section 16010.

PART 2 PRODUCTS

2.01 GENERAL

A. The equipment included in this Section consists of several panel types designated as lighting and power panelboards for use in applications up to 600 volts with interrupting ratings of 10,000 through 100,000 amps. Cabinets are galvanized code gauge steel and trims shall be door-in-door with one door over the interior and an additional door over the wiring gutters. Fast mounting type with release mechanisms mounted behind locked door which are keyed alike. The finished product shall bear an Underwriters Laboratory label and any panel, whether service entrance or not, shall bear a "Suitable for Service Entrance" label if it has the minimum number of disconnects to so classify it.

2.02 BREAKERS

A. Ratings shall be as shown on the drawings. Interrupting rating shall be as indicated on the drawings or as required to withstand the available fault current, whichever is greater.

B. Unless otherwise noted on the drawings, all breakers shall have the following minimum ratings according to Federal Spec WP375A or better:

Breaker Type	WP 375	Trip Range	Poles	Interrupting Capacity
Bolted	2a	0-100	1	10,000 @ 277V
Bolted	2d	0-100	2&3	14,000 @ 480V
Bolted	3B	101-225	2&3	STD
Bolted	4B	226-400	2&3	STD
Bolted	5A	401-800	2&3	STD

C. Breakers shall be bolt-on quick-make, quick-break type having thermal and magnetic elements. Two and three pole circuit breakers shall be common-trip type with one handle. Handle ties are not acceptable.

D. Breakers shall be fully rated for operation at 40 C with no derating necessary.

E. Lugs: Approved for 75° C copper rated conductors.

F. Provide any test kits necessary to calibrate and test the circuit breakers.

2.03 PANELBOARDS

A. 120/240 V panelboard shall be Cutler Hammer Type PRL1a, or approved equal.

B. 277/480 V panelboard shall be Cutler Hammer Type PRL 4, or approved equal.

2.04 GROUND BUSSES

A. Each panel shall have a separate copper ground bus.

2.05 MAIN BUSSES AND NEUTRAL

A. All busses shall be tin plated copper with full capacity neutral where required of a type and size as shown on the drawings. Minimum bus ampacity shall be 100 Amps unless otherwise noted.

B. Bussing shall be full size distributed phase sequence type extending the full length of the panel.

2.06 SEQUENCING

A. All breakers shall be installed in panels in the same sequences shown in the schedules.

2.07 BOX SIZE

A. Minimum box width is 20-inches.

B. Box length shall be sufficient for 42 circuits unless otherwise noted on the Plans.

2.08 CABINET

A. Code gauge steel per NEMA PB1-1977 and UL 67.

B. Nema 12 enclosure for indoor locations.

C. NEMA 4X SS for outdoor locations.

2.09 IDENTIFICATION

A. Identify all circuit breakers with a circuit number corresponding to those shown on the panel schedules.

B. Provide a typewritten directory. Pencil in spares. Install directory in a permanent clear plastic holder securely attached to the panel door.

C. Provide a nameplate per 16010.

PART 3 EXECUTION

3.01 DELIVERY AND STORAGE

A. Delivery. Prepare panelboards, circuit breakers and accessories for shipment to job site.

B. Storage and Handling at Job Site. The CONTRACTOR shall store and handle all panelboards at the job site, while such materials are awaiting installation, in conformance with the following:

1. Store panelboards, circuit breakers and accessories in an area protected from weather, moisture or possible damage.
2. Do not store materials directly on the ground.
3. Handle items to prevent damage to interior or exterior surfaces.
4. If items are stored inside the proposed building, consideration shall be given to weight of the items and the effect of concentrated loads on the building slabs, foundation, and other structural members. CONTRACTOR shall contact ENGINEER or OWNER for permission to store materials with a load exceeding 200 pounds per square foot.

3.02 INSTALLATION

A. The CONTRACTOR shall receive, set in place, wire and provide all labor incident to demonstration that the panels form an integral system prior to final acceptance.

B. Mount panel so that bottom is 3'- 0" from floor level. Mount lower only where necessary to have top breaker no more than 6'- 6" above floor level.

C. Provide wire tags on each wire as it leaves the panel and again at each termination.

D. Provide a neatly type written directory identifying each circuit as to the load it serves. Label spares in pencil. Indicate panelboard source of power.

E. Take and record load on each lighting circuit; identify the number of convenience outlets on each circuit and record the same. Identify the loads on all other circuits and record the VA of each.

SECTION 9.7: CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work performed under this Section consists of providing all labor, material, tools, equipment and related items required to furnish, install, and place into operation all circuit breakers in their own enclosures.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Electrical General Information: Section 16010

1.03 REFERENCE STANDARDS

A. NEMA AB1

B. ANSI

C. NEC

D. OSHA

E. UL 489

1.04 ACCEPTABLE MANUFACTURERS

A. Square D Company

B. General Electric Company

C. Cutler Hammer Corporation

D. Engineer Approved Equal

1.05 SUBMITTALS

A. Make submittals in conformance with Section 16010.

B. Include the following as a minimum:

1. Manufacturer's name and model number.

2. Voltage and current rating and symmetrical interrupting current, SIC rating.

3. Enclosure type.

4. Nameplate designations.

5. Circuit breaker technical data including characteristic trip curve on 5 cycle log-log paper.

6. Additional data as necessary to substantiate that the materials conform to the requirements of this section.

C. Submit O&M Manuals in accordance with Section 16010

PART 2 PRODUCTS

2.01 MATERIALS

A. Type: Quick-make, quick-break molded case, thermal magnetic type.

B. Common trip: Two and three pole breakers to be common trip with no tie handles.

C. Rating: Calibrated at 40 degrees C. to carry the current shown continuously with no need for derating. A.I.C. interrupting rating as indicated on the one line diagram.

D. Lugs fully rated for use at 75 Deg. C copper rated cable without derating current carrying capacity of the wire.

E. Enclosure NEMA 12 indoors. NEMA 4X, SS, outdoors.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install at the locations shown on the Plans.

B. Mounting height to be 4'- 6" above finished floor unless otherwise noted. Maximum height of operating handle shall not exceed 5'- 6".

C. Support on channel iron, Unistrut, or equivalent supports per Section 16010.

3.02 TESTING

A. Test for proper operation. See Section 16950.

SECTION 9.8: SAFETY SWITCHES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work performed under this Section consists of providing all labor, material, tools, equipment and related items required to furnish and install safety switches.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: Section 16010.

B. Electrical General Information: Section 16010

1.03 REFERENCE STANDARDS

A. NEMA KSI-1991

B. ANSI

C. NEC

D. OSHA

E. UL

F. FED. SPEC. WS-865c

1.04 ACCEPTABLE MANUFACTURERS

A. Square D Company

B. General Electric Company

C. Cutler Hammer Corporation

D. Engineer Approved Equal

1.05 SUBMITTALS

A. Make submittals in conformance Section 16010.

B. Include the following:

1. Manufacturer's catalog number.

2. Voltage and current rating.

3. Enclosure type.

4. Nameplate designation.

5. Technical data including fuse curve plotted on 5 cycle log-log paper.

6. Additional data as necessary to substantiate that the materials conform to the requirements of this section.

PART 2 PRODUCTS

2.01 STANDARD DISCONNECT SWITCH

A. Type: Heavy duty Type HD fused or non-fused as shown on the Plans. U.L. labeled.

B. Construction: Quick-make, quick-break operating handles with provisions for padlocking in the "off" position. Handle interlocked with door to prevent unauthorized opening with the switch in the "on" position. Provide with equipment ground lug.

