Standard Specifications for Public Works Construction

North Central Texas

Third Edition 1998

North Central Texas Council of Governments
616 Six Flags Drive, Suite 200
P. O. 5888
Arlington, Texas 76005-5888
(817) 640-3300

© 1998 North Central Texas Council of Governments
WHAT IS NCTCOG?

The North Central Texas Council of Governments is a voluntary association of cities, counties, school districts and special districts within the sixteen-county North Central Texas region. It was established in 1966 to assist local governments in planning for common needs, cooperating for mutual benefit and coordinating for sound regional development.

The Council of Governments is an organization of, by and for local governments. Its purpose is to strengthen both the individual and collective power of local governments – and to help them recognize regional opportunities, resolve regional problems, eliminate unnecessary duplication, and make joint regional decisions – as well as to develop the means to assist in the implementation of those decisions.

North Central Texas is a sixteen-county metropolitan region centered around the urban centers of Dallas and Fort Worth. NCTCOG currently has 226 members, including 16 counties, 160 cities, 26 school districts, and 24 special districts. The area of the region is approximately 12,800 square miles, which is larger than nine states, and the population of the region is approximately 4.3 million, which is larger than 30 states.

NCTCOG's structure provides that each member government appoints a voting representative from its governing body. These voting representatives make up the NCTCOG General Assembly which annually elects an Executive Board. The Executive Board is the policy approval body for all NCTCOG activities and is supported by technical, study, and policy development committees as well as a professional staff, led by R. Michael Eastland, Executive Director.

NCTCOG's offices are located in Arlington in the Centerpoint Two Building at 616 Six Flags Drive (approximately one-half mile south of the main entrance to Six Flags over Texas).

NORTHERN CENTRAL TEXAS COUNCIL OF GOVERNMENTS EXECUTIVE BOARD 1997-98

<table>
<thead>
<tr>
<th>President</th>
<th>Director</th>
<th>Director</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elzie Odom</td>
<td>Morris Parrish</td>
<td>Bobbie Mitchell</td>
</tr>
<tr>
<td>Mayor</td>
<td>Mayor</td>
<td>Mayor</td>
</tr>
<tr>
<td>City of Arlington</td>
<td>City of Irving</td>
<td>City of Lewisville</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vice President</th>
<th>Director</th>
<th>Regional Citizen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ron Harmon</td>
<td>Mary Poss</td>
<td>Beatrice Butler</td>
</tr>
<tr>
<td>Commissioner</td>
<td>Councilmember</td>
<td>Terrell, TX</td>
</tr>
<tr>
<td>Johnson County</td>
<td>City of Dallas</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Secretary-Treasurer</th>
<th>Director</th>
<th>Regional Citizen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ron Harris</td>
<td>Becky Haskin</td>
<td>Dr. Frank Longoria</td>
</tr>
<tr>
<td>County Judge</td>
<td>Councilmember</td>
<td>Denton, TX</td>
</tr>
<tr>
<td>Collin County</td>
<td>City of Fort Worth</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Past President</th>
<th>Director</th>
<th>General Counsel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jim Jackson</td>
<td>Tom Vandergriff</td>
<td>Jerry Gilmore</td>
</tr>
<tr>
<td>Commissioner</td>
<td>County Judge</td>
<td></td>
</tr>
<tr>
<td>Dallas County</td>
<td>Tarrant County</td>
<td></td>
</tr>
</tbody>
</table>

COPYRIGHT

This copyrighted document, in whole or in part, may not be photocopied, printed or otherwise reproduced without the prior written approval of NCTCOG's Director of Environmental Resources.

USE AND MODIFICATION

The Standard Specifications and Standard Drawings are regional provisions recommended by the Public Works Advisory Committee and endorsed by the NCTCOG Executive Board. The use of these standards shall be under the supervision and seal of a professional engineer in the State of Texas. Any modification to these standard specifications and drawings shall be clearly noted on engineering plans and contract documents prepared under the supervision and seal of a registered professional engineer.
FOREWORD


The Standard Specifications for Public Works Construction are intended to be dynamic in nature. They are meant to be continually updated, supplemented, and improved. NCTCOG will be conducting a comprehensive review and refinement of the Standards over the next few years. We encourage the users of this document to notify us of needed modifications to these standards or if there are provisions that should be added. Please use the enclosed change proposal form and send any comments to the attention of the Public Works Advisory Committee, care of NCTCOG Department of Environmental Resources, at P.O. Box 5888, Arlington, Texas 76005. Users may call the Environmental Resources Department at metro 817/695-9210 with any immediate questions regarding the Standard Specifications.

ACKNOWLEDGMENTS

NCTCOG is sincerely appreciative and forever indebted to all of the public works professionals who unselfishly provided their invaluable time and expertise in the review and production of these specifications and drawings. Special thanks goes to the engineering firms of Gonzalez & Schneebiger (formerly Powell & Powell) and Camp Dresser & McKee for their efforts in the CAD production of the Standard Drawings. Additionally, much appreciation goes to Madelon Blackwell, Sharon Bell, and Barbara Maxwell for their hard work and diligence in typing the 2nd Edition Standard Specifications into MSWord files.

PUBLIC WORKS ADVISORY COMMITTEE 1997-98

<table>
<thead>
<tr>
<th>Name</th>
<th>City/Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>George Behmanesh, Chairman</td>
<td>Carl McChesney, City Engineer</td>
</tr>
<tr>
<td>Asst.Dir. of Transportation &amp; Public Works City of Fort Worth</td>
<td>City of Richardson</td>
</tr>
<tr>
<td>Bill Verkest, Vice Chairman</td>
<td>Jerry Clark, Director of Engineering &amp; Transportation City of Denton</td>
</tr>
<tr>
<td>Director of Engineering Services City of Arlington</td>
<td>Randy Walhoud, Division Manager, Construction City of Carrollton</td>
</tr>
<tr>
<td>Alan Upchurch</td>
<td>Jim McMeans, Public Works Director City of Grand Prairie</td>
</tr>
<tr>
<td>City Engineer</td>
<td>Mike Barnes, Director of Public Works City of Keller</td>
</tr>
<tr>
<td>City of Plano</td>
<td>Lee Bradley, Water Director City of Fort Worth</td>
</tr>
<tr>
<td>Jerry Murawski</td>
<td>Allen Beene, Director of Public Works Dallas County</td>
</tr>
<tr>
<td>City Engineer</td>
<td></td>
</tr>
<tr>
<td>George Conner</td>
<td></td>
</tr>
<tr>
<td>Director of Public Works</td>
<td></td>
</tr>
<tr>
<td>City of Allen</td>
<td></td>
</tr>
<tr>
<td>Dennis Schwartz</td>
<td></td>
</tr>
<tr>
<td>Director of Public Works</td>
<td></td>
</tr>
<tr>
<td>City of Duncanville</td>
<td></td>
</tr>
<tr>
<td>Fiona Allen</td>
<td></td>
</tr>
<tr>
<td>Assistant Director of Utilities/Operations City of Arlington</td>
<td></td>
</tr>
</tbody>
</table>

NCTCOG STANDARD SPECIFICATIONS 3rd EDITION DEVELOPMENT TEAM

<table>
<thead>
<tr>
<th>Name</th>
<th>City/Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenneth Calhoun</td>
<td>Jeff Rice, Environmental Planner II</td>
</tr>
<tr>
<td>Development Engineering Specialist</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Melanie Saller, Environmental Planner I</td>
</tr>
<tr>
<td></td>
<td>Lois Thompson, Executive Secretary</td>
</tr>
</tbody>
</table>

JANUARY 1998
Table of Contents

SECTION I -- STANDARD SPECIFICATIONS

TABLE OF CONTENTS

PART I GENERAL PROVISIONS
   DIVISION 1 PROPOSAL REQUIREMENTS AND OTHER GENERAL CONDITIONS

PART II MATERIALS
   DIVISION 2 MATERIALS

PART III CONSTRUCTION METHODS
   DIVISION 3 SITE PREPARATION
   DIVISION 4 SUBGRADE, SUBBASE AND BASE COURSES
   DIVISION 5 PAVEMENT AND SURFACE COURSES
   DIVISION 6 UNDERGROUND CONDUIT CONSTRUCTION
   DIVISION 7 STRUCTURES
   DIVISION 8 MISCELLANEOUS CONSTRUCTION

APPENDIX A MODEL FORMS

INDEX

SECTION II -- STANDARD DRAWINGS

TABLE OF CONTENTS

DIVISION 1000 EROSION AND SEDIMENT CONTROL

DIVISION 2000 PAVEMENT SYSTEMS

DIVISION 3000 GENERAL UNDERGROUND CONDUIT

DIVISION 4000 WATER DISTRIBUTION

DIVISION 5000 WASTEWATER COLLECTION

DIVISION 6000 STORMWATER DRAINAGE

JANUARY 1998
SECTION I

Standard Specifications
This page was intentionally left blank.
SECTION I -- STANDARD SPECIFICATIONS

PART I GENERAL PROVISIONS

DIVISION 1 PROPOSAL REQUIREMENTS AND OTHER GENERAL CONDITIONS

PURPOSE

Item 1.0. Definitions
Item 1.1. Proposal Form
Item 1.2. Quantities in Proposal Form
Item 1.3. Examination of Plans, Specifications and Site of the Work
Item 1.4. Preparation of Proposal
Item 1.5. Proposal Guaranty
Item 1.6. Filing of Proposals
Item 1.7. Withdrawing Proposals
Item 1.8. Opening Proposals
Item 1.9. Irregular Proposals
Item 1.10. Rejection of Proposals
Item 1.11. Disqualification of BIDDERS
Item 1.12. Consideration of Contract
Item 1.13. Award of Contract and Commencement of Work
Item 1.14. Return of Proposal Guaranty
Item 1.15. Surety Bonds
Item 1.16. Notice to Proceed
Item 1.17. Execution of Contract
Item 1.18. Failure to Execute Contract
Item 1.19. Priority of Contract Documents
Item 1.20. Correlation and Intent of Documents
Item 1.21. CONTRACTOR’S Warranties and Understanding
Item 1.22. CONTRACTOR’S Responsibilities
Item 1.23. Compliance with Laws
Item 1.24. Protection of Work and of Persons and Property
Item 1.25. Payment for Labor and Material; No Liens
Item 1.26. Insurance
Item 1.27. Materials and Workmanship; Warranties and Guarantees
Item 1.28. Shop Drawings, Product Data and Samples
Item 1.29. Means and Methods of Construction
Item 1.30. Supervision by CONTRACTOR
Item 1.31. Employees
Item 1.32. Working Area; Coordination with Other CONTRACTORS; Final Cleanup
Item 1.33. Other CONTRACTORS; Obligation to Cooperate
Item 1.34. OWNER’S Right to Temporarily Suspend Work
Item 1.35. Use of Completed Portions of Work
Item 1.36. Delays; Extension of Time; Liquidated Damages
Item 1.37. Change or Modification of Contract
Item 1.38. Payment for Extra Work
Item 1.39. Disputed Work and Claims for Additional Compensation
Item 1.40. Performance of Extra or Disputed Work
Item 1.41. Authority of the Engineer
Item 1.42. Inspection and Tests
Item 1.43. No Waiver of Rights or Estoppel
Item 1.44. CONTRACTOR Default; OWNER’S Right to Suspend Work and Annul Contract
Item 1.45. Suspension by Court Order Against the OWNER
Item 1.46. Subcontracts
Item 1.47. Assignments

JANUARY 1998
PART II MATERIALS

DIVISION 2 MATERIALS

Item 2.1. Aggregates
Item 2.2. Portland Cement Concrete and Related Materials
Item 2.3. Masonry Materials
Item 2.4. Bituminous Materials
Item 2.5. Lime Products
Item 2.6. Wood Products
Item 2.7. Piling Material
Item 2.8. Chain Link and Barrier Fences
Item 2.9. Paint and Protective Coatings
Item 2.10. Electrical Components
Item 2.11. Metal for Structures
Item 2.12. Underground Conduit and Related Material
Item 2.13. Valves
Item 2.14. Fire Hydrants
Item 2.15. Materials for Seeding and Sodding
Item 2.16. Brass Stops, Cocks and Fittings for Waterworks Service
Item 2.17. Bronze Service Clamps
Item 2.18. Seamless Copper Tubing
Item 2.19. Precast Reinforced Manhole Sections
Item 2.20. Fiberglass Manholes
Item 2.21. Preformed Flexible Joint Sealant
Item 2.22. Tunnel Wood Lagging
Item 2.23. Geotextiles
Item 2.24. Gabion Structures

PART III CONSTRUCTION METHODS

DIVISION 3 SITE PREPARATION

Item 3.1. Preparing Right-of-Way
Item 3.2. Clearing and Grubbing
Item 3.3. Unclassified Street Excavation
Item 3.4. Parkways
Item 3.5. Unclassified Channel Excavation
Item 3.6. Borrow
Item 3.7. Embankment
Item 3.8. Top Soil
Item 3.9. Sodding
Item 3.10. Seeding
Item 3.11. Fertilizer
Item 3.12. Temporary Erosion, Sediment and Water Pollution Control

DIVISION 4 SUBGRADE, SUBBASE AND BASE COURSES
Definitions
Item 4.1. Sprinkling for Dust Control
Item 4.2. Rolling
Item 4.3. Subgrade Preparation
Item 4.4. Gravel Base Course
Item 4.5. Flexible Base (Crushed Stone)
Item 4.6. Lime Treatment
Item 4.7. Portland Cement Treatment
Item 4.8. Asphalt Treatment
Item 4.9. Portland Cement Modification of Subgrade Soils

DIVISION 5 PAVEMENT AND SURFACE COURSES
Item 5.1. Asphalts, Oils and Emulsions
Item 5.2. Gravel Surface
Item 5.3. Prime Coat
Item 5.4. Emulsified Asphalt Treatment
Item 5.5. Single Bituminous Surface Treatment (Seal Coat)
Item 5.6. Double Bituminous Surface Treatment
Item 5.7. Hot-Mix Asphalt Concrete Pavement
Item 5.8. Portland Cement Concrete Pavement

DIVISION 6 UNDERGROUND CONDUIT CONSTRUCTION
Item 6.1. General
Item 6.2. Excavation and Backfill
Item 6.3. Foundation
Item 6.4. Jacking, Boring or Tunneling
Item 6.5. Street Cut Excavation and Repair Standards
Item 6.6. Street, Highway and Railroad Crossing
Item 6.7. Underground Conduit Installation

DIVISION 7 STRUCTURES
Item 7.1. Structural Excavation
Item 7.2. Drilled Shaft Foundation
Item 7.3. Driving Piling
Item 7.4. Concrete for Structures
Item 7.5. Lightweight Concrete for Structures
Item 7.6. Concrete Structures
Item 7.7. Prestressed Concrete for Structures
Item 7.8. Prestressing
Item 7.9. Pneumatically Placed Concrete
Item 7.10. Steel Structures
Item 7.11. Structural Bolting
Item 7.12. Precast Concrete Units
DIVISION 8 MISCELLANEOUS CONSTRUCTION

Item 8.1. Barriers and Warning and/or Detour Signs
Item 8.2. Concrete Curb and Gutter
Item 8.3. Concrete Sidewalks and Driveway Approaches
Item 8.4. Concrete Medians
Item 8.5. Reinforced Concrete Headers
Item 8.6. Concrete Steps
Item 8.7. Retaining Walls
Item 8.8. Sawing
Item 8.9. Painting
Item 8.10. Electrical Conduit
Item 8.11. Metal Beam Guard Rail
Item 8.12. Railing
Item 8.13. Chain Link and Guard Fence
Item 8.14. Wire Fence
Item 8.15. Riprap
Item 8.16. Gabion Structure Assembly
Item 8.17. Solid Concrete Interlocking Paving Units

APPENDIX A MODEL FORMS

APPENDIX A.1. CONTRACTOR’S AFFIDAVIT OF FINAL PAYMENT
APPENDIX A.2. CERTIFICATE
APPENDIX A.3. STANDARD CONSTRUCTION CONTRACT
APPENDIX A.4. PERFORMANCE BOND
APPENDIX A.5. PAYMENT BOND
APPENDIX A.6. CHANGE ORDER

INDEX
PART I

General Provisions
This page was intentionally left blank.
PART I GENERAL PROVISIONS

DIVISION 1 PROPOSAL REQUIREMENTS AND OTHER GENERAL CONDITIONS

PURPOSE
Item 1.0. Definitions
Item 1.1. Proposal Form
Item 1.2. Quantities in Proposal Form
Item 1.3. Examination of Plans, Specifications and Site of the Work
Item 1.4. Preparation of Proposal
Item 1.5. Proposal Guaranty
Item 1.6. Filing of Proposals
Item 1.7. Withdrawing Proposals
Item 1.8. Opening Proposals
Item 1.9. Irregular Proposals
Item 1.10. Rejection of Proposals
Item 1.11. Disqualification of BIDDERS
Item 1.12. Consideration of Contract
Item 1.13. Award of Contract and Commencement of Work
Item 1.14. Return of Proposal Guaranty
Item 1.15. Surety Bonds
Item 1.16. Notice to Proceed
Item 1.17. Execution of Contract
Item 1.18. Failure to Execute Contract
Item 1.19. Priority of Contract Documents
Item 1.20. Correlation and Intent of Documents
Item 1.21. CONTRACTOR’S Warranties and Understanding
Item 1.22. CONTRACTOR’S Responsibilities
Item 1.23. Compliance with Laws
Item 1.24. Protection of Work and of Persons and Property
Item 1.25. Payment for Labor and Material; No Liens
Item 1.26. Insurance
Item 1.27. Materials and Workmanship; Warranties and Guarantees
Item 1.28. Shop Drawings, Product Data and Samples
Item 1.29. Means and Methods of Construction
Item 1.30. Supervision by CONTRACTOR
Item 1.31. Employees
Item 1.32. Working Area; Coordination with Other CONTRACTORS; Final Cleanup
Item 1.33. Other CONTRACTORS; Obligation to Cooperate
Item 1.34. OWNER’S Right to Temporarily Suspend Work
Item 1.35. Use of Completed Portions of Work
Item 1.36. Delays; Extension of Time; Liquidated Damages
Item 1.37. Change or Modification of Contract
Item 1.38. Payment for Extra Work
Item 1.39. Disputed Work and Claims for Additional Compensation
Item 1.40. Performance of Extra or Disputed Work
Item 1.41. Authority of the Engineer
Item 1.42. Inspection and Tests
Item 1.43. No Waiver of Rights or Estoppel
Item 1.44. CONTRACTOR Default; OWNER’S Right to Suspend Work and Annul Contract
Table of Contents

GENERAL PROVISIONS

Item 1.45. Suspension by Court Order Against the OWNER
Item 1.46. Subcontracts
Item 1.47. Assignments
Item 1.48. Claims Against OWNER and Action Thereon
Item 1.49. OWNER’S Officers, Employees or Agents
Item 1.50. Patents
Item 1.51. Monthly Estimate, Partial Payments, Retainage, Final Inspection, Acceptance and Final Payment
Item 1.52. Payment Withheld
Item 1.53. Service of Notices
Item 1.54. Unlawful Provisions Deemed Stricken
Item 1.55. All Legal Provisions Included
Item 1.56. Equal Employment Opportunity
Item 1.57. Termination for Convenience of the OWNER
Item 1.58. State and Local Sales and Use Taxes
Item 1.59. Venue and Governing Law
Item 1.60. No Waiver of Legal Rights
Item 1.61. Obligation to Perform Functions
Item 1.62. Successors and Assigns
Item 1.63. Headings
DIVISION 1 PROPOSAL REQUIREMENTS AND OTHER GENERAL CONDITIONS

PURPOSE
The purpose of this document is to accomplish the following:
— provide a common framework for public works construction,
— simplify the bidding process for both local governments and contractors,
— provide a continuing amendment process to meet the changing demands for new technologies, new materials and improved methods, and
— decrease construction costs for public works projects.

It is not the intent of these specifications to create or otherwise establish or designate any particular class or group of persons or products that will or should be especially protected or benefited by the terms of these standard specifications. Nor is it the intent of these specifications to exclude alternative materials or prohibit alternative construction methods.

ITEM 1.0. DEFINITIONS
The following words and expressions, or pronouns used in their place, shall wherever they appear in this contract be construed as follows, unless a different meaning is clear from the context:

Addendum, Bulletin or Letter of Clarification: Any additional contract provisions, or change, revisions or clarification of the contract documents issued in writing by the OWNER, to prospective bidders prior to the receipt of bids.

Contract or Contract Documents: The written agreement covering the performance of the work. The contract and contract documents include the advertisement, instructions to bidders, proposal, addendum, specifications, including the general, special and technical conditions, provisions, plans or working drawings — and any supplemental changes or agreements pertaining to the work or materials therefor; and bonds and any additional documents incorporated by reference in the above.

CONTRACTOR: The person, persons, partnership, firm, corporation, association or organization, or any combination thereof, entering into the contract for the performance of the work, acting directly or through a duly authorized representative.

Other CONTRACTORS: Any contractor, other than the CONTRACTOR or his subcontractors, who has a direct contact with the OWNER for work on or adjacent to the site of the work.

Contract Work: Everything expressly or impliedly required to be furnished and done by the CONTRACTOR by any one or more parts of the contract documents, except "extra work" as hereinafter defined; it being understood that, in case of any inconsistency between any part or parts of this contract, the OWNER shall determine which shall prevail in accordance with Item 1.20. hereof.

Engineer: The term "Engineer" means the Engineer or his duly authorized representative. The Engineer shall be understood to be the engineer of the OWNER, and nothing contained in the contract documents shall create any contractual or agency relationship between the Engineer and the CONTRACTOR.

Extra Work: Work other than that which is expressly or impliedly required by the contract documents at the time of the execution of the contract.

Change Order: A written order to the CONTRACTOR authorizing and directing an addition, deletion or revision in the work within the general scope of the contract documents, or authorizing an adjustment in the contract price or the contract time.

Contract Price: The total monies payable to the CONTRACTOR under the terms and conditions of the contract documents. When used in such context, it may also mean the unit price of an item of work under the contract terms.

OWNER'S Representative: The Engineer or other duly authorized assistant, agent, engineer, inspector or superintendent acting within the scope of the particular duties instructed to him.

Drawings or Contract Drawings: Only those drawings specifically entitled as such and as specified in the contract, or in any bulletin, or any detailed drawing furnished by the OWNER, pertaining or supplemental thereto.

Inspector: Any representative of the OWNER designated to inspect the work.

JANUARY 1998
Major Item: A major item is any line item of the work to be performed which amounts to 5 percent or more of the total contract amount.

Materialman or Supplier: Any subcontractor contracting with the CONTRACTOR, or any of his subcontractors, to fabricate or deliver or who actually fabricates or delivers, materials, supplies or equipment to be consumed or incorporated into the work.

Notice: Written notice effective the date of the postmark thereon, or if hand delivered, effective the date of hand delivery.

OWNER: The public governmental agency identified throughout the contract documents or the entity as specifically identified in the contract. The term OWNER means the OWNER or its authorized representative.

Payment Bond: The approved form of security furnished by the CONTRACTOR and his sureties for the protection of all claimants supplying labor and materials in the prosecution of the work.

Performance Bond: The approved form of security furnished by the CONTRACTOR and his sureties conditioned upon the faithful performance of the work in strict accordance with the plans, specifications and contract documents.

Proposal: The written statement or statements duly submitted to the OWNER by the person, persons, partnership, company, firm, association or corporation proposing to do the work contemplated, including the approved form on which the formal bids for the work are to be proposed.

Plan or Plans: All the drawings pertaining to the contract and made a part thereof, including any supplementary drawings or addenda as the Engineer may issue in order to clarify other drawings, or for the purpose of showing changes in the work hereinafter authorized, or for showing details not shown therein.

Specifications or Contract Specifications: All of the general, special and technical conditions or provisions, and all addendum or supplements thereto.

Site: The area upon or in which the CONTRACTOR'S operations are carried on, and such other areas adjacent thereto as may be designated as such by the OWNER.

Subcontractors: Any persons, firm or corporation, other than employees of the CONTRACTOR, who or which contracts with the CONTRACTOR to furnish, or who actually furnishes, labor and/or materials and equipment at or about the site.

Sureties: The corporate bodies which are bound by such bonds as are required with and for the CONTRACTOR. The sureties engaged to be responsible for the entire and satisfactory fulfillment of the contract, and for any and all requirements as set out in the specifications, contract or plans.

The Work: All work including the furnishing of all labor, materials, tools, equipment, required submittals and incidentals to be performed by the CONTRACTOR under the terms of the contract.

Directed, Required, Approved and Words of Like Import: Whenever they apply to the work or its performance, the words “directed,” “required,” “permitted,” “ordered,” “designated,” “established,” “prescribed” and words of like import used in the contract, specifications or upon the drawings shall imply the direction, requirement, permission, order, designation or prescription of the OWNER; and “approved,” “acceptable,” “satisfactory” and words of like import shall mean approved by, acceptable to or satisfactory to the OWNER.

Equal: Materials, articles or methods which are of equal or higher quality than those specified or shown on the drawings and as further defined in the “or equal” clause.

Special Provisions or Conditions: The special clauses, setting forth conditions or requirements peculiar to the specific project involved, supplementing the standard or general specifications and taking precedence over any conditions or requirements of the standard or general specifications with which they are in conflict.

Working Time, Completion Time or Contract Time: The time set forth in the contract for the performance and completion of the work contracted for. The time may be expressed as calendar days, working days or a specific date.

Calendar Day or Days: Any successive days of the week or month, no days being excepted.

Working Day: A working day is defined as a calendar day not including Saturdays, Sundays or those legal holidays as specified in the list prepared by the OWNER for contract purposes, in which weather or other conditions not under the control of the CONTRACTOR shall permit the performance of the principal units of work underway for a continuous period of not less than seven hours between 7 a.m. and 6 p.m. A principal unit of work shall be that unit which controls the completion time of the contract. Nothing in this definition shall be construed as prohibiting the CONTRACTOR from working on Saturdays if he so desires and permission of the OWNER has been granted. Work on Sundays shall not be permitted except in cases of extreme emergency and then only with the written permission of
the OWNER. If Saturday or Sunday work is permitted, working time shall be charged on the same basis as week days. Where the working time is expressed as calendar days or a specific date, the concept of working days shall no longer be relevant to the contract.

Abbreviations: Wherever the abbreviations defined herein occur on the plans, in the specifications, contract, bonds, advertisement, proposal or in any other document or instrument herein contemplated or to which the specifications apply or may apply, the intent and meaning shall be as follows:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>AATCC</td>
<td>American Association of Textile Chemists and Colorists</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>API</td>
<td>American Petroleum Institute</td>
</tr>
<tr>
<td>AREA</td>
<td>American Railway Engineering Assn.</td>
</tr>
<tr>
<td>ASA</td>
<td>American Standards Association</td>
</tr>
<tr>
<td>Asph.</td>
<td>Asphalt</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>AT&amp;SF</td>
<td>Atchinson, Topeka and Santa Fe Railroad</td>
</tr>
<tr>
<td>Ave.</td>
<td>Avenue</td>
</tr>
<tr>
<td>AWS</td>
<td>American Welding Society</td>
</tr>
<tr>
<td>AWWA</td>
<td>American Water Works Association</td>
</tr>
<tr>
<td>Blvd.</td>
<td>Boulevard</td>
</tr>
<tr>
<td>C</td>
<td>Centigrade</td>
</tr>
<tr>
<td>CI</td>
<td>Cast Iron</td>
</tr>
<tr>
<td>CL</td>
<td>Center Line</td>
</tr>
<tr>
<td>cm</td>
<td>Centimeter</td>
</tr>
<tr>
<td>CO</td>
<td>Cleanout</td>
</tr>
<tr>
<td>Conc.</td>
<td>Concrete</td>
</tr>
<tr>
<td>Cond.</td>
<td>Conduit</td>
</tr>
<tr>
<td>Corr.</td>
<td>Corrugated</td>
</tr>
<tr>
<td>Cu.</td>
<td>Cubic</td>
</tr>
<tr>
<td>Culv.</td>
<td>Culvert</td>
</tr>
<tr>
<td>CY</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>Dia.</td>
<td>Diameter</td>
</tr>
<tr>
<td>DPL</td>
<td>Dallas Power &amp; Light Company</td>
</tr>
<tr>
<td>Dr.</td>
<td>Driveway</td>
</tr>
<tr>
<td>Elev.</td>
<td>Elevation</td>
</tr>
<tr>
<td>F</td>
<td>Fahrenheit</td>
</tr>
<tr>
<td>Ft. or '</td>
<td>Foot or Feet</td>
</tr>
<tr>
<td>Gal.</td>
<td>Gallon</td>
</tr>
<tr>
<td>GTE</td>
<td>General Telephone and Electric Co.</td>
</tr>
<tr>
<td>HP</td>
<td>Horsepower</td>
</tr>
<tr>
<td>Hr.</td>
<td>Hour</td>
</tr>
<tr>
<td>HS</td>
<td>Horseshoe</td>
</tr>
<tr>
<td>ID</td>
<td>Inside Diameter</td>
</tr>
<tr>
<td>In. or &quot;</td>
<td>Inch or Inches</td>
</tr>
<tr>
<td>Kg.</td>
<td>Kilogram</td>
</tr>
<tr>
<td>Lb.</td>
<td>Pound or Pounds</td>
</tr>
<tr>
<td>LF.</td>
<td>Linear foot or feet</td>
</tr>
<tr>
<td>Lin.</td>
<td>Linear</td>
</tr>
<tr>
<td>LOI</td>
<td>Loss on Ignition</td>
</tr>
<tr>
<td>LSG</td>
<td>Lone Star Gas Co.</td>
</tr>
<tr>
<td>m</td>
<td>Meter</td>
</tr>
<tr>
<td>Max.</td>
<td>Maximum</td>
</tr>
<tr>
<td>MH</td>
<td>Manhole</td>
</tr>
<tr>
<td>Min.</td>
<td>Minimum</td>
</tr>
<tr>
<td>mm</td>
<td>Millimeter</td>
</tr>
<tr>
<td>Mono.</td>
<td>Monolithic</td>
</tr>
<tr>
<td>No.</td>
<td>Number</td>
</tr>
<tr>
<td>OD</td>
<td>Outside Diameter</td>
</tr>
<tr>
<td>%</td>
<td>Percent</td>
</tr>
<tr>
<td>PI</td>
<td>Plasticity Index</td>
</tr>
<tr>
<td>psi</td>
<td>Pounds per Square Inch</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinyl Chloride</td>
</tr>
<tr>
<td>R</td>
<td>Radius</td>
</tr>
<tr>
<td>Reinf.</td>
<td>Reinforced or reinforcing</td>
</tr>
<tr>
<td>Rem.</td>
<td>Remove</td>
</tr>
<tr>
<td>Rep.</td>
<td>Replace</td>
</tr>
<tr>
<td>R/W,</td>
<td>Right-of-Way</td>
</tr>
<tr>
<td>ROW</td>
<td>Right-of-Way</td>
</tr>
<tr>
<td>San., San.</td>
<td>Sanitary</td>
</tr>
<tr>
<td>Sec.</td>
<td>Second</td>
</tr>
<tr>
<td>Sq.</td>
<td>Square</td>
</tr>
<tr>
<td>St.</td>
<td>Street or Storm</td>
</tr>
<tr>
<td>Std.</td>
<td>Standard</td>
</tr>
<tr>
<td>Str.</td>
<td>Strength</td>
</tr>
<tr>
<td>SWBT</td>
<td>Southwestern Bell Telephone Company</td>
</tr>
<tr>
<td>SY</td>
<td>Square Yard</td>
</tr>
<tr>
<td>TESCO</td>
<td>Texas Electric Service Company</td>
</tr>
<tr>
<td>TPL</td>
<td>Texas Power &amp; Light Company</td>
</tr>
<tr>
<td>Texas</td>
<td>Texas State Department of Highways and Public Transportation</td>
</tr>
<tr>
<td>um</td>
<td>Micrometers</td>
</tr>
<tr>
<td>Vert.</td>
<td>Vertical</td>
</tr>
<tr>
<td>Vol.</td>
<td>Volume</td>
</tr>
<tr>
<td>WUT</td>
<td>Western Union Telegraph Company</td>
</tr>
<tr>
<td>Company</td>
<td></td>
</tr>
<tr>
<td>Yd.</td>
<td>Yard</td>
</tr>
</tbody>
</table>
ITEM 1.1. PROPOSAL FORM
The owner shall furnish bidders with proposal 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 bid prices are asked. The proposal form shall specify the form and amount of the proposal guaranty.