C. Enclosure: NEMA 12 indoors. NEMA 4X SS surface mounted outdoors.

D. Ratings: Horsepower rated for 250 volts A.C. or 600 volts A.C. as required for their service.

E. Fuses: Dual element type sized per N.E.C. Bussman, Chase Shawmut, or equal.

2.02 MANUAL TRANSFER SWITCH

A. Type: Double pole, double throw. With solid neutral assembly. Load make and load break. U.L. Listed.

B. Construction: Quick-make, quick-break operating handles with provisions for padlocking in the "off" position and in the “on” positions. Handle interlocked with door to prevent unauthorized opening with the switch in the "on" position. Provide with equipment ground lug.

C. Enclosure: NEMA 12 indoor. NEMA 4X SS surface mounted outdoors.

D. Ratings: Horsepower rated for 250 volts A.C. or 600 volts A.C. as required for their service.

E. Lugs: Fully rated for continuous operation at 75 deg. C.

F. Fuses: Non-fused.

2.03 NAMEPLATES

A. Install a nameplate on the switch identifying the Normal and Emergency as wall as the Off positions. Comply with Section 16010.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install at locations shown on the Plans.

B. Mounting height to be 3'- 0" above finished floor to bottom of switch unless otherwise noted. Maximum height of operating handle shall not exceed 6'-6".

C. Provide channel iron or Unistrut supports for mounting. Per Section 16010.

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SECTION 9.9: GROUNDING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work performed under this Section consists of providing all labor, material, tools, equipment and related items required to furnish and install an electrical grounding system in conduits.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: Section 01300

B. Electrical General Provisions: Section 16010

C. Calibration and Testing: Section 16950.

1.03 REFERENCE STANDARDS

A. NEC

B. IEEE Standard 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

C. ANSI/UL 467 - Safety Standard for Grounding and Bonding Equipment.

PART 2 PRODUCTS

2.01 MATERIAL

A. All wire and fittings shall be 98 percent conductivity copper.

B. Ground Rods shall be Copperweld, or equal, copperclad steel rods, 3/4" X 10'-0" unless otherwise noted.

C. Above ground connections shall be made with ground lugs, terminals, posts, etc., Burndy, Thomas & Betts, or equal.

D. Connections below grade shall be made with Cadweld process, or equal, connections.

PART 3 EXECUTION

3.01 SYSTEM GROUNDING

A. The secondary of all alternating current distribution systems which are to be grounded shall have the common conductor connected directly to the grounding conductor at the point of supply, i.e., on the line side of the main disconnect switch.

B. All grounding shall be tested in accordance with Section 16950.

3.02 SAFETY GROUNDING OF EQUIPMENT

A. Safety grounding of equipment will be accomplished by providing an equipment ground wire, as shown on the drawings which will be no less than the size recommended in Article 250 of the National Electric Code. This ground will extend throughout the system by means of insulated green ground wires connected to ground buses in each switchgear, motor control center, panelboard and terminal on each outlet box, light fixture housing or grounding terminal of the motor. Install bonding jumpers from ground lugs on conduit grounding bushings to ground buses.

B. Each ground bus in addition to connecting to its feeder ground will be grounded to the building ground rods where applicable.

C. Connect ground wires entering outlet boxes in a manner which will allow removal of the receptacle without interrupting the continuity of the grounding circuit. A grounding screw attached to the box, and used for no other purpose, will accomplish this.

D. Where the equipment has no facility to attach an equipment ground wire, use a Burndy Quicklug or equal. Clean the metal surface under the lug to bright metal so that good contact can be made.

E. Connect equipment grounds to motors using a grounding stud threaded into the stationary frame of the motor and not the end bell.

F. Make ground connections to equipment by using ground lugs; or, ground bars where they are provided. Do not make connections to equipment anchor bolts.

G. Connect equipment ground wires to grounding lugs in the lighting panel. DO NOT CONNECT EQUIPMENT GROUNDS AND NEUTRALS AT THE PANELBOARD.

H. All underground cable connections and taps shall be made by a thermoweld process similar or equal to the Cadweld process. Coat connections with Koppers Bitumastic No. 505, or equal.

I. Grounding rods shall be used for grounding electrodes. They shall be placed at convenient locations as shown on the drawings. Ground rods shall be Copperweld with machined drive points and chamfered drive ends. The top of the rods shall be driven at least 18-inches below finished grade. Rods shall be a minimum of 3/4-inch in diameter and not less than 10-feet in length.

J. Furnish a separate dedicated insulated ground conductor and ground rod for the instrumentation and telemetry system. Connect ground wire to a dedicated insulated ground bus in the Pump Control Panel.

K. General items to be grounded shall consist of enclosures and/or frames for motor starters, circuit breakers, transformers, safety switches, switchgear, panelboards, motors, capacitors and exposed metal parts of similar equipment. These items shall have solidly grounded cable connections to the grounding system.

L. Connect the X_o terminal of the lighting transformer to building steel or underground metallic water piping where available. Otherwise connect to ground loop.

M. Ground cable termination to enclosure and frames shall be similar to Thomas and Betts 71000 Series.

N. Ground wires installed above grade to be insulated and in conduit for protection. Bare ground wires shall be installed in Schedule 40 PVC conduit.

O. In general, resistance to ground shall not exceed 10 Ohms; however, resistance to ground of the instrument ground shall not exceed 1 Ohm.

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SECTION 9.10: EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work performed under this Section consists of providing all labor, material, tools, equipment and related items required to furnish, install and place into operation exterior lighting fixtures, supports and accessories.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: 01300.

B. Concrete: 03002.

C. Electrical General Requirements: 16010.

D. Conduit Systems: 16110.

E. Wire and Cable: 16120.

1.03 REFERENCE STANDARDS

A. NEC

B. OSHA

C. ANSI

D. IEEE

E. NEMA

F. UL

1.04 SUBMITTALS

A. The submittal shall be in accordance with the requirements of 01300. Include sufficient data to substantiate that the materials conform to the requirements of this section.

B. Furnish submittal for luminaires indicating physical characteristics, finish, pole, base, mounting, hardware including diagram of mounting and photometric data.

C. The ballast and lamp shall be included with the fixture submittal where applicable.

. Submit all lighting fixtures in one brochure with sections labeled for each fixture according to the letter designation shown on the Lighting Fixture Schedule and include all pertinent information with the fixture.

1.05 COORDINATION

A. Locations of lighting fixtures shown on the drawings are approximate only. the final location shall be dependent on physical conditions encountered during construction. where lighting fixtures conflict with work by other trades, and must be relocated, the Contractor shall have written approval from the Engineer prior to relocating the fixture(s).

PART 2 PRODUCTS

2.01 LIGHTING FIXTURE TYPE

A. The lighting fixture type and manufacturer are specified on the drawings.

B. Lighting fixtures with the same function and performance shall be acceptable as substitutions in accordance with 16010.

C. Furnish all fixtures with a low temperature ballast.

2.02 FINISH

A. Prime coat all metal surfaces prior to application of two coats of paint finish.

B. Paint finish shall be suitable for a corrosive environment.

2.03 METAL POLES

A. Furnish structural concrete base as shown on the drawings. Concrete installation shall comply with 03002.

B. Fixture anchor bolts, nuts and base plate shall be prime coated after installation.

C. Install steel pole on base in accordance with pole manufacturer's requirements using anchor bolts of a material and size specifically made for this application. Orient base parallel with curb line.

D. All conduits stubbing-up through the base shall be rigid galvanized steel with plastic insulated bushing on the end.

E. Install a 3/4" x 10'- 0" ground rod at the base of the pole to ground the pole.

F. Plumb pole first using leveling nuts, then grout in space between base of pole and footing with non-shrink grout.

2.04 PHOTOCELL

A. Lighting fixture shall be furnished with an integral line voltage photocell.

PART 3 EXECUTION

3.01 DELIVERY AND STORAGE

A. Delivery. Prepare lighting fixtures and accessories for shipment to the job site.

B. Storage and Handling at Job Site. The Contractor shall store and handle all lighting fixtures at the job site, while such materials are awaiting installation, in conformance with the following:

C. Store lighting fixtures accessories in an area protected from weather, moisture or possible damage.

D. Do not store materials directly on the ground.

E. Handle items to prevent damage to interior or exterior surfaces.

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SECTION 9.11: CONTROL PANELS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The work performed under this Section consists of providing all labor, material, tools, equipment and related items required to furnish and install the control panel.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Submittals: Section 01300.

B. Electrical General Information: Section 16010.

C. Instrumentation and Controls - General: Section 16900.

D. Contract Closeout: Section 01700.

1.03 REFERENCE STANDARDS

A. NEMA

B. UL 508

C. NEC

D. ISA

E. JIC EGP-1-1967

1.04 SUBMITTALS

A. Make all submittals in conformance with Section 16900.

B. Include the following:

1. Scale drawings showing the location of face-of-panel mounted devices. Include a legend listing and identifying the face-of-

panel devices by their assigned tag numbers, nameplate inscriptions, service legends and annunciator inscriptions.

2. A listing of devices mounted within the panel. Include the tag number, description, manufacturer and complete model number for each device.

3. Panel elementary diagrams similar to and developed from the drawings. Add switched analog signals, panel power distribution, and ancillary devices such as relays, alarms, fuses, lights, fans, heaters, etc. Show circuits and components individually. Show panel terminal and wire identification numbers. Do not submit typical diagrams for multiple circuits.

4. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.

5. Color schedule with color samples and paint chips for the control panels and consoles.

6. Power requirement and heat dissipation summary for all panels. State required voltages, currents, and phase(s). Maximum heat dissipation shall be stated in Btu/hr.

7. Data sheets which contain specific features such as ranges and options.

8 A device list, grouped by device type, for each panel. Include the complete manufacturer's part number, including option designations.

9. Cut sheets and catalog information for pre-manufactured enclosures. Indicate options to be supplied.

10. Fabrication drawings for custom enclosures.

1.05 MAINTENANCE

A. Provide the following spare parts:

1. One relay for every 20 relays or fraction thereof for each type of relay.

2. Other replacement parts as recommended by the manufacturer.

B. Provide the following special tools:

1. Lamp installer.

2. Mounting ring wrench(s) for pushbuttons switches and lights.

3. Relay checkout tool to hold relay in operated position.

C. Provide the following expendables:

1. One year's supply of recorder pens if disposable, otherwise, one year's supply of ink.

2. One light bulb for every 10 light bulbs or fraction thereof for each type of bulb supplied.

1.06 OPERATION AND MAINTENANCE MANUALS

A. Submit Operation and Maintenance Manuals in accordance with Section 16010.

PART 2 PRODUCTS

2.01 GENERAL

A. Panel is to be constructed to the approximate dimensions shown on the drawings.

B. Panel is to be deadfront construction with indicating lights, switches, pushbuttons, meters, etc. mounted on interior swingout panels. Handles for the main circuit breaker, branch circuit breakers and motor starter disconnects shall be installed on the swingout panel doors so they can be operated without opening the swingout door. Interior swingout panels shall be constructed of ¼” ABS plastic. Metal swingout panels are not acceptable. Interior door shall employ a quarter turn latching mechanism to secure the panel to the enclosure.

C. All instruments, devices and wiring are to be arranged such that everything can be installed, removed and serviced through the door.

D. Wire entering the panels is to enter via conduits with bushings. All wiring is to be terminated on terminals located on an interior panel prior to being connected to any instrument or switch.

E. The interior of each panel is to be painted white and the exterior color is to be selected by the OWNER from paint samples furnished by the manufacturer.

F. Each panel is to be equipped with a print pocket for storing applicable drawings.

G. Panel doors are to have heavy gauge continuous hinges. Hinges and doors are to be capable of supporting weight of equipment mounted on doors.

H. Mounting channels and interior panels are to be provided in the cabinets for mounting terminals, relays, etc.

I. Each panel is to be completely assembled and wired at the factory such that installation can be accomplished by connecting field wiring to terminal strips located on a lower portion of the interior panel.

J. Panel is to be freestanding with feet designed to elevate the panel 12” above grade.

K. Equipment is to be arranged on the back panel so that all 480 Volt devices and wiring are segregated from the 120 Volt devices. Terminal blocks for 480 Volt wiring shall be segregated from those for 120 Volt wiring.

L. Provide bulkhead fillings for tubing entering the panel.

M. Panel shall contain power and grounding distribution blocks. Distribution blocks shall be Square D Type LB, or approved equal.

2.02 ENCLOSURES

A. Panels shall be constructed from 12 gauge steel minimum. Seams are to be continuously welded with no holes or knockouts. Doors are to have rolled lip around three sides and are to have quarter turn latches and locking door handle. Handle shall be located on the right side door. All doors are to have an oil resistant gasket.

B. Panels located outdoors are to be NEMA 4X SS conforming to UL 508, VDE IP66, IEC 529, IP66. Outdoor panels are to be dead-front type with control switches, indicating lights, etc. mounted on an interior swing out door.

C. A full size steel back panel is to be provided inside each enclosure. Relays, terminal blocks, etc., are to be mounted on the back panel. Enclosures located indoors are to be Hoffman Concept Series, or equal.

D. Cut, punch or drill cutouts for face-of-panel mounted instruments and smoothly finish with rounded edges.

E. Provide steel stiffeners on the back of the panel face as may be required to prevent deflection due to instruments, operation of equipment, or opening/closing of doors. Use 0.25 inch high by 1 inch wide by 0.5 inch deep minimum stiffeners and tack welded to the panel.

F. Provide internal condensation and freezing protection with thermostatically controlled heater on outdoor enclosures. Thermostat adjustable between 40° F to 80° F.

G. Provide a print pocket within enclosures.

H. Furnish outdoor enclosures with vapor phase protective corrosion inhibitors equal to Hoffman A-HCI-5E or -10E. Activate inhibitor upon delivery of the panel to the site. Do not store panels with inhibitors inactive.

I. Each panel is to contain a duplex receptacle (1P, 20A, 120V, 3W polarized).

J. Provide all cabinets with a fluorescent light. Provide complete with limit switch to activate light when door is opened. Light is to be Hoffman Cat. No. A-LTDA1, or equal.

2.03 CONTROL COMPONENTS

A. Pushbuttons, selector switches and pilot lights are to be heavy-duty oil tight industrial type as manufactured by Square D, Allen Bradley, General Electric or Westinghouse. NEMA 4 pushbuttons, selector switches and pilot lights are to be provided for outdoor panels. Pilot lights shall be LED type push to test. Terminals of all devices located on the face of the control panel shall have recessed terminals

B. Legend Plates: Manufacturer's standard with lettering indicated on the Plans. To be of the same manufacture as the respective pushbutton, selector switch or pilot light.

C. Control Relays: Idec Series RR3B, or equal, tube base relay with on/off pilot light, 120 VAC, 60 Hz coil, 10 amp, 3 PDT contacts. With screw terminal socket.

D. Timing Relays: Square D Class 9050 Type JCK 70, or equal, programs required. Plug in octal base type. With screw terminal base.

E. Run Time Meters: Grasslin Type UWZ 48E Flush Mount, or equal. 120 VAC, 60 Hz coil. Timing range to 99999.9 hours, non-resettable.

F. Interface Relays: Potter & Brumfield Type KRPA-11DY. 48 VDC; DPDT, 5 amp contacts; with screw terminal socket.

G. Alternator: Time Mark 261D120, or approved equal.

H. Circuit Breakers: Circuit breakers shall be molded case type with thermal magnetic trip. Multi-pole breakers shall have a common operating handle. Handle-ties will not be accepted.