ITEM 1.2. QUANTITIES IN PROPOSAL FORM
The quantities of the work and materials set forth in the proposal form 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.

ITEM 1.3. EXAMINATION OF PLANS, SPECIFICATIONS AND SITE OF THE WORK
Bidders are advised that the plans, specifications and other documents on file as stated in the advertisement 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.

ITEM 1.4. PREPARATION OF PROPOSAL
The bidder shall submit his 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, both in words and numerals, for which he proposes to do the work contemplated or furnish the material required. Such prices shall be written in ink distinctly and legibly. In cases of discrepancy between the price written in words and price written in figures, the price written in words shall govern. If the proposal is submitted by an individual, his name must be signed by him or his duly authorized agent. If the 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 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 proposal must be properly certified and must be in writing and submitted with the proposal. The proposal shall be executed in ink. It is understood and agreed that the proposal may not be withdrawn once the bid-opening process has begun.

ITEM 1.5. PROPOSAL GUARANTY
No proposal shall be considered unless it is accompanied by a 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 dam-
GENERAL PROVISIONS

ages 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 requisite notices may be delivered and upon whom service of process may be had.

In the event 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.

ITEM 1.6. FILING OF PROPOSALS

No proposal shall be considered unless it is filed at the place and within the time limit for receiving proposals as stated in the advertisement. Each proposal shall be in a sealed envelope, plainly marked with the word “Proposal” and the name or description of the project as designated in the advertisement.

ITEM 1.7. WITHDRAWING PROPOSALS

Proposals filed with the OWNER can be withdrawn or modified and redeposited prior to the time set for opening proposals. Request for non-consideration of proposals must be made in writing addressed to the OWNER prior to the time set for opening proposals. After other proposals are opened and publicly read, the proposal for which non-consideration is properly requested may be returned unopened. The proposal may not be withdrawn after the bid opening has commenced. The bidder, in submitting the same, warrants and represents that his bid has been carefully reviewed and checked and that it is in all things true and accurate and free of mistakes and that such bid shall not and cannot be withdrawn after opening because of any mistake committed by the bidder; provided, however, that any bidder may withdraw his bid 60 days after the actual date of opening thereof, should no award have been made to such bidder.

ITEM 1.8. OPENING PROPOSALS

The proposals filed with the OWNER shall be opened at the time stated in the advertisement, or any subsequently issued addendum, and publicly read aloud, and shall thereafter remain on file with the OWNER. No contract shall be awarded based on such proposals until after at least two days have elapsed.

ITEM 1.9. IRREGULAR PROPOSALS

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 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, he 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 any error discovered.

ITEM 1.10. REJECTION OF PROPOSALS

The OWNER reserves the right to reject any or all proposals; and all proposals submitted are subject to this reservation. Proposals shall be rejected for any of the following specific reasons:

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

(b) proposal unaccompanied by the required bid security;

(c) proposal constituting a nonresponsive bid;

JANUARY 1998
ITEM 1.11. DISQUALIFICATION OF BIDDERS
Bidders may be disqualified and their proposal not considered for any of the following specific reasons:
(a) reason for believing collusion exists among the bidders;
(b) reasonable grounds for believing that any bidder is interested in more than one proposal for the work contemplated;
(c) the bidder 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;
(d) the bidder being in arrears on any existing contract or having defaulted on a previous contract;
(e) lack of competency, responsibility or financial capability as revealed by the bid questionnaires, financial statement, etc.;
(f) uncompleted work which in the judgment of the OWNER shall prevent or hinder the prompt completion of additional work if awarded;
(g) failure of bidder to use OWNER’S form of bid bond in submitting his bid, or submission of a cashier’s check drawn on a state or national bank not located in the OWNER’S jurisdictional area;
(h) unbalanced value of any bid items.

ITEM 1.12. CONSIDERATION OF CONTRACT
After proposals are opened, the proposals shall be tabulated for comparison on the basis of the bid prices and quantities shown in the proposal. Until final award of the contract, the OWNER reserves the right to reject any or all proposals, to waive technicalities or irregularities at its option, to readvertise for new proposals or proceed to do the work otherwise in the best interests of the OWNER. Each bidder shall be furnished a copy of the bid tabulation upon request.

ITEM 1.13. AWARD OF CONTRACT AND COMMENCEMENT OF WORK
The award, if made, shall be to the lowest responsible bidder within 90 days after the opening of proposals; but in no case shall the award be made until after investigations are made as to the responsibility of the bidder to whom it is proposed to award the contract. Following award and execution of the contract and required surety bonds, the CONTRACTOR shall commence work within 10 days from the date specified in a written work order to be 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, the contract amount to remain unchanged.

ITEM 1.14. RETURN OF PROPOSAL GUARANTY
The OWNER shall normally return the proposal guaranties accompanying all proposals within 10 working days after bid opening except for the three apparent low proposals. The three apparent low proposal guaranties shall be retained by the OWNER until the required contract and surety bonds have been executed, after which they shall be returned.

ITEM 1.15. SURETY BONDS
(a) Contractor Surety. With the execution and delivery of the contract, the CONTRACTOR shall furnish and file with the OWNER in the amounts herein required, performance and payment bonds in accordance with the provisions of Article 5160, Revised Civil Statutes of Texas, as amended and Article 7.19-1 of the Insurance Code, as amended. These required surety bonds are set forth in Item 1.21.1. The sureties shall be listed in the most current Federal Register Treasury List. The OWNER reserves the right to reject any and all sureties.
(b) Developer Surety. In order to insure that it might not incur liabilities, a city may require, before it gives approval of the plans for development, that the OWNER of said development shall provide sufficient surety to guarantee that
ITEM 1.16. NOTICE TO PROCEED
Upon receipt of the executed contract and the required surety bonds, a notice to proceed shall be issued indicating the date upon which the contract time shall start and the projected date of completion.

ITEM 1.17. 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 receipt 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.

ITEM 1.18. FAILURE TO EXECUTE CONTRACT
The failure of the bidder 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 security. In the event the OWNER should readvertise for bids, the defaulting CONTRACTOR shall not be eligible to bid.

ITEM 1.19. PRIORITY OF CONTRACT DOCUMENTS
In case of conflict between contract documents, priority of interpretation shall be in the following order: signed agreement (or contract), performance and payment bonds, proposal, special provisions (or conditions), advertisement for bids (or invitation to bidders, or request for proposals), project (or contract) drawings, these Standard Specifications for Public Works Construction - North Central Texas, standard drawings, referenced specifications. (Reference Items 1.20.1., 1.20.3., 1.39., and 1.41.)

ITEM 1.20. CORRELATION AND INTENT OF DOCUMENTS
The contract documents are complementary and what is called for by any one shall be as binding as if called for by all. The intent of the documents, unless otherwise specifically provided, is to produce complete and finished work, which the CONTRACTOR undertakes to do in full compliance with the contract documents. It is not intended to mention every item of work in the specifications which can be adequately shown on the drawings nor to show on the drawings all items of work described or required by the specifications. All materials or labor for work shown on the drawings or reasonably inferable therefrom as being necessary to produce a finished job shall be provided by the CONTRACTOR whether or not same is expressly covered in the specifications. No verbal conversation, understanding or agreement with any officer or employee or agent of the OWNER, either before or after the execution of the contract, shall affect or modify any of the terms, conditions or obligations contained in the contract documents.

1.20.1. CONTRACT DRAWINGS AND SPECIFICATIONS
The OWNER shall furnish the CONTRACTOR, without charge, such copies of the contract and any supplemental drawings and specifications reasonably necessary for the proper execution of the work. At least one copy of all drawings and specifications shall be accessible at all times to the OWNER at the job site.

The plans, these specifications, the proposal, special provisions and all supplementary documents are intended to describe a complete work and are essential parts of the contract. All requirements occurring in any of them is binding. In cases of discrepancies, figure dimensions shall govern over scaled dimensions, plans shall govern over specifications, and special provisions shall govern over both general and standard specifications.

1.20.2. SUPPLEMENTAL DRAWINGS AND SPECIFICATIONS
In order to carry out the intent of the contract documents and to assist the CONTRACTOR in performing his work, the OWNER, after the execution of the contract, may, by supplemental drawings, specifications or otherwise, furnish additional information or instructions as may be necessary for construction purposes.

JANUARY 1998
All such supplemental drawings, specifications or instructions are intended to be consistent with the contract documents and reasonably inferable therefrom. Therefore, no extra costs shall be allowed by the OWNER on a claim that particular supplemental drawings, specifications or instructions differ from the requirements of the contract documents, incurring extra costs, unless the CONTRACTOR has first brought the matter, in writing, to the OWNER’S attention for adjustment before proceeding with the work covered by such.

If the OWNER shall decide that there is no departure from the requirements of the contract documents, the CONTRACTOR shall then proceed with the work as shown, specified or directed. If the OWNER shall decide that extra work is involved, he shall so modify the supplemental drawings, specifications or instructions to eliminate the extra work, or cause a written change order to be issued in accordance with Item 1.37. herein.

1.20.3. ERRORS AND CORRECTIONS IN DRAWINGS AND SPECIFICATIONS

The CONTRACTOR shall not take advantage of any apparent errors, omissions or discrepancies in the drawings or specifications; and the Engineer shall be permitted to make such corrections or interpretations as may be necessary for the fulfillment of the intent of the contract documents. In case of any errors, omissions or discrepancies in the drawings or specifications, the CONTRACTOR shall promptly submit the matter to the OWNER who, in turn, shall promptly make a determination and issue the necessary instructions in writing. Any adjustment by the CONTRACTOR without this determination and instructions shall be at the CONTRACTOR’S own risk and expense. The work is to be made complete as intended by the contract documents.

1.20.4. 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 of these structures on the plans or to 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.

ITEM 1.21. CONTRACTOR’S WARRANTIES AND UNDERSTANDING

In consideration of, and to induce the award of this contract to him, the CONTRACTOR represents and warrants:
(a) that he is financially solvent, and sufficiently experienced and competent to perform the work;
(b) that the facts stated in the proposal and the information given by him pursuant to the bidding documents are true and correct in all respects;
(c) that he has read, understood and complied with all the requirements set forth in the bidding documents;
(d) that he is familiar with and understands all laws and regulations applicable to the work; and
(e) unless otherwise specifically provided for in the contract documents, the CONTRACTOR shall do all the work and shall furnish all the tools, equipment, machinery, materials, labor and appliances, except as herein otherwise specified, necessary or proper for performing and completing the work required by this contract, in the manner and within the time herein prescribed.

By executing the contract, the CONTRACTOR represents that he has visited the site of work, has fully familiarized himself with the local and on-site conditions under which the work is to be performed and has correlated his observation with the requirements of the contract documents. In addition, the CONTRACTOR represents that he has satisfied himself as to subsurface conditions at the site of the work. Information, data and representations contained in the contract documents pertaining to the conditions at the site, including subsurface conditions, are for information only and are not warranted or represented in any manner to accurately show the conditions at the site of the work. The CONTRACTOR agrees that he shall make no claims for damages, additional compensation or extension of time against the OWNER because of encountering actual conditions in the course of the work which vary or differ from conditions or information contained in the contract documents. All risks of differing subsurface conditions shall be borne solely by the CONTRACTOR.
1.21.1. SURETY BONDS

With the execution and delivery of the contract, the CONTRACTOR shall furnish and file with the OWNER in the amounts herein required, the surety bonds specified hereunder. Without exception, the OWNER’S bond forms must be used, and exclusive venue for any lawsuit in connection with such bonds shall be specified as the county in which the OWNER’S principal office is located. Such surety bonds shall be in accordance with the provisions of Article 5160, Revised Civil Statutes of Texas, as amended, and Article 7.19-1 of the Insurance Code, as amended. These bonds shall automatically be increased by the amount of any change order or supplemental agreement which increases the contract price with or without notice to the surety, but in no event shall a change which reduces the contract amount reduce the penal amount of such bonds.

(a) Performance Bond. A good and sufficient bond in an amount not less than 100 percent of the approximate total amount of the contract, as evidenced by the proposal tabulation, or otherwise guaranteeing the full and faithful execution of the work and performance of the contract in accordance with the plans, specifications and contract documents, including any extensions thereof, for the protection of the OWNER. This bond shall provide for the repair and/or replacement of all defects due to faulty materials and workmanship that appear within a period of one year from the date of completion and acceptance of the improvement by the OWNER or such lesser or greater period as may be designated in the contract documents.

(b) Payment Bond. A good and sufficient bond in an amount not less than 100 percent of the approximate total amount of the contract, as evidenced by the proposal tabulation, or otherwise guaranteeing the full and proper protection of all claimants supplying labor and material in the prosecution of the work provided for in said contract and for the use of each claimant.

(c) Sureties. No sureties shall be accepted by the OWNER who are now in default or delinquent on any bonds or who are interested in any litigation against the OWNER. All bonds shall be made on forms furnished by the OWNER and shall be executed by not less than one corporate surety authorized to do business in the State of Texas and acceptable to the OWNER. The sureties shall be listed in the most current Federal Register Treasury List. Each bond shall be executed by the CONTRACTOR and surety. Each surety shall designate an agent resident in the OWNER’S jurisdictional area acceptable to the OWNER to whom any requisite notices may be delivered and on whom service of process may be had in matters arising out of such suretyship. The OWNER reserves the right to reject any and all sureties.

(d) Additional or Substitute Bonds. If at any time the OWNER is or becomes dissatisfied with any surety, then upon the performance or payment bond, the CONTRACTOR shall, within five days after notice form the OWNER to do so, substitute an acceptable bond (or bonds), or provide an additional bond, in such form and sum and signed by such other surety or sureties as may be satisfactory to the OWNER. The premiums on such bonds shall be paid by the CONTRACTOR without recourse to the OWNER. No further payments under the contract shall be deemed due or payable until the substitute or additional bonds shall have been furnished and accepted by the OWNER.

ITEM 1.22. CONTRACTOR’S RESPONSIBILITIES

1.22.1. PERFORMANCE OF THE WORK

In addition to those matters elsewhere expressly made the responsibility of the CONTRACTOR, the CONTRACTOR shall have the full and direct responsibility for the performance and completion of the work under this contract and for any act or neglect of the CONTRACTOR, his agents, employees or subcontractors. He shall bear all losses, if any, resulting on account of the amount and character of the work, or because the conditions under which the work must be done are different from what were estimated or anticipated by him, or because of weather, floods, elements or other causes.

1.22.2. INDEMNIFICATION

The CONTRACTOR and his sureties shall indemnify, defend and save harmless the OWNER and all of its officers, agents and employees from all suits, actions or claims of any character, name and description brought for or on account of any injuries or damages received or sustained by any person, persons or property on account of the operations of the CONTRACTOR, his agents, employees or subcontractors; or on account of any negligent act or fault of the CONTRACTOR, his agents, employees or subcontractors in the execution of said contract; or on account of the failure of the CONTRACTOR to provide the necessary barricades, warning lights or signs; and shall be required to pay any judgment, with cost, which may be obtained against the OWNER growing out of such injury or damage.

JANUARY 1998
The CONTRACTOR likewise covenants and agrees to, and does hereby, indemnify and hold harmless the OWNER from and against any and all injuries, loss or damages to property of the OWNER during the performance of any of the terms and conditions of this Contract, whether arising out of or in connection with or resulting from, in whole or in part, any and all alleged acts or omissions of officers, agents, servants, employees, contractors, subcontractors, licenses or invitees of the OWNER.

1.22.3. SUPERVISION AND CONSTRUCTION PROCEDURES
The CONTRACTOR shall supervise and direct all the work, using his best skill and attention. He shall be solely responsible for all construction means, methods, techniques, sequences and procedures and for coordinating all portions of the work under the contract.

The CONTRACTOR shall carefully study and compare the contract documents and shall at once report to the OWNER any error, inconsistency or omission he may discover. The CONTRACTOR shall perform no portion of the work at any time without contract documents or, where required, approved shop drawings, product data or samples for such portion of the work.

The CONTRACTOR shall be responsible to the OWNER for the acts and omissions of his employees, subcontractors and their agents, employees and subcontractors performing any of the work under a contract with the CONTRACTOR.

The CONTRACTOR shall not be relieved from his obligations to perform the work in accordance with the contract documents either by the activities or duties of the OWNER in his administration of the contract, or by inspections, tests or approvals required or performed by persons other than the CONTRACTOR.

1.22.4. LABOR AND MATERIALS
Unless otherwise provided in the contract documents, the CONTRACTOR shall provide and pay for all labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation and other facilities and services necessary for the proper execution and completion of the work, whether temporary or permanent and whether or not incorporated or to be incorporated into the work.

The CONTRACTOR shall at all times enforce strict discipline and good order among his employees and shall not employ on the work site any unfit person or anyone not skilled in the task assigned to him.

1.22.5. PROGRESS SCHEDULE
The CONTRACTOR, immediately after being awarded the contract, shall prepare and submit for the OWNER’s information an estimated progress schedule for the work. The progress schedule shall be related to the entire project to the extent required by the contract documents and shall provide for expeditious and reasonable execution of the work. The progress schedule shall be updated upon request by the OWNER.

1.22.6. PERFORMANCE OF THE WORK
The CONTRACTOR shall begin the work to be performed under this contract not later than 10 days from the date specified in the work order and shall conduct the work in such a manner and with sufficient equipment, material and labor as is necessary to insure its completion within the working time. It is the intent of this specification to provide a continuous construction operation without delay except as occasioned by unforeseeable causes beyond the control and without the fault or negligence of the CONTRACTOR, and it shall be the CONTRACTOR’s responsibility to execute the work in the most expeditious manner.

Work shall be done only during the regular and commonly accepted and prescribed working hours. No work shall be done on nights, Sundays or regular holidays unless permission is given by the OWNER.

The rate of progress shall be such that the whole work shall be performed and the premises cleaned up in accordance with the contract within the working time established in the contract, unless an extension of time is made in the manner hereinafter specified.

ITEM 1.23. COMPLIANCE WITH LAWS
The CONTRACTOR shall fully comply with all local, state and federal laws, including all codes, ordinances and regulations applicable to this contract and the work to be done thereunder, which exist or which may be enacted later by governmental bodies having jurisdiction or authority for such enactment.
ITEM 1.24. PROTECTION OF WORK AND OF PERSONS AND PROPERTY

1.24.1. PROTECTION OF WORK
During performance and up to date of final acceptance, the CONTRACTOR shall be under the absolute obligation to protect the finished work against any damage, loss or injury. In the event of such damage, loss or injury, the CONTRACTOR shall promptly replace or repair such work, whichever the OWNER shall determine to be preferable. The obligation to deliver finished work in strict accordance with the contract prior to final acceptance shall be absolute and shall not be affected by the OWNER’S approval of or failure to prohibit means and methods of construction used by the CONTRACTOR. All risk of loss or damage to the work shall be borne solely by the CONTRACTOR until final completion and acceptance of all work by the OWNER, as evidenced by the OWNER’S issuance of a certificate of acceptance.

1.24.2. PROTECTION OF PERSONS AND PROPERTY
The CONTRACTOR shall have the responsibility to provide and maintain all warning devices and take all precautionary measures required by law or otherwise to protect persons and property while said persons or property are approaching, leaving or within the work site or any area adjacent to said work site. No separate compensation shall be paid to the CONTRACTOR for the installation or maintenance of any warning devices, barricades, lights, signs or any other precautionary measures required by law or otherwise for the protection of persons or property.

The CONTRACTOR shall assume all duties owed by the OWNER to the general public in connection with the general public’s immediate approach to and travel through the work site and the area adjacent to said work site. Where the work is carried on in or adjacent to any street, alley, sidewalk, public right-of-way or public place, the CONTRACTOR shall at his own cost and expense provide such flagmen and watchmen and furnish, erect and maintain such warning devices, barricades, lights, signs and other precautionary measures for the protection of persons or property as may be prudent or necessary, or as are required by law. The CONTRACTOR’S responsibility for providing and maintaining flagmen, watchmen, warning devices, barricades, signs and lights and other precautionary measures shall not cease until the project shall have been completed and accepted by the OWNER, and shall cease when the certificate of acceptance is issued by the OWNER as mentioned in Item 1.51.

If the OWNER discovers that the CONTRACTOR has failed to comply with the applicable federal and state law (by failing to furnish the necessary flagmen, warning devices, barricades, lights, signs or other precautionary measures for the protection of persons or property), the OWNER may order the CONTRACTOR to take such additional precautionary measures as required by law to be taken to protect persons and property.

In addition, the CONTRACTOR shall be held responsible for all damages to the work and other public or private property due to the failure of warning devices, barricades, signs, lights or other precautionary measures in protecting said property; and whenever evidence is found of such damage, the OWNER may order the damaged portion immediately removed and replaced by and at the cost and expense of the CONTRACTOR.


1.24.3. TRENCH SAFETY
The CONTRACTOR shall be responsible for complying with state laws and federal regulations relating to trench safety, including those which may be enacted during the performance under this contract. The CONTRACTOR shall be responsible for selecting an appropriate method of providing trench safety after due consideration of the job conditions, location of utilities, pavement conditions and other relevant factors. Slope-back methods which may result in unnecessary displacement of utilities and/or destruction of pavement may not be used without permission from the OWNER. The CONTRACTOR shall be responsible for providing to the OWNER an acceptable trench safety plan signed and sealed by a Professional Engineer qualified to do such work and registered in Texas. Devices used to provide...
trench safety such as trench shields and shoring systems will be likewise certified by professional engineers registered in the State of Texas or by a professional engineer registered in the state of manufacture of the shield.

1.24.4. PAYMENT FOR TRENCH SAFETY
Payment for trench safety shall be by the lineal feet of trench exceeding a depth of five (5) ft. Excavation for slope-back methods shall be subsidiary to the trench safety pay item including replacement and recompaction. Excess excavation for other trench safety methods is also subsidiary to the trench safety pay item. Costs relating to the preparation of the trench safety plan including geotechnical investigation, testing and report preparation fees are all subsidiary to the pay item for trench safety. Should trench safety measures be required during contract performance where no pay item has been provided, then the CONTRACTOR shall immediately notify the OWNER and, if directed to do so, provide trench safety under the provisions of Item 1.37.3. and/or 1.38. Should the OWNER fail to authorize the work as provided for in 1.37.3. and 1.38., then the CONTRACTOR shall proceed under the provisions of Items 1.39. and 1.40. Trench safety requirements are mandatory and may not be waived.

1.24.5. PAYMENT FOR SPECIAL SHORING
Payment for special shoring, if any, shall be based on the square feet of shoring used.

ITEM 1.25. PAYMENT FOR LABOR AND MATERIAL; NO LIENS
The CONTRACTOR for himself or any of his subcontractors shall pay all indebtedness which may become due to any person, firm or corporation having furnished labor, material or both in the performance of this contract. It shall be the responsibility of each person, firm or corporation claiming to have furnished labor, materials or both, in connection with this contract, to protect his or its interest in the manner prescribed by applicable laws of the State of Texas, provided, however, that as this contract provides for a public works project, no lien of any kind shall ever exist or be placed against the work or any portion thereof, or any public funds or retainage held by the OWNER; and any subcontractor shall look solely to the CONTRACTOR and the payment bond surety, and not the OWNER, for payment of any outstanding amounts due for labor, materials or any other indebtedness in connection with the work. However, the OWNER may, at any time prior to making final payment, require the CONTRACTOR to furnish a Consent of Surety to any payment due the CONTRACTOR for completed work and may, at the discretion of the OWNER or the request of the Surety, make the check jointly payable to the CONTRACTOR and the Surety.

ITEM 1.26. INSURANCE

1.26.1. CONTRACTOR’S INSURANCE
Without limiting any of the other obligations or liabilities of the CONTRACTOR, during the term of the contract the CONTRACTOR and each subcontractor at their own expense shall purchase and maintain the herein stipulated minimum insurance with companies duly approved to do business in the State of Texas and satisfactory to the OWNER. Certificates of each policy shall be delivered to the OWNER before any work is started, along with a written statement from the issuing company stating that said policy shall not be canceled, nonrenewed or materially changed without 30 days advance written notice being given to the OWNER, except when the policy is being canceled for nonpayment of premium, in which case 10 days advance written notice is required. Prior to the effective date of cancellation, the CONTRACTOR must deliver to the OWNER a replacement certificate of insurance or proof of reinstatement. A model Certificate of Insurance is illustrated in Appendix A.2. Coverage shall be of the following types and not less than the specified amounts:
(a) workers’ compensation as required by Texas law, with the policy endorsed to provide a waiver of subrogation as to the OWNER; employer’s liability insurance of not less than $100,000 for each accident, $100,000 disease — each employee, $500,000 disease-policy limit.
(b) commercial general liability insurance, including independent contractor’s liability, completed operations and contractual liability, covering, but not limited to, the liability assumed under the indemnification provisions of this contract, fully insuring CONTRACTOR’S (or subcontractor’s) liability for injury to or death of OWNER’S employees and third parties, extended to include personal injury liability coverage with damage to property of third parties, with minimum limits as set forth below:
The policy shall include coverage extended to apply to completed operations, asbestos hazards (if this project involves work with asbestos) and XCU (explosion, collapse and underground) hazards. The completed operations coverage must be maintained for a minimum of one year after final completion and acceptance of the work, with evidence of same filed with OWNER.

1.26.2. OWNER’S PROTECTIVE LIABILITY INSURANCE

CONTRACTOR shall obtain, pay for and maintain at all times during the prosecution of the work under this contract an OWNER’S protective liability insurance policy naming the OWNER and the Engineer as insureds for property damage and bodily injury, which may arise in the prosecution of the work or CONTRACTOR’S operations under this contract. Coverage shall be on an “occurrence” basis, and the policy shall be issued by the same insurance company that carries the CONTRACTOR’S liability insurance with a combined bodily injury and property damage minimum limit of $600,000 per occurrence and $1,000,000 aggregate.

1.26.3. “UMBRELLA” LIABILITY INSURANCE

If required by OWNER, CONTRACTOR shall obtain, pay for and maintain umbrella liability insurance during the contract term, insuring CONTRACTOR for an amount of not less than $1,000,000 per occurrence combined limit for bodily injury and property damage that follows form and applies in excess of the primary liability coverages required hereinabove. The policy shall provide “drop down” coverage where underlying primary insurance coverage limits are insufficient or exhausted. OWNER and Engineer shall be named as additional insureds.

1.26.4. RAILROAD PROTECTIVE INSURANCE

When required in the Special Provisions, CONTRACTOR shall obtain, maintain and present evidence of railroad protective insurance (RPI). The policy shall be in the name of the railroad company having jurisdiction over the right-of-way involved. The minimum limit of coverage shall meet the specifications provided by the railroad company. The OWNER shall specify the amount of RPI necessary.

1.26.5. POLICY ENDORSEMENTS AND SPECIAL CONDITIONS

(a) Each insurance policy to be furnished by CONTRACTOR shall include the following conditions by endorsement to the policy:

1. Each policy shall name the OWNER as an additional insured as to all applicable coverage;

2. Each policy shall require that 30 days prior to the cancellation, nonrenewal or any material change in coverage, a notice thereof shall be given to OWNER by certified mail. If the policy is canceled for nonpayment of premium, only 10 days written notice to OWNER is required;

3. The term “OWNER” shall include all authorities, boards, bureaus, commissions, divisions, departments and offices of the OWNER and individual members, employees and agents thereof in their official capacities and/or while acting on behalf of the OWNER;

4. The policy phrase “other insurance” shall not apply to the OWNER where the OWNER is an additional insured on the policy; and
(5) all provisions of the contract concerning liability, duty and standard of care together with the indemnification provision, shall be underwritten by contractual liability coverage sufficient to include such obligations within applicable policies.

(b) Insurance furnished by the CONTRACTOR shall be in accordance with the following requirements:

(1) any policy submitted shall not be subject to limitations, conditions or restrictions deemed inconsistent with the intent of the insurance requirements to be fulfilled by the CONTRACTOR. The OWNER’s decision thereon shall be final;

(2) all policies are to be written through companies duly licensed to transact that class of insurance in the State of Texas; and

(3) all liability policies required herein shall be written with an “occurrence” basis coverage trigger.

(c) CONTRACTOR agrees to the following:

(1) CONTRACTOR hereby waives subrogation rights for loss or damage to the extent same are covered by insurance. Insurers shall have no right of recovery or subrogation against the OWNER, it being the intention that the insurance policies shall protect all parties to the contract and be primary coverage for all losses covered by the policies;

(2) companies issuing the insurance policies and CONTRACTOR shall have no recourse against the OWNER for payment of any premiums or assessments for any deductibles, as all such premiums and deductibles are the sole responsibility and risk of the CONTRACTOR;

(3) approval, disapproval or failure to act by the OWNER regarding any insurance supplied by the CONTRACTOR (or any subcontractors) shall not relieve the CONTRACTOR of full responsibility or liability for damages and accidents as set forth in the contract documents. Neither shall the bankruptcy, insolvency or denial of liability by the insurance company exonerate the CONTRACTOR from liability; and

(4) no special payments shall be made for any insurance that the CONTRACTOR and subcontractors are required to carry; all are included in the contract price and the contract unit prices.

Any of such insurance policies required under this section may be written in combination with any of the others, where legally permitted, but none of the specified limits may be lowered thereby.

ITEM 1.27. MATERIALS AND WORKMANSHIP; WARRANTIES AND GUARANTEES

Unless otherwise expressly provided in the contract drawings or specifications, the work shall be performed in accordance with the best modern practice with materials and workmanship of the highest quality and suitable for their purpose. The OWNER shall judge and determine the CONTRACTOR’s compliance with these requirements.

1.27.1. “OR EQUAL” CLAUSE

Whenever a material or article required is specified or shown on the plans, by using the name of a proprietary product or of a particular manufacturer or vendor, any material or article which the Engineer determines shall perform adequately the duties imposed by the general design or which the Engineer deems to be of similar appearance (in cases where appearance is of importance) shall be considered equal and satisfactory, provided the material or article so proposed is of equal substance and function. Authorization for any substitution of materials or articles must be obtained by the CONTRACTOR from the Engineer before proceeding with such substitution.

Should an authorized substitution require redesign of a portion of the work or alterations to the plans or specifications in order for the materials or articles which are to be substituted to properly fit or in other ways to be satisfactory, the Engineer shall accomplish such redesigns and alterations. The CONTRACTOR shall bear all reasonable costs associated with redesign and alteration efforts performed by the Engineer.

1.27.2. MATERIALS AND EQUIPMENT

The CONTRACTOR shall be free to secure the approved materials, equipment and articles from sources of his own selection. However, if the OWNER finds that the work shall be delayed or adversely affected in any way because a selected source of supply cannot furnish a uniform product in sufficient quantity and at the time required and a suitable source does exist, or the product is not suitable for the work, the OWNER shall have the right to require the original source of supply changed by the CONTRACTOR. The CONTRACTOR shall have no claim for extra cost or damage because of this requirement.
The CONTRACTOR warrants to the OWNER that all materials and equipment furnished under this contract shall be new unless otherwise specified in the contract documents and that same shall be of good quality and workmanship, free from faults and defects and in conformance with the contract documents. All materials and equipment not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective and shall be promptly repaired or replaced by the CONTRACTOR at the CONTRACTOR's sole cost upon demand of the OWNER. If required by the OWNER, the CONTRACTOR shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

1.27.3. WORKMANSHIP
The CONTRACTOR shall promptly correct or replace all work rejected by the OWNER as defective or as failing to conform to the contract documents whether observed before or after substantial completion and whether or not fabricated, installed or completed. The CONTRACTOR shall bear all costs of correcting such rejected work, including costs incurred for additional services made necessary thereby.