I. Power Monitor: Furnish a power monitor to sense the incoming voltage to the panel and trip out the motors and alarm on undervoltage, phase failure, incorrect phase sequence or phase reversal. Three phase power monitors shall be Time Mark Model 2644, or approved equal, automatic reset type. Single-phase power monitors shall be Time Mark Model 268, or approved equal, automatic reset type.

J. Alarm Light: Alarm light shall be AC/DC Type OL, or approved equal, with integral flasher and red polycarbonate lens. With cast aluminum base having a threaded hole in the bottom for installation on the top of the control panel.

K. Alarm Horn: Alarm horn shall be Edwards Model 876-N5, or approved equal, weatherproof type with bottom conduit opening. Sound level of 103 dB at 10 ft. UL approved for outdoor installation.

L. Pump Moisture Relays: Pump moisture detector relays shall be SSAC, Inc. Series LLc5-A, or approved equal, with adjustable sensing resistance. Relays shall be plug-in type with octal base. The relay shall be connected to moisture probes in the pump housing and shall operate when the probes detect water and shall stay energized until the water level falls back down below the low probe. Where Flygt pumps are furnished, the relay

will be a Flygt Minicas that will be furnished by the pump supplier for installation in the control panel.

M. Uninterruptible Power Supply: UPS shall be APC Type SU, or approved equal, consisting of a static dc to ac sine wave inverter, a battery charger, a battery with sealed maintenance free cells, output voltage and power delivered indicators, 120 VAC receptacles for load device plugs, and accessories. An alarm relay contact output shall be provided to activate on low battery condition and/or UPS failure.

The UPS shall be rated for the connected load plus 25% spare and shall be capable of carrying the rated load for 14 minutes.

UPS shall have a 2-year warranty

2.04 MOTOR STARTERS

A.

Мотор Стартерс: Мотор стартерс сηαλλ βε Χυτλερ Ηαμμερ Αδϖανταγε ορ αππ ροϖεδ εθυαλ.

2.05 CIRCUIT BREAKERS

A. Provide a main circuit breaker and branch circuit breakers as required.

B. Breakers shall be molded case with thermal magnetic trip units with the continuous current rating shown.

C. Breakers on 480 Volt systems shall be Square D, or equal, 600 Volt rated. Breakers for 120 Volt service shall be Square D Type QO, or equal.

2.06 WIRING

A. General Wiring: Use #14 AWG, 19 strand copper with Type THHN insulation.

B. Flexible Wiring: Use #14 AWG, 41 strand copper Type SIS for wiring from terminal blocks to 120 VAC devices located on cabinet doors, i.e., pushbuttons, selector switches, pilot lights and annunciator. Leave sufficient slack to allow for full opening of cabinet door.

C. Instrument Wiring: Twisted pair, #16 AWG, stranded copper. Dekoron No. 1852, or equal. Ground shield only at terminal board. Leave sufficient slack for full opening of door.

D. Segregate dc signal wiring from ac control wiring, group functionally and arrange neatly to facilitate tracing of circuits.

E. Use Panduit, or equal, wiring ducts where possible, and provide a minimum of 20 percent spare space. Run ac and dc in separate ducts.

F. Use plastic wiring wraps to bundle wires outside of ducts. Secure to panel steel at maximum 12 inch intervals. Bundle ac and dc separately.

G. Provide Brady, or equal, wire markers to identify each wire at both the terminal block and the device, i.e., at both ends.

H. Color code as follows:

1. Line and load circuits ac or dc power - Black
2. AC control circuits - Red
3. DC control circuits - Blue
4. Interlock control circuits on the panel energized from an external source - Yellow
5. Equipment grounding conductors - Green
6. Neutral conductor - White

I. Terminal Blocks:

1. Factory assembled on mounting channel.
2. Screw type with pressure plate, 300 volt, full size. Buchanan, or equal.
3. Continuous marking strip.
4. Separate terminal for each shield wire.
5. Reserve one side of each strip for incoming field wiring. Do not make common connections and jumpers required for internal wiring on the field side of the terminal.
6. Do not terminate more than two wires under any one terminal.
7. Provide separate terminal blocks for ac and dc wiring respectively.
8. Space terminal block strips no closer than 6 inches center to center.
9. Provide a minimum of 25 percent spare terminals on each strip. In addition, provide terminal blocks for terminating spare wires being installed on this project.

J. Grounding:

1. Provide one ground bus for signal grounds and one for equipment grounds.
2. Provide each bus with grounding lugs for connection to the external grounding system.

2.07 INSTRUMENT AND CONTROL PANEL IDENTIFICATION

A. All devices on the panel are to be permanently identified. The device designations are to agree with those shown on the drawings. Each device is to be provided with permanent type identifying nameplate. Nameplates, unless specified otherwise, are to be approximately one inch by four inches, constructed of black and white laminated phenolic material having engraved letters approximately 1/4 inch high extending through the black face into the white layer. Nameplates, where specified, may be omitted if nameplate description of approximately the same dimension is more convenient and suitable located on the instrument door or face. Nameplates located on the panel face are to be secured with two brass screws. Recorder nameplates may be installed on the instrument using a good adhesive.

2.08 O & M MANUALS

A. Provide three (3) copies of Operation and Maintenance Manuals containing the following information:

1. Wiring diagrams.
2. Panel face layout to scale.
3. Interior layout to scale.
4. Operation and maintenance instructions on the instruments supplied with the panel.

2.09 SCADA SYSTEM COMPONENTS

A. Furnish PLC, radio, antenna, UPS and 24VDC power supply per Section 16904.

PART 3 EXECUTION

3.01 SHIPMENT AND STORAGE

A. Cabinets are to be prepared for shipment in weatherproof and crush-proof containers.

B. Handling of cabinets is to be accomplished with extreme care, especially after removal from shipping containers.

C. Cabinets to be stored in covered storage protected from the weather, dust and possible damage when handling other equipment.

3.02 INSTALLATION

A. Cabinets are to be installed in the locations shown on the Plans.

B. All wiring is to be connected as shown on Plans and all systems are to be thoroughly checked out.

SECTION 9.12 REMOTE TELEMETRY UNITS

PART 1 GENERAL

1.01 SCOPE

Furnish and install complete Remote Telemetry Unit, RTU as specified herein and as shown on the Plans.

RTU components shall be installed in the Pump Control Panel specified in Section 16902.

The work done under this Section shall be performed by a qualified Scada Systems Contractor who meets the requirements of this Section.

1.02 RELATED SPECIFICATIONS

Section 01300 – Submittals
Section 16010 – General Electrical Requirements.
Section 16902 - Pump Control Panel
Section 16951 – Testing Instruments and Controls

1.03 APPLICABLE STANDARDS AND SPECIFICATIONS

Process Controller based RTU shall be designed, constructed and tested according to the latest applicable sections of ANSI, ASTM, IEEE, NEC, NEMA, MG-1, NFPA, UL, AEIC, IEC, ISA and IS09001/9003 standards. Requirements listed in the Drawings and Specifications are considered additional to the standard requirements listed above.

1.04 SCADA SYSTEM CONTRACTOR

The components of the Scada System shall be furnished and installed by a qualified contractor meeting the requirements of this Section.

Any contractor not listed above desiring to bid this project must submit the following information at lest 10 days in advance of the bid date. The information shall be submitted in triplicate and shall include:

Name, address and telephone number of Contractor

Listing of all projects of a similar size and type that the Contractor has constructed within the past 5 years. A Contractor not having the required experience will not be considered.

Names, addresses and telephone numbers of each of the Owners of each of the systems constructed by the Contractor.

A description of each system constructed by the Contractor. Include the type of RTU, HMI, cost, etc. Projects of less complexity and cost will not be considered.