1.27.4. SPECIAL WARRANTY
If within one year after final acceptance of the work by the OWNER, as evidenced by the final certificate of acceptance or within such longer or shorter period of time as may be prescribed by law or by the terms of any other applicable special warranty on designated equipment or portions of work as required by the contract documents, any of the work is found to be defective or not in accordance with the contract documents, the CONTRACTOR shall correct it promptly after receipt of a written notice from the OWNER to do so. This obligation shall survive termination of the contract. The OWNER shall give such notice promptly after discovery of the condition.

The CONTRACTOR shall remove from the site all portions of the work which are defective or nonconforming and which have not been corrected unless removal is waived in writing by the OWNER.

1.27.5. SUBCONTRACTORS' AND MANUFACTURERS' WARRANTIES
All subcontractors', manufacturers' and suppliers' warranties and guarantees, express or implied, respecting any part of the work and any materials used therein, shall be obtained and enforced by the CONTRACTOR for the benefit of the OWNER without the necessity of separate transfer or assignment thereof, provided that if directed by the Engineer, the CONTRACTOR shall assign such warranties and guarantees in writing to the OWNER.

1.27.6. CORRECTED WORK WARRANTY
Any work repaired or replaced, pursuant to this section, shall be subject to the provisions of this section to the same extent as work originally performed.

1.27.7. RIGHTS AND REMEDIES
The rights and remedies of the OWNER provided in this section are in addition to, and do not limit, any rights or remedies afforded to the OWNER by law or any other provision of the contract documents, or in any way limit the OWNER's right to recovery of damage due to default under the contract.

ITEM 1.28. SHOP DRAWINGS, PRODUCT DATA AND SAMPLES
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.

The CONTRACTOR shall provide, review, approve and submit, with reasonable promptness and in such sequence as to cause no delay in the work or in the work of the OWNER or any separate CONTRACTOR, 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 he has determined and verified all materials, field measurements, and field construction criteria related thereto, or shall do
GENERAL PROVISIONS

so, and that he 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.

The CONTRACTOR shall be responsible for delays caused by rejection of the submittal of inadequate or incorrect shop drawings, product data or samples. The CONTRACTOR shall be responsible for seeing that any “approved” copies of shop drawings bearing the approval of the Engineer are allowed on the job site. The CONTRACTOR shall be responsible for providing all copies of approved shop drawings necessary for the construction operations.

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

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.

ITEM 1.29. MEANS AND METHODS OF CONSTRUCTION

Unless otherwise expressly provided in the contract drawings, specifications or bulletins, the means and methods of construction shall be such as the CONTRACTOR may choose; subject, however, to the OWNER’S right to prohibit means and methods proposed by the CONTRACTOR which in the OWNER’S judgment:
(a) shall constitute a hazard to the work, or to persons or property, or shall violate express requirements of applicable laws or ordinances; or
(b) shall cause unnecessary or unreasonable inconvenience to the public; or
(c) shall not produce finished work in accordance with the requirements of the contract documents; or
(d) shall not assure the work to be completed within the time allowed by the contract.

The OWNER’S approval of the CONTRACTOR’S means or methods of construction, or the OWNER’S failure to exercise his right to prohibit such means or methods, shall not relieve the CONTRACTOR of his responsibility for the work or of his obligation to accomplish the result intended by the contract documents; nor shall the exercise or non-exercise of such rights to prohibit create a cause of action for damages or provide a basis for any claim by the CONTRACTOR against the OWNER.

1.29.1. SANITARY PROVISIONS

The CONTRACTOR shall establish and enforce among his employees such regulations in regard to cleanliness and disposal of garbage and waste as shall tend to prevent the inception and spread of infectious or contagious diseases and to prevent effectively the creation of a nuisance about the work on any property either public or private, and such regulations as are required by the OWNER shall be put into immediate force and effect by the CONTRACTOR. The necessary sanitary conveniences for the use of laborers on the work, properly secluded from public observation, shall be constructed and maintained by the CONTRACTOR in such a manner and at such points as shall be approved by the OWNER, and their use shall be strictly enforced by the CONTRACTOR. All sanitary laws and regulations of the State of Texas and the OWNER’S jurisdiction shall be strictly complied with.

1.29.2. PUBLIC CONVENIENCE AND SAFETY

Materials stored about the work site shall be so placed, and the work shall at all times be so conducted, as to cause no greater obstruction to the traveling public than is considered necessary by the OWNER. The CONTRACTOR shall make provisions by bridges or otherwise at all cross streets, highways, sidewalks and private driveways for the free passage of pedestrians and vehicles, provided that where bridging is impracticable or unnecessary, in the opinion of the OWNER, the CONTRACTOR may make arrangements satisfactory to the OWNER for the diversion of traffic and shall, at
his own expense, provide all material and perform all work necessary for the construction and maintenance of roadways and bridges for the diversion of traffic. Sidewalks must not be obstructed except by special permission of the OWNER. The materials excavated, and the construction materials or plant used in the construction of the work, shall be placed so as not to endanger the work or prevent free access to all fire hydrants, water valves, gas valves, manholes for the telephone, telegraph signal or electric conduits, sanitary sewers and fire alarm or police call boxes in the vicinity.

The OWNER reserves the right to remedy any neglect on the part of the CONTRACTOR as regards to the public convenience and safety which may come to its attention, after 24 hours’ notice in writing to the CONTRACTOR, save in cases of emergency, when it shall have the right to remedy any neglect without notice; and in either case, the cost of such work done by the OWNER shall be deducted from the monies due or to become due the CONTRACTOR. The CONTRACTOR shall notify the OWNER when any street is to be closed or obstructed; such notice shall in the case of major thoroughfares or streets upon which transit lines operate be made 48 hours in advance. The CONTRACTOR shall, when directed by the OWNER, keep any street or streets in condition for unobstructed use by emergency services. Where the CONTRACTOR is required to construct temporary bridges or to make other arrangements for crossing over ditches or streams, his responsibility for accidents shall include the roadway approaches as well as the structures of such crossings.

Where the work passes over or through private property, the OWNER shall provide such right-of-way. The CONTRACTOR shall notify the proper representatives of any public utility, corporation, any company or individual, not less than 48 hours in advance of any work which might damage or interfere with the operation of their property along or adjacent to the work. The CONTRACTOR shall be responsible for all damage or injury to property of any character (except such as may be required by the provisions of the contract documents or caused by agents or employees of the OWNER) by reason of any negligent act or omission on the part of the CONTRACTOR, his employees, agents or subcontractors, or at any time due to defective work or materials, or due to his failure to reasonably or properly prosecute the work, and said responsibility shall not be released by the fact that the work shall have been completed and accepted.

When and where any such damage or injury is done to public or private property on the part of the CONTRACTOR, he shall restore or have restored at his own cost and expense such property to a condition similar or equal to that existing before such damage was done by repairing, rebuilding or otherwise restoring as may be directed, or he shall make good such damage or injury in a manner acceptable to the property owner or the Engineer. In case of failure on the part of the CONTRACTOR to restore such property or make good such damage or injury, the OWNER may, upon 48 hours’ written notice, under ordinary circumstances, and without notice when a nuisance or hazardous condition results, proceed to repair, rebuild or otherwise restore such property as may be determined necessary, and the cost thereof shall be deducted from any monies due or to become due the CONTRACTOR under his contract; or where sufficient contract funds are unavailable for this purpose the CONTRACTOR or his surety shall reimburse the OWNER for all such costs.

**ITEM 1.30. SUPERVISION BY CONTRACTOR**

The status of the CONTRACTOR is that of an independent CONTRACTOR under Texas law and the work under this contract shall be under the direct charge and superintendence of the CONTRACTOR. Except where the CONTRACTOR is an individual and gives his personal superintendence to the work, the CONTRACTOR shall provide a competent superintendent or general foreman on the work site at all times during progress with full authority to act for him. The CONTRACTOR shall also provide an adequate staff for the coordination and expediting of his work.

The superintendent and staff shall be satisfactory to the OWNER. The superintendent or general foreman shall not be changed during this contract except with the written consent of the OWNER or unless the superintendent or general foreman proves unsatisfactory to the CONTRACTOR and ceases to be in his employ.

If the superintendent should be or become unsatisfactory to the OWNER, he shall be removed by the CONTRACTOR upon written direction of the OWNER, and in such event, the CONTRACTOR shall not be entitled to file a claim for any additional working time or money from the OWNER.
ITEM 1.31. EMPLOYEES
The CONTRACTOR shall employ only competent, efficient workmen and shall not use on the work any unfit person or one not skilled in the work assigned to him and shall at all times maintain good order among his employees.

Whenever the OWNER shall inform the CONTRACTOR in writing that, in his opinion, any employee is unfit, unskilled, disobedient or is disrupting the orderly progress of the work, such employee shall be removed from the work and shall not again be employed on it.

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

ITEM 1.32. WORKING AREA; COORDINATION WITH OTHER CONTRACTORS; FINAL CLEANUP
The CONTRACTOR shall confine his equipment, storage of materials and construction operations to the area shown on the contract drawings or stated in the specifications, prescribed by ordinance, laws, or permits or as may be directed by the OWNER, and shall not unreasonably encumber the site or public right-of-way with his construction equipment, plant or materials.

Such area shall not be deemed for the exclusive use of the CONTRACTOR. Other contractors of the OWNER may enter upon and use such portions of the area and for such items as determined by the OWNER are necessary for all purposes required by their contracts. The CONTRACTOR shall give to such other contractors all reasonable facilities and assistance to the end that the work on this and other contracts shall not be unduly or unreasonably delayed. Any additional areas desired by the CONTRACTOR for his use shall be provided by him at his own cost and expense.

Upon completion of the work and before final acceptance and final payment shall be made, the CONTRACTOR shall completely clean and remove from the site of the work surplus and discarded materials, temporary structures and debris of every kind. He shall leave the site of the work in a neat and orderly condition equal to that which originally existed, or as called for in the contract documents. Surplus and waste materials removed from the site of the work shall be disposed of at locations satisfactory to the Engineer, and at the CONTRACTOR’s sole cost.

1.32.1. CONSTRUCTION STAKES
Unless otherwise expressly provided in the contract drawings or specifications, the OWNER or his representative shall furnish and set all lines, grades, bench marks, centerlines and measurements necessary to the proper performance and control of the work contracted for under these specifications. The OWNER or his representative shall furnish the CONTRACTOR with all necessary information relating to the lines and grades. Such stakes or markings as the OWNER or his representative may establish either for his own use or the CONTRACTOR’S guidance shall be preserved by the CONTRACTOR until authorized by the OWNER or his representative to be removed. The CONTRACTOR shall be charged for the cost of replacing stakes which he has disturbed.

If the contract drawings or specifications stipulate that the CONTRACTOR is to provide construction stakes, the CONTRACTOR shall provide competent staff or employ a qualified survey firm. After completion of staking, the CONTRACTOR shall furnish survey field notes and cut sheets to the OWNER or his representative for review. However, review of survey field notes and cut sheets shall in no way relieve the CONTRACTOR of liability for incorrectly setting stakes. When not listed as a separate pay item in the contract, construction staking shall be considered as incidental work, and the cost thereof shall be included in such pay items as are provided in the contract.

1.32.2. RAILWAY CROSSINGS
Where the work encroaches upon any right-of-way of any railway, the OWNER shall secure the necessary easement for the work. Where railway tracks are to be crossed, the CONTRACTOR shall observe all the regulations and instructions of the railway company as to methods of doing the work or precautions for safety of property and the public. All negotiations with the railway company, except for right-of-way, shall be made by the CONTRACTOR. The railway company shall be notified by the CONTRACTOR not less than five days prior to commencing the work. The CONTRACTOR shall not be paid separate compensation for such railway crossing but shall receive only the compensation as set out in the proposal.
ITEM 1.33. OTHER CONTRACTORS; OBLIGATION TO COOPERATE

The OWNER may award other contracts for additional work on this project, and the CONTRACTOR shall fully cooperate with such other contractors and shall coordinate and fit his work to be done hereunder to such additional work as may be contracted by the OWNER. At the time of bidding, prospective bidders shall be advised of other planned contract work which is expected to affect the work area. The CONTRACTOR shall not commit or permit any act which shall interfere with the performance of work by any other contractor.

Upon receiving written notice from the CONTRACTOR that another contractor is failing to coordinate his work with the work under this contract as directed by the OWNER, the OWNER shall promptly investigate the charge and take such necessary action as the situation may require. However, the OWNER shall not be liable to the CONTRACTOR for damages suffered by the CONTRACTOR due to the fault or negligence of another contractor or through failure of another contractor to carry out the directions of the OWNER. Should any interference occur between contractors, the Engineer may furnish the CONTRACTOR with written instructions designating priority of effort or change in methods, whereupon the CONTRACTOR shall immediately comply with such direction. In such event, the CONTRACTOR shall be entitled to an extension of working time only for unavoidable delays verified by the Engineer; however, no increase in the contract price shall be due the CONTRACTOR.

ITEM 1.34. OWNER'S RIGHT TO TEMPORARILY SUSPEND WORK

1.34.1. REASONS FOR SUSPENSION

The OWNER shall have the right by written order to temporarily suspend the work, in whole or in part, whenever, in the judgment of the OWNER, such temporary suspension is required:
(a) in the interest of the OWNER generally,
(b) due to government or judicial controls or orders which make performance of this contract temporarily impossible or illegal,
(c) to coordinate the work of separate contractors at the job site,
(d) to expedite the completion of a separate contract even though the completion of this particular contract may be thereby delayed,
(e) because of weather conditions unsuitable for performance of the work, or
(f) because the CONTRACTOR is proceeding contrary to contract provisions or has failed to correct conditions considered unsafe for workmen.

The written order of the OWNER to the CONTRACTOR shall state the reasons for suspending the work and the anticipated periods for such suspension. Upon receipt of the OWNER'S written order, the CONTRACTOR shall suspend the work covered by the order and shall take such means and precautions as may be necessary to properly protect the finished and partially finished work, the unused materials and uninstalled equipment, including the providing of suitable drainage about the work and erection of temporary structures where necessary. The CONTRACTOR shall not suspend the work without written direction from the Engineer and shall proceed with the work promptly when notified by the Engineer to resume operations.

1.34.2. NO ADDITIONAL COMPENSATION

No additional compensation shall be paid to the CONTRACTOR for such suspension under Item 1.34.1.(f) above or otherwise where same is caused by the fault of the CONTRACTOR. Where such temporary suspension is not due to the fault of the CONTRACTOR, he shall be entitled to:
(a) an equitable extension of working time for the completion of the work, not to exceed the delay caused by such temporary suspension, as determined by the OWNER; and
(b) the actual and necessary costs of properly protecting the finished and partially finished work, unused materials and uninstalled equipment during the period of the ordered suspension as determined by the OWNER as being beyond the contract requirements, such costs, if any, to be determined on the basis set forth in Item 1.38. herein; and
(c) where the CONTRACTOR elects to move equipment from the job site and then return it to the site when the work is ordered resumed, the actual and necessary costs of these moves, in an amount determined by the OWNER under the provisions of Item 1.38.
ITEM 1.35. USE OF COMPLETED PORTIONS OF WORK

The OWNER may, after written notice to the CONTRACTOR, and without incurring any liability for increased compensation to the CONTRACTOR, take over and use any completed portion of the work prior to the final completion and acceptance of the entire work included in the contract, and notwithstanding that the time allowed for final completion has not expired. The CONTRACTOR shall not object to, nor interfere in any way with, such occupancy or use after receipt of the OWNER’S written notice.

Immediately prior to such occupancy and use, the OWNER shall inspect such portion of the work to be taken over and shall furnish the CONTRACTOR a written statement of the work, if any, still to be done on such part. The CONTRACTOR shall promptly thereafter complete such unfinished work to permit occupancy and use on the date specified in the OWNER’S written order, unless the CONTRACTOR shall permit specific items of work to be finished after the occupancy and use by the OWNER.

The provisions in the last two paragraphs above shall not apply to portions of roads, streets, bridges or detours upon which traffic is diverted to enable the continuation of the contract work.

In the event the CONTRACTOR is unreasonably delayed by the OWNER exercising its rights under this section, the CONTRACTOR may submit a request for an extension of time under Section 1.36.; no claim, however, for additional compensation may be filed.

ITEM 1.36. DELAYS; EXTENSION OF TIME; LIQUIDATED DAMAGES

The CONTRACTOR shall be entitled to an extension of working time under this contract only when claim for such extension is submitted to the OWNER in writing by the CONTRACTOR within seven days from and after the time when any alleged cause of delay shall occur, and then only when such time is approved by the OWNER. In adjusting the contract working time for the completion of the project, unforeseeable causes beyond the control and without the fault or negligence of the CONTRACTOR, including but not restricted to inability to obtain supplies and materials, acts of God or the public enemy, acts of the OWNER, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, unusually severe weather conditions or delays of subcontractors due to such causes beyond their control shall be taken into consideration.

If the satisfactory execution and completion of the contract should require work and materials in greater amounts or quantities than those set forth in the contract, requiring more time for completion than the anticipated time, then the contract working time shall be equitably increased, but not more than in the same proportion as the cost of the additional work bears to the cost of the original work contracted for. No allowances shall be made for delays or suspension of the performance of the work due to the fault of the CONTRACTOR.

No adjustment to working time shall be made if, concurrently with the equitable cause for delay, there existed a cause for delay due to the fault or negligence of the CONTRACTOR, his agents, employees or subcontractors; and no adjustment shall be made to the contract price and the CONTRACTOR shall not be entitled to claim or receive any additional compensation as a result of or arising out of any delay resulting in adjustment to the working time hereunder, including delays caused by the acts or negligence of the OWNER. Notwithstanding any other provision of the contract documents, all claims for extension of working time must be submitted in accordance with Item 1.36., and no act of the OWNER shall be deemed a waiver or entitlement of such extension.

1.36.1. LIQUIDATED DAMAGES FOR FAILURE TO COMPLETE ON TIME

The time of completion is the essence of this contract. For each calendar day that any work shall remain uncompleted after the time specified in the proposal and the contract, or the increased time granted by the OWNER, or as equitably increased by additional work or materials ordered after the contract is signed, the sum per day given in the following schedule, unless otherwise specified in the special provisions, shall be deducted from the monies due the CONTRACTOR.
The sum of money thus deducted for such delay, failure or noncompletion is not to be considered as a penalty, but shall be deemed, taken and treated as reasonable liquidated damages, per calendar day that the CONTRACTOR shall be in default after the time stipulated in the contract for completing the work. The said amounts are fixed and agreed upon by and between OWNER and CONTRACTOR because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the OWNER in such event would sustain; and said amounts are agreed to be the amount of damages which the OWNER would sustain and which shall be retained from the monies due, or that may become due, the CONTRACTOR under this contract; and if said monies be insufficient to cover the amount owing, then the CONTRACTOR or his surety shall pay any additional amounts due.

**ITEM 1.37. CHANGE OR MODIFICATION OF CONTRACT**

**1.37.1. INCREASED OR DECREASED QUANTITIES OF WORK**

The OWNER reserves the right to make changes in the quantities of the work, as may be considered necessary or desirable, and such changes shall not be considered as waiving or invalidating any conditions or provisions of the contract or bonds. The CONTRACTOR shall perform the work as altered, whether increased or decreased, and no allowances shall be made for anticipated profits.

The OWNER reserves the right to decrease the work under this contract. Payment to the CONTRACTOR for the contract items shall be made for the actual quantities of work performed and material furnished at the unit prices set forth in the contract, except as provided below.

When the quantity of work to be done or of materials to be furnished under any major item of the contract is more than 125 percent of the quantity stated in the contract, then either party to the contract, upon demand, shall be entitled to negotiate for revised consideration on the portion of work above 125 percent of the quantity stated in the contract.

When the quantity of work to be done or of materials to be furnished under any major item of the contract is less than 75 percent of the quantity stated in the contract, then either party to the contract, upon demand, shall be entitled to negotiate for revised consideration on the work performed.

Any revised consideration shall be paid for as is hereinafter provided under Item 1.38. The foregoing notwithstanding, the total original contract shall not be increased more than 25 percent or reduced by more than 25 percent without the written consent of the CONTRACTOR.

**1.37.2. ALTERATION OF PLANS AND SPECIFICATIONS**

The OWNER reserves the right to make such changes in the plans and specifications and in the character of the work as may be necessary or desirable to insure completion in the most satisfactory manner, provided such changes do not materially alter the original plans and specifications or change the general nature of the work as a whole. Such changes shall not be considered as waiving or invalidating any condition or provision of the contract and bonds. Such changes shall be issued by the Engineer.

**1.37.3. EXTRA WORK**

When any work is necessary to the proper completion of the project and for which no prices are provided for in the proposal and contract, the CONTRACTOR shall do such work, but only when and as ordered in writing by the Engineer. Payment for extra work shall be made as hereinafter provided in Item 1.38.

---

**Amount of Contract ($)** | **Amount of Liquidated Damages ($)**
---|---
Less than 5,000.00 | 60.00 Per Day
5,000.00 to 14,999.99 | 80.00 Per Day
15,000.00 to 24,999.99 | 100.00 Per Day
25,000.00 to 49,999.99 | 120.00 Per Day
50,000.00 to 99,999.99 | 160.00 Per Day
100,000.00 to 1,000,000.00 | 240.00 Per Day
More than 1,000,000.00 | 500.00 Per Day

JANUARY 1998
ITEM 1.38. PAYMENT FOR EXTRA WORK

The extra work done by the CONTRACTOR as authorized and approved by the Engineer 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:

(a) 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.

(b) 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.

(c) Method "C" — by actual field cost of the work plus 15 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; 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 direct the form in which the accounts of actual field cost shall be kept and shall specify in writing the method of doing work and the type and kind of machinery and equipment to be used. The 15 percent of the actual field cost to be paid to 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.

ITEM 1.39. DISPUTED WORK AND CLAIMS FOR ADDITIONAL COMPENSATION

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, either before proceeding with such work or complying with such order or determination, notify the OWNER in writing of his contentions with respect thereto and request a final determination thereof.

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 that the 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 Item 1.37 hereof, 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, he 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 therefor. 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 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 his books and records showing all of his 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, when 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 therefor, 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.

**ITEM 1.40. 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 Item 1.38, hereof, or is performing disputed work or complying with a determination or order under protest in accordance with Item 1.39, hereof, the CONTRACTOR shall daily furnish the OWNER’S representative at the site with three copies of verified statements showing:

(a) 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

(b) the nature, cost and quantity of any materials, plant equipment 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 of his 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 therefor; 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.

**ITEM 1.41. AUTHORITY OF THE ENGINEER**

All work shall be performed in a good and workmanlike manner and to the satisfaction of the Engineer. The Engineer shall decide all questions which arise as to the quality and acceptability of materials furnished, work performed, manner of performance, rate of progress of the work, sequence of the construction, interpretation of the plans and
specifications, acceptable fulfillment of the contract; compensation, mutual rights between contractors under these specifications and suspension of the work. He shall determine the amount and quality of work performed and materials furnished; and his decisions and estimates shall be final. His estimate in such event shall be a condition precedent to the right of the CONTRACTOR to receive money due him under the contract.

1.41.1. OWNER’S REPRESENTATIVES
Where the contract documents indicate that determinations, directions or approvals shall be made by the OWNER or “Owner’s representatives,” this shall mean the OWNER acting directly, or through duly authorized persons acting within the limit of authority delegated to them. Any determination, direction or approval of such authorized representatives shall be subject to review by the OWNER’S representative.

1.41.2. OWNER’S REPRESENTATIVE’S FINAL DETERMINATION
The OWNER’S representatives’s determinations shall be final relative to the proper performance of the work and the materials used, and the CONTRACTOR is bound thereby.

It is hereby covenanted and agreed between the two parties of this contract that the OWNER’S representative shall review and determine all disputes, controversies or claims of either party in relation to this contract or its performance. Such determination shall be made in writing by the OWNER’S representative within a reasonable time and shall be final and conclusive upon both the CONTRACTOR and the OWNER. It is further covenanted and agreed between the two parties to the contract that the determination by the OWNER’S representative shall be a condition precedent to the right of any legal action at law or in equity that either party may have against the other.

ITEM 1.42. INSPECTION AND TESTS
The CONTRACTOR shall furnish the OWNER with every reasonable facility for ascertaining whether or not the work performed was in accordance with the requirements and intent of the plans and specifications. Any work done (except excavation) or materials used without suitable inspection by the OWNER may be ordered removed and replaced at the CONTRACTOR’S expense.

1.42.1. REMOVAL OF DEFECTIVE AND UNAUTHORIZED WORK
All work which has been rejected or condemned shall be repaired, or if it cannot be repaired satisfactorily, it shall be removed and replaced at the CONTRACTOR’S expense. Defective materials shall be immediately removed from the site of the work. Work done without line and grade having been given, work done beyond the lines or not in conformity with the grades shown on the plans or as given, save as herein provided, work done without written authority and prior agreement in writing as to process, shall be done at the CONTRACTOR’S risk and shall be considered unauthorized and at the option of the OWNER may not be measured and paid for and may be ordered removed at the CONTRACTOR’S expense. Upon failure of the CONTRACTOR to repair satisfactorily or to remove and replace, if so directed, rejected, unauthorized or condemned work or materials immediately after receiving notice from the OWNER, the OWNER shall, after giving written notice to the CONTRACTOR, have the authority to cause defective work to be remedied or removed and replaced, or to cause unauthorized work to be removed and to deduct the cost thereof from any monies due or to become due the CONTRACTOR. Alternatively, the OWNER may, at its option, declare the CONTRACTOR in default, in which event the performance bond surety shall complete the contract.

1.42.2. FINAL INSPECTION
The OWNER shall make final inspection of all work included in the contract as soon as practicable after the work is completed and ready for acceptance. If the work is not acceptable to the OWNER at the time of such inspection, he shall inform the CONTRACTOR as to the particular defects to be remedied before final acceptance shall be made.

1.42.3. SAMPLES AND TESTS OF MATERIALS
Unless otherwise stipulated in the contract documents, initial testing of all materials, construction items or products incorporated in the work shall be performed at the direction and expense of the OWNER, including initial compaction and density tests deemed necessary.

In the event materials, construction items or products incorporated in the work fail to satisfy the minimum requirements of the initial test, appropriate prove out test shall be made as directed by the OWNER to determine the ex-
tent of the failure and to verify that the corrective measures have brought the item up to specification requirements. The cost of all testing necessary to determine the extent of the failure and the adequacy of the corrective measures shall be the responsibility of the CONTRACTOR.

The failure of the OWNER to make any tests of materials shall in no way relieve the CONTRACTOR of his responsibility of furnishing materials conforming to the contract documents.

Tests, unless otherwise specified, shall be made in accordance with the latest methods of the American Society for Testing and Materials. The CONTRACTOR shall provide such facilities as the OWNER may require for collecting and forwarding samples and shall not use the materials represented by the samples until tests have been made. The CONTRACTOR shall furnish adequate samples without charge.

The inspections and tests made by the OWNER, its inspectors or agents, shall ordinarily be made without cost to the CONTRACTOR unless otherwise expressly specified in the contract documents. The CONTRACTOR shall furnish without additional cost to the OWNER such materials for testing as may be reasonably necessary. Retesting after failure to pass tests shall be at the expense of the CONTRACTOR. Should the percentage of rejected material or equipment be unreasonably large, the additional cost of such inspection and tests resulting therefrom shall be borne by the CONTRACTOR. The OWNER shall judge what is extra inspection and shall determine the additional cost incurred thereby and payable by the CONTRACTOR.

**ITEM 1.43. NO WAIVER OF RIGHTS OR ESTOPPEL**

The OWNER, or any officer or agent thereof, shall not be precluded at any time, either before or after final completion and acceptance of the work and final payment therefor from:

(a) showing the true and correct amount, classifications, quality and character of the work done and materials furnished by the CONTRACTOR or any other person under this contract, or from showing at any time that any determination, return, decision, approval, order, letter, payment or certification is untrue and incorrect or improperly made in any particular, or that the work or the materials or any parts thereof do not in fact conform to the contract requirements; and

(b) demanding the recovery from the CONTRACTOR of any overpayments made to him, or such damages as the OWNER may sustain by reason of the CONTRACTOR'S failure to perform each and every part of this contract in strict accordance with its terms; or both.

**ITEM 1.44. 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 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 perpetrating fraud on the OWNER in the construction of work under contract.

**JANUARY 1998**
(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, sublet 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 its 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 hereinafore 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 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 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.

ITEM 1.45. SUSPENSION BY COURT ORDER AGAINST THE OWNER

The CONTRACTOR shall suspend such part or parts of the work pursuant to a court order issued against the OWNER and shall not be entitled to additional compensation by virtue of such court order; neither shall the CONTRACTOR be liable to the OWNER in the event the work is suspended by such court order, unless such suspension is due to the fault or negligence of the CONTRACTOR.

ITEM 1.46. 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 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 which the OWNER may deem would not be in the OWNER'S best interest.

The CONTRACTOR shall, as soon as practicable after signing the contract, submit a separate written notice to the OWNER identifying each proposed subcontractor. 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.

If the OWNER determines that any proposed subcontractor is unacceptable, he 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.

If an approved subcontract fails to properly perform the work undertaken, he 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 therefor.

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 he and they 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. The CONTRACTOR shall be solely responsible for the acts, omissions, negligence or defaults of his 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 his 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 provisions contained herein shall likewise apply to any sub-subcontracts.

ITEM 1.47. 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.

ITEM 1.48. CLAIMS AGAINST OWNER AND ACTION THEREON.

No claim against the OWNER under the contract or for breach of the contract or additional compensation for extra or disputed work shall be made or asserted against the OWNER under the contract or in any court action except pursuant to the provisions of Items 1.38., 1.39. and 1.40., and unless the CONTRACTOR shall have strictly complied with all requirements relating to the giving of notice and information with respect to such claim as required under said sections.

ITEM 1.49. OWNER'S OFFICERS, EMPLOYEES OR AGENTS

1.49.1. CLAIM AGAINST OFFICERS, EMPLOYEES OR AGENT OF THE OWNER.

No claim whatsoever shall be made by the CONTRACTOR against any officer, employee or agent of the OWNER for or on account of, anything done or omitted to be done in connection with this contract.

JANUARY 1998
1.49.2. FINANCIAL INTEREST IN ANY CONTRACT BY OWNER’S OFFICERS, EMPLOYEES OR AGENTS

No officer, employee or agent of the OWNER shall have a financial interest, direct or indirect, in any contract with the OWNER or be financially interested, directly or indirectly, in the sale to the OWNER of any land, materials, supplies or services, except on behalf of the OWNER as an officer or employee. Any willful violation of this article shall constitute malfeasance in office, and any officer or employee guilty thereof shall thereby forfeit his office or position. Any violation of this article with the knowledge, expressed or implied, of the persons, partnership, company, firm, association or corporation contracting with the OWNER shall render the contract involved voidable by the OWNER.

ITEM 1.50. PATENTS

The CONTRACTOR shall pay all royalties and license fees and shall provide, by suitable legal agreement with the patentee or OWNER, for the use of any design, device, material or process covered by letters, patent or any copyright. The CONTRACTOR shall indemnify, defend, hold and save the OWNER and its officers, employees and agents harmless from all liability and claims for infringement of any patent or copyright.

In the event that any claims, suit or action at law or in equity of any kind whatsoever is brought against the OWNER, or its officers, employees or agents involving any such patents, copyrights or license rights, then the OWNER shall have the right to and may retain from any money due or to become due to the CONTRACTOR such sum deemed necessary by the OWNER for its protection until such claim or suit shall have been settled and satisfactory evidence to that effect shall have been furnished the OWNER.

ITEM 1.51. MONTHLY ESTIMATE, PARTIAL PAYMENTS, RETAINAGE, FINAL INSPECTION, ACCEPTANCE AND FINAL PAYMENT

1.51.1. MONTHLY ESTIMATE

Between the 25th day and the last day of each month, the OWNER shall make an approximate estimate of the value of the work done during the month under the specifications. Whenever the said estimate or estimates of work done since the last previous estimate exceeds $100 in amount, a percentage of such estimate sum shall be paid the CONTRACTOR on or before the 15th day of the month next following. The monthly estimate may include acceptable nonperishable materials delivered to the work; such payment shall be allowed on the same percentage basis of the net invoice value as provided hereinafter. The percent retained by the OWNER shall normally be up to 10 percent at completion; unless otherwise stated. At the midpoint, or at any subsequent time, if the OWNER determines that the progress on the contract is satisfactory in all respects, it may at its discretion cease to retain additional funds until the completion of the project, or until progress ceases to be satisfactory. The OWNER shall make the sole determination in this matter.