Identify the personnel to be employed on the project. The project superintendent must have at least 5 years continuous experience on like projects with like equipment.

Describe provisions for service, technical assistance, response time and replacement parts. Include the anticipated work hour and off hour response time.7

1.05 PROGRAMMING AND MASTER STATION ADDITIONS

All programming and master station additions shall be done by the City of Waco.

Master station additions shall include developing the individual display screens to match those of the existing lift station displays.

1.06 SUBMITTALS

Submittals shall be made in accordance with the requirements of Section 16010. In addition the following specific information herein shall be provided:

Submittal Data: Submit the following data for RTU and its accessories and appurtenances:

Manufacturer and model number(s) for all system components.

Catalog data for complete system fabrication – enclosure, devices, components, wiring, cable, etc., identifying:

Ampacity and voltage ratings and sizes, style, configuration, arrangement, etc.

Wiring/cable insulation rating

Construction – dimensions, weight, size, layout, etc.

Enclosure rating – open, NEMA1, NEMA 1A, NEMA 3, NEMA 12, etc.

Manufacturer's recommendation for – special tools, spare parts, replacement parts, related accessories.

Data and ratings for other accessories and appurtenances furnished where applicable.

Submittal data shall be sufficient to determine compliance, either meet or exceed, the Specifications.

Operation and Maintenance Documentation – (O&M) Manuals: Furnish complete, quantity as specified in Section 16010. As a minimum, O&M's shall provide the following:

All data per SUBMITTALS, Subsection A, above.

Physical dimensions, weight and installation diagram(s): wiring and schematic diagrams/drawings and/or instrumentation loop diagram(s) – applicable.

1.07 WARRANTY

Warranty shall begin upon final acceptance following successful completion of the field-testing and performance of the installed equipment.

The Manufacturer shall warrant against faulty or inadequate design, improper assembly and erection, defective workmanship and materials, and leakage, breakage or other failure.

The Manufacturer is to furnish a written warranty agreeing to furnish and install FOB Austin, Texas, at his own expense, and part(s) proving defective within twelve (12) months of the final acceptance.

The Manufacturer shall also provide a written one year limited warranty for the Process Controller based RTU system – including its components, accessories and appurtenances for one year.

PART 2 PRODUCTS

2.01 GENERAL

Each RTU shall consist of a programmable logic controller, radio, antenna, connecting cable and accessories as shown on the drawings, as specified herein and as otherwise required for a complete operating system.

Contractor shall provide all programming necessary to accomplish the functions outlined in the loop descriptions included in these specifications and all additional programming required to perform the functions described on the drawings.

Contractor shall provide an electronic copy on CDR of all the ladder logic included in the programming.

2.02 PLC

The PLC system shall be a microprocessor, computer based device that can be programmed to collect data, process control logic and functions and communicate data per the execution of a programmed set of commands and instructions (a user application program). The PLC shall communicate input and output data to remote field devices – transducers, transmitters, switches, contacts, controllers, process actuators, etc.

The PLC shall operate as a stand-alone unit without support from external or additional master or mainframe computer system. Stand-alone operation shall be complete with power supply, central processor unit (CPU), diskless ROM and RAM memory of required/designated rating, and inputs/outputs (I/O's) for process data and communications port(s) for unit programming and remote communications.

PLC shall have two communication ports, one configured for Modbus slave.

All operator adjustable setpoints shall be saved to retentive flash memory.

The controller shall have an EEPROM for storage of program in the event of long term power loss.

The City of Waco will do all of the programming required for the PLC.

2.03 ANTENNA

Directional Antenna:

Yagi type, 10 dB gain, 50 Ohms impedance. Scala Electronics (Kathrein, Inc.).

Furnish complete with SS mounting hardware and fasteners, internal balun, coax feed connectors (sealed to prevent moisture penetration), heavy aluminum mounting casting with mounting hardware, fittings and accessories.

Omni-Directional Antenna:

Antenex Model FG9026, or approved equal, 6 dB gain.

2.04 RADIO

Radio shall be a MDS TransNet 900, unlicensed spread spectrum type suitable for use on a multiple address system.

Power output shall be 1 Watts maximum.

Radios shall be powered off a 24 VDC power supply in the control panel enclosure and shall be mounted on a bracket within the enclosure.

Radios shall be configured by the City of Waco.

2.05 ANTENNA FEED CABLE

Antenna cable shall be ½” diameter, low loss, coaxial RF transmission cable, rated 50 Ohms.

Cable shall be Andrew Cable Company Model LDF4-50A, Heliax, ½” coaxial cable rated for 100-1000 MHz frequency. Cables over 75 ft in length shall be 7/8” Andrew Heliax.

Furnish the cable complete with all necessary connectors, antenna grounding kit, lightning suppressor and watertight feed/transmission cable entry for conduit raceway system. Connectors shall be N Type, Andrew 7/16 DIN, or approved equal.

Cable lightning suppressor shall be Polyphaser Model IS-B50LN-C2, or approved equal.

Each antenna cable shall be grounded at the base with a Decibel Products, or approved equal, grounding strap kit.

2.06 BATERY BACKUP

Battery backup shall be Universal Power Group Type AGM, or approved equal.

2.07 POWER SUPPLY

Power supply shall be IDEC PS5R, or approved equal, 120 VAC input, 24 VDC regulated output, 2.5 Amps minimum, DIN-rail mounted in the control panel enclosure. With overcurrent and over voltage protection. Primary and secondary shall be fused.

Power supply shall have an LED indicating that power is on.

Provide Nicad battery backup sized to provide continuous operation at full load for 90 minutes after a power failure.

2.08 SURGE PROTECTION

Each individual product provided shall fully comply with all requirements shown for that size and type of TVSS unit. Rated UL 1283.

120/240 volt single phase service entrances and 120 volt control power protection (PLC, Autodialer, UPS, etc.). Use Innovative Technology, Model P-1S 120/240+ or equal.

2.09 OPERATORS INTERFACE

Operators interface shall be Allen Bradley Panelview, or approved equal, with two line text display and with keypad for operator entry. The interface shall be capable of performing the tasks outlined in the drawings.

The display shall have a minimum of 5 user defined pushbuttons and allow up to 256 messages.

Display shall be an LCD with an LED backlight and flash memory.

All setpoints shall be password protected.

2.10 TOOLS, SPARE PARTS AND ACCESSORIES

Tools: All tools recommended by the manufacturer shall be provided.

Spare Parts: All spare parts recommended by the manufacturer shall be provided.

Furnish one spare DI module, one spare DO module and one spare AI module to match those shown on the drawings.

PART 3 EXECUTION

3.01 GENERAL

Install the antenna and RTU at each site at the location indicated on the drawings. Orient the antenna so it points to the master station.

Provide support brackets or shelf in each RTU for the radio. Install all items so there is adequate ventilation around each item

Test the operation of the system after the PLC has been programmed. System shall be tested in the shop prior to shipment to the field.

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SECTION 9.13 CALIBRATION AND TESTING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Provide all equipment and labor required for calibration, setting and testing as described herein or otherwise required. All tests are to be witnessed by the Owner and Engineer. Give written notification of the tests at least seven days prior. Repair or replace all defective material, equipment or workmanship disclosed as a result of these tests at no additional cost to the Owner.

1.02 RECORDS

A. Provide the Owner six (6) copies of reports of all of the following tests including the piece of equipment or wiring tested, the date tested, weather conditions, and test value results. Include test reports in Operations and Maintenance Manuals where applicable. Report forms shall be the same or similar to those attached to this specification.