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.

1.51.2. RETAINAGE

As security for the faithful completion of the work by the CONTRACTOR, the OWNER shall retain 15 percent of the total dollar amount of work done on all contracts $25,000.00 and less; 10 percent of the total dollar amount of work done on all contracts in excess of $25,000.00 and less than $400,000.00; five percent of the total dollar amount of work done on all contracts of $400,000.00 or more. On all contracts in excess of $400,000, the following shall apply: (a) on all contracts in excess when work progress is 80 percent complete, retainage may, at the OWNER’S option, be reduced to two percent of the dollar value of all work satisfactorily completed to date (not to include material on hand), provided that the CONTRACTOR is making satisfactory progress and there is no cause of greater retainage as determined by the Engineer.
(b) when work progress is substantially complete, the retainage may be further reduced to only that amount necessary to assure completion as determined by the Engineer;
(c) if the OWNER determines that the CONTRACTOR is not making satisfactory progress or if there is other specific cause, the OWNER may, at its discretion, reinstate up to the five percent retainage.

1.51.3. 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.

1.51.4. 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 or 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 within 30 days after the final acceptance, provided that the CONTRACTOR has furnished to the OWNER a consent of surety 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. A model CONTRACTOR'S Affidavit of Final Payment and Release is illustrated in Appendix A 1.

The acceptance by 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.

ITEM 1.52. 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:
(a) unsatisfactory progress of the work not caused by conditions beyond the CONTRACTOR'S control,
(b) defective work not corrected,
(c) CONTRACTOR'S failure to carry out instructions or orders of the OWNER or his representative,
(d) a reasonable doubt that the contract can be completed for the balance then unpaid,
(e) work or execution thereof not in accordance with the contract documents,
(f) claim filed by or against the CONTRACTOR or reasonable evidence indicating probable filing of claims,
(g) failure of the CONTRACTOR to make payments to subcontractor or for material or labor,
(h) damage to another contractor,
(i) unsafe working conditions allowed to persist by the CONTRACTOR,
(j) failure of the CONTRACTOR to provide work schedules as required by the OWNER,
(k) use of subcontractors without the Engineer's approval or
(l) failure of the CONTRACTOR to keep current as-built record drawings at the job site or to turn same over in completed form to the OWNER.

When the above grounds are removed, payment shall be made for amounts withheld because of them, and OWNER shall never be liable for interest on any delayed or late payment.
ITEM 1.53. SERVICE OF NOTICES
The OWNER and the CONTRACTOR shall each designate addresses where all notices, directions or other communication may be delivered or to which they may be mailed.

Notices to the surety or sureties on contract bonds shall be directed or delivered to the home office, or to the agent or agents who executed the bonds on behalf of the surety or sureties, or to their designated agent for delivery of notices.

Actual delivery of any such notice, direction or communication to the aforesaid places or depositing it in a post-paid wrapper addressed thereto in any post office regularly maintained by the United States Postal Service shall be conclusively deemed to be sufficient service thereof upon the above persons as of the date of such delivery or deposit.

The designated addresses may be changed at any time by an instrument in writing executed by the party changing the addresses and delivered to the other party.

Nothing herein contained shall, however, be deemed to preclude or tender inoperative the service of any notice, direction or communication upon the above parties personally or, if the CONTRACTOR be a corporation, upon any officer or director thereof.

ITEM 1.54. UNLAWFUL PROVISIONS DEEMED STRICKEN
If this contract contains any unlawful provisions not an essential part of the contract and which shall not appear to have been a controlling or material inducement to the making thereof, such unlawful provisions shall be of no effect. Upon the application of either party, the unlawful part shall be considered stricken from the contract without affecting the remainder of the contract.

ITEM 1.55. ALL LEGAL PROVISIONS INCLUDED
It is the intent and agreement of the parties to this contract that all legal provisions of law required to be inserted herein shall be and are inserted herein. If through mistake or oversight, however, any such provision is not herein inserted, or is not inserted in proper form, then upon application of either party, the contract shall be amended so as to strictly comply with the law and without prejudice to the rights of either party hereunder.

ITEM 1.56. EQUAL EMPLOYMENT OPPORTUNITY
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 to be provided 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 he 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.
ITEM 1.57. TERMINATION FOR CONVENIENCE OF THE OWNER

1.57.1. NOTICE OF TERMINATION

The performance of the work under this contract may be terminated by the OWNER in whole or from time to time in part, in accordance with this section, whenever the OWNER shall determine that such termination is in the best interest of the OWNER. Any such termination shall be effected by mailing a notice of termination to the CONTRACTOR specifying the extent to which performance of work under the contract is terminated, and the date upon which such termination becomes effective. Receipt of the notice shall be deemed conclusively presumed and established when the letter is placed in the United States Mail by the OWNER. Further, it shall be deemed conclusively presumed and established that such termination is made with just cause as herein stated; and no proof in any claim, demand or suit shall be required of the OWNER regarding such discretionary action.

1.57.2. CONTRACTOR ACTION

After receipt of a notice of termination, and except as otherwise directed by the Engineer, the CONTRACTOR shall:
(a) stop work under the contract on the date and to the extent specified in the notice of termination;
(b) place no further orders or subcontracts for materials, services or facilities except as may be necessary for completion of such portion the work under the contract as is not terminated;
(c) terminate all orders and subcontract to the extent that they relate to the performance of work terminated by the notice of termination;
(d) transfer title to the OWNER and deliver in the manner, at the times, and to the extent, if any, directed by the Engineer:
   (1) the fabricated or unfabricated parts, work in process, completed work, supplies and other material produced as a part of, or acquired in connection with the performance of, the work terminated by the notice of termination; and
   (2) the completed or partially completed plans, drawings, information and other property which, if the contract had been completed, would have been required to be furnished to the OWNER.
(e) complete performance of such part of the work as shall not have been terminated by the notice of termination; and
(f) take such action as may be necessary, or as the Engineer may direct, for the protection and preservation of the property related to its contract which is in the possession of the CONTRACTOR and in which the OWNER has or may acquire an interest.

At a time not later than 30 days after the termination date specified in the notice of termination, the CONTRACTOR may submit to the Engineer a list, certified as to the quantity and quality, of any or all items of termination inventory not previously disposed of, exclusive of items the disposition of which has been directed or authorized by the Engineer. Not later than 15 days thereafter, the OWNER shall accept title to such items and remove them or enter into a storage agreement covering the same, provided that the list submitted shall be subject to verification by the Engineer upon removal of the items, or, if the items are stored, within 45 days from the date of submission of the list, and provided that any necessary adjustments to correct the list as submitted shall be made prior to final settlement.

1.57.3. TERMINATION CLAIM

Within 60 days after notice of termination, the CONTRACTOR shall submit his termination claim to the Engineer in the form and with the certification prescribed by the Engineer. Unless one or more extensions in writing are granted by the Engineer upon request of the CONTRACTOR, made in writing within such 60-day period or authorized extension thereof, any and all such claims shall be conclusively deemed waived.

1.57.4. AMOUNTS

Subject to the provisions of Item 1.57.3., the CONTRACTOR and OWNER may agree upon the whole or any part of the amount or amounts to be paid to the CONTRACTOR by reason of the total or partial termination of work pursuant hereto, provided that such agreed amount or amounts shall never exceed the total contract price as reduced by the amount of payments otherwise made and as further reduced by the contract price of work not terminated. The contract shall be amended accordingly, and the CONTRACTOR shall be paid the agreed amount. No amount shall be due for lost or anticipated profits. Nothing in Item 1.57.5. hereunder, prescribing the amount to be paid to the
CONTRACTOR in the event of failure of the CONTRACTOR and the OWNER to agree upon the whole amount to be paid to the CONTRACTOR by reason of the termination of work pursuant to this section, shall be deemed to limit, restrict or otherwise determine or affect the amount or amounts which may be agreed upon to be paid to the CONTRACTOR pursuant to this paragraph.

1.57.5. FAILURE TO AGREE

In the event of the failure of the CONTRACTOR and the OWNER to agree, as provided in Item 1.57.4., upon the whole amount to be paid to the CONTRACTOR by reason of the termination of work pursuant to this section, the OWNER shall determine, on the basis of information available to it, the amount, if any, due to the CONTRACTOR by reason of the termination and shall pay to the CONTRACTOR the amounts determined. No amount shall be due for lost or anticipated profits.

1.57.6. DEDUCTIONS

In arriving at the amount due the CONTRACTOR under this section, there shall be deducted (a) all unliquidated advance or other payments on account theretofore made to the CONTRACTOR, applicable to the terminated portion of this contract; (b) any claim which the OWNER may have against the CONTRACTOR in connection with this contract; and (c) the agreed price for or the proceeds of sale of any materials, supplies or other things kept by the CONTRACTOR or sold, pursuant to the provisions of this clause, and not otherwise recovered by or credited to the OWNER.

1.57.7. ADJUSTMENT

If the termination hereunder be partial prior to the settlement of the terminated portion of this contract, the CONTRACTOR may file with the Engineer a request in writing for an equitable adjustment of the price or prices specified in the contract relating to the continued portion of the contract (the portion not terminated by the notice of termination), and such equitable adjustment as may be agreed upon shall be made in such price or prices; nothing contained herein, however, shall limit the right of the OWNER and the CONTRACTOR to agree upon the amount or amounts to be paid to the CONTRACTOR for the completion of the continued portion of the contract when said contract does not contain an established contract price for such continued portion.

1.57.8. NO LIMITATION OF RIGHTS

Nothing contained in this section shall limit or alter the rights which the OWNER may have for termination of this contract under Item 1.44. hereof entitled “CONTRACTOR Default; OWNER’s Right to Suspend Work and Annual Contract” or any other right which OWNER may have for default or breach of contract by CONTRACTOR.

ITEM 1.58. STATE AND LOCAL SALES AND USE TAXES

The OWNER qualifies for exemption from the state and local sales and use taxes, pursuant to the provisions of Section 151.309 of the Texas Limited Sales, Excise and Use Tax Act. Therefore, the CONTRACTOR shall not pay such taxes which would otherwise be payable in connection with the performance of this contract.

The CONTRACTOR shall issue an exemption certificate in lieu of the tax on 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.

Under “reasons said purchaser is claiming this exemption” in the exemption certificate, the CONTRACTOR must name the OWNER and the project for which the equipment, material and supplies are being purchased, leased or rented.
ITEM 1.59. VENUE AND GOVERNING LAW

The parties herein agree that this contract shall be enforceable in the county in which the OWNER’s principal office is located, and if legal action is necessary in connection therewith, exclusive venue shall lie in this county. The terms and provisions of the contract documents shall be construed in accordance with the laws and court decisions of the State of Texas.

ITEM 1.60. NO WAIVER OF LEGAL RIGHTS

Inspection by the Engineer; any order, measurement, quantity or certificate by the Engineer; any order by the OWNER for payment of money; any payment for or acceptance of any work; or any extension of time or any possession taken by the OWNER shall not operate as a waiver of any provisions of the contract or any power therein reserved to the OWNER of any rights or damages therein provided. Any waiver of any breach of contract shall not be held to be a waiver of any other or subsequent breach. The OWNER reserves the right to correct any error that may be discovered in any estimate that may have been paid and to adjust the same to meet the requirements of the contract documents. The OWNER reserves the right to recover by process of law sums as may be sufficient to correct any error or make good any deficiency in the work resulting from such error, dishonesty or collusion by the CONTRACTOR or his agents and the Engineer or his assistants, discovered in the work after the final payment has been made.

Neither final acceptance of the work nor final payment shall relieve the CONTRACTOR of responsibility for faulty materials or workmanship, and the CONTRACTOR shall promptly remedy any defects due thereto and pay for any damage to other work resulting therefrom. Likewise, neither final acceptance nor final payment, nor partial or entire use or occupancy of the work by the OWNER shall constitute acceptance of work not done in accordance with the contract documents or relieve CONTRACTOR of liability with respect to any expressed or implied warranties or responsibility for faulty materials or workmanship, whether same be patently or latently defective.

ITEM 1.61. OBLIGATION TO PERFORM FUNCTIONS

Any failure or neglect on the part of OWNER, Engineer or inspectors to enforce provisions herein dealing with supervision, control, inspection, testing or acceptance and approval of the work shall never operate to relieve CONTRACTOR from full compliance with the contract documents nor render OWNER liable to CONTRACTOR for money damages, extensions of time or increased compensation of any kind.

ITEM 1.62. SUCCESSORS AND ASSIGNS

Subject to the limitations upon assignment and transfer herein contained, this contract shall be binding upon and inure to the benefit of the parties hereto, their respective successors and assigns.

ITEM 1.63. HEADINGS

The title and headings contained in the contract documents and the subject organization are used only to facilitate reference, and in no way define or limit the scope of intent of any of the provisions of this contract.
This page was intentionally left blank.
PART II

Materials
This page was intentionally left blank.
DIVISION 2 MATERIALS

**Item 2.1. Aggregates**
- 2.1.1. Aggregates for Portland Cement Concrete
- 2.1.2. Aggregates for Hot-Mix Asphaltic Concrete (HMAC)
- 2.1.3. Subbase Material
- 2.1.4. Non-Pumping Subbase
- 2.1.5. Trench Backfill
- 2.1.6. Riprap or Stone Masonry
- 2.1.7. Pipe Bedding Material for Storm Sewers
- 2.1.8. Pipe Bedding Material for Water and Sanitary Sewer Mains

**Item 2.2. Portland Cement Concrete and Related Materials**
- 2.2.1. Cement
- 2.2.2. Chemical Admixtures
- 2.2.3. Mineral Filler
- 2.2.4. Water
- 2.2.5. Dowel Bars
- 2.2.6. Steel Reinforcement
- 2.2.7. Steel Wire Reinforcement
- 2.2.8. Reinforcement Bar Chairs
- 2.2.9. Joint Filler
- 2.2.10. Joint Sealing
- 2.2.11. Curing Materials
- 2.2.12. Elastomeric Materials
- 2.2.13. Fibrous Reinforcement

**Item 2.3. Masonry Materials**
- 2.3.1. General Requirements for Masonry Materials
- 2.3.2. Drain Tile
- 2.3.3. Sewer and Manhole Brick
- 2.3.4. Stone Masonry
- 2.3.5. Concrete Masonry Units (precast lattice blocks)

**Item 2.4. Bituminous Materials**
- 2.4.1. General Requirements for Bituminous Materials
- 2.4.2. Oil Asphalt
- 2.4.3. Asphalt Cement
- 2.4.4. Latex Additives
- 2.4.5. Cut-Back Asphalt
- 2.4.6. Road Oils
- 2.4.7. Cracked Fuel Oils and Crude Oils
- 2.4.8. Emulsified Asphalt
- 2.4.9. Flux Oil
- 2.4.10. Precoat Material
- 2.4.11. Catalytically-Blown Asphalt Joint and Crack Sealer
- 2.4.12. Storage, Heating and Application Temperature
- 2.4.13. Hot-Mix Asphaltic Concrete
- 2.4.14. Asphaltic Stabilized Base
- 2.4.15. Hot-Mix, Cold-Laid Asphaltic Concrete (Cold-Mix)
Table of Contents

<table>
<thead>
<tr>
<th>Item 2.5.</th>
<th>Lime Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5.1.</td>
<td>Lime</td>
</tr>
<tr>
<td>2.5.2.</td>
<td>Hydrated Lime (Dry)</td>
</tr>
<tr>
<td>2.5.3.</td>
<td>Hydrated Lime (Slurry)</td>
</tr>
<tr>
<td>2.5.4.</td>
<td>Quicklime</td>
</tr>
<tr>
<td>2.5.5.</td>
<td>Rejection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 2.6.</th>
<th>Wood Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.6.1.</td>
<td>Lumber and Timber</td>
</tr>
<tr>
<td>2.6.2.</td>
<td>Plywood</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 2.7.</th>
<th>Piling Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.7.1.</td>
<td>Timber Piles</td>
</tr>
<tr>
<td>2.7.2.</td>
<td>Steel Piles</td>
</tr>
<tr>
<td>2.7.3.</td>
<td>Concrete Piles</td>
</tr>
<tr>
<td>2.7.4.</td>
<td>Rejection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 2.8.</th>
<th>Chain Link and Barrier Fences</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.8.1.</td>
<td>Heavy Duty Chain Link Fencing</td>
</tr>
<tr>
<td>2.8.2.</td>
<td>Wire Fencing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 2.9.</th>
<th>Paint and Protective Coatings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.9.1.</td>
<td>Paint</td>
</tr>
<tr>
<td>2.9.2.</td>
<td>Galvanizing</td>
</tr>
<tr>
<td>2.9.3.</td>
<td>Aluminizing</td>
</tr>
<tr>
<td>2.9.4.</td>
<td>Corrosion-Resistant Coatings and Liners for Sanitary Sewers and Appurtenances</td>
</tr>
<tr>
<td>2.9.5.</td>
<td>Polyethylene Wrap for Metal Pipe and Fittings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 2.10.</th>
<th>Electrical Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.10.1.</td>
<td>General Requirements for Electrical Components</td>
</tr>
<tr>
<td>2.10.2.</td>
<td>Material</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 2.11.</th>
<th>Metal for Structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.11.1.</td>
<td>Structural Steel</td>
</tr>
<tr>
<td>2.11.2.</td>
<td>Rivets</td>
</tr>
<tr>
<td>2.11.3.</td>
<td>Bolts</td>
</tr>
<tr>
<td>2.11.4.</td>
<td>Forgings</td>
</tr>
<tr>
<td>2.11.5.</td>
<td>Castings</td>
</tr>
<tr>
<td>2.11.6.</td>
<td>Bronze Castings and Sheet Copper</td>
</tr>
<tr>
<td>2.11.7.</td>
<td>Metal Railings</td>
</tr>
<tr>
<td>2.11.8.</td>
<td>Miscellaneous Metals</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 2.12.</th>
<th>Underground Conduit and Related Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.12.1.</td>
<td>Clay Sewer Pipe</td>
</tr>
<tr>
<td>2.12.2.</td>
<td>Concrete Sewer Pipe, Nonreinforced with Rubber Gasket Joints</td>
</tr>
<tr>
<td>2.12.3.</td>
<td>Reinforced Concrete Culvert, Storm Drain, Pipe and Box Section</td>
</tr>
<tr>
<td>2.12.4.</td>
<td>Reinforced Concrete Sewer Pipe and Rubber Gasket Joints</td>
</tr>
<tr>
<td>2.12.5.</td>
<td>Concrete Pressure Pipe and Fittings</td>
</tr>
<tr>
<td>2.12.6.</td>
<td>Thermoplastic or Thermosetting Coated Concrete Pipe and Fittings</td>
</tr>
<tr>
<td>2.12.7.</td>
<td>Gray Iron Pressure Pipe and Fittings</td>
</tr>
<tr>
<td>2.12.8.</td>
<td>Ductile-Iron Pressure Pipe and Fittings</td>
</tr>
</tbody>
</table>
2.12.9. Steel Pipe and Fittings
2.12.10. (Deleted)
2.12.11. (Deleted)
2.12.12. ABS and PVC Composite Pipe for Sanitary Sewers
2.12.13. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings with Modified Wall Profiles and Performance Standards
2.12.14. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings with Dimension Control
2.12.15. Polyethylene Plastic Pipe — Nonpressure Type — For Slip-Lining
2.12.16. Corrugated Metal Pipe or Pipe Arch Shapes
2.12.17. Structural Plate Structures
2.12.18. (Deleted)
2.12.19. Tunnel Liner Plates
2.12.20. Polyvinyl Chloride (PVC) Water Pipe
2.12.21. (Deleted)
2.12.22. Polyethylene (PE) Large Diameter Sewer Pipe with Modified Wall Profiles and Performance Standards
2.12.23. Fiberglass (Glass — Fiber Reinforced Thermosetting — Resin) Sewer Pipe
2.12.24. Polyethylene (PE) Corrugated and Corrugated Smooth Lined Storm Sewer and Drainage Tubing and Fittings
2.12.25. Polyvinyl Chloride (PVC) Pressure Rated Pipe (SDR Series)
2.12.26. Polyethylene (PE) Pressure Pipe and Fittings — for Water Distribution

Item 2.13. Valves
2.13.1. Gates Valves for Ordinary Waterworks Services
2.13.2. Air Valves
2.13.3. Brass Wheel Valves
2.13.4. Butterfly Valves

Item 2.14. Fire Hydrants
2.14.1. General
2.14.2. Supplementary Details Specified
2.14.3. Turns to Open
2.14.4. Breakable Type Hydrants
2.14.5. Main Valve Seats
2.14.6. Gaskets — Ground Line
2.14.7. Nozzle Cap Chains
2.14.8. Flanges
2.14.9. Operating Stems
2.14.10. O-Ring
2.14.11. Extensions
2.14.13. Drawings
2.14.15. Upperstem Thread Lubrication
2.14.16. Affidavit of Compliance
2.14.17. Tests
2.14.18. Sample Hydrant

Item 2.15. Materials for Seeding and Sodding
2.15.1. Turfgrass
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.15.2</td>
<td>Fertilizer</td>
</tr>
<tr>
<td>2.15.3</td>
<td>Hydro Mulch Materials</td>
</tr>
<tr>
<td>2.15.4</td>
<td>Soil Amendments</td>
</tr>
<tr>
<td>2.15.5</td>
<td>Rejection</td>
</tr>
<tr>
<td><strong>2.16.</strong></td>
<td><strong>Brass Stops, Cocks and Fittings for Waterworks Service</strong></td>
</tr>
<tr>
<td>2.16.1</td>
<td>General</td>
</tr>
<tr>
<td>2.16.2</td>
<td>Physicals</td>
</tr>
<tr>
<td>2.16.3</td>
<td>Design Features of Stops and Cocks</td>
</tr>
<tr>
<td>2.16.4</td>
<td>Design Features of Fittings</td>
</tr>
<tr>
<td>2.16.5</td>
<td>Tests</td>
</tr>
<tr>
<td>2.16.6</td>
<td>Rejection</td>
</tr>
<tr>
<td><strong>2.17.</strong></td>
<td><strong>Bronze Service Clamps</strong></td>
</tr>
<tr>
<td>2.17.1</td>
<td>General</td>
</tr>
<tr>
<td>2.17.2</td>
<td>Saddles</td>
</tr>
<tr>
<td>2.17.3</td>
<td>Straps</td>
</tr>
<tr>
<td>2.17.4</td>
<td>Gasket</td>
</tr>
<tr>
<td>2.17.5</td>
<td>Material</td>
</tr>
<tr>
<td>2.17.6</td>
<td>Hydrostatic Test</td>
</tr>
<tr>
<td>2.17.7</td>
<td>Rejection</td>
</tr>
<tr>
<td><strong>2.18.</strong></td>
<td><strong>Seamless Copper Tubing</strong></td>
</tr>
<tr>
<td>2.18.1</td>
<td>General</td>
</tr>
<tr>
<td>2.18.2</td>
<td>Quality</td>
</tr>
<tr>
<td>2.18.3</td>
<td>Rejection</td>
</tr>
<tr>
<td><strong>2.19.</strong></td>
<td><strong>Precast Reinforced Manhole Sections</strong></td>
</tr>
<tr>
<td>2.19.1</td>
<td>General</td>
</tr>
<tr>
<td>2.19.2</td>
<td>Joints</td>
</tr>
<tr>
<td>2.19.3</td>
<td>Coatings and Linings</td>
</tr>
<tr>
<td>2.19.4</td>
<td>Lifting Devices</td>
</tr>
<tr>
<td>2.19.5</td>
<td>Rejection</td>
</tr>
<tr>
<td><strong>2.20.</strong></td>
<td><strong>Fiberglass Manholes</strong></td>
</tr>
<tr>
<td>2.20.1</td>
<td>General</td>
</tr>
<tr>
<td>2.20.2</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>2.20.3</td>
<td>Manhole Configuration</td>
</tr>
<tr>
<td>2.20.4</td>
<td>Watertight Construction</td>
</tr>
<tr>
<td>2.20.5</td>
<td>Installation</td>
</tr>
<tr>
<td>2.20.6</td>
<td>Testing</td>
</tr>
<tr>
<td>2.20.7</td>
<td>Rejection</td>
</tr>
<tr>
<td><strong>2.21.</strong></td>
<td><strong>Preformed Flexible Joint Sealant</strong></td>
</tr>
<tr>
<td>2.21.1</td>
<td>General</td>
</tr>
<tr>
<td>2.21.2</td>
<td>Applicable Standards</td>
</tr>
<tr>
<td>2.21.3</td>
<td>Basis of Acceptance</td>
</tr>
<tr>
<td>2.21.4</td>
<td>Material</td>
</tr>
<tr>
<td>2.21.5</td>
<td>Installation of Joint Sealant</td>
</tr>
<tr>
<td>2.21.6</td>
<td>Compliance with Specifications</td>
</tr>
<tr>
<td>2.21.7</td>
<td>Rejection</td>
</tr>
</tbody>
</table>
### Item 2.22. Tunnel Wood Lagging
- **2.22.1.** General
- **2.22.2.** Material
- **2.22.3.** Tests
- **2.22.4.** Rejection

### Item 2.23. Geotextiles
- **2.23.1.** General
- **2.23.2.** Material Requirements
- **2.23.3.** Geotextiles Used in Drainage, Erosion Control and Stabilization Applications
- **2.23.4.** Geotextiles Used in Silt Fencing
- **2.23.5.** Geotextiles Used in Paving Applications
- **2.23.6.** Certification
- **2.23.7.** Construction Methods
- **2.23.8.** Rejection

### Item 2.24. Gabion Structures
- **2.24.1.** General
- **2.24.2.** Gabions
- **2.24.3.** Stone
- **2.24.4.** Geotextile Fabric
- **2.24.5.** Protective Aggregate Filter Layer
- **2.24.6.** Rejection
DIVISION 2 MATERIALS

ITEM 2.1. AGGREGATES

2.1.1. AGGREGATES FOR PORTLAND CEMENT CONCRETE

(a) General Requirements.

(1) General. Aggregates for portland cement concrete shall conform to the requirements contained in this Item 2.1.1, 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) Storage. The manner of handling and storage of aggregates shall be such as to prevent intrusion of foreign materials and segregation of sizes. If materials are stored on the ground, the stockpile sites shall be grubbed, cleaned of all vegetation and leveled. In this case, the bottom six-in. layer of aggregate shall not be disturbed and shall not be used in the work.

Where two or more sizes or types of aggregates are delivered to the job, each size or type shall be stored separately.

Lightweight aggregates shall be stockpiled on the job or at a central batching plant for a minimum of 24 hours prior to use in the project. At the plant, the aggregate shall be wetted to a uniform moisture content of not less than three percent below saturated surface dry condition before or while being loaded for shipment. Care shall be exercised to maintain this uniformity of moisture until the aggregates are used in the mix. Wetting of stockpiles to maintain the required percent moisture shall be performed at least 12 hours prior to use.

At the time of use, the aggregates shall be free from frozen material and foreign matter. All grass, wood, sticks, burlap, paper or other material which may have become mixed with the aggregates while stockpiled or in handling must be removed.

(3) Aggregates Weighing. Aggregates weighing equipment shall conform to the following general requirements and shall be approved by the OWNER prior to use:

(a) the storage bins shall be of suitable size and shape to adequately meet the needs of the weighing and batching equipment. The framework and foundation shall be adequate to support the total imposed loads.

(b) the weighing hopper or container shall be of suitable size and tight enough to hold the entire load without leakage. It shall be supported entirely upon the scales and be free of other supports. Hopper construction should provide access for adequate and easy removal of any overload. The discharge gate shall have a substantial latch which shall hold tightly during the introduction of aggregates into the hopper. When more than one aggregate size is to be weighed in a single hopper, there shall be a separate compartment for each size. This arrangement shall facilitate separate aggregates discharge and overload removal.

(c) the scales for weighing aggregates may be either the horizontal-beam or springless-dial type of heavy duty design construction. The design shall incorporate the scales as an integral part of the batching plant. Scale accuracy should demand a maximum error of 0.5 percent of net load with minimum graduations not greater than 25 pounds (11.3 kg). With the beam-type scales, provisions (such as a “tell-tale” dial) shall be made to indicate to the operator that the required load in the weigh box is being approached. The indicator should show at least the last 200 pounds (90 kg) of load. A device on the weighing beam shall clearly indicate the critical position. Dial-type scales shall be provided with pointers to indicate the full load for each aggregate. All indicators shall be designed to prevent unauthorized change. The dial or “tell-tale” device shall be in full view of the operator while changing the weigh box, and the operator shall have convenient access to all controls.

(d) aggregates weighing equipment shall be fully loaded before testing and using in order to allow settlement and adjustment under working conditions.

(4) Aggregates Measuring. The volume measuring equipment shall consist of approved boxes, pans or mechanical devices, which, while in operation, shall give the required volumes of the different kinds of aggregates required for the several classes of concrete. They shall also be so marked and designed that the OWNER can accurately and conveniently check the quantities of each aggregate being used.

Concrete made by continuous mixing shall conform to Concrete Made by Volumetric Batching and Continuous Mixing, ASTM Designation C 685.
The fine and coarse aggregates shall be measured loose and separately.

(5) Tests. Test of aggregates shall be made in accordance with the applicable current ASTM standards. The tests used for aggregates are listed below:

<table>
<thead>
<tr>
<th>ASTM Designations</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 29 Unit Weight and Voids in Aggregates</td>
<td></td>
</tr>
<tr>
<td>C 33 Concrete Aggregates</td>
<td></td>
</tr>
<tr>
<td>C 40 Organic Impurities in Fine Aggregates for Concrete</td>
<td></td>
</tr>
<tr>
<td>C 88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate</td>
<td></td>
</tr>
<tr>
<td>C 123 Lightweight Pieces in Aggregate</td>
<td></td>
</tr>
<tr>
<td>C 125 Concrete and Concrete Aggregates, Definition of Terms Relating to</td>
<td></td>
</tr>
<tr>
<td>C 127 Specific Gravity and Absorption of Coarse Aggregate</td>
<td></td>
</tr>
<tr>
<td>C 128 Specific Gravity and Absorption of Fine Aggregate</td>
<td></td>
</tr>
<tr>
<td>C 131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine</td>
<td></td>
</tr>
<tr>
<td>C 136 Sieve Analysis of Fine and Coarse Aggregates</td>
<td></td>
</tr>
<tr>
<td>C 142 Clay Lumps and Friable Particles in Aggregates</td>
<td></td>
</tr>
<tr>
<td>C 330 Lightweight Aggregates for Structural Concrete</td>
<td></td>
</tr>
<tr>
<td>C 535 Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine</td>
<td></td>
</tr>
<tr>
<td>C 641 Staining Materials in Lightweight Concrete Aggregates</td>
<td></td>
</tr>
<tr>
<td>D 8 Materials for Roads and Pavements, Definition of Terms Relating to</td>
<td></td>
</tr>
<tr>
<td>D 75 Sampling Aggregates</td>
<td></td>
</tr>
<tr>
<td>D 422 Particle-Size Analysis of Soils</td>
<td></td>
</tr>
<tr>
<td>D 423 Liquid Limit of Soils</td>
<td></td>
</tr>
<tr>
<td>D 424 Plastic Limit and Plasticity Index of Soils</td>
<td></td>
</tr>
<tr>
<td>D 2217 Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants</td>
<td></td>
</tr>
</tbody>
</table>

(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:

<table>
<thead>
<tr>
<th>Material removed by decantation</th>
<th>Other deleterious substances such as coal, shale, coated grains and soft flaky particles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material removed by decantation</td>
<td>3.0%</td>
</tr>
<tr>
<td>Other deleterious substances</td>
<td>3.0%</td>
</tr>
<tr>
<td>such as coal, shale, coated</td>
<td></td>
</tr>
<tr>
<td>grains and soft flaky particles</td>
<td></td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Passing 7/16 in. sieve (9.5 mm)</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing No. 4 sieve (4.75 mm)</td>
<td>95 to 100%</td>
</tr>
<tr>
<td>Passing No. 8 sieve (2.36 mm)</td>
<td>80 to 100%</td>
</tr>
</tbody>
</table>
The fine aggregates shall have a fineness modulus as shown in Item 2.1.1.(b)(6) and shall also meet the requirements of Item 2.1.1.(b)(1).