PART 2 PRODUCTS

2.01 MATERIALS

A. Use meters, meggers and other test devices specifically approved for the test.

B. Test devices to be provided with calibration certificate.

PART 3 EXECUTION

3.01 MEGGER TESTS

A. Use a minimum 500 volt megohmmeter.

B. Take each reading for at least one minute.

C. Include the following tests:

1. 115 and 230 volt motors..... 5.0 Megohms
2. 460 volt motors..... 7.0 "
3. 600 volt wiring up to 1000 ft..... 25.0 "

D. Test all wiring including main service feeders, motor feeders and branch circuit wiring.

3.02 GROUND TESTING

A. Take ground resistance measurements in normally dry weather, not less than 48 hours after rainfall, with the ground under test isolated from other grounds.

B. Measure the resistance of each ground rod. Submit in writing to the Owner a record indicating the rod location, the resistance measured and the soil condition at the time.

C. Take ground resistance measurements on the building water service where it is used as a ground also.

D. Install additional grounding if the resistance to ground measures more than 25 OHM's at any location.

3.03 MOTOR TESTING

A. Megger test motors for insulation and stator winding resistance.

B. Dry out any wet insulation by use of space heaters or other approved methods.

C. Check coupling alignment, shaft end play, lubrication and other mechanical checks as required. Follow manufacturer's instructions.

D. Check for proper rotation.

E. Combined or coupled motor and pump vibration testing under actual pumping conditions, at both full and reduced speeds.

3.04 RECEPTACLES

A. Test all receptacles for proper connections and grounding. Use an approved plug in tester.

3.05 CONTROL CIRCUITS

A. Check all circuits for continuity, proper connection and proper operations.

B. Set all time delay relays and timers for the desired operation. Record the settings, indicating the relay or timer, its location and the setting used. Verify all settings with a stopwatch.

3.06 LIGHTING

A. Turn on all lights after lamping them with new lamps.

B. Turn on all lights at each panelboard with lights on and submit typewritten results to the Owner. Results to include panelboard number and location, branch circuit number and load served, and amperage reading.

C. Allow outdoor lights to remain on for 72 hours to check ballasts as well as lamps. Replace any defective material.

3.07.1 MOTOR STARTERS

A. Set all motor circuit protectors, all feeder circuit breakers and all overload relays.

B. Record the following information and submit the same to the Engineer for checking:

1. Starter number..

2. Load served and location.

3. Full load amps.

4. Locked rotor amps.

5. Overload heater unit used.

6. Overload relay setting used.

7. MCP setting used.

C. Take and record amperage readings on all feeders and motors to ensure proper phase balance.

3.08 CONTROLS AND INSTRUMENTATION

A. Test controls and instrumentation for continuity and proper operation. Comply with Section 16951.

B. Calibrate, set and test instruments in accordance with the Instrument Supplier's published recommendations.

C. Provide written records of all tests. Include certifications and settings for all instruments.

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SECTION 9.14 TESTING INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

This Section describes field testing requirements including the manner in which the testing is to take place. Refer to other applicable Sections of this Specification for testing and calibration requirements of individual instrument and control devices.

1.02 SUBMITTALS

A. The following information shall be included in the submittal for this Section:

1. Loop checkout schedule.

2. Loop checkout procedures including sign-off forms.

3. Schedules, procedures and sign-off forms for all other tests specified.

B. Within two weeks following completion of any field tests, test report/documentation shall be submitted to the ENGINEER.

1.03 GENERAL

A. Extensive field testing shall be performed to verify the operation of the entire system.

B. Field testing shall be sequential in nature and shall be organized by site.

C. Site testing shall include loop checkout.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 SITE TESTING

A. Loops

1. Loop tests shall include the following:

a. Wetwell high level and low level alarms.

b. Pump control.

d. Power failure alarm.

e. Pump moisture alarm.

f. Pump temperature alarm.

2. Each loop shall be tested from the element, i.e., switch, transmitter or relay, to the starter or control panel as applicable. The OWNER and ENGINEER shall witness all tests.

3. All loop checks shall be documented and submitted to the ENGINEER. Documentation shall include:

a. Loop name.

b. Loop description.

c. Termination information.

d. Drawing reference.

e. Type of test(s) performed.

f. Date tested.

g. Signature of tester and date.

h. Signature of OWNER and ENGINEER and date.

i. Problem description, if any.

4. All loops found to contain defective or inoperable equipment shall be summarized on separate sheets and submitted to the ENGINEER and OWNER.

a. Work performed under this Contract shall be corrected and rechecked.

b. Correction of defective work by others shall be coordinated by the OWNER. Rechecking shall be performed as a part of this Contract.

B Alarm Conditions

1. Cause an actual alarm condition to occur or simulate an alarm condition for each alarm.

2. Observe the alarm light.

3. Silence the alarm horn and reset the alarm light each time.

C Lift Pump Control

1. Test the pump controls for each pump for the following:

a. Manual operation at full voltage.

b. Automatic operation.

c Low level cutoff.

2. Observe the following during the testing:

a. Motor status lights.

b. Motor run time meter.

3.02 MAINTENANCE OF OPERATIONS

A. Field testing shall be scheduled through the Owner at least 7 days in advance.

B. No testing that may affect operation shall be permitted without Owner's concurrence.

C. No testing shall be performed on Monday or Friday.

3.03 TESTING PRECEDENTS

A. The following conditions shall be met prior to the start of any testing:

1. All documentation pertinent to the equipment being tested shall be on-site.

2. All spare parts, expendables and test equipment pertinent to the equipment being tested shall be on-site, labeled and properly stored.

3. All field equipment supplied and pertinent to the equipment being tested shall be operational.

4. Test schedules and test procedures shall have been submitted to and approved by the Owner..

B. All test procedures and test results shall reflect information contained within the various operation and maintenance manuals furnished.

3.04 OWNER PARTICIPATION

A. The Owner. may participate in testing activities at its discretion.

B. Owner's participation and use shall be such that it does not adversely affect specified testing requirements. No claim for delay shall be allowed unless the following conditions are met:

1. The Owner and the ENGINEER are notified verbally that Owner actions could cause delay if continued.

2. The Owner or the ENGINEER persists in the delay action.

3. Written documentation is submitted to the ENGINEER within 24 hours that describes the Owner's action and impact.

INDEX OF STANDARD SPECIFICATIONS FOR CONSTRUCTION

Description	Section Number	Page Number
Abbreviations	GP Section 10.1	GP-75
Abbreviations and Terms	GP Section 10	GP-63
Aggregates for Hot-Mix Asphalt Concrete Pavement	Sectjion 3.3 Part 2.A.1	3-17
Aggregates for Portland Cement Concrete	Section 5.1 Part 2.A.1	5-2
Air Release Valves, construction of	Section 4.9 Part 3.A.8	4-85
Air Valves	Section 4.7 Part 2.E.2	4-48
Aluminizing	Section 6.8 Part 2.C	6-28
Asphalt Cement	Section 3.1 Part 2.A.2	3-2
Asphalts, Oils, and Emulsions	Section 3.1	3-2
Assignments	GP Section 2.3	GP-15
Authority of Owner and Engineer	GP Section 2.11	GP-21
Award and Execution of Contract	GP Section 2.2	GP-14
Backflow Prevention	Section 4.12	4-101
Barriers and Warning and/or Detour Signs	Section 6.1	6-2
Base Courses	Section 2.3	2-10
Blocking	Section 4.9 Part 3.A.12	4-86
Boring, Construction by	Section 4.4 Part 3.A.3	4-24
Brass Stops, Cocks and Fittings for Waterworks Service	Section 4.7 Part 2.F.3	4-55
Brass Wheel Valves	Section 4.7 Part 2.E.3	4-49
Butterfly Valves	Section 4.7 Part 2.E.4	4-51
Cast-in-Place Pipe, construction of	Section 4.8 Part 3.B.1	4-66
Catalytically Brown Asphalt Joint and Crack Sealer	Section 3.1 Part 2.A.7	3-12
Cement	Section 5.1 Part 2.A.2	5-6
Change Management - City Projects	GP Section 3.4	GP-24
Change Management - Development Projects	GP Section 3.5	GP-25
Changed Conditions	GP Section 4.4	GP-35
Changes in Work	GP Section 4	GP-33
Changes Initiated by the Owner	GP Section 4.2	GP-33
Changes Requested by the Contractor	GP Section 4.1	GP-33
Chemical Admixtures	Section 5.1 Part 2.A.3	5-6
Clearing and Grubbing	Section 1.2	1-4
Completion and Acceptance	GP Section 7.7	GP-51
Completion of the Work	GP Section 3.3	GP-24
Concrete	Section 5	5-1
Concrete and Reinforcement	Section 5.1	5-2
Concrete Curb and Gutter	Section 5.3	5-39
Concrete Mix Design and Control	Section 5.1 Part 3.A	5-16
Concrete Sidewalks and Driveway Approaches	Section 5.4	5-43
Confined Space Plan	GP Section 3.6.C	GP-28
Connections to Existing Water Mains	Section 4.9 Part 3.A.5	4-83

Description	Section Number	Page Number
Construction Schedule and Commencement of Work	GP Section 7.1	GP-47
Contract Administration	GP Section 3	GP-23
Contract Bonds	GP Section 2.5	GP-17
Contractor Default	GP Section 7.4	GP-48
Contractor's Equipment and Facilities	GP Section 8.1	GP-53
Contractor's Representative	GP Section 8.7	GP-58
Control of Materials	GP Section 5	GP-39
Cooperation and Collateral Work	GP Section 8.8	GP-59
Cooperation, Utilities	GP Section 6.6	GP-45
Corrosion Resistant Coatings and Liners for Sanitary Sewers and Appurtenances	Section 4.7 Part 2.F.12	4-59
Cured-In-Place Pipe (CIPP)	Section 4.7 Part 2.B.1	4-41
Curing Concrete	Section 5.1 Part 3.H	5-30
Curing Materials	Section 5.1 Part 2.A.11	5-12
Cut-back Ashphalt	Section 3.1 Part 2.A.4	3-5
Defective Work	Section 5.1 Part 3.J	5-33
Definitions	GP Section 1	GP-5
Deflection Test	Section 4.8 Part 3.C.3	4-76
Deformed PVC Pipe	Section 4.7 Part 2.B.2	4-43
Deformed PVC Pipe, construction of	Section 4.8 Part 3.B.2	4-70
Delays, and Extensions of Time	GP Section 7.5	GP-50
Delays, Utilities	GP Section 6.5	GP-45
Density, Fill	Section 1.5 Part 3.D	1-12
Disputed Work	GP Section 4.5	GP-39
Dowel Bars	Section 5.1 Part 2.A.6	5-9
Drilled Concrete Shafts	Section 5.5	5-46
Ductile Iron Pressure Pipe and Fittings	Section 4.7 Part 2.A.3	4-33
Earthen Fill	Section 1.5 Part 3.B	1-11
Electrical Conduit	Section 6.9	6-35
Emulsified Asphalt	Section 3.1 Part 2.A.5	3-9
Environmental an Safety Plans	GP Section 3.6	GP-25
Equal Opportunity Employment	GP Section 8.15	GP-65
Excavation and Backfill, Piping Systems	Section 4.2	4-5
Excavation of Channels	Section 1.3 Part 3.A.2	1-7
Excavation of Streets	Section 1.3 Part 3.A.1	1-6
Excess Excavation	Section 1.3 Part 3.C	1-7
Existing Structures	GP Section 2.10	GP-21
Extra Work	GP Section 4.3	GP-34
Facilities for Dewatering of Water Lines	Section 4.9 Part 3.A.11	4-86
Fencing	Section 1.12	1-37
Fertilizer	Section 1.9	1-22

Description	Section Number	Page Number
Fiberglass Manholes	Section 4.7 Part 2.C.2	4-46
Fiberglass Sewer Pipe	Section 4.7 Part 2.A.4	4-36
Fill	Section 1.5	1-10
Finishing, Concrete	Section 5.1 Part 3.F	5-26
Fire Hydrants	Section 4.7 Part 2.F.1	4-53
Fire Hydrants, construction of	Section 4.9 Part 3.A.9	4-85
Fittings	Section 4.7 Part 2.F.2	4-55
Flexible Base (Crushed Stone)	Section 2.3.B	2-13
Flux Oil	Section 3.1 Part 2.A.6	3-9
Force Majeure	GP Section 8.20	GP-67
Gabion Structure	Section 6.11	6-44
Galvanizing	Section 6.8 Part 2.B	6-26
Gate Valves	Section 4.7 Part 2.E.1	4-48
General, Contract Administration	GP Section 3.1	GP-23
Grading in Right-of-Way Behind Curb	Section 1.4	1-9
Gravel Base Course	Section 2.3.A	2-10
Hot-Mix Asphalt Concrete Pavement	Section 3.3	3-17
Hydrostatic Test	Section 4.9 Part 3.A.3	4-80
Indemnification	GP Section 8.14	GP-65
Inspection Access	GP Section 2.13	GP-22
Inspection Notification	GP Section 2.12	GP-21
Institutions	GP Section 10.2	GP-80
Jacking, Boring, or Tunneling	Section 4.4	4-22
Jacking, Construction by	Section 4.4 Part 3.A.2	4-22
Joint Filler	Section 5.1 Part 2.A.9	5-11
Joint Sealing	Section 5.1 Part 2.A.10	5-11
Joints	Section 4.7 Part 2.D	4-47
Labor	GP Section 8.3	GP-53
Latex Additives	Section 3.1 Part 2.A.3	3-5
Laws to be Observed	GP Section 8.13	GP-64
Leak Clamps	Section 4.7 Part 2.F.6	4-57
Liability Insurance	GP Section 8.4	GP-54
Lightweight Aggregates	Section 5.2 Part 2.A.1	5-35
Lightweight Concrete	Section 5.2	5-35
Lime	Section 2 Part A.2	2-24
Lime Treatment	Section 2.4	2-24
Line Valve Installation	Section 4.9 Part 3.A.7	4-85
Liquidated Damages	GP Section 7.8	GP-52
Location, Utilities	GP Section 6.1	GP-43
Low Pressure Air Test	Section 4.8 Part 3.C.2	4-72
Lump Sum Wok	GP Section 9.2	GP-69

Description	Section Number	Page Number
Manholes	Section 4.7 Part 2.C	4-44
Materials and Workmanship	GP Section 5.1	GP-39
Materials Testing, Concrete	Section 5.6	5-51
Materials Testing, Pavement and Surface Courses	Section 3.7	3-37
Materials Testing, Subgrade and Base Courses	Section 2.6	2-33
Measurement and Payment	GP Section 9	GP-69
Measurement for Quanitities of Unit Price Work	GP Section 9.1	GP-69
Metal Beam Guadrail	Section 6.5	6-10
Mineral Filler	Section 5.1 Part 2.A.4	5-8
Miscellaneous Construction	Section 6	6-1
Mixing, Lightweight Concrete	Section 5.2 Part 3.C	5-38
Mobilization	Section 6.4	6-9
Modification	GP Section 8.22	GP-68
Offsets or Other Debts Against City	GP Section 8.18	GP-67
Oil Asphalt	Section 3.1 Part 2.A.1	3-2
Paint	Section 6.8 Part 2.A	6-16
Painting	Section 6.8	6-16
Patent Fees or Royalties	GP Section 8.12	GP-64
Pavement and Surface Courses	Section 3	3-1
Pavement Markings	Section 6.2	6-3
Payment	GP Section 9.3	GP-69
Permits	GP Section 8.6	GP-58
Pipe Bedding Material for Storm Sewers	Section 4.2 Part 2.A.1	4-5
Pipe Bedding Material for Water and Sanitary Sewer Mains	Section 4.2 Part 2.A.2	4-6
Pipe Bursting	Section 4.11	4-95
Pipes	Section 4.7 Part 2.A	4-32
Piping Materials	Section 4.7	4-32
Pitot Outlets	Section 4.7 Part 2.F.8	4-58
Placing Concrete	Section 5.1 Part 3.E	5-20
Placing Reinforcement, Concrete	Section 5.1 Part 3.D	5-19
Plans and Specifications	GP Section 2.6	GP-17
Plugs	Section 4.9 Part 3.A.14	4-87
Polyehtylene Wrap for Metal Pipe and Fittings	Section 4.7 Part 2.F.13	4-62
Polyvinyl Chloride (PVC) Sewer Pipe & Fittings with Dimension Control	Section 4.7 Part 2.A.1	4-32
Polyvinyl Chloride (PVC) Water Pipe	Section 4.7 Part 2.A.2	4-32
Portland Cement Concrete Pavement	Section 3.6	3-29
Portland Cement Modification of Subgrade Soils	Section 2.2.B	2-6
Portland Cement Treatment (Pug Base)	Section 2.3.C	2-17
Precast Reinforce Concrete Box Sections	Section 4.7 Part 2.F.10	4-58