(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:

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing No. 30 sieve (600 um)</td>
<td>95 to 100%</td>
</tr>
<tr>
<td>Passing No. 100 sieve (150 um)</td>
<td>70 to 100%</td>
</tr>
</tbody>
</table>

(6) Additional Requirements. For Class A, C, E and F concrete, as defined in Item 7.4.5., the fineness modulus as defined below for fine aggregates shall be between 2.30 and 3.10.

For Class H concrete, the finest 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 percentages by weight:

<table>
<thead>
<tr>
<th>Material Removed by Decantation</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material removed by decantation</td>
<td>1.0%</td>
</tr>
<tr>
<td>Shale, slate or other similar material</td>
<td>1.0%</td>
</tr>
<tr>
<td>Clay lumps</td>
<td>0.25%</td>
</tr>
<tr>
<td>Soft fragments</td>
<td>3.0%</td>
</tr>
<tr>
<td>Other deleterious substances, including friable, thin, elongated or laminated pieces</td>
<td>3.0%</td>
</tr>
<tr>
<td>The sum of all deleterious substances, exclusive of material removed by decantation</td>
<td>5.0%</td>
</tr>
</tbody>
</table>

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 the following table "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) Additional Requirements. 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 further supply sources to the project by the OWNER. Such rejection shall incur no cost to the OWNER.

### COARSE AGGREGATE GRADING

**Grade No. 1 — Maximum Nominal Size 2 1/4 in. (63 mm)**

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 in. (75 mm)</td>
<td>100%</td>
</tr>
<tr>
<td>2 1/2 in. (63 mm)</td>
<td>95 to 100%</td>
</tr>
<tr>
<td>2 in. (50 mm)</td>
<td>80 to 100%</td>
</tr>
<tr>
<td>1 1/2 in. (37.5 mm)</td>
<td>50 to 85%</td>
</tr>
<tr>
<td>3/4 in. (19.0 mm)</td>
<td>20 to 40%</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>0 to 5%</td>
</tr>
</tbody>
</table>

**Grade No. 2 — Maximum Nominal Size 1 1/4 in. (37.5 mm)**

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 in. (50 mm)</td>
<td>100%</td>
</tr>
<tr>
<td>1 1/2 in. (37.5 mm)</td>
<td>95 to 100%</td>
</tr>
<tr>
<td>3/4 in. (19.0 mm)</td>
<td>40 to 70%</td>
</tr>
<tr>
<td>3/8 in. (9.5 mm)</td>
<td>10 to 30%</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>0 to 5%</td>
</tr>
</tbody>
</table>

**Grade No. 3 — Maximum Nominal Size 1 in. (25 mm)**

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2 in. (37.5 mm)</td>
<td>95 to 100%</td>
</tr>
<tr>
<td>3/4 in. (19.0 mm)</td>
<td>60 to 90%</td>
</tr>
<tr>
<td>1/2 in. (12.5 mm)</td>
<td>25 to 60%</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>0 to 5%</td>
</tr>
</tbody>
</table>

**Grade No. 4 — Maximum Nominal Size 3/8 in. (9.5 mm)**

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 in. (12.5 mm)</td>
<td>95 to 100%</td>
</tr>
<tr>
<td>3/8 in. (9.5 mm)</td>
<td>70 to 95%</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>0 to 25%</td>
</tr>
</tbody>
</table>
(d) Lightweight Aggregates.

(1) General. Lightweight aggregates shall consist of expanded clay or shale having strong, durable particles; and conforming to the requirements of Lightweight Aggregates for Structural Concrete, ASTM Designation C 330.

(2) Deleterious Substances. The maximum amount of deleterious substances shall not exceed the following percentages by weight:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss on ignition</td>
<td>5%</td>
</tr>
<tr>
<td>Clay lumps</td>
<td>2%</td>
</tr>
</tbody>
</table>

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.

If, after a test for staining materials (ASTM Designation C 641), 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 (Fe₂O₃) is found, the aggregate shall be rejected.

(3) Tests. Lightweight aggregates shall have a percent of wear not more than 40 when tested according to ASTM Designation C 131.

(4) 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:

<table>
<thead>
<tr>
<th>Size</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 in. (19.0 mm)</td>
<td>90 to 100%</td>
</tr>
<tr>
<td>1/8 in. (9.5 mm)</td>
<td>20 to 55%</td>
</tr>
<tr>
<td>No. 4 sieve (4.75 mm)</td>
<td>0 to 10%</td>
</tr>
<tr>
<td>No. 8 sieve (2.36 mm)</td>
<td>0 to 5%</td>
</tr>
</tbody>
</table>

(5) Additional Requirements. The natural fine aggregate shall conform to the requirements for aggregate shown in Item 2.1.1.(b)(4).

(6) 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.

(e) Pit-Run and Re-Mix Aggregate.

(1) General. Pit-run aggregate is the natural gravel and sand obtained from pits without the addition of other fine or coarse aggregates and shall consist of hard, durable, uncoated pebbles or stone particles mixed with sand.

Re-mix aggregate is uncrushed native rock and sand that has been washed and screened and possesses all of the different sizes of aggregates.

(2) Deleterious Substances. Pit-run and re-mix aggregate shall be free from lumps of clay and from injurious amounts of dust, shale, soft or flaky particles, salt and alkali.

(3) Gradation. Pit-run and re-mix aggregate shall be well graded from coarse to fine when tested by standard laboratory methods and shall meet the following minimum requirements for percentages by weight:

<table>
<thead>
<tr>
<th>Size</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 in. (0.6 cm)</td>
<td>55 to 60%</td>
</tr>
</tbody>
</table>

(4) Additional Requirements. Pit-run aggregate shall not be used for high strength concrete of 3000 psi (20,684 kPa) and above. Pit-run aggregate may be used only for concrete cushion, cradle and protection for pipe.

Re-mix aggregate shall not be used for high-strength concrete of 3000 psi (20,684 kPa) and above. Re-mix aggregate may be used only as a substitute for pit-run aggregate or when specified.

(5) Rejection. Pit-run and re-mix aggregate may be rejected for failure to meet any of the requirements of this specification.
2.1.2. AGGREGATES FOR HOT-MIX ASPHALTIC CONCRETE (HMAC)

(a) General Requirements.

(1) General. Aggregates shall conform to the requirements contained in this Item 2.1.2. 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) Storage. Prior to stockpiling of aggregates, the area shall be cleaned of trash, weeds and grass and be relatively smooth. Aggregates shall be stockpiled in such a manner as to prevent mixing of one aggregate with another. Coarse aggregates for Type “B” and Type “D” shall be separated into at least two stockpiles of different gradation, such as a large coarse aggregate and a small coarse aggregate stockpile and such that the grading requirements of the specified type shall be met when the piles are combined in the asphaltic mixture. No coarse aggregate stockpile shall contain more than 15 percent by weight of material that shall pass a No. 10 (2.00 mm) sieve except as noted on the plans. Fine aggregate stockpiles may contain coarse aggregate in the amount of up to 20 percent by weight; however, the coarse aggregate shall meet the quality tests specified herein for “Coarse Aggregates.” Suitable equipment of acceptable size shall be furnished by the CONTRACTOR to work the stockpiles and prevent segregation of the aggregates.

(3) Aggregates Weighing. When specifically indicated on the plans, asphaltic mixture mixing plants used in the production of asphaltic base and surface mixtures shall be equipped with approved fully automatic devices for the batching and cycling operations. There shall be interlock cut-off circuits to interrupt and stop all operations at any time that there is malfunctioning of any part of the control system.

The automatic proportioning controls shall include equipment for accurately proportioning batches of the various components of the mixture by weight. Visible dial scales shall be provided to show the weights of each batch ingredient.

Over-and-under asphalt and aggregates weight check sensors shall be included in the proportioning system to check the accuracy of the asphalt and aggregate bin weights. The over-under tolerance limits for aggregate shall be selected by the OWNER after the amounts of the various ingredients have been determined for a batch of mixture. The equipment shall be capable of a tolerance range of plus or minus one-half percent to plus or minus two percent as applied to the material being weighed. The tolerance limits for asphalt shall be plus or minus one scale gradation for the aggregates scales and plus or minus three scale gradations for the asphalt scales. The tolerances shall be locked in such manner that the settings for the over-and-under sensors cannot be altered or bypassed without the express permission of the OWNER. The system shall incorporate provisions for a manual check which the operator would perform periodically as required by the OWNER.

At least one set of scale dials shall be provided, one dial for aggregates and one dial for asphalt. The scale dials shall be divided into increments not to exceed 1/10,000 of the total dial capacity. The scale dials may be located either in a dustproof control room or on the plant near the weighing hopper. In either location, the scale dials shall accurately indicate the weight in the weighing hopper from zero load to the maximum batch weight.

If the scale dials are located on the plant outside the control room, there shall be provided either an identical set of scale dials inside the control room or digital weight indicators, which for either type shall duplicate, within a tolerance of plus or minus one scale gradation for aggregates scales and plus or minus one scale gradation for asphalt scales, readings of the scale dial indicators located outside on the plant. Wherever located, the scale dials shall be so positioned that the dial and indicators are in full view of the operator in the electronic control room. The normal weight of a batch of aggregate shall be not less than one half the aggregate scale dial capacity.

The automatic proportioning system shall be provided with low bin indicators arranged in such manner that under normal working operations the batching operation shall be automatically stopped when the level of material in any supply bin is not sufficient to complete the weighing of a complete batch of asphaltic mixture.

The system shall include a batch counter which can be preset for determining the number of batches which may be desired in one uninterrupted production sequence; and a counter to show the number of batches for the day’s run.

The mixer shall have an accurate timelocking device to control the operation of a complete mixing cycle by locking the weigh box gate(s) after charging the mixer. It shall remain locked until the mixing cycle is complete; the
mixture has been dumped; and the mixer discharge gate is closed. The timing device shall automatically control the dry and wet mixing period in accordance with the governing specification.

The control of the time shall be adjustable and capable of being present at the time intervals directed by the OWNER. Changes in mixing time shall be made only when approved in writing by the OWNER.

The aggregate dryer and asphalt tank heaters shall be equipped with burners that are automatically controlled by thermostats. This automatic equipment shall control the heat of the materials within the specified tolerances. Manual controls shall be used only as directed by the OWNER.

Temperature recording devices shall be supplied to record the temperatures of the aggregates at the discharge end of the dryer and the asphalt near the discharge value of the mixer unit.

The automatic heat control panel and the temperature recording devices shall be located inside the dustproof control room.

Automatic controls shall be housed in a dustproof room located in such manner that the mixer discharge chute is in full view of the operator.

If at any time the automatic control devices become inoperative, the plant operations shall be allowed to continue under manual controls for not more than two days of operation, at which time all plant operations shall cease until the necessary repairs are made. Continuous and frequent breakdowns of the automatic control devices shall be cause for suspending operations until the devices are properly repaired.

When specifically provided for in the plans, the proportioning system shall be equipped with an automatic digital record printer and shall record batch weights and print out the required information on a continuous tape or ticket through the use of a printing calculator. When requested by the OWNER, the CONTRACTOR shall demonstrate the accuracy of the printout device within a tolerance of plus or minus one scale graduation for the aggregate scales and plus or minus one scale graduation for the asphalt scales. The printout accuracy shall also apply to the no-load condition.

In the event of a breakdown of the recording equipment, the pay weights shall be determined by weighing the mix in the trucks on approved platform and recording scales or by calculated batch weights for a maximum period of not more than two working days. Continuous and frequent breakdowns of the recording equipment shall be cause for suspending operations until the recorder is properly repaired.

Each individual ticket or continuous tape shall contain the following readable information printed automatically by the digital record printer:

- Date.
- Project Identification Code Number. (This number shall be supplied by the OWNER.)
- Time of day to the nearest minute at intervals not greater than for each truck load, or at intervals not greater than 10 batches when material is being deposited into a storage bin.
- Mix Design Number.
- Zero scale record for aggregate and asphalt to be printed at intervals not greater than 10 batches when material is being deposited in a storage bin.
- Weight of each aggregate for each batch recorded accumulatively or separately.
- Total weight of all aggregates in each batch.
- Weight of asphalt in batch.
- Total of batch weights (combined mixture of asphalt and aggregate) for the day and/or any part of a day as required by the OWNER. This printing shall be required on the tape or ticket at the times specified herein during each day of operation.
- Total of either the aggregates or the asphalt for the day and/or any part of a day as required by the OWNER. This printing shall be required on the tape or ticket at the times specified herein during each day of operation.

One copy of the tape shall be provided the OWNER at the end of each day's run. If the tickets are used, the OWNER shall be furnished three tickets with each truckload.

The recording until shall be in the same room as the automatic batching console unit. The recording unit may be separate from the console.
The cold aggregates bins shall have at least four compartments of sufficient size to store the amount of aggregates required to keep the plant in continuous operation; and shall be of proper design to prevent overflow of material of one bin to that of another bin. The proportioning device shall be such as shall provide a uniform and continuous flow of aggregates in the desired proportion to the dryer. Each aggregate shall be proportioned in a separate compartment.

The hot aggregates bins shall be so constructed that oversize and overloaded material shall be discarded through a discharge chute. Hot bins that become deficient in material shall activate a switch that automatically stops the plant until the proper adjustments are made in the aggregates gates.

(4) Feeding and Drying. The feeding of various sizes of aggregates to the dryer shall be done through the cold aggregates bin and proportioning device in such a manner that a uniform and constant flow of materials in the required proportions shall be maintained. When specified on the plans, the cold aggregates bins shall be charged by use of a clamshell, dragline, shovel or front-end loader. The aggregates shall be dried and heated to the temperature necessary to produce a mixture having the specified temperature. In no case shall the aggregates be introduced into the mixing unit at a temperature more than 400°F (204°C).

The dryer shall be of the type that continually agitates the aggregates during heating and in which the temperature can be so controlled that aggregates shall not be injured in the necessary drying and heating operations required to obtain a mixture of the specified temperature. The burner, or combination of burners, and type of fuel used shall be such that in the process of heating the aggregates to the desired or specified temperature, no residue from the fuel shall adhere to the heated aggregates. A recording thermometer shall be provided which shall record the temperature of the aggregates when they leave the dryer. The dryer shall be of sufficient size to keep the plant in continuous operation.

(5) Screening and Proportioning. The proportioning of the various materials entering into the asphaltic mixture shall be as directed by the OWNER and in accordance with these specifications. Aggregates shall be proportioned by weight, using the weigh box and batching scales herein specified when the weight-batch type of plant is used; and by volume, using the hot aggregates proportioning device when the continuous mixer type of plant is used. The asphaltic material shall be proportioned by weight, using the specified equipment.

The screening capacity and size of the bins shall be sufficient to screen and store the amount of aggregates required to properly operate the plant and keep the plant in continuous operation at full capacity. Provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where representative samples may be taken from the hot bins for testing. The aggregates shall be separated into at least four bins when producing Type B mixture, and at least three bins when producing Type D mixtures. If mineral filler is used, an additional bin shall be provided. These bins shall contain the following sizes of aggregates:

**Type B (Fine Graded Base or Leveling-Up Course):**

- Bin No. 1: shall contain aggregates of which 85 to 100 percent by weight shall pass the No. 10 (2.0 mm) sieve.
- Bin No. 2: shall contain aggregates of which at least 70 percent by weight shall be of such size as to pass the No. 4 (4.75 mm) sieve and be retained on the No. 10 (2.0 mm) sieve.
- Bin No. 3: shall contain aggregates of which at least 75 percent by weight shall be of such size as to pass the 3/16 in. (9.5 mm) sieve and be retained on the No. 4 (4.75 mm) sieve.
- Bin No. 4: shall contain aggregates of which at least 75 percent by weight shall be of such size as to pass the 1 in. (25.0 mm) sieve and be retained on the 3/16 in. (9.5 mm) sieve.

**Type D (Fine Graded Surface Course):**

- Bin No. 1: shall contain aggregates of which 85 to 100 percent by weight shall pass the No. 10 (2.0 mm) sieve.
- Bin No. 2: shall contain aggregates of which at least 70 percent by weight shall be of such size as to pass the No. 4 (4.75 mm) sieve and be retained on the No. 10 (2.0 mm) sieve.
- Bin No. 3: shall contain aggregates of which at least 75 percent by weight shall be of such size as to pass the 3/16 in. (12.5 mm) sieve and be retained on the No. 4 (4.75 mm) sieve.

**For other plant type requirements, refer to Item 2.4.13(e).**
(6) Tests. Test of aggregates, when required, shall be made in accordance with the applicable current ASTM Standards and Test Methods of the Texas Department of Transportation. The tests used for HMAC aggregates are as follows:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM C 136</td>
<td>Sieve Analysis of Fine and Coarse Aggregate.</td>
</tr>
<tr>
<td>ASTM D 2419</td>
<td>Sand Equivalent Value of Soils and Fine Aggregate.</td>
</tr>
<tr>
<td>ASTM D 4318</td>
<td>Method of Calculating the Plasticity Index of Soils.</td>
</tr>
<tr>
<td>Tex-217-F</td>
<td>(I &amp; II) Determination of Deleterious Material and Decantation Test for Coarse Aggregates.</td>
</tr>
<tr>
<td>ASTM D 692</td>
<td>Determination of Deleterious Material and/or Crushed Particles in Mineral Aggregate.</td>
</tr>
<tr>
<td>ASTM D 2419</td>
<td>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.</td>
</tr>
</tbody>
</table>

(7) 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.

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. 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 aggregate sand passing the No. 40 (425 um) sieve shall not be more than six when tested in accordance with ASTM Designation D 4318.

(4) Gradation. Fine aggregate sand shall be that portion of the sand in the total aggregate passing the No. 10 (2.0 mm) sieve. It shall be well graded and composed of sound, durable sand particles.

(c) Limestone or Steel Slag Screenings.

(1) General. Stone or steel slag 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 portion of the fine aggregates passing the No. 40 (425 um) sieve shall not be more than six when tested in accordance with ASTM Designation D 4318. Fine aggregates from each source shall meet plasticity requirements.

(4) Gradation. The stone or steel slag screening shall meet the following grading requirements unless otherwise shown on the plans:

<table>
<thead>
<tr>
<th>Percent by Weight or Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 3/16 in. (9.5 mm) sieve</td>
</tr>
<tr>
<td>Passing No. 200 (75 um) sieve</td>
</tr>
</tbody>
</table>

When authorized by the OWNER, stone or steel slag screenings containing particles larger than 3/8 in. (9.5 mm) may be used but only that portion of the material passing the 3/16 in. (9.5 mm) 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, gravel or steel slag 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 Texas DOT Test Method Tex-217-F (Part II, Decantation) shall not be more than two percent. The stone, gravel or steel slag 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 Tests, ASTM Designation C 131.

(4) Gradation. The coarse aggregates shall be that portion of the total aggregates retained on the No. 10 sieve (2.0 mm). The crushed gravel shall be so crushed that not less than 90 percent of the particles shall have more than one crushed face. 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 Texas DOT Test Method Tex-217-F (Part II, 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 aggregate 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 Texas DOT Test Method Tex-200-F (Part 1 or Part 3 as applicable), it shall meet the following percentages by weight:

<table>
<thead>
<tr>
<th>Passing No. 30 sieve (600 um)</th>
<th>95 to 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing No. 80 sieve (180 um)</td>
<td>Not Less Than 75%</td>
</tr>
<tr>
<td>Passing No. 200 sieve (75 um)</td>
<td>Not Less Than 55%</td>
</tr>
</tbody>
</table>

(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.

2.1.3. SUBBASE MATERIAL

(a) Gravel Base Course.

(1) General. The material shall consist of durable particles of gravel or crushed stone 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.

(2) Tests. The soil binder shall meet the following requirements:
The liquid limit shall not exceed 35 when tested in accordance with ASTM Designation D 423.
The plastic limit shall be determined by testing in accordance with ASTM Designation D 424.
The plasticity index shall not exceed 12 when calculated in accordance with ASTM Designation D 424.
The preparation of samples for testing according to ASTM Designation D 423 and D 424 shall be in accordance with the requirements of ASTM Designation D 2217.
The linear shrinkage shall not exceed six percent.

(3) Gradation. The material when tested by standard laboratory methods shall meet the following percentages by weight:

<table>
<thead>
<tr>
<th>Passing</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 3/4 in. sieve (45 mm)</td>
<td>100%</td>
</tr>
<tr>
<td>3/8 in. sieve (9.5 mm)</td>
<td>40 to 80%</td>
</tr>
<tr>
<td>No. 4 sieve (4.75 mm)</td>
<td>25 to 60%</td>
</tr>
<tr>
<td>No. 40 sieve (425 um)</td>
<td>15 to 35%</td>
</tr>
</tbody>
</table>

Material passing the No. 40 sieve (425 um) shall be known as “soil binder.”

Materials containing conglomerate or gravel larger than 2 in. (50 mm) 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.

(4) 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.

(b) Flexible Base (Crushed Stone).

(1) 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.

(2) Tests. The soil binder shall meet the following requirements:
The liquid limit shall not exceed 40 when tested in accordance with ASTM Designation D 423.
The plastic limit shall be determined by testing in accordance with ASTM Designation D 424.
The plasticity index shall not exceed 12 nor be less than four when calculated in accordance with ASTM designation D 424.
The preparation of samples for testing according to ASTM Designations D 423 and D 424 shall be in accordance with the requirements of ASTM Designation D 2217.
Materials retained on the No. 4 sieve (4.75 mm) 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, Texas SDHPT Test Method Tex-116-E, shall not develop more than 50 percent soil binder.
(3) Gradation. The material shall be obtained from approved sources; shall be crushed; and shall consist of durable particles of stone mixed with approved binding materials. The material shall be approved by the OWNER at the source. The process material when properly shaked and tested by standard laboratory methods shall meet the following requirements:

<table>
<thead>
<tr>
<th>Gradation Requirement</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 1 3/4 in. sieve (45 mm)</td>
<td>100%</td>
</tr>
<tr>
<td>Passing No. 4 sieve (4.75 mm)</td>
<td>35 to 55%</td>
</tr>
<tr>
<td>Passing No. 40 sieve (425 um)</td>
<td>15 to 40%</td>
</tr>
</tbody>
</table>

Materials passing the No. 4 (4.75 mm) sieve shall be known as “binder.” The portion of material passing the No. 40 (425 um) sieve shall be known as “soil binder.”

(4) 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.

2.1.4. NON-PUMPING SUBBASE

(a) General. This specification covers material for use under concrete pavement to prevent pumping of the subbase material under the pavement slab.

Granular materials for use as subbase under concrete pavement may be composed of sand, sand-gravel, crushed stone, crushed or granulated slag or combinations of these materials.

(b) Tests. The material shall be sampled and tested in accordance with the following methods:

- Passing the No. 200 (75 um) sieve. Amount of material finer than No. 200 (75 um) sieve in aggregate in accordance with ASTM D 1140.
- Plastic limit and plasticity index. Determining the plastic limit and plasticity index of soils in accordance with ASTM D 424.
- Liquid limit. Liquid limit of the soils shall be determined in accordance with ASTM D 423.
- Moisture density relationships. Moisture density relationships of soils using a 10 lb. hammer and an 18 in. drop shall be determined in accordance with ASTM D 1557.

(c) Gradation. The material shall meet the following requirements:

<table>
<thead>
<tr>
<th>Gradation Requirement</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Size</td>
<td>Not more than 1/3 the thickness of the subbase</td>
</tr>
<tr>
<td>Passing No. 200 (75 um) sieve</td>
<td>15% maximum</td>
</tr>
<tr>
<td>Plasticity Index</td>
<td>6 maximum</td>
</tr>
<tr>
<td>Liquid Limit</td>
<td>25 maximum</td>
</tr>
</tbody>
</table>

NOTE: Materials with a higher percentage passing No. 200 (75 um) sieve or with a higher plasticity index than six or a higher liquid limit than 25 may be used, provided that a stabilization method found to be locally suitable is used.

The material shall be graded suitably to permit compaction to such a density that a minimum increase in densification shall occur after the pavement is in service.

(d) 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.

2.1.5. TRENCH BACKFILL (Cross-Reference 6.2.10.)

(a) Type “A”.

(1) General. Type “A” backfill shall be sandy gravel material and shall meet the following requirements:

(2) Tests.

The liquid limit shall not exceed 35 when tested in accordance with ASTM Designation D 423.
The plasticity index shall not exceed 10 when calculated in accordance with ASTM Designation D 424. 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.

(3) Gradation. The material when tested by standard laboratory methods shall meet the following percentages by weight:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 2 in. sieve (50 mm)</td>
<td>100%</td>
</tr>
<tr>
<td>Passing (\frac{1}{2}) in. sieve (12.5 mm)</td>
<td>50 to 85%</td>
</tr>
<tr>
<td>Passing No. 4 sieve (4.75 mm)</td>
<td>20 to 65%</td>
</tr>
<tr>
<td>Passing No. 100 sieve (150 um)</td>
<td>0 to 5%</td>
</tr>
</tbody>
</table>

(b) Alternate Allowable Type “A”. Field sand having the following requirements may be used in lieu of Type “A” backfill for filling trenches. 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.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing No. 4</td>
<td>100%</td>
</tr>
<tr>
<td>Passing No. 16</td>
<td>80 to 100%</td>
</tr>
<tr>
<td>Passing No. 50</td>
<td>20 to 60%</td>
</tr>
<tr>
<td>Passing No. 100</td>
<td>10 to 40%</td>
</tr>
<tr>
<td>Passing No. 200</td>
<td>0 to 10%</td>
</tr>
</tbody>
</table>

(c) Types “B” and “C.”

(1) General. Type “B” backfill is imported sandy gravel material. Type “C” backfill is native material from trench excavation. Types “B” and “C” backfill shall meet the following requirements:

(2) Tests. The liquid limit shall not exceed 35 when tested in accordance with ASTM Designation D 423. The plasticity index shall not exceed 12 when tested in accordance with ASTM Designation D 424.

(3) Gradation.

<table>
<thead>
<tr>
<th>MATERIAL REQUIREMENTS</th>
<th>TYPE BACKFILL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of rock volume allowed regardless of trench width</td>
<td>“B” Sandy Gravel</td>
</tr>
<tr>
<td>Greatest dimension of rock allowed in trenches 4 ft. or less in width</td>
<td>50%</td>
</tr>
<tr>
<td>Percent of maximum allowable dimension rock to total backfill volume, regardless of trench width</td>
<td>3%</td>
</tr>
<tr>
<td>Greatest dimension of rock allowed in trenches greater than 4 ft. in width. Total volume not to exceed 1% of backfill</td>
<td>6 in.</td>
</tr>
<tr>
<td>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 to be used.</td>
<td></td>
</tr>
<tr>
<td>Percent of backfill by volume, of clay or gumbo lumps permitted regardless of trench width</td>
<td>25%</td>
</tr>
<tr>
<td>Largest dimension of clay or gumbo lumps in trenches 4 ft. or less in width</td>
<td>6 in.</td>
</tr>
<tr>
<td>Largest dimension of clay or gumbo lumps permitted in trench greater than 4 ft. in width. Total volume not to exceed 1%</td>
<td>10 in.</td>
</tr>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>
(4) Additional Requirements.
   (A) Additional requirements for Type “B” backfill when used in streets:
      35 percent or less to total volume shall pass the No. 200 (75 um).
   (B) Additional requirements for Type “C” backfill when used in streets:
      Material otherwise meeting specification requirements and having a PI of 15 or less shall be considered
      as suitable for compaction by jetting in locations where the water can be drained off.
      Material otherwise meeting specifications requirements and having a PI greater than 15 shall be
      considered as suitable for use only when compaction procedure includes mechanical compaction.
      Material shall be of such characteristics that it shall stabilize without the use of lime or other similar
      additive and form an acceptable street subbase material.

   (d) Alternate Allowable Type “C.”
      (1) General. When material which shall meet the specification for Type “C” backfill material is not available in
      sufficient supply from trench excavation, the CONTRACTOR may be allowed to bring in a material which does not
      meet requirements for Type “B” backfill if the following conditions are complied with:
      Material must have the approval of the OWNER before being permitted to be brought to the job site and used.
      Material shall have superior soil characteristics for use in street subgrades to that of the excavated material
      being used on the project as Type “C” backfill material and may be of lower quality than Type “A” or Type “B”.
      Material shall be of such characteristics that it shall stabilize without the use of lime or other similar additive
      and form an acceptable street subbase material.
      No payment shall be made for material permitted by this alternative.

   (e) Flowable Backfill. Flowable backfill shall consist of a mixture of native soils or manufactured materials, cement
      and/or fly ash, and water which produces a material with unconfined compressive strength of between 250 and 450
      psi after 28 days. Any materials used shall be primarily granular, with a plasticity index <12 and with 100% passing
      a 7/16 in. sieve. The flowable mixture shall be mixed in a pug mill, concrete mixer, or transit mixer and shall have a
      minimum slump of 5 in. The flowable mixture must be allowed to set prior to the placement of any overlying
      material.

   (f) Modified Flowable Backfill. Modified flowable backfill in areas of possible future excavation such as utility
      installations shall consist of a mixture of native soils or manufactured materials, cement and/or fly ash, air entraining
      material, and water which produces a material with unconfined compressive strength of between 50 and 150 psi after
      28 days. Modified flowable backfill in permanent areas such as abandoned pipe closures, abutments and
      embankments shall contain similar materials and shall have an unconfined compressive strength of greater than 150
      psi after 28 days. Any materials used shall be primarily granular, with a plasticity index <12 and with 100% passing
      a 7/16 in. sieve. The flowable mixture shall be mixed in a pug mill, concrete mixer, or transit mixer and shall have a
      minimum slump of 5 in. The flowable mixture must be allowed to set prior to the placement of any overlying
      material.

   (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.

2.1.6. RIPRAP OR STONE MASONRY
(a) General. Riprap or stone masonry shall consist of either natural stone or broken portland cement concrete.
(b) Material and Dimensions.
   (1) General. Natural stone for riprap shall consist of field stone 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

JANUARY 1998
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 2.2.6., “Steel Reinforcement.”

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 Item 3.7.6., “Concrete Structures.”

Individual riprap material shall have a minimum thickness of 4 in. (10.0 cm) and minimum surface dimensions of 12 in. by 24 in. (30 cm by 60 cm). Smaller fragments may be used only to fill the voids between the above minimum size of riprap materials.

(2) 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 (1.36 kg to 68.1 kg) each, and at least 60 percent of the stones shall weigh more than 100 pounds (45.4 kg) 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° 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 pounds (45.4 kg to 68.1 kg) 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 that a toe wall of concrete, having dimensions and reinforcement as shown on the plans, shall be used.

Stones for Foundation Protection: Stones for foundation protection shall range in weight up to 300 pounds (136 kg) 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 in. 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.

(3) Grouted Riprap.

Grouted Riprap, Type A and Type B: Stones used in these types of riprap shall weigh between 40 and 150 pounds (18.2 kg to 68.1 kg) 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.

(4) 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 (45.4 kg to 68.1 kg) each, 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 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.
MATERIALS

Common Dry Riprap and Common Mortar: The stones for this type shall be not less than one third of a cubic foot (0.028 m³) in volume and not less than 4 in. (10 cm) in length dimensions. The width of the stones shall not be less than twice the thickness.

(c) 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.

2.1.7. 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 earth bedding. The various types of bedding shall be prepared as follows:

(b) Earth Bedding. The pipe shall be bedded in a foundation of undisturbed stable earth, which has been accurately shaped to fit the lower part of the pipe exterior for at least 15 percent of its overall height. The OWNER may require the use of a template if necessary to secure reasonably accurate shaping of the foundation material. The barrel of the pipe shall be bedded throughout its entire length. Recesses shall be excavated at joints of sufficient size and depth to provide ample space for placing the required jointing material. Filling and ramming with earth (or similar materials beneath the pipe) to raise it to grade shall be concrete composed of one part cement and 12 parts aggregates, which shall be placed by the CONTRACTOR at his own cost and expense.

(c) Trench. The trench shall be excavated to a minimum depth of three inches below the grade of the outside of the pipe. The trench shall then be filled up to and around the pipe exterior for at least 15 percent of its overall height with one screened pit gravel, passing 1 1/2 inch sieve and retained on 1/4 inch sieve; or pea gravel, passing 1/6 inch sieve and retained on 1/6 inch sieve. The aggregates used shall contain not more than a total of eight percent by weight of deleterious substances such as clay, shale or organic matter.

(d) Concrete Bedding.

(1) Concrete Cushion Bedding. In this type of bedding, the lower part of the pipe exterior shall be bedded in a continuous cushion of concrete having a minimum thickness under the pipe of 2 in. and extending up the sides of the pipe for at least 15 percent of its overall height. 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 placing of the concrete cushion. The pipe shall be placed in the concrete cushion before the concrete has taken its initial set. Concrete for cushion shall be composed of a dry mix composed of one part cement and 12 parts aggregates. Water shall be added to the mix only when authorized by the OWNER, and then only to the extent necessary for the hydration of the cement. The use of unyielding material to support the pipe shall not be permitted.

(2) Concrete Cradle Bedding. In this part of bedding, the lower part of the pipe exterior shall be bedded in a continuous cradle of concrete having a minimum thickness under the pipe of 2 in. and extending up the sides of the pipe for a height equal to one-fourth of the inside diameter. The cradle shall have a minimum side thickness of 4 in. and shall be constructed monolithically without horizontal construction joints. 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 placing of the concrete cradle. The pipe shall be placed in the concrete cradle before the concrete has taken its initial set. Concrete for cradle shall be a dry mix composed of one part cement and 12 parts aggregates. Water shall be added to the mix only when authorized by the OWNER, and then only to the extent necessary for the hydration of the cement. The use of unyielding material to support the pipe shall not be permitted.

(3) Rock Bedding/Foundation.

(A) Description. Rock foundation shall be composed of sound and durable particles of crushed stone from the Bridgeport, Texas, area or approved equal.

(B) Deleterious Substances. Rock foundation shall contain not more than one percent by weight of organic matter (other than native bitumen), clays, loam or pebbles coated therewith and shall contain not more than five percent by weight of any one of or combination of slate, shale, schist or soft particles of sandstone.

JANUARY 1998

67
(C) Gradation. Sizes shall be graded from 1 in. (2.5 cm) (passing 1 in. (2.5 cm) sieve, but retaining on 7/8 in. (2.2 cm) sieve), to 5 in. (12.7 cm)(100 percent passing 5 in. (12.7 cm) sieve), and shall be free from “flats” and “splinters.”

(e) Rock or Other Incompressible Foundation. Where rock or gravelly soil, hardpan or other unyielding material is encountered at the grade line of the storm sewer, such materials shall be removed in accordance with the requirements for the designated bedding and as directed by the OWNER. The type of bedding to be used in such cases shall be specified or shown on the plans or as directed by the OWNER.

(f) 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.

2.1.8. 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 Texas SDHPT Test Method Tex-410-A.

(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 Texas State Department of Highways and Public Transportation Standard Specifications for Construction of Highways, Streets and Bridges.

<table>
<thead>
<tr>
<th>Standard Crushed Rock — Aggregate Grade 4</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained on 1 1/2 in. sieve</td>
<td>0%</td>
</tr>
<tr>
<td>Retained on 1 in. sieve</td>
<td>0 to 5%</td>
</tr>
<tr>
<td>Retained on 7/8 in. sieve</td>
<td>40 to 75%</td>
</tr>
<tr>
<td>Retained on No. 4 sieve</td>
<td>90 to 100%</td>
</tr>
<tr>
<td>Retained on No. 8 sieve</td>
<td>95 to 100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fine Crushed Rock — Aggregate Grade 8</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained on 1 1/2 in. sieve</td>
<td>0%</td>
</tr>
<tr>
<td>Retained on 7/8 in. sieve</td>
<td>0 to 5%</td>
</tr>
<tr>
<td>Retained on No. 4 sieve</td>
<td>35 to 60%</td>
</tr>
<tr>
<td>Retained on No. 8 sieve</td>
<td>90 to 100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coarse Crushed Rock</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 1 1/2 in. sieve</td>
<td>100%</td>
</tr>
<tr>
<td>Retained on 3/4 in. sieve</td>
<td>100%</td>
</tr>
</tbody>
</table>

(b) Granular Material. Granular material shall be free flowing, such as sand or hydraulically graded crushed stone fines, or mixed sand and gravel, or sandy loam. The material shall be free from lumps, stones over two inches in diameter, clay and organic matter.

(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 for “Crushed Stone Embedment,” Item 2.1.8.(a), except the gradation shall be:

<table>
<thead>
<tr>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 5 in. sieve</td>
</tr>
<tr>
<td>Retained on 2 in. sieve</td>
</tr>
</tbody>
</table>
Natural Gravel. Natural gravel shall consist of uncrushed stones meeting the requirements for wear as outlined in Item 2.1.8.(a). 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:

<table>
<thead>
<tr>
<th>Percent</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 1(\frac{1}{2}) in. sieve</td>
<td>100%</td>
</tr>
<tr>
<td>Retained on (\frac{3}{4}) in. sieve</td>
<td>100%</td>
</tr>
</tbody>
</table>

Sand. Sand shall consist of clean, hard, durable, uncoated grains, free from lumps and organic material. All particles must pass a No. 8 sieve.

ITEM 2.2. PORTLAND CEMENT CONCRETE AND RELATED MATERIALS

2.2.1. 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 Item 7.4.5., 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) Delivery. Cement delivered in bags shall be legibly marked on the bag with brand and name of the manufacturer, shall be in good condition at the time of delivery, and shall contain 94 pounds (43 kg) net. Bags of cement varying more than five percent from the specified weight may be rejected, and if the average net weight in any shipment, as determined by weighing 50 bags taken at random, is less than 94 pounds (43 kg), the entire shipment may be rejected. Cement salvaged from discarded or used bags shall not be used.

Cement delivered in bulk may be used, provided the manner and method of handling is approved by the OWNER. When delivered in bulk, the brand name of the manufacturer contained in the shipping information accompanying the shipment shall be furnished to the OWNER prior to the use of the cement. Bulk cement shall be weighed on approved scales.

Cement from different manufacturers, although tested and approved, shall not be mixed, except as approved by the OWNER.

The CONTRACTOR, when required, shall furnish to the OWNER, with each shipment of cement, a statement as the specific surface of the cement expressed in square centimeters per gram.

(c) Cement Weighing Equipment. Bulk cement shall be batched by weight. The scales shall be either the beam or springless dial type, of substantial construction with a maximum allowable error of 0.5 percent of the net load and with minimum gradations of not greater than five pounds (2.5 kg). Provisions shall be made for indicating to the operator that the required load in the weight box or container is being approached, which device shall indicate at least the last 50 pounds (23 kg) of the load. Dial type scales shall be provided with a pointer to the dial.

When a closed-type cement box is used, the cement-weighing scales shall be provided with a springless dial indicator or tare beam to indicate when the weigh box is empty. This indicator for the empty condition of the weigh box shall be in continuous operation. The weigh box shall be fitted with an approved vent and a tightly covered inspection opening of not less than 12 in. square (77 sq. cm). The weigh box and scales shall be maintained in a satisfactory condition to meet the requirements for accuracy for weight.

(d) Volume and Weight of Bag of Cement. A bag of cement as packed by the manufacturer and weighing 94 pounds (43 kg) shall be considered one cubic foot (.28m³).

(e) Storage. Cement shall be stored in a suitable weathertight building which shall protect the cement from dampness, and placed in such manner that shall permit easy access for proper inspection and identification of each shipment.
(f) 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. any bag of cement which has partially set or which contains any lumps or cakes;
2. all cement salvaged from torn, discarded or used bags; or
3. bulk cement which has partially set or which contains any lumps or cakes.

2.2.2. CHEMICAL ADMIXTURES

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.

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:

(a) 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, Type “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.

(b) OWNER’s option: High range water-reducing admixtures, super-plasticizers conforming to ASTM Designation C 494, Type “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.

(c) 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.

Either prior to or at any time during construction, the OWNER may require that the air-entraining admixture selected by the CONTRACTOR be tested to determine its effect upon the strength of the concrete. When so tested, a seven-day compressive strength of concrete, made with cement and aggregates in proportions to be used in the work and containing the admixture in an amount sufficient to produce from three to six percent entrained air in the plastic concrete, shall be no less than 85 percent of the strength of concrete, made with the same materials and with the same cement content and consistency but without the admixture.

Any other admixtures for whatever purpose shall have the approval of the OWNER prior to incorporation into the concrete mix.

(d) Mineral Admixtures. Fly ash shall conform to the current requirements of “Standard Specifications for 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 “Loss on Ignition” requirements shall be a maximum of 3 (three) percent. Fly ash shall be sampled and tested at a frequency schedule in accordance with current requirements of “Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for use as a Mineral Admixture in Portland Concrete.”
Cement Concrete,” ASTM Designation C 311. All sources of fly ash for use in portland cement concrete shall be approved by the OWNER.

The CONTRACTOR when required by the OWNER, shall furnish laboratory analysis to verify that a fly ash source meets ASTM requirements.

With the approval of the OWNER, fly ash may be used in all classes of concrete to replace a portion of the portland cement in a mix design. Unless otherwise approved by the OWNER, the maximum cement reduction shall not exceed 20 percent by weight per cubic yard of concrete, and fly ash replacement shall be 1.25 pounds per 1.0 pound of cement reduction. The water-cement ratio of the concrete mix shall be based on total cementitious (cement plus fly ash) materials. Proposed concrete mix designs with materials certification data and laboratory or field trial mix test results on the properties of the fresh and hardened concrete shall be submitted to the OWNER for approval. Such data shall be resubmitted for approval annually, or when there is a change in materials, or when required by the OWNER.

Alternate brands and classes of fly ash shall not be substituted in approved concrete mix designs.

2.2.3. 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:

<table>
<thead>
<tr>
<th>Retained on No. 30 (600 um) sieve</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained on No. 200 (75 um) sieve</td>
<td>0% to 35%</td>
</tr>
</tbody>
</table>

Where a mineral filler is used, it shall be measured by volume or weighed and batched separately.

2.2.4. 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.
(e) Rejection. Water for use with cement may be rejected for failure to meet any of the requirements of this specification.

2.2.5. DOWEL BARS
(a) General. Dowel and tie bars shall be either straight or bent, smooth or deformed, as shown on the plans and shall conform to the requirements of Item 2.2.6, “Steel Reinforcement.” The dowel bars shall be coated with either hot asphalt or red lead and oil to the extent shown on the plans. See plans for designated coating.
(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 in. (0.3 cm), and one end of the cap shall be rightly closed. The cap shall be installed to allow the bar to move not less than 1/4 in. (3 cm) in either direction.
2.2.6. 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).
2. Axle steel: Axle-Steel Deformed and Plain Bars for Concrete Reinforcement, ASTM Designation A 617.
3. Rail steel: Rail-Steel Deformed and Plain Bars for Concrete Reinforcement, ASTM Designation A 616.

Axle steel shall not be permitted on structures and the use of rail steel or 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. 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 for spiral reinforcement shall be plain bars rolled from billets directly reduced from ingots and shall conform to the requirements of ASTM Designation A 615.

(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 not 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) 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 material.

(f) Rejection. Reinforcement may be rejected for failure to meet all of the requirements of this specification, and specifically for the following:

1. reinforcement exceeding the allowable variations,
2. reinforcement not bent in accordance with the details,
3. reinforcement with a coating of dirt, loose scale, paint, oil or other foreign substances which shall prevent bonding of the concrete and reinforcement, or
4. twisted bars.

2.2.7. STEEL WIRE REINFORCEMENT

(a) General. At the owner's option the use of welded wire fabric may be used in lieu of deformed reinforcement bars unless otherwise shown on the plans or in the contract specifications.

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 12 x 12- W 4 x W 4 with a nominal diameter in inches of 0.225 and a nominal weight 0.136 lbs/linear foot.

(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.
MATERIALS

(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:
   (1) reinforcement exceeding the allowable variations,
   (2) reinforcement not bent in accordance with the details,
   (3) reinforcement with a coating of dirt, loose scale, paint, oil or other foreign substances which shall prevent bonding of the concrete and reinforcement, or
   (4) twisted bars.

2.2.8. REINFORCEMENT BAR CHAIRS

(a) General. Reinforcement bar chairs or supports shall be of adequate strength (if specified) to support the reinforcement bars and shall not bend or break under the weight of the reinforcement bars or CONTRACTOR’S personnel walking on the reinforcing bars.

   Bar chairs may be made of metal (free of rust), precast mortar or concrete blocks or plastic. Pre-cast mortar or concrete blocks must be approved by the OWNER; and the CONTRACTOR shall supply test data showing the strength of the mortar or concrete blocks.

   For approval of plastic chairs, representative samples of the plastic shall show no visible indications of deterioration after immersion in a five percent solution of sodium hydroxide for 120 hours.

(b) Rejection. Bar chairs may be rejected for failure to meet any of the requirements of this specification.

2.2.9. 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 or a premolded asphalt board (ASTM Designation D 545).

   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 of selected stock of redwood, cypress, gum, southern yellow pine, or Douglas fir timber. 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 effects that shall impair its usefulness as a joint filler. With the exception of redwood and cypress, all boards shall have a creosote or pentachlorophenol treatment of not less than six pounds per cubic foot. When oven dried at 230°F (110°C) to a constant weight, the weight of the board per cubic foot (minus creosote) shall not be less than 20 pounds (9 kg), nor more than 35 pounds (16 kg).

   Asphalt boards for expansion joint filler shall be of the required size and uniform thickness and, when used in transverse joints, they shall conform approximately to the shape of the pavement crown shown on the plans and details. Asphalt boards shall consist of two liners of 0.016 asphalt impregnated kraft paper filled with a mastic mixture of asphalt and vegetable fiber and/or mineral filler. Boards shall be smooth, flat and straight throughout, and shall be sufficiently rigid to permit ease of installation. Boards shall be furnished in lengths equal to the width between longitudinal joints, and may be furnished in strips or scored sheet of the required shape.

   Asphalt boards, when tested in accordance with the following described methods, shall not deflect from the horizontal more than 3/8 inches in 3'1/2 inches (2 cm in 9 cm). A sample of the board, 2 in. (5 cm) wide and 6 in. (15 cm) long, flat, straight and cut with its length parallel to the lay of the fiber, shall be clamped between two blocks in the direction of its thickness in such manner that 3'1/2 in. (9 cm) length of the sample shall extend unsupported and at right angles from the common plane of the block faces. The samples and clamp so assembled shall be maintained at a temperature of 180°F (82°C) for two hours, with the length and width of the clamped portion of the sample horizontal after which the deflection from the horizontal of the unclamped portion shall be immediately measured.

(c) Dimensions. The thickness of the expansion joint filler shall be shown on the plans; the width shall be not less than that shown on the plans, providing for the top seal space.
(d) Rejection. Expansion joint filler may be rejected for failure to meet any of the requirements of this specification.

2.2.10. JOINT SEALING

(a) General. Joint sealing compound shall consist of hot poured rubber. The joint sealing compound shall melt to the proper consistency for pouring and shall solidify on cooling to atmospheric temperatures. It shall not crack or break when exposed to low temperatures.

The joint sealing filler shall be melted in an approved oil-batch kettle with continuous mechanical agitation. The kettle shall be equipped with temperature indicators. The OWNER shall determine the optimum temperature for proper pouring fluidity, and the CONTRACTOR shall maintain the material within close range of optimum temperature. At no time shall the temperature exceed 450°F (232°C); and any material heated above 450°F shall be rejected. Joint sealing compound shall not be poured at atmospheric temperatures below 32°F (0°C).

(b) Material. The material when tested in accordance with Texas SDHPT Test Method Tex-525-C shall meet the following requirements:

1. Penetration: At 77°F (25°C), 7 oz. (200 grams), 60 sec. penetration shall be not less than 0.1 in. (0.28 cm).
   At 77°F (25°C), 5 oz. (150 grams), 5 sec penetration shall be 0.45 to 0.3 in. (0.75 cm).
2. Flow: At 5 hours, 140°F (60°C), 75° incline flow shall be not more than 0.2 in. (0.5 cm).
3. Bond extension: 15°F (-9°C), 5 cycles. There shall be no cracking of the joint sealing material or break in the bond between the joint sealer material and the mortar pieces.

(c) Ready-Mixed Cold-Applied Joint and Crack Sealer. This sealer shall consist of a homogeneous blend of asphalt, rubber, inert filler and a suitable solvent or solvents. The material shall be a resilient, adhesive compound capable of effectively sealing properly cleaned joints in concrete pavement against infiltration of moisture throughout repeated cycles of contraction and expansion and which will not be picked up by vehicle tires particularly at summer temperatures.

The material when tested in accordance with Texas SDHPT Test Method Tex-525-C shall meet the following requirements:

<table>
<thead>
<tr>
<th>Penetration:</th>
<th>At 77°F (25°C), as received, 5 oz. (150 grams), 5 sec. penetration shall be not less than 1.1 in. (2.75 cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At 77°F (25°C), after evaporation of solvent, 5 oz. (150 grams), 5 sec. penetration shall be not less than 0.9 in. (2.20 cm)</td>
</tr>
<tr>
<td></td>
<td>At 32°F (0°C), after evaporation of solvent, 7 oz. (200 grams), 60 sec. penetration shall be not less than 0.4 in. (1.00 cm)</td>
</tr>
<tr>
<td>Flow:</td>
<td>Not more than 0.2 in. (0.5 cm)</td>
</tr>
<tr>
<td>Bond:</td>
<td>There shall be no cracking of the material or failure in bond between the material and the mortar test blocks during or at the end of five cycles</td>
</tr>
</tbody>
</table>

(d) Dimensions. The thickness of the expansion joint filler shall be shown on the plans. The width shall not be less than that shown on the plans, which provides for the top seal space.

(e) Rejection. Expansion joint filler may be rejected for failure to meet any of the requirements of this specification.

(f) Thermoplastic. Thermoplastic cold-applied jointing material may be used if approved by the OWNER, and it shall be installed according to the manufacturer's recommendations.

2.2.11. 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 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 (0.01 oz. per m²) of surface.

(2) Cotton Mats. The cotton mats used for curing shall meet the following requirements:

Each mat shall have a finished width of approximately 5 ft. 6 in. (1.7m); and after shrinkage shall be at least 6 in. (15 cm) longer than the width of the concrete to be cured.

The mats shall be composed of a single layer of cotton filler, completely enclosed in a cover of cotton cloth. The cotton filler shall be of low grade cotton, cotton linters of such shall contain not less than 3/4 pound (0.34 kg) of cotton filler per square yard of mat, uniformly distributed. The cotton cloth used for covering material shall be Osnaburg, weighing not less than 6 3/10 ounces per square yard (0.21 kg per sq. m).

All mats shall be stitched longitudinally with continuous parallel rows of stitching at intervals of not more than 4 in. (10 cm) or shall be tufted both transversely and longitudinally at intervals of not more than 3 in. (7.6 cm). The sewing or tufting shall not be done so tightly that the mat shall not contact the surface of the concrete at all points when saturated with water.

To insure the complete covering of the concrete where the mats fit together, there shall be a flap extending all along one side of each mat. This flap shall be composed of two thicknesses of the cover material and shall be at least 6 in. in width.

(3) Waterproof Paper. Waterproof paper shall consist of two sheets of plain kraft paper cemented together with a bituminous material in which are imbedded cords or strands of fiber running in both directions of the paper, not more than 1 3/4 in. (3 cm) apart. The paper shall be light in color; shall be free of visible defects; and shall have a uniform appearance. It shall be sufficiently strong and tough to permit its use under the conditions existing on streets and structural work without tearing or otherwise becoming unfit for the use for which it is intended. The paper shall conform to specifications for Sheet Materials for Curing Concrete, ASTM Designation C 171.

When tested in accordance with ASTM Designation C 156, the paper shall restrict the loss of water present in the test specimen at the time of application of the waterproof paper to not more than 0.055 grams per square centimeter of surface.

(4) 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 in.). 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.

(5) Asphalt for Curing Concrete Base. Where asphalt is used for curing concrete base, the material shall conform to the requirements of Item 2.4.2., "Oil Asphalt," for the type and grade designated by the OWNER.

(c) Rejection. Concrete curing materials may be rejected for failure to meet any of the requirements of this specification.

JANUARY 1998
2.2.12. ELASTOMERIC MATERIALS
(a) General. This material shall conform to the requirements of the Texas Department of Transportation, Standard Specifications for Construction of Highways, Streets and Bridges, Item 435. This item shall govern for the materials, testing and fabrication of elastomeric materials, except as otherwise covered in other specifications or on the plans.
(b) Rejection. Elastomeric materials may be rejected for failure to meet any of the requirements of this specification.

2.2.13. FIBROUS REINFORCEMENT
(a) General. At the OWNER’s option, fibrous reinforcement in concrete may be used unless otherwise shown on the plans or in the contract documents. Fibrous reinforcement shall not be used as a replacement for any reinforcement required for structural purposes.
(b) Material. Fibers for reinforcement of concrete shall be in accordance with materials specified in ASTM Designation C 1116.
(c) Length and Size. The fibers shall be length and size as specified in ASTM Designation C 1116.
(d) Testing. Test Method for Time of Flow of Fiber-Reinforced Concrete, ASTM Designation C 995 and Test Method for Flexural Toughness and First Crack Strength of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading), ASTM Designation C 1018 in addition to applicable ASTM methods for the testing of concrete shall be used to test the fiber-reinforced concrete. Performance of fiber-reinforced concrete shall meet all requirements as specified in Section 21 of ASTM Designation C 1116.
(e) Rejection. Fibrous reinforcement or fiber-reinforced concrete may be rejected for failure to meet any of the requirements of this specification or ASTM Designation C 1116.

ITEM 2.3. MASONRY MATERIALS

2.3.1. GENERAL REQUIREMENTS FOR MASONRY MATERIALS
(a) General. It is expected that the CONTRACTOR shall use the practices described in the applicable sections of Division 6 and 8 as well as the recommended practices of ASTM in the use of masonry materials.

2.3.2. DRAIN TILE
(a) Clay Drain Tile. Clay drain tile shall conform to the requirements of Clay Drain Tile, ASTM Designation C 4, and as specified on the plans.
(b) Concrete Drain Tile. Concrete drain tile shall conform to the requirements of Concrete Drain Tile, ASTM Designation C 412, and as specified on the plans.
(c) Rejection. In the event any drain tile material fails to conform to the requirements of the specifications, the manufacturer may sort it, and new specimens shall be selected by the OWNER. The new specimens shall be tested at the expense of the manufacturer. If the second set of specimens fails to conform to the test requirements, the entire lot shall be rejected.

2.3.3. SEWER AND MANHOLE BRICK
Sewer and/or manhole brick material shall conform to the requirements of Sewer and Manhole Brick (Made from Clay or Shale), ASTM Designation C 32, and as specified on the plans.
(a) Rejection. In the event any sewer or manhole brick material fails to conform to the requirements of the specifications, the manufacturer may sort it, and new specimens shall be tested at the expense of the manufacturer. If the second set of specimens fails to conform to the test requirements, the entire lot shall be rejected.

2.3.4. STONE MASONRY (SEE ITEM 2.1.6. RIPRAP OR STONE MASONRY)

2.3.5. CONCRETE MASONRY UNITS (PRECAST LATTICE BLOCKS)
Concrete masonry units shall conform to the requirements of Concrete Masonry Units for Construction of Catch Basins and Manholes, ASTM Designation C 139, and as specified on the plans.
(a) Rejection. In the event any concrete masonry material fails to conform to the requirements of the specifications, the manufacturer may sort it, and new specimens shall be selected by the OWNER. The new specimens shall be tested
at the expense of the manufacturer. If the second set of specimens fails to conform to the requirements, the entire lot shall be rejected.

ITEM 2.4. BITUMINOUS MATERIALS

2.4.1. GENERAL REQUIREMENTS FOR BITUMINOUS MATERIALS

(a) General. This section of the specifications consists of bituminous material, including oil asphalts, cut-back asphalts, 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 347°F (175°C).

(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.

2.4.2. 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 347°F (175°C) and shall meet the requirements for oil asphalt shown in Table No. 1.

(b) Rejection. Any material specified in this section may be rejected for failure to meet any of the provisions for this specification, or for any defect causing it to be unsuitable for its intended use.

<table>
<thead>
<tr>
<th>Type-Grade</th>
<th>OA-30</th>
<th>OA-175**</th>
<th>OA-400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration at 32°F (0°C) 200 g., 60 sec.</td>
<td>15</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Penetration at 77°F (25°C) 100 g., 5 sec.</td>
<td>25</td>
<td>35</td>
<td>150</td>
</tr>
<tr>
<td>Penetration at 115°F, 50 g., 5 sec.</td>
<td>—</td>
<td>65</td>
<td>—</td>
</tr>
<tr>
<td>Ductility at 77°F (25°C) 5 cm/min., cms: Original</td>
<td>2</td>
<td>—</td>
<td>70</td>
</tr>
<tr>
<td>Flash Point C.O.C., °F (°C)</td>
<td>—</td>
<td>450(230)</td>
<td>425(220)</td>
</tr>
<tr>
<td>Softening point, R. &amp; B., °F (°C)</td>
<td>185(85)</td>
<td>95(35)</td>
<td>130(54)</td>
</tr>
<tr>
<td>Thin Film Oven Test, 1/8 in. Film, 50 g., 5 hours, 325°F (16°C)</td>
<td>—</td>
<td>0.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Penetration of Residue, at 77°F (25°C), 100 g., 5 sec. % of Original Pen.</td>
<td>—</td>
<td>—</td>
<td>40</td>
</tr>
<tr>
<td>Ductility of Residue at 77°F (25°C), 5 cm/min, cms</td>
<td>—</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>Solubility in Trichloroethylene, %</td>
<td>99.0</td>
<td>—</td>
<td>99.0</td>
</tr>
<tr>
<td>Spot Test on Original OA</td>
<td>Neg.</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Float Test at 122°F (50°C), sec.</td>
<td>—</td>
<td>—</td>
<td>120</td>
</tr>
<tr>
<td>Tensile strength, %</td>
<td>—</td>
<td>—</td>
<td>75</td>
</tr>
<tr>
<td>Ductility, 77°F (25°C), 5 cm/min., Original Res., cms</td>
<td>—</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>Subject to Thin Film Test, cm</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*Detected by vacuum distillation (by evaporation if unable to reduce by vacuum).

**For use with latex additive only.
TABLE NO. 2 — REQUIREMENTS FOR ASPHALT CEMENT

<table>
<thead>
<tr>
<th>Test</th>
<th>Viscosity Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AC-3</td>
</tr>
<tr>
<td>Viscosity, 140°F (60°C) Stokes</td>
<td>300</td>
</tr>
<tr>
<td>Viscosity, 275°F, (135°C) Stokes</td>
<td>1.1</td>
</tr>
<tr>
<td>Penetration, 77°F, (25°C)</td>
<td>210</td>
</tr>
<tr>
<td>Flash point C.O.C. 5°F(°C)</td>
<td>425</td>
</tr>
<tr>
<td>Solubility in trichloroethylene</td>
<td>99.0</td>
</tr>
<tr>
<td>Tests on residues from thin film</td>
<td>—</td>
</tr>
<tr>
<td>for 140°F (60°C) stokes</td>
<td>—</td>
</tr>
<tr>
<td>Ductility, 77°F (25°C) 5 cms. per min. cms.</td>
<td>100</td>
</tr>
<tr>
<td>Spot Test</td>
<td>—</td>
</tr>
</tbody>
</table>

2.4.3. ASPHALT CEMENT

(a) General. The material for asphalt cement shall be homogeneous, shall be free from water, shall not foam when heated to 347°F (175°C) 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.

2.4.4. 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>
<thead>
<tr>
<th>Properties for Latex Additives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monomer ration, B/S</td>
</tr>
<tr>
<td>Minimum solids content</td>
</tr>
<tr>
<td>Solids content per gal. @ 67%</td>
</tr>
<tr>
<td>Coagulum on 80-mesh screen</td>
</tr>
<tr>
<td>Type Anti-Oxidant</td>
</tr>
<tr>
<td>Mooney viscosity of polymer</td>
</tr>
<tr>
<td>(M/L 4 @ 212°F (100°C))</td>
</tr>
<tr>
<td>pH of latex</td>
</tr>
<tr>
<td>Surface tension</td>
</tr>
<tr>
<td>Brookfield viscosity of latex</td>
</tr>
</tbody>
</table>

(b) Rejection. Latex additive material may be rejected for failure to meet any of the requirements of this specification.

The finished latex-asphalt blend shall meet the viscosity and ductility requirements shown in Table No. 4, Requirements for Latex Additives.

<table>
<thead>
<tr>
<th>Requirements for Latex Additives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity at 140°F (60°C), stokes</td>
</tr>
<tr>
<td>Ductility at 39.2°F (4°C), 2 cm. per min., cm.</td>
</tr>
</tbody>
</table>
2.4.5. 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 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 Table 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 Tables Nos. 1, 2 and 4, fluxed or blended with a naphtha-solvent.

(b) Test Reports and Certifications. Test reports and certifications for cut-back asphalt shall be furnished in accordance with Item 2.4.1(b).

(c) Temperatures. The cut-back 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 12; 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 (4°C).

Unless otherwise specified, the various grades of asphalt shall be applied at a temperature range as indicated in Table No. 13.

(d) Material Requirements. The material for cut-back asphalt shall meet the requirements shown in Table No. 5, Requirements for Cut-Back Asphalt.

(e) Rejection. Cut-back asphalt material may be rejected for failure to meet any of the requirements of this specification.

<table>
<thead>
<tr>
<th>TABLE NO. 5 — REQUIREMENTS FOR CUT-BACK ASPHALT</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAPID CURING</td>
</tr>
<tr>
<td>Type-Grade</td>
</tr>
<tr>
<td>Flash Point, T.O.C., °F (°C)</td>
</tr>
<tr>
<td>Furoil Viscosity, sec., (225°C)</td>
</tr>
<tr>
<td>At 140°F (60°C)</td>
</tr>
<tr>
<td>At 180°F (80°C)</td>
</tr>
<tr>
<td>The distillate, expressed as percent by volume of total distillate to 680°F, shall be as follows:</td>
</tr>
<tr>
<td>Off at 437°F (225°C)</td>
</tr>
<tr>
<td>Off at 500°F (260°C)</td>
</tr>
<tr>
<td>Off at 600°F (315°C)</td>
</tr>
<tr>
<td>Residue from 680°F (360°C) Distillation, Volume, %</td>
</tr>
<tr>
<td>Test on Distillation Residue:</td>
</tr>
<tr>
<td>Penetration at 77°F (25°C) 100 g., 5 sec.</td>
</tr>
<tr>
<td>Ductility at 77°F, 5 cm/min., cms.</td>
</tr>
<tr>
<td>Spot Test</td>
</tr>
</tbody>
</table>

JANUARY 1998
### TABLE NO. 5 — REQUIREMENTS FOR CUT-BACK ASPHALT (Continued)

#### MEDIUM CURING

<table>
<thead>
<tr>
<th>Type-Grade</th>
<th>MC-30</th>
<th>MC-70</th>
<th>MC-250</th>
<th>MC-800</th>
<th>MC-3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water, %</td>
<td>Min.</td>
<td>Max.</td>
<td>Min.</td>
<td>Max.</td>
<td>Min.</td>
</tr>
<tr>
<td>Flash Point, T.O.C., °F(°C)</td>
<td>100</td>
<td>0.2</td>
<td>100</td>
<td>0.2</td>
<td>150</td>
</tr>
<tr>
<td>Kinematic Viscosity at 140°F (60°C) C St.</td>
<td>30</td>
<td>60</td>
<td>70</td>
<td>140</td>
<td>250</td>
</tr>
</tbody>
</table>

The distillate, expressed as percent by volume of total distillate to 680°F (360°C), shall be as follows:

- Off at 437°F (225°C): 25%
- Off at 500°F (260°C): 70%
- Off at 600°F (315°C): 75%
- Residue from 680°F (360°C) Distillation, Volume, %:
  - 50%
  - 55%
  - 60%
  - 75%
  - 80%

Tests on Distillation Residue:

- Penetration at 77°F (25°C), 100 g., 5 sec.: 120
- Ductility 77°F (25°C), 5 cm/min., cms.: 100*
- Solubility in Trichloroethylene, %: 99

*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.