Description	Section Number	Page Number
Precast Reinforced Manhole Sections	Section 4.7 Part 2.C.1	4-44
Preparing Right-of-Way	Section 1.1	1-2
Prime Coat	Section 2.5	2-31
Project Site Maintenance	GP Section 8.9	GP-59
Proposal Requirements	GP Section 2.1	GP-11
Prosecution of Work	GP Section 7.2	GP-47
Prosecution, Progress, and Acceptance of the Work	GP Section 7	GP-47
Protection and Restoration of Existing Improvements	GP Section 8.10	GP-61
Protection of Trees and Shrubs	Section 1.2 Part 3.C	1-5
Protection, Utilities	GP Section 6.2	GP-43
Provisions for Drainage, Excavation	Section 1.3 Part 3.B	1-7
Public Convenience and Safety	GP Section 8.11	GP-62
Purging and Disinfection of Water Mains	Section 4.9 Part 3.A.13	4-86
Quality of Concrete	Section 5.1 Part 3.B	5-16
Quality of Concrete, Lightweight Concrete	Section 5.2 Part 3.B	5-37
Railing	Section 6.6	6-12
Ready Mix, Concrete	Section 5.1 Part 3.C	5-18
Rehabilitation of Existing Base and Pavement	Section 2.3.D	2-22
Reinforced Concrete Culverts and Storm Drain Pipe	Section 4.7 Part 2.A.5	4-36
Reinforced Concrete Pipe, construction of	Section 4.10 Part 3.A.1	4-92
Relocation, Utilities	GP Section 6.4	GP-44
Removal and Replacement of Sod, Shrubbery, Plants, Etc.	Section 1.2 Part 3.B	1-4
Removal of Forms and Falsework	Section 5.1 Part 3.I	5-33
Removal, Utilities	GP Section 6.3	GP-35
Responsibilities of the Contractor	GP Section 8	GP-53
Right to Assurance	GP Section 8.23	GP-68
Right-of-Way	GP Section 2.8	GP-19
Riprap	Section 6.10	6-39
Roadway Illumination Assemblies	Section 6.3	6-7
Rock Fill	Section 1.5 Part 3.C	1-11
Rolling	Section 2.1	2-2
Rubber Gasket Joints	Section 4.7 Part 2.D.1	4-47
Rubber Gasket Joints, construction of	Section 4.8 Part 3.A.1	4-64
Sanitary Sewer	Section 4.8	4-64
Sanitary Sewer Manholes, construction of	Section 4.8 Part 3.A.3	4-65
Sawing	Section 6.7	6-14
Scope and Control of the Work	GP Section 2	GP-11
Seamless Copper Tubing	Section 4.7 Part 2.F.4	4-56
Seeding	Section 1.8	1-18
Service Saddles	Section 4.7 Part 2.F.7	4-57

Description	Section Number	Page Number
Services and Bullheads	Section 4.9 Part 3.A.10	4-86
Sewer Appurtenances, construction of	Section 4.8 Part 3.A.2	4-66
Site Work	Section 1	1-1
Slurry Seal	Section 3.5	3-28
Sodding	Section 1.7	1-14
Sprinkling for Dust Control	Section 1.11	1-36
Stainless Steel Tapping Sleeve	Section 4.7 Part 2.F.5	4-58
State and local Sales and Use Taxes	GP Section 8.16	GP-66
Steel Reinforcement	Section 5.1 Part 2.A.7	5-9
Steel Wire Reinforcement	Section 5.1 Part 2.A.8	5-10
Storage, Heating, and Application Temperatures, Bituminous Materials	Section 3.1 Part 3.A	3-13
Storm Sewer	Section 4.10	4-92
Storm Sewer Appurtenances, construction of	Section 4.10 Part 3.A.2	4-93
Storm Sewer Appurtenances, Materials for	Section 4.7 Part 2.F.11	4-59
Storm Sewer Manholes, construction of	Section 4.10 Part 3.A.3	4-94
Storm Water Pollution Prevention	Section 1.10	1-24
Storm Water Pollution Prevention Plan	GP Section 3.6.D	GP-28
Street Cut Excavation and Repair Standards	Section 4.3	4-20
Street, Highway, and Railroad Crossing	Section 4.5	4-27
Subcontracts	GP Section 2.4	GP-13
Subgrade and Base Courses	Section 2	2-1
Subgrade Courses	Section 2.2	2-4
Subgrade Preparation	Section 2.2.A	2-4
Submittals	GP Section 3.2	GP-24
Subsurface Data	GP Section 2.7	GP-19
Supervision and Superintendence	GP Section 8.2	GP-53
Surveying	GP Section 2.9	GP-20
Suspension of Work	GP Section 7.3	GP-48
Tack Coat	Section 3.2	3-15
Traffic Control Plan	GP Section 3.6.A	GP-26
Taps and Tap Assemblies in Water Mains	Section 4.9 Part 3.A.6	4-84
Tax Certification	GP Section 8.17	GP-67
Time of Completion	GP Section 7.6	GP-51
Time of Filing Claims	GP Section 8.19	GP-67
Topsoil	Section 1.6	1-13
Trench Backfill	Section 4.2 Part 2.A.3	4-7
Trench Safety Plan	GP Section 3.6.B	GP-26
Trenchless Rehab Construction Methods	Section 4.8 Part 3.B	4-68
Trenchless Rehab Pipe	Section 4.7 Part 2.B	4-41
Tunneling, Construction by	Section 4.4 Part 3.A.4	4-24

Description	Section Number	Page Number
Unclassified Excavation	Section 1.3	1-6
Underground Pipe Installation	Section 4.6	4-29
Use of Improvements During Construction	GP Section 7.9	GP-52
Utilities	GP Section 6	GP-43
Valves	Section 4.7 Part 2.E	4-48
Vaults	Section 4.7 Part 2.F.9	4-58
Vaults	Section 4.9 Part 3.A.15	4-87
Venue	GP Section 8.24	GP-68
Waiver	GP Section 8.21	GP-68
Warm-Mix Asphalt Concrete Pavement	Section 3.4	3-27
Water	Section 5.1 Part 2.A.5	5-8
Water Pipe	Section 4.9	4-79
Water Pipe Appurtenances, construction of	Section 4.9 Part 3.A.4	4-83
Water, Wastewater, and Storm Water Utility Construction	Section 4	4-1
Water, Wastewater, and Storm Water Utility Construction, General	Section 4.1	4-2
Workers' Compensation Insurance	GP Section 8.5	GP-55