#### SLOW CURING

<table>
<thead>
<tr>
<th>Test Description</th>
<th>ASTM Test No.</th>
<th>SC-70</th>
<th>SC-250</th>
<th>SC-800</th>
<th>SC-3000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Point, C.O.C. °F (°C)</td>
<td>D92</td>
<td>150 (66)</td>
<td>175 (79)</td>
<td>200 (93)</td>
<td>225 (107)</td>
</tr>
<tr>
<td>Viscosity at 140°F (70°C) Kinematic CS (mm²/s)</td>
<td>D2170</td>
<td>70 - 140</td>
<td>250 - 500</td>
<td>800 - 1600</td>
<td>3000 - 6000</td>
</tr>
<tr>
<td>Distillation Total Dist. to 680°F (360°C), Vol. %</td>
<td>D402</td>
<td>10 - 30</td>
<td>4 - 20</td>
<td>2 - 12</td>
<td>0 - 5</td>
</tr>
<tr>
<td>Kinematic Viscosity on Residue at 140°F (60°C) Stokes (mm²/s)</td>
<td>D2170</td>
<td>4 - 70</td>
<td>8 - 100</td>
<td>20 - 160</td>
<td>40 - 350</td>
</tr>
<tr>
<td>Ductility of Asphalt Residue at 77°F (25°C), cm. Min.</td>
<td>D113</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>Asphalt Residue at 77°F (25°C), cm. Min.*</td>
<td>D243</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Solubility in CC., % Min.</td>
<td>D2042</td>
<td>99.5</td>
<td>99.5</td>
<td>99.5</td>
<td>99.5</td>
</tr>
<tr>
<td>Water, % Max.</td>
<td>D95</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Heptane Xylene Equivalent, % Max. (AASHOT-102)</td>
<td>—</td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

*If ductility at 77°F (25°C) is less than 100, the material shall be acceptable if the ductility at 60°F is greater than 100.

### 2.4.6. ROAD OILS

(a) General. The material for road oils shall meet the requirements shown on Table No. 6, Requirements for Road Oils.

(b) Rejection. Road oils material may be rejected for failure to meet any of the requirements of this specification.
2.4.7. CRACKED FUEL OILS AND CRUDE OILS

(a) General. The materials for cracked fuel oils and crude oils shall meet the requirements in Table No. 7, Requirements for Cracked Fuel Oils and Crude Oils.

(b) Rejection. Cracked fuel oils and crude oils materials may be rejected for failure to meet all of the requirements of this specification.

---

**TABLE NO. 7 — REQUIREMENTS FOR CRACKED FUEL OILS AND CRUDE OILS**

<table>
<thead>
<tr>
<th>Type-Grade</th>
<th>Cracked Fuel Oil</th>
<th>Crude Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Content of 100 Penetration at 77°F (25°C)</td>
<td>65</td>
<td>80</td>
</tr>
<tr>
<td>Asphalt Content of 260 Penetration 77°F (25°C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash Point T.O.C., °F (C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash Point C.O.C., °F (C)</td>
<td>250 (121)</td>
<td></td>
</tr>
<tr>
<td>Furol Viscosity at 77°F (25°C) Sec.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furol Viscosity at 122°F (50°C) Sec.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss at 212°F (100°C), 20 g., 5 hrs., %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss at 325°F (163°C), 50 g., 7 hrs., %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water and Sediment, %</td>
<td></td>
<td>2.0</td>
</tr>
<tr>
<td>Penetration of Residue after Evaporation Loss</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**TABLE NO. 6 — REQUIREMENTS FOR ROAD OILS**

<table>
<thead>
<tr>
<th>Type-Grade</th>
<th>RO-3</th>
<th>RO-4</th>
<th>RO-95</th>
<th>RO-Special</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water, %</td>
<td>—</td>
<td>0.2</td>
<td>—</td>
<td>0.2</td>
</tr>
<tr>
<td>Asphalt content of 85 to 115 penetration by vacuum distillation</td>
<td>60</td>
<td>55</td>
<td>80</td>
<td>55</td>
</tr>
<tr>
<td>Flash Point, C.O.C. °F (°C)</td>
<td>225 (107°C)</td>
<td>175 (79°C)</td>
<td>250 (121°C)</td>
<td>225 (107°C)</td>
</tr>
<tr>
<td>Furol Viscosity: At 122°F (50°C), Sec.</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Furol Viscosity: At 140°F (60°C), Sec.</td>
<td>200</td>
<td>320</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Loss at 212°F (100°C) 20 g., 5 hrs., %</td>
<td>—</td>
<td>6.0</td>
<td>—</td>
<td>0.6</td>
</tr>
<tr>
<td>Loss at 325°F (163°C) 50 g., 7 hrs., %</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Water and Sediment</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Penetration of residue after evaporative loss 100 g., 5 sec.</td>
<td>—</td>
<td>—</td>
<td>175</td>
<td>250</td>
</tr>
<tr>
<td>Ductility of residue at 77°F (25°C), 5 cm/min., cms.</td>
<td>100</td>
<td>100</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Solubility in Trichloroethylene, %</td>
<td>99</td>
<td>99</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Float Test at 122°F (50°C), Sec.</td>
<td>—</td>
<td>—</td>
<td>140</td>
<td>175</td>
</tr>
<tr>
<td>Spot Test</td>
<td>Neg.</td>
<td>Neg.</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

---

**2.4.6. Item 2.4.6.**
2.4.8. 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. 8, Requirements for Emulsified Asphalt - Cationic Emulsions/Anionic Emulsions.

(b) Testing Requirements. Test reports and certification shall be made for emulsified asphalt in accordance with Item 2.4.1.(b), “Tests and Certification of Bituminous Materials,” of these specifications.

(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 (70°C). 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 (4°C). Unless otherwise specified, emulsified asphalt shall be applied at a temperature within the limits specified in Table No. 12, 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.

<table>
<thead>
<tr>
<th>TABLE 8 — REQUIREMENTS FOR EMULSIFIED ASPHALT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CATIONIC EMULSIONS</td>
</tr>
<tr>
<td>Type-Grade</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Viscosity, Saybolt Furol at 77°F (25°C), sec.</td>
</tr>
<tr>
<td>Viscosity, Saybolt Furol at 122°F (50°C), sec.</td>
</tr>
<tr>
<td>Settlement, *5 days, %</td>
</tr>
<tr>
<td>Storage stability test, **1 day, %</td>
</tr>
<tr>
<td>Demulsibility, ***35 ml 0.8 % sodium dioethyl sulfosuccinate, %</td>
</tr>
<tr>
<td>Coating ability and water resistance:</td>
</tr>
<tr>
<td>Coating, dry aggregate</td>
</tr>
<tr>
<td>Coating, after spraying</td>
</tr>
<tr>
<td>Coating, wet aggregate</td>
</tr>
<tr>
<td>Coating, after spraying</td>
</tr>
<tr>
<td>Particle charge test</td>
</tr>
<tr>
<td>Sieve test, %</td>
</tr>
<tr>
<td>Cement mixing test, %</td>
</tr>
<tr>
<td>Distillation:</td>
</tr>
<tr>
<td>Oil distillate, by volume of emulsion</td>
</tr>
<tr>
<td>Residue, percent</td>
</tr>
<tr>
<td>Tests on Residue from Distillation Test:</td>
</tr>
<tr>
<td>Penetration, 77°F (25°C), 100 g., 5 sec.</td>
</tr>
<tr>
<td>Ductility, 77°F (25°C), 5 cm/min., cm</td>
</tr>
<tr>
<td>Solubility in TCE, %</td>
</tr>
<tr>
<td>Ash, %</td>
</tr>
</tbody>
</table>

*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 lapse is less than 5 days.

**The 24-hr (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 date of shipment.
2.4.9. FLUX OIL

(a) General. Fluxing material shall be free from foreign matter and shall meet the requirements of Table No. 9, Requirements for Flux Oil.

(b) Rejection. Flux oil material may be rejected for failure to meet all of the requirements of this specification.

2.4.10. PRECOAT MATERIAL

(a) General. Precast material may consist of any of one of the various types asphaltic materials listed in this specification, approved by the OWNER, including "special precoat material." Requirements for precoat material shall be in accordance with Table No. 10, Requirements for Precast Material.

(b) Rejection. Precast material may be rejected for failure to meet any of the requirements of this specification.

---

**TABLE 8 — REQUIREMENTS FOR EMULSIFIED ASPHALT (Continued)**

<table>
<thead>
<tr>
<th>Type-Grade</th>
<th>Rapid Setting</th>
<th>Medium Setting</th>
<th>Slow Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EA-HVRS</td>
<td>EA-HVRS 90</td>
<td>EA-HVMS</td>
</tr>
<tr>
<td>Furol Viscosity at 77°F (25°C), Sec. C</td>
<td>100</td>
<td>300</td>
<td>100</td>
</tr>
<tr>
<td>Furol Visc at 122°F (50°C)</td>
<td>63</td>
<td>—</td>
<td>63</td>
</tr>
<tr>
<td>Residue by Distillation, %</td>
<td>2.0</td>
<td>—</td>
<td>2.0</td>
</tr>
<tr>
<td>Oil Portion of Distillate, %</td>
<td>0.1</td>
<td>—</td>
<td>0.1</td>
</tr>
<tr>
<td>Miscibility (Standard Test)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Coating</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cement Mixing, %</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Demulsibility 50 cc of N/10 CaCl₂, %</td>
<td>60</td>
<td>—</td>
<td>60</td>
</tr>
<tr>
<td>Demulsibility of 33 cc of N/50 CaCl₂</td>
<td>97.5</td>
<td>—</td>
<td>97.5</td>
</tr>
<tr>
<td>Solubility in TCE, %</td>
<td>100</td>
<td>—</td>
<td>100</td>
</tr>
</tbody>
</table>

---

**TABLE 9 — REQUIREMENTS FOR FLUX OIL**

<table>
<thead>
<tr>
<th>Type</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water, %</td>
<td>—</td>
<td>0.2</td>
</tr>
<tr>
<td>Furol Viscosity at 122°F (50°C)</td>
<td>50 (10)</td>
<td>100 (38)</td>
</tr>
<tr>
<td>Flash Point, C.O.C., °F (°C)</td>
<td>250 (121)</td>
<td>—</td>
</tr>
<tr>
<td>Loss on Heating, 50g., 5 hrs. at 325°F (163°C)</td>
<td>—</td>
<td>5</td>
</tr>
<tr>
<td>Asphalt content of 85 to 15 Penetration by Vacuum distillation, weight, %</td>
<td>25</td>
<td>—</td>
</tr>
</tbody>
</table>

---

**TABLE 10 — REQUIREMENTS FOR PRECOAT MATERIAL**

<table>
<thead>
<tr>
<th>Type</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water, %</td>
<td>—</td>
<td>0.2</td>
</tr>
<tr>
<td>Flash Point, C.O.C., °F (°C)</td>
<td>200 (93)</td>
<td>—</td>
</tr>
<tr>
<td>Furol Viscosity at 140°F (60°C)</td>
<td>150</td>
<td>250</td>
</tr>
<tr>
<td>Distillation to 680°F (360°C):</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Initial Boiling Point, °F (°C)</td>
<td>500 (600)</td>
<td>—</td>
</tr>
<tr>
<td>Residue by weight, %</td>
<td>70</td>
<td>—</td>
</tr>
<tr>
<td>Penetration residue, 77°F (25°C), 100g., 5 sec.</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>

*Applies only when OWNER designates material for winter use.

JANUARY 1998
2.4.11. 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° to 475°F (232° to 246°C). Requirements for the material shall be in accordance with Table No. 11, Requirements for Catalytically-Blown Asphalt Joint and Crack Sealer.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type-Grade</td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>Penetration, 77°F (25°C), 100g., 5 sec</td>
<td>68</td>
<td>88</td>
</tr>
<tr>
<td>Penetration, 32°F (0°C), 200g., 60 sec</td>
<td>38</td>
<td>-</td>
</tr>
<tr>
<td>Penetration, 115°F (45°C), 50g., 5 sec</td>
<td>-</td>
<td>160</td>
</tr>
<tr>
<td>Softening Point, R. &amp; B., °F (°C)</td>
<td>175</td>
<td>(80)</td>
</tr>
<tr>
<td>Flash, C.O.C., °F (°C)</td>
<td>500</td>
<td>-</td>
</tr>
<tr>
<td>Ductility 77°F (25°C), 5 cm/min., cm</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Flow, 140°F (60°C), cm</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Ash Weight, %</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>Settlement Ratio</td>
<td>-</td>
<td>1.02</td>
</tr>
<tr>
<td>Britteness Test, 32°F (0°C)</td>
<td>No Cracking</td>
<td>No Cracking</td>
</tr>
</tbody>
</table>

(b) Rejection. Catalytically-blown asphalt joint and crack sealer material may be rejected for failure to meet all of the requirements of this specification.

2.4.12. STORAGE, HEATING AND APPLICATION TEMPERATURE
(a) General. Asphalt materials should be applied at the temperature which provides proper and uniform distribution. Within practical limits, higher temperatures than necessary should be avoided. Satisfactory application should be obtained within the recommended ranges shown in Table No. 12, Requirements for Storage, Heating and Application Temperature. No material shall be heated above the maximum temperature shown.
(b) Rejection. Materials provided that do not meet the requirements of this specification for storage, heating and application of asphaltic materials may be rejected.

2.4.13. HOT-MIX ASPHALTIC CONCRETE
(a) General. Asphalatic concrete shall consist of a hot mixture of mineral aggregate and asphaltic materials, and it may be a binder course, a surface course, a leveling-up course, or any combination of these courses.
(b) Material. Mineral aggregates shall consist of a fine aggregate, coarse aggregate and a mineral filler. Representative samples of the materials proposed to, where required, 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 2.1.2., “Aggregates for Hot-Mix Asphaltic Concrete,” of these specifications 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 above 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.

Only one grade of asphalt shall be required for all the types of mixtures unless otherwise shown on the plans or required by the owner.

The asphaltic material for tack coat shall be emulsified asphalt, EA-11M diluted with 50 percent water. Requirements for emulsified asphalt are shown on Table No. 9.

(c) 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 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 meet the following requirements by weight:

| FINE GRADE BINDER OF LEVELING-UP COURSE (TYPE “B”) |
|-----------------------------------|---------|----------|
| Passing                           | Retained On | Percent |
| 1 in. sieve                       |          | 100%     |
| 1/4 in. sieve                     |          | 95 to 100% |
| 3/8 in. sieve                     | 3/8 in. sieve | 21 to 53% |
| No. 4 sieve                       | No. 10 sieve | 5 to 26%  |
| Total retained on No. 10 sieve    |          | 50 to 74% |
| No. 10 sieve                      | No. 40 sieve | 6 to 32%  |
| No. 40 sieve                      | No. 80 sieve | 4 to 21%  |
| No. 80 sieve                      | No. 200 sieve | 3 to 21%  |
| No. 200 sieve                     |          | 1 to 8%  |

The asphaltic material shall form from 3.5 to 7.0 percent of the mixture by weight.

| FINE GRADE SURFACE COURSE (TYPE “D”) |
|-----------------------------------|---------|----------|
| Passing                           | Retained On | Percent |
| 1/2 in. sieve                     |          | 100%     |
| 3/8 in. sieve                     |          | 85 to 100% |
| 3/8 in. sieve                     | No. 4 sieve | 21 to 53% |
| No. 4 sieve                       | No. 10 sieve | 11 to 32% |
| Total retained on No. 10 sieve    |          | 54 to 74% |
| No. 10 sieve                      | No. 40 sieve | 6 to 32%  |
| No. 40 sieve                      | No. 80 sieve | 4 to 27%  |
| No. 80 sieve                      | No. 200 sieve | 3 to 27%  |
| No. 200 sieve                     |          | 1 to 8%  |

The asphaltic material shall form from 4.0 to 8.0 percent of the mixture by weight.
### TABLE NO. 12 — REQUIREMENTS FOR STORAGE, HEATING AND APPLICATION TEMPERATURE

<table>
<thead>
<tr>
<th>Type-Grade</th>
<th>Application and Mixing</th>
<th>Heating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recommended Range, °F (°C)</td>
<td>Maximum Allowable, °F (°C)</td>
</tr>
<tr>
<td>AC-3, 5, 10, 20, 40, OA-175</td>
<td>275-325 (135-163)</td>
<td>350 (177)</td>
</tr>
<tr>
<td>OA-30</td>
<td>400-500 (204-260)</td>
<td>500 (260)</td>
</tr>
<tr>
<td>OA-400</td>
<td>220-300 (104-149)</td>
<td>350 (177)</td>
</tr>
<tr>
<td>RC-1</td>
<td>100-150 (38-65)</td>
<td>175 (80)</td>
</tr>
<tr>
<td>RC-2</td>
<td>125-180 (52-82)</td>
<td>200 (93)</td>
</tr>
<tr>
<td>RC-250</td>
<td>150-200 (65-93)</td>
<td>210 (99)</td>
</tr>
<tr>
<td>RC-3</td>
<td>160-210 (71-99)</td>
<td>230 (110)</td>
</tr>
<tr>
<td>RC-4</td>
<td>180-240 (82-115)</td>
<td>270 (132)</td>
</tr>
<tr>
<td>RC-5</td>
<td>215-270 (102-182)</td>
<td>285 (140)</td>
</tr>
<tr>
<td>MC-30</td>
<td>70-150 (21-65)</td>
<td>175 (80)</td>
</tr>
<tr>
<td>MC-70</td>
<td>125-210 (52-80)</td>
<td>200 (93)</td>
</tr>
<tr>
<td>MC-250</td>
<td>125-210 (52-99)</td>
<td>240 (115)</td>
</tr>
<tr>
<td>MC-800</td>
<td>175-260 (80-127)</td>
<td>275 (135)</td>
</tr>
<tr>
<td>MC-3000</td>
<td>225-275 (113-135)</td>
<td>290 (143)</td>
</tr>
<tr>
<td>RO-3</td>
<td>160-210 (71-99)</td>
<td>250 (121)</td>
</tr>
<tr>
<td>RO-4</td>
<td>100-150 (38-65)</td>
<td>200 (93)</td>
</tr>
<tr>
<td>RO-95</td>
<td>230-300 (110-149)</td>
<td>325 (163)</td>
</tr>
<tr>
<td>RO-Special</td>
<td>160-220 (71-164)</td>
<td>260 (127)</td>
</tr>
<tr>
<td>Crude Oil</td>
<td>100-150 (38-65)</td>
<td>175 (80)</td>
</tr>
<tr>
<td>Cracked Fuel Oil</td>
<td>160-220 (71-164)</td>
<td>260 (127)</td>
</tr>
<tr>
<td>EA-10S, EA-11M, EA-CSS-1, EA-CSS-1h</td>
<td>50-130 (10-84)</td>
<td>140 (60)</td>
</tr>
<tr>
<td>Cat, Blown Asphalt</td>
<td>425-475 (218-246)</td>
<td>500 (260)</td>
</tr>
<tr>
<td>Special Precast Material</td>
<td>125-250 (52-121)</td>
<td>275 (135)</td>
</tr>
</tbody>
</table>

**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 cut-backs.

The **Owner** shall specify or approve a mixture within the above specified limits for all types of mixtures, which shall be suitable for the work in which the asphaltic concrete shall be used. The percentages of asphalt shall not vary more than 0.4 percent from the proportions established by the **Owner**.

(d) **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 in., 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 in any particular.

(e) **Mixing Plants.** Mixing plants may be either the weight-batching plant, the continuous mixing type plant or the drum mixing type plant as hereinafter described. All types of plants shall be equipped with satisfactory conveyors, power units, aggregates handling equipment, hot-aggregates screens and bins and dust collectors.
(1) Weight Batching Plant. The proportioning of the various materials entering into the asphaltic mixture shall be as approved or directed by the OWNER. The OWNER shall have access at all times to all parts of the paving plant. The plant shall be of the batch type provided with separate storage bins and chambers for heating and mixing the materials.

The various sizes of mineral aggregates as received shall be stored or stockpiled separately, and the feeding of all sizes of mineral aggregates to the dryer shall be done by mechanical means that shall give a uniform and continuous feed to each of the sizes incorporated in order to give a control of the temperature and grading of the mineral aggregates.

The drying of the mineral aggregates shall be done in such a manner that the finer particles shall not escape with the furnace gases. If forced draft is used, a dust collector system shall be installed. If natural draft is used, the OWNER may require a dust collector system to prevent loss of the finer particles. The aggregate shall be heated in a suitable apparatus which continuously agitates the aggregate during the heating and in which the temperature can be efficiently and positively controlled so that the aggregates shall not be damaged and the mixture produced shall have a temperature between 225°F and 350°F (107°C and 177°C).

A recording thermometer shall be provided which shall record the temperature of the aggregates as they leave the dryer. The recording thermometer shall be provided with a 24-hour chart and may be so equipped that it shall record both the temperature of the aggregates and the temperature of the asphalt incorporated into the batch. The drying apparatus shall be of sufficient size to dry and heat the amount of aggregates required to maintain the plant in continuous operation.

The screening capacity and size of the bins shall be sufficient to screen and store the amount of aggregates required to properly operate the plant and keep the plant in continuous operation at full capacity. Provisions shall be made to enable inspection forces to have easy and safe access to the proper location on the mixing plant where representative samples may be taken from the hot bins for testing. The aggregates shall be separated into at least four bins when producing Type "B" mixtures and at least three bins when producing Type "D" mixtures. If mineral filler is needed, an additional bin shall be provided. These bins shall contain the sizes of aggregates as shown in Item 2.1.2.(a)(5), "Screening and Proportioning."

(2) Continuous Mixing Plant. Cold-aggregates bin and proportioning devices, dryer, and screening and proportioning shall conform to the requirements hereinabove for the weight-batching type of plant.

The hot-aggregates proportioning device shall be so designed that when properly operated, a uniform and continuous flow of aggregates into the mixer shall be maintained.

The asphaltic material spray bar shall be so designed that the asphalt shall be uniformly and continuously sprayed into the mixture.

An accurate asphaltic material meter shall be installed in the asphalt line leading to the spray bar, so that the amount of asphalt being used can be accurately determined.

The mixer shall be of the pugmill continuous type and shall have a capacity of not less than 40 tons (1,450 metric tons) of mixture per hour. Any mixer that segregates the aggregates or fails to secure a thorough and uniform mixing of the aggregates or fails to secure a thorough and uniform mixing of the aggregates with the asphaltic material shall not be used. This shall be determined by taking samples from different parts of a truckload and testing by the extraction test. These tests must show that the load is uniform throughout.

The amount of aggregates and asphaltic material entering the mixer and the rate of travel through the mixer shall be so coordinated that a uniform mixture of the specified grading and asphalt content shall be produced.

The mixture shall not vary from the specified mixture by more than the specified tolerances.

The asphaltic mixture shall be at a temperature of between 225° and 350°F (107°C and 177°C) when dumped from the mixer. The OWNER shall determine the lowest temperature, within the above limitations, at which the material can be satisfactorily dried, mixed, transported, spread and compacted, and the mixture furnished by the CONTRACTOR shall be between this determined temperature and 30°F (17°C).

(3) Drum Mixing Plant. The plant shall be adequately designed and constructed for the process of mixing aggregates and asphalt in the drum mixer. The plant shall be equipped with satisfactory conveyors, power units, aggregates-handling equipment and feed controls and shall consist of the following essential pieces of equipment.
CONTRACTOR determined. The asphalt measuring device dumped from the heating and in which necessary drying occurs during device placement shall provide a uniform and continuous flow of aggregates in the desired proportion to the drum mixer.

The system shall provide positive weight measurement of the combined cold-aggregates feed by use of belt scales or other approved devices. Provisions of a permanent nature shall be made for checking the accuracy of the measuring device as required by Item 2.4.13.(f), "Equipment." When a belt scale is used, mixture production shall be maintained so that the scale normally operates between 50 percent and 100 percent of its rated capacity. Belt scale operation below 50 percent of the rated capacity may be allowed by the OWNER if accuracy checks show the scale to meet the requirements of Item 2.4.13.(f), "Equipment," at the selected rate, and it can be satisfactorily demonstrated to the OWNER that the mixture uniformity and quality have not been adversely affected.

A scalping screen shall be required, unless otherwise shown on the plans, and shall be located ahead of any weighing device.

The asphaltic mixture shall be at a temperature of between 225°F and 350°F (107°C and 177°C) when dumped from the mixer. The OWNER shall determine the lowest temperature, within the above limitations, at which the material can be satisfactorily dried, mixed, transported, spread and compacted, and the mixture furnished by the CONTRACTOR shall be between this lowest determined temperature and 30°F (17°C) higher.

An asphaltic material measuring device meeting the requirements of Item 2.4.13.(f), "Equipment," shall be placed in the asphalt line leading to the drum mixer so that the cumulative amount of asphalt used can be accurately determined. Provisions of a permanent nature shall be made for checking the accuracy of measuring device output. The asphalt measuring device and line to the measuring device shall be protected with a jacket of hot oil or other approved means to maintain the temperature of the line and measuring device near the temperature specified for the asphaltic material. Unless otherwise shown on the plans, the temperature of the asphaltic material entering the measuring device shall be maintained at plus or minus 10°F (5.5°C) of the temperature at which the asphalt measuring device was calibrated and set.

The asphaltic material feed-control shall be coupled with the total aggregate weight measuring device in such manner as to automatically vary the asphalt-feed rate as required to maintain the required proportion.

The drum mix system shall be of the type that continually agitates the aggregates and asphalt mixture during heating and in which the temperature can be so controlled that aggregates and asphalt shall not be damaged in the necessary drying and heating operations required to obtain a mixture of the specified temperature. A continuously recording thermometer shall be provided which shall indicate the temperature of the mixture as it leaves the drum mixer.

A surge-storage system shall be required. It shall be adequate to minimize the production interruptions during the normal day's operations and shall be constructed to minimize segregation. A device such as gob hopper or other similar device approved by the OWNER to prevent segregation in the surge-storage bin shall be required.

Scales may be standard platform truck scales, belt scales or other equipment such as weigh hopper (suspended) scales approved by the OWNER. All scales shall conform to Item 2.4.13.(f), "Equipment." If truck scales are used, they shall be placed at a location approved by the OWNER. If other weighing equipment is used, the OWNER may require weight checks by truck scales for the basis of approval of the equipment.

(f) Equipment.

(1) Bins. Bin storage shall be provided with tight cut-off gates to prevent leakage of aggregates or mineral filler into the weight box. The weight box for aggregates shall be of sufficient capacity to hold a complete batch of aggregates and mineral filler without wasting or leveling and shall be so designed that it shall quickly discharge the entire batch into the mixer. The weight box shall be provided with a close fitting and quick operating cut-off gate so that there shall be no leakage of the aggregates into the mixer and shall be satisfactorily attached to the batching scales.

(2) Scales. Scales used for weighing different grades of mineral aggregates may be either the springless dial type or the multi-beam type. All scales must be a tare beam for balancing, the beam scales must also be equipped with a telltale indicator of the springless dial type indicating over-and-under loads of at least 50 pounds (23 kg).
Scales shall be accurate within four pounds per 1000 pounds (2 kg per 454 kg). If plant vibration interferes with accurate weighing, the scales shall be insulated against shock or vibration.

(3) Material Bucket. The asphaltic material bucket shall be of sufficient size to hold the necessary asphaltic material for one batch. If the material is measured by weight, the bucket shall be properly attached to the scales herein specified. If the proportioning is by volume based on weight, the measuring bucket used shall be of the overflow type and shall meet the requirements of the owner.

(4) Asphalt Storage. Asphalt storage shall be sufficient to meet the requirements of the plant. Asphalt in storage shall be heated by steam coils, absolutely tight to prevent leakage of moisture into the asphalt; the steam for heating shall not be at a temperature in excess of 400°F (204°C); direct fire heating of the asphalt shall not be permitted.

(5) Steam Heating Systems. The steam heating system shall insure the maintaining of the asphalt at a uniform draw-off temperature at the asphalt bucket of between 275°F and 375°F (135°C - 190°C). The temperature shall be maintained with an efficient positive control of heat at all times as directed or approved by the owner. Asphalt heated beyond 375°F (190°C) either before or during mixing with the mineral aggregate shall be rejected. The draw-off at the asphalt bucket shall be of a quick cut-off type which shall not leak. The asphalt supply line shall be of circulating type, and equipped with a recording thermometer indicating the temperature of the asphalt at the draw-off valve. This thermometer may be combined with the one used in recording the temperature of the aggregate.

(6) Weight Bucket. The asphalt weight bucket shall be of an approved type. The scales of weighing the asphalt shall be either the springless dial type or the multi-beam type. The dial type shall be arranged for rapid adjustment at zero and shall be provided with a pointer to indicate the weight of the asphalt required in one batch. The beam type shall have a tare beam for balancing and shall be equipped with a telltale indicator of the springless dial type. If plant vibration interferes with accurate weighing, the scales shall be insulated against shock or vibration. The asphalt shall be sprayed into the mixer through an approved spray bar that shall distribute the asphalt uniformly throughout the length of the mixer.

(7) Mixer. The mixer shall be of the pugmill type and shall have a capacity of not less than 1,000 pounds (450 kg) in a single batch. The number of blades and their position shall give a uniform and complete circulation of the batch. A mixer that segregates mineral aggregate, or fails to secure a thorough and uniform mixing with the asphalt and mineral filler, shall not be permitted to be used. The adequacy of the mixer to produce a successful mix shall be determined by mixing the standard batch for the required time, then dumping the batch, and taking samples from different parts of the batch; the samples shall be tested by the extraction test and shall show that the batch is uniform throughout.

All mixers shall be provided with an automatic time lock on the discharge gates of the mixer and the weigh box; and shall be locked for a period of 45 seconds after all the mineral aggregates have been introduced into the mixer. When discharged, the mixture shall have a temperature of 225°F to 350°F (107°C - 177°C). The dump doors of the mixer shall be tight to the dry mineral aggregate or dust so that there shall be no spilling from the pugmill or drum. In introducing the batch into the mixer, all mineral aggregates shall first be introduced. Aggregates shall be thoroughly mixed for a period of 5 to 10 seconds before the asphalt is added; then the total mixture shall be mixed for the time required to produce a homogeneous mixture, in which all particles of the aggregates are uniformly coated.

(g) Stability. The asphaltic mixture from the weight-batching plant and from the continuous mixing type plant, when tested in accordance with the current methods outlined in the Texas DOT Test Method Tex-208-F, shall have the following laboratory density and stability:

Density (%)  
Maximum 94  
Minimum 98  
Optimum 96  
Stability (%) Hveem Stabilometer  
Not less than 42 except when otherwise shown on the plans.
If the mixture produced does not have the specified qualities, the mixture shall be changed until it does conform to the specified qualities.

(h) Transporting. Asphaltic concrete shall be transported from the plant to the site of the work in tight vehicles with metal bottoms previously cleaned of all foregoing substances. The OWNER may require that the vehicles be suitably insulated, and each load shall be covered with canvas or other suitable material of sufficient size to protect the asphaltic concrete from the weather and to prevent loss of material.

(i) 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 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.

(j) Rejection. Asphaltic concrete may be rejected for failure to meet all of the requirements of this specification.

2.4.14. ASPHALTIC STABILIZED BASE

(a) General. Asphalt stabilized base shall consist of a compact mixture of mineral aggregates and asphaltic material mixed hot in a mixing plant. It may be a base course, subbase course, or foundation course.

(b) Material.

(1) Asphaltic Material:

(A) Mixture. Asphalt for the mixture shall be of the types of asphalt cement as determined by the OWNER and shall meet the requirements above. The grade of asphalt to be used shall be determined by the OWNER after design tests have been made using the mineral aggregate approved for use in the construction. 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 mixture 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 this source shall not be changed during the course of the project, except by written permission of the OWNER.

(B) Tack Coat. The asphaltic material for tack coat shall meet the requirements for emulsified asphalt EA-11M diluted with equal parts of water, cut-back asphalt RC-2, or shall be a cut-back asphalt made by combing 50 to 70 percent by volume of the asphaltic material as specified for the type of paving mixture with 30 to 50 percent by volume of gasoline and/or kerosene. If RC-2 cut-back asphalt is used, it may, upon instructions from the OWNER, be diluted by the addition of an approved grade of gasoline and/or kerosene, not to exceed 15 percent by volume. Asphaltic materials shall meet the requirements above.

(2) Mineral Aggregate.

(A) Description. The material shall be crushed or uncrushed and screened as necessary to meet the requirements hereinafter specified and shall consist of durable coarse aggregate particles mixed with approved binding materials.

(B) Grades. Unless otherwise specified, the grading of the mineral aggregate shall conform to the limitations as shown below:

<table>
<thead>
<tr>
<th>Grade I:</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained on Sq. Sieve:</td>
<td>1 1/2 in.</td>
</tr>
<tr>
<td></td>
<td>1 in.</td>
</tr>
<tr>
<td></td>
<td>3/8 in.</td>
</tr>
<tr>
<td></td>
<td>No. 4</td>
</tr>
<tr>
<td></td>
<td>No. 40</td>
</tr>
</tbody>
</table>
2.4.14. Grade 2: Percent by Weight

<table>
<thead>
<tr>
<th>Retained on Sq. Sieve</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ³/₄ in.</td>
<td>0%</td>
</tr>
<tr>
<td>1 ¹/₄ in.</td>
<td>0 to 10%</td>
</tr>
<tr>
<td>No. 4</td>
<td>45 to 75%</td>
</tr>
<tr>
<td>No. 40</td>
<td>60 to 85%</td>
</tr>
</tbody>
</table>

2.4.14. Grade 3: Percent by Weight

<table>
<thead>
<tr>
<th>Retained on Sq. Sieve</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ³/₄ in.</td>
<td>0%</td>
</tr>
<tr>
<td>No. 40</td>
<td>60 to 85%</td>
</tr>
</tbody>
</table>

2.4.14. Grade 4

<table>
<thead>
<tr>
<th>Retained on Sq. Sieve</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>As shown on plans</td>
</tr>
</tbody>
</table>

Unless otherwise specified on the plans, the mineral aggregate for Grades 1, 2, and 3 shall meet the following physical requirements:

- Wet Ball Mill: 50 Max.
- P.I.: 15 Max.
- L.L.: 40 Max.

Sand equivalent value shall not be less than 40.

Mineral aggregate for Grade 4 shall meet the physical requirements shown on the plans.

Testing of the mineral aggregate shall be in accordance with the following test methods:

- Preparation of Soil Constants: ASTM D4318
- Sieve Analysis: ASTM D4318
- And Sieve Analysis: ASTM D4318
- Plastic Limit: ASTM D4318
- Plasticity Index: ASTM D136
- Sieve Analysis: ASTM D2419
- Wet Ball Mill: Tex-101-E
- Sand Equivalent: Tex-116-E

(c) Asphalt Stabilized Mixture.

1. Paving Mixture. The mixture shall consist of a uniform mixture of mineral aggregates and asphaltic material. The mineral aggregates shall conform to gradation requirements as shown on the plans. The asphaltic material shall form from four to nine percent of the mixture by weight unless otherwise shown on the plans.

2. Tolerance. The OWNER shall designate the asphalt content to be used in the mixture after design tests have been made with the aggregates to be used in the project. When tests as determined by the OWNER are made, samples of the mixture shall not vary from the asphalt content designated by the OWNER by more than 0.5 percent dry weight (based on total mixture).

(d) Mixing Plants. Mixing plants may be either the weight-batching type plant, the continuous mixing type plant, or the drum mixing type plant as described in Item 2.4.13.(e), except that requirements for Type “B” and “D” mixtures of fine graded surface course are deleted.

(e) Equipment. Equipment for storage, weighing and heating of materials shall be as described in Item 2.4.13.(f), “Equipment.”

(f) Stability. The asphaltic mixtures for the weight-batching type plant and from the continuous mixing type plant, when tested in accordance with the current methods outlined in Texas SDHPT Test Method Tex-200-4 (Part I or Part III as applicable), shall have the following laboratory density and stability:

- Density (%)
  - Minimum 94
  - Maximum 98
Item 2.4.14.

Optimum 96

Stability (% Hveem Stabilometer

Not less than 42 except when otherwise shown on the plans.

If the mixture produced does not have the specified qualities, the mixture shall be changed until it does conform to the specified qualities.

(g) Rejection. Asphaltic stabilized base material aggregates and asphaltic material may be rejected for failure to meet all of the requirements of this specification.

2.4.15. HOT-MIX, COLD-LAID ASPHALTIC CONCRETE (Cold Mix)

(a) General. Hot-Mix, Cold-Laid Asphaltic Concrete shall consist of surface mix. It shall be used only for patching utility cuts, pot-holes and any temporary pavement repairs.

(b) Material.

(1) Asphaltic Material.

(A) Mixture. Asphalt for the mixture shall be of the types of asphalt cement as determined by the OWNER and shall meet the requirements above. The grade of asphalt to be used shall be determined by the OWNER after design tests have been made using the mineral aggregate approved for use in the construction. The CONTRACTOR shall notify the OWNER of the source of his asphaltic material prior to production of the asphaltic mixture, and this source shall not be changed during the course of the project except by written permission of the OWNER.

(B) Tack Coat. The asphaltic material for tack coat shall meet the requirements for emulsified asphalt EA-11M diluted with equal parts of water.

(2) Mineral Aggregate.

(A) Description. The material shall be crushed or uncrushed and screened as necessary to meet the requirements hereinafter specified and shall consist of durable coarse aggregate particles mixed with approved binding materials.

(B) Grades. Unless otherwise specified, the grading of mineral aggregate shall conform to the limitations as shown below:

<table>
<thead>
<tr>
<th>Percent Aggregate by Weight</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 1/8 in. sieve</td>
<td>100%</td>
</tr>
<tr>
<td>Passing 1/4 in. sieve</td>
<td>80 to 100%</td>
</tr>
<tr>
<td>Passing 1/4 in. sieve, retained on No. 10 sieve</td>
<td>27 to 58%</td>
</tr>
<tr>
<td>Total retained on No. 10 sieve</td>
<td>42 to 58%</td>
</tr>
<tr>
<td>Passing No. 10 sieve, retained on No. 40 sieve</td>
<td>6 to 32%</td>
</tr>
<tr>
<td>Passing No. 40 sieve, retained on No. 80 sieve</td>
<td>4 to 32%</td>
</tr>
<tr>
<td>Passing No. 80 sieve, retained on No. 200 sieve</td>
<td>3 to 32%</td>
</tr>
<tr>
<td>Passing No. 200 sieve</td>
<td>1 to 8%</td>
</tr>
</tbody>
</table>

The asphaltic material shall form from 4 to 7.5% of the mixture by weight.

(c) Primer. When approved by the Engineer, the use of an asphaltic primer will be permitted. In the event the asphalt primer is used, the hydrocarbon volatile content of the asphaltic concrete, as determined by ASTM D 1641, shall not exceed 0.6 percent of the mixture by weight. The asphalt content of the primer shall be included in the total asphalt content of the paving mixture.

(d) Water. Water in an amount not to exceed 3 percent by weight of the mixture, as determined by ASTM D 1641, may be used in preparing the mixture. In the event water is used in the mixing operation, adequate measuring devices as approved by the Engineer shall be used, and the water shall be administered to the mix through an approved spray bar.

When used, the primer and/or water shall be added as directed by the Engineer during the mixing.

(e) Physical Properties of the Mixture. The materials may be mixed on the job or at some central mixing plant and shipped ready for use. Mixtures that do not remain workable a sufficient period of time to permit unloading by normal means, proper spreading, blading and rolling will not be acceptable.

92 JANUARY 1998
(f) Mixing Plants. Mixing plants may be either the weight-batching type plant, the continuous mixing type plant, or the drum mixing type plant as described in Item 2.4.13(e), “Mixing Plants.”

(g) Equipment. Equipment for storage, weighing and heating of materials shall be as described in Item 2.4.13(f), “Equipment.”

(h) Rejection. Asphaltic mixtures may be rejected for failure to meet all of the requirements of this specification.

ITEM 2.5. LIME PRODUCTS

2.5.1. LIME

(a) General. This section deals with the material specifications for hydrated lime as it may be utilized for the stabilization of soils in dry form or in slurry form. The treating of quicklime to form hydrated lime is also described.

2.5.2. HYDRATED LIME (DRY)

(a) General. Hydrated lime shall consist of a dry powder. This material is to consist essentially of calcium hydroxide.

(b) Materials. When sampled and tested according to Texas SDHPT Test Method Tex-600-J, hydrated lime shall conform to the following requirements as to chemical composition:

| Hydrate Alkalinity, percent by weight Ca(OH)2 | Min. 90.0% |
| Unhydrated lime content, percent by weight CaO | Max. 5.0% |
| “Free Water” content, percent by weight H2O | Max. 4.0% |

The percent by weight of residue retained shall conform to the following requirements:

| Residue retained on a No. 6 (3360 micron) sieve | None |
| Residue retained on a No. 10 (2000 micron) sieve | Max. 1.0% |
| Residue retained on a No. 30 (590 micron) sieve | Max. 2.5% |

2.5.3. HYDRATED LIME (SLURRY)

(a) General. Hydrated lime slurry shall be a pumpable suspension of solids in water. The solids portion of the mixture, when considered on the basis of “solids content,” shall consist principally of hydrated lime of a quality and fineness sufficient to meet the following requirements as to chemical composition and residue.

(b) Materials.

(1) Chemical Composition. The “solids content” of the lime slurry shall have a hydrate alkalinity Ca(OH)2 of not less than 90 percent by weight.

(2) Residue. The percent by weight of residue retained in the “solid content” of lime slurry shall conform to the following requirements:

| Residue retained on a No. 6 (3360 micron) sieve | None |
| Residue retained on a No. 10 (2000 micron) sieve | Max. 1.0% |
| Residue retained on a No. 30 (590 micron) sieve | Max. 2.5% |

(c) Water. Type B, commercial lime slurry, shall conform to one of the following three grades:

Grade 1: The “dry solids contents” shall be at least 31 percent by weight of the slurry.

Grade 2: The “dry solids contents” shall be at least 35 percent by weight of the slurry.

Grade 3: The “dry solids contents” shall be at least 46 percent by weight of the slurry.

2.5.4. QUICKLIME

(a) General. Quicklime shall consist of a dry powder in a tank to form a lime slurry and is restricted to 'Slurry Placing' only, in accordance with Item 4.6.4.(b)(2).
CAUTION: HANDLING AND USE OF QUICKLIME CAN BE DANGEROUS. QUICKLIME SHOULD BE PRESCRIBED BY A REGISTERED PROFESSIONAL ENGINEER FAMILIAR WITH ITS USE.

(b) Material. Quicklime shall conform to the chemical requirements of Quicklime for Structural Purposes, ASTM Designation C 5.

2.5.5. REJECTION

All materials which do not conform to the requirements of this specification shall be rejected.

ITEM 2.6. WOOD PRODUCTS

2.6.1. LUMBER AND TIMBER

(a) General. Structural lumber or timber shall be of the kind 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.

(b) 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.

(c) Sizes. The plans show the nominal sizes, but actual sizes shall conform to American Lumber Standards.

(d) 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 cooper 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.

(e) Rejection. Lumber and timber may be rejected for failure to meet all of the requirements of this specification.

2.6.2. PLYWOOD

(a) 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.

(b) Grades. All plywood shall be engineering grade “B-B” exterior or better.

(c) Grade Marking. Each sheet of plywood shall bear the official stamp of a quality control agency stating the grade of the sheet.

(d) Rejection. Plywood may be rejected for failure to meet all of the requirements of this specification.

ITEM 2.7. PILING MATERIALS

2.7.1. 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 plans 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 Item 2.6.1.(d), “Treatment with Preservatives.” 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 that the scar does not exceed 36 in., and provided that 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 in. (10 cm). 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 (30 cm) of piling shall not exceed twice the width of the maximum allowable knot for that section of pile.

Piling which shows 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 piling which shall permit a number 10 B&S (diameter 0.102 in.) wire to be extended three feet (1 m) 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 1/6 in. (2 cm).

Shakes smaller than one-third of the diameter of the pile may be permitted, provided that 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 in. and, in addition, one-third or more summer-wood measured over the third, fourth and fifth in. from the center of the pile along a radial line. Where there are less than six annual rings per in., piling may be accepted if there is an average of one-half or more summer-wood. 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 1/120ths of the actual diameter of the pile at the butt. Treated piles preferably shall have as much sapwood as possible. In southern pines, the sapwood thickness shall be not less than 1-1/2 in. (3.8 cm), and in Douglas fir, not less than 1 in. (2.5 cm) 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 pilings are smooth and clean. Care shall be taken to remove as little sapwood as possible, and piling should not be injured by unnecessary ax 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 1/4 in. (2 cm) in width or 8 in. (20 cm) in length, and there shall be at least 1 in. (2.5 cm) 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 1/4 in. (0.6 cm), except at knot whorls. The circumference at any point between the knot whorls shall not be reduced by more than 1 in. (2.5 cm).

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 in. (5 cm) 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 of 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 in. (15 cm) 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 in. (2.5 cm) 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 ft. (1.2 m) from the butt, measured under the bark, shall be as follows:

<table>
<thead>
<tr>
<th>Length of Piling</th>
<th>Minimum Diameter 4 ft. (1.2 m) from Butt</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 ft (12 m) and under</td>
<td>12 in. (30 cm)</td>
</tr>
<tr>
<td>Over 40 ft. (12 m)</td>
<td>13 in. (33 cm)</td>
</tr>
</tbody>
</table>

The minimum diameter of the tip shall be as follows:

<table>
<thead>
<tr>
<th>Length of Piling</th>
<th>Minimum of Diameter of Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 ft. (6 m) and under</td>
<td>9 in. (23 cm)</td>
</tr>
<tr>
<td>21 ft. — 44 ft. (6.4 — 12.4m)</td>
<td>8 in. (20 cm)</td>
</tr>
<tr>
<td>Over 45 ft. (13.7 m)</td>
<td>7 in. (18 cm)</td>
</tr>
</tbody>
</table>

The maximum diameter of the butt shall be 18 in. (46 cm) 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 ft. (1.5 m) 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. (5 cm) 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.

2.7.2. 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 specification relating directly thereto.

Splices in steel piles shall be made by a full penetration butt weld of the entire cross section. Care 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 ft. (3 m) 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.

2.7.3. 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 of Item 2.2, "Portland Cement Concrete and Related Materials." 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 the Item 7.6, "Concrete Structures":

The form foundation shall be unyielding. Timber sills or joists, 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 in. thick (minimum) (15 cm) 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 3/4 in. (2 cm) 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 1/2 in. (1.3 cm) 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 Item 7.6, "Concrete Structures," except that corners may be filleted or rounded.

All square piling corners shall have a 1 in. (2.5 cm) 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 form after the concrete strength reaches 400 psi (28 kg per sq. cm) 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 the Item 2.2.6, "Steel Reinforcement."

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 (42 kg per sq. cm), or a minimum compressive strength of 3600 psi (253 kg per sq. cm), tested in accordance with Texas SDHPT 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 method 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 for immediate review and correction of the conditions causing the 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 it 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 in. (0.3 cm).

The head of the pile shall not be out of square by more than 1/8 in. (0.3 cm).

Small damaged or honeycombed areas which are purely surface in nature (not over 1 in. (2.5 cm) deep may be repaired. Damage or honeycomb in excess of this shall be tentatively rejected, but shall be subject to structural review.

When piling is cast with internal voids, the position of the void shall be within plus or minus 1/2 in. (1.3 cm).

Piling cracked in the process of curing, handling and driving shall be subject to the following provisions:

(1) piling which has cracks showing severe spalling sufficient opening to indicate that 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 that 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 in. (0.08 cm) or greater in width shall have a V-formed 1/8 in. (0.3 cm) 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 in. (2.5 cm) 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 Item 7.8., "Prestressing."

(6) all replacements 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 the Item 7.10.18., "Welding."

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 the Item 7.6., "Concrete Structures."

When 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 the Item 2.11., "Metal For Structures." All concrete materials and their preparation and placing shall be in accordance with the requirements of the Item 7.6., "Concrete Structures," and the Item 7.4., "Concrete for Structures," 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 the Item 2.2.6., "Steel Reinforcement." The sizes and dimensions of reinforcing steel shall be as shown on the plans. Welding shall be done in accordance with Item 7.10.18., "Welding." The required sizes and dimensions of the metal piling shall be as shown on the plans.

The methods of handling shall be such that 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 off 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 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 off 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 test 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 ft. (1.5 m). 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 Item 2.9., "Paint and Protective Coatings," 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 Item 2.9., "Paint and Protective Coatings." Painting shall extend to a point 1 ft. (0.3 m) below the finished ground line unless the pile is standing in water, in which case paint shall extend below 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 Item 7.7., "Prestressed Concrete For Structures," and Item 7.8., "Prestressing." This includes the de-
sign, 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 inspections facilities.
For prestressed piling, concrete shall be of the class shown on the plans.

2.7.4. REJECTION
Any concrete piling not conforming to these specifications and applicable provisions of other sections shall be re-
jected. Any defect causing it to be unsuitable for its intended use shall be cause for rejection of the piling.

ITEM 2.8. CHAIN LINK AND BARRIER FENCES

2.8.1. HEAVY DUTY CHAIN LINK FENCING
(a) General. This item covers materials used to construct chain link fencing in accordance with the plans and any
typical details which may be shown on the plans.
(b) Material.
(1) Fabric. The base metal of the fabric shall be a good commercial quality of steel wire. The wire shall be
woven throughout in the form of approximately uniform square mesh, having parallel sides and horizontal and verti-
cal diagonals of approximately uniform dimensions. The top and bottom of the fabric shall be knuckled or barbed as
specified. The sizes of wire and mesh shall be as specified. The entire fabric shall be zinc coated in accordance with
Zinc-Coated Steel Chain Link Fence Fabric, ASTM Designation A 392.
(2) Posts. Posts may be rolled, formed or tubular in cross section and shall be in accordance with Strength Re-
quirements of Metal Posts and Rails for Industrial Chain Link Fence, ASTM Designation F 669. All posts shall meet
the weight and length requirements as shown on the plans. All posts not galvanized shall be painted with an ap-
proved anti-corrosive paint.
(3) Rails, Gates, Braces and Fittings. Rails, gates and braces may be rolled, formed or tubular in cross section
and shall be in accordance with Strength Requirements of Metal Posts and Rails for Industrial Chain Link Fence,
ASTM Designation F 669. Fittings and appurtenances shall be in accordance with Fence Fittings, ASTM Designa-
tion F 626. All rails, braces and fittings not galvanized shall be painted with an approved anti-corrosive paint.
(4) Barbed Wire. Barbed wire shall be two strand twisted No. 12½ AWS gauge galvanized steel wire with two-
point barbs of No. 14 AWS gauge galvanized steel wire and conforming to Zinc-Coated (Galvanized) Steel Barbed
Wire, ASTM Designation A 121, Class 1.
(c) Concrete. Concrete shall be as specified on the plans and in accordance with Item 2.2., “Portland Cement Con-
crete and Related Materials,” of these specifications.
(d) Rejection. Failure to meet all of the specifications contained in this section shall be cause for rejection.

2.8.2. WIRE FENCING
(a) General. This item covers materials used to construct wire fencing in accordance with the plans and any typical
details which may be shown on the plans.
(b) Material.
(1) Fabric. The base metal of the fabric shall be of a good commercial quality of steel or iron as specified. The
wire shall be the height and design shown on the plans. The top and bottom wires shall be a minimum No. 10 AWS
gauge, and the intermediate wires and vertical stays shall be No. 12½ AWS gauge. The entire fabric shall be zinc
coated in accordance with Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric, ASTM Designation A 116.
(2) Metal Posts. Metal posts may be rolled, formed or tubular in cross section and shall be in accordance with
Strength Requirements of Metal Posts and Rails for Industrial Chain Link Fence, ASTM Designation F 669. All
posts shall meet the weight and length requirements as shown on the plans. All posts not galvanized shall be painted
with an approved anti-corrosive paint.
(3) Wood Posts. Wood posts shall be the length and dimensions shown on the plans. The timbers shall be sound
and free from all decay, shakes, splits, unsound or excessive knots or any other defects that might impair their
strength or durability. Knots shall not exceed one-third of the small dimension or diameter of the post. A line drawn
between the center of each end shall not fall outside the center of the post at any point more than by 2 in. (5 cm).
Knots shall be trimmed flush and the ends cut square. Untreated posts may be cedar, redwood, cypress or live oak.
Treated posts may be pine, spruce or fir. Treated posts shall have a creosote oil or pentachlorophenol treatment of not less than eight pounds per cubic foot (128 kg per cubic meter).

(4) Rails, Gates, Braces and Fittings. Rails, gates, and braces may be rolled, formed or tubular in cross section and shall be in accordance with Strength Requirements of Metal Posts and Rails for Industrial Chain Link Fence, ASTM Designation F 669. Fittings and appurtenances shall be in accordance with Fence Fittings, ASTM Designation F 626. All rails, braces and fittings not galvanized shall be painted with an approved anti-corrosive paint.

(5) Barbed Wire. Barbed wire shall be two strand twisted No. 121/2 AWS gauge galvanized steel wire with two-point barbs of No. 14 AWS gauge steel wire and conforming to Zinc-Coated (Galvanized) Steel Barbed Wire, ASTM Designation A 121, Class I.

(c) Rejection. Failure to meet all of the specifications contained in this section shall be cause for rejection.

ITEM 2.9. PAINT AND PROTECTIVE COATINGS

2.9.1. PAINT

(a) General. 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 or thicken in the container, or become granular or 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.

(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.

(c) 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:

1. PIGMENTS

(A) White:

(1) Pure TiO₂ Rutile — Titanium Dioxide Pigments, ASTM Designation D 476, Type IV.

(2) Lead free zinc yellow — Zinc Oxide, ASTM Designation D 79, either American or French process.

(B) Yellow: Zinc Yellow (Zinc Chromate) Pigments, ASTM Designation D 478.

(C) Red: Red Lead, ASTM Designation D 83.

(D) Green: Chrome Oxide Green, ASTM Designation D 263.

(E) Metallic:

(1) 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 Power 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 Xylo!* and 80 ml of Mineral Spirits.*

*Xylo! — *Industrial Grade Xylene, ASTM Designation D 364

(2) Zinc Dust — Zinc Dust (Metallic Zinc Powder), ASTM Designation D 520.

(F) Inert:
(1) Talc — Magnesium Silicate Pigment, ASTM Designation D 605.
(2) Diatomaceous Silica Pigment, ASTM Designation D 604, Type A.

(2) RESINS
(A) Chlorinated Paraffin: MIL-C-429A, Type I or Type II.
(B) Solid Petroleum Resin:
Melting Point, °F (Ring and Bell) 200-300
Acid Number 1 Max.
Saponification Number 2 Max.
Specific Gravity 1.0 Min.
Color: 50% solution (by weight) in Xylo!* 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%
Xylo!* shall show no cloud or settling after 24 hours at 77°F.
*Xylo! — *Industrial Grade Xylene, ASTM Designation D 364.
Mineral Spirits — Petroleum Spirits (Mineral Spirits), ASTM Designation D 235, Type IV

(C) Polyurethane Resin (60%):
(1) General:
Type: Oil Modified
Type Oil: Linseed
Type Solvent: Mineral Spirits*
% Solids: 59.9 — 61.0

(2) Solid Resin Basis:
<table>
<thead>
<tr>
<th></th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid Number:</td>
<td>—</td>
<td>3.5</td>
</tr>
<tr>
<td>% Nitrogen:</td>
<td>2.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Free NOC:</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Iodine Number of Fatty Acids:</td>
<td>177</td>
<td>—</td>
</tr>
</tbody>
</table>

(3) Resin Solutions:
<table>
<thead>
<tr>
<th></th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Solids:</td>
<td>59.0</td>
<td>61.0</td>
</tr>
<tr>
<td>Weight per gallon:</td>
<td>7.0</td>
<td>7.8</td>
</tr>
<tr>
<td>Modifying Resins:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Appearance: Clear, transparent and homogeneous when examined by transmitted light

(4) 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

(5) Viscosity, Gardner: With Mineral Spirits*

<table>
<thead>
<tr>
<th></th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>59.0 to 61.0% Solids:</td>
<td>Z</td>
<td>Z-2</td>
</tr>
<tr>
<td>50.0% Solids:</td>
<td>E</td>
<td>H</td>
</tr>
<tr>
<td>40.0% Solids:</td>
<td>A-3</td>
<td>A</td>
</tr>
</tbody>
</table>

*Mineral Spirits — shall meet Petroleum Spirits (Mineral Spirits), ASTM Designation D 235, Type IV, and, in addition shall have a KB value from 34 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.
(D) Vinyl-Toluene/Acrylate Copolymer:

(1) General:

Form: Shall be white granular powder or friable granular

<table>
<thead>
<tr>
<th></th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity, 25°C:</td>
<td>1.025</td>
<td>1.035</td>
</tr>
<tr>
<td>Refraction Index, 25°C:</td>
<td>1.553</td>
<td>1.563</td>
</tr>
<tr>
<td>Softening Point, °C:</td>
<td>130</td>
<td>140</td>
</tr>
<tr>
<td>Acid Number:</td>
<td>—</td>
<td>6.1</td>
</tr>
</tbody>
</table>

(2) Solution Viscosity, Seconds #4:

<table>
<thead>
<tr>
<th>Ford Cup, 77°, with Xylol*:</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>40% Non-Volatile:</td>
<td>60</td>
<td>110</td>
</tr>
<tr>
<td>33½% Non-Volatile:</td>
<td>25</td>
<td>55</td>
</tr>
<tr>
<td>30% Non-Volatile:</td>
<td>14</td>
<td>40</td>
</tr>
</tbody>
</table>

(3) Film: A one mil dry film cast from a 30% solution in Xylol* shall be colorless and transparent.

*Xylol — shall meet Industrial Grade Xylene, ASTM Designation D 364.

In addition to the above requirements, the infrared spectra shall match the spectra on file with the Materials and Test Division of Texas State Department of Highways and Public Transportation.

(E) Long Oil Alkyd (70%):

(1) 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) 24%
Minimum on Non-Volatile:
Type of Oil: Soybean
% Oil on Non-Volatile Calculated: 65
Mineral Spirits** tolerance: 1000%
Resin and/or derivatives: None
Phenolic Resin Modifiers: None

(2) 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 3/4 full test tube at +5°F. This rubber-alkyd solvent solution shall produce a clear film upon drying.

(3) 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.

(F) 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.
Substitution in a standard formula shall not result in a viscosity variation greater than 4 KU.

*Toluene shall meet Industrial Grade Toluene, ASTM Designation D 362.
(3) **OILS**

(A) **Raw Linseed Oil:** ASTM Designation D 234.

(B) **Polymerized Linseed Oil:**

<table>
<thead>
<tr>
<th>Property</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid Number</td>
<td>—</td>
<td>3.0</td>
</tr>
<tr>
<td>Iodine Number, Wijs</td>
<td>115</td>
<td>130</td>
</tr>
<tr>
<td>Saponification Number</td>
<td>190</td>
<td>199</td>
</tr>
<tr>
<td>Refractive Index, 25°C</td>
<td>1.483</td>
<td>1.491</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>0.955</td>
<td>0.965</td>
</tr>
<tr>
<td>% Solids</td>
<td>99.5</td>
<td>—</td>
</tr>
</tbody>
</table>

(C) **Modified Linseed Oil:**

<table>
<thead>
<tr>
<th>Property</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid Number</td>
<td>—</td>
<td>4.0</td>
</tr>
<tr>
<td>Iodine Number, Wijs</td>
<td>150</td>
<td>180</td>
</tr>
<tr>
<td>Saponification Number</td>
<td>152</td>
<td>172</td>
</tr>
<tr>
<td>Refractive Index, 25°C</td>
<td>1,500</td>
<td>1,508</td>
</tr>
<tr>
<td>Viscosity, Gardner</td>
<td>Z-3</td>
<td>Z-4</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>0.975</td>
<td>0.985</td>
</tr>
<tr>
<td>% Solids</td>
<td>99.5</td>
<td>—</td>
</tr>
</tbody>
</table>

(D) **Surface Activity Oil:**

<table>
<thead>
<tr>
<th>Property</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud Point, °F</td>
<td>44</td>
<td>48</td>
</tr>
<tr>
<td>Pour Point, °F</td>
<td>40</td>
<td>44</td>
</tr>
<tr>
<td>Free Fatty Acids (as oleic)</td>
<td>—</td>
<td>2.0%</td>
</tr>
<tr>
<td>Iodine Number</td>
<td>60</td>
<td>70</td>
</tr>
<tr>
<td>Saponification Number</td>
<td>185</td>
<td>195</td>
</tr>
<tr>
<td>Flash Point, °F, COC</td>
<td>390</td>
<td>—</td>
</tr>
<tr>
<td>Fine Point, °F, COC</td>
<td>420</td>
<td>—</td>
</tr>
<tr>
<td>Color, NPA</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Specific Gravity, 60°F</td>
<td>0.895</td>
<td>0.905</td>
</tr>
<tr>
<td>Viscosity SSU, 100°F</td>
<td>90</td>
<td>100</td>
</tr>
</tbody>
</table>

(4) **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 Naphtha:** VM&P Naphthas, ASTM Designation D 3735, Type 1.

(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

(H) **Aromatic Naphtha:** SC-100

<table>
<thead>
<tr>
<th>Property</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Aromatics</td>
<td>95</td>
<td>—</td>
</tr>
<tr>
<td>Boiling Range</td>
<td>310</td>
<td>350</td>
</tr>
<tr>
<td>Kauri-Butanol Value</td>
<td>90</td>
<td>—</td>
</tr>
<tr>
<td>Specific Gravity, 25°C</td>
<td>0.865</td>
<td>8.876</td>
</tr>
<tr>
<td>Appearance</td>
<td>Clear, Sediment Free</td>
<td></td>
</tr>
</tbody>
</table>

(I) **Butyl Cellosolve**

<table>
<thead>
<tr>
<th>Property</th>
<th>Clear, Sediment Free</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Clear, Sediment Free</td>
</tr>
<tr>
<td>Color</td>
<td>Water White</td>
</tr>
<tr>
<td>Boiling Range, °F</td>
<td>166 to 173</td>
</tr>
<tr>
<td>Chemical Formula</td>
<td>C₄H₉OC₂H₄OH</td>
</tr>
</tbody>
</table>

(5) **ADDITIVES AND CHEMICALS**

(A) **Driers:** Liquid Paint Driers, ASTM Designation D 600.
(B) Additives must be approved by the OWNER prior to the use of coatings in which the additive is proposed for use.

(1) Anti-Skinning Agent.
(2) Betone — N.L. Industries
(3) Thix-A-Trol "ST", N.L. Industries
(4) Stabilizer:
   (i) Thermolite 813, M&T Chemicals, Inc.
   (ii) Stanclere™, Interstab Chemicals, Inc.

(d) Traffic Paint
(1) General. Paint for traffic striping and marking shall correspond with the requirements as shown in this specification or on the plans and contract documents.
(2) Pigments:
   (A) White:
      (1) Pure Titanium Dioxide, Rutile, nonchalking: Titanium Dioxide Pigments, ASTM Designation D 476, Type II.
      (2) Zinc Oxide: Zinc Oxide, ASTM Designation D 79, either American process or French process.
   (B) Colored:
      (1) 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.
         TiO₂: 9.5% min.
         Fe₂O₃: 2.0 to 3.0%
         pH: 6.5 to 7.0
         Ignition Loss: 0.35% max.
         Y (luminosity): 42.5 to 45.5
   (2) 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.

<table>
<thead>
<tr>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial:</td>
<td>53</td>
</tr>
<tr>
<td>Final:</td>
<td>45</td>
</tr>
</tbody>
</table>

   In addition, the allowable change between the initial and final luminance factors shall be no more than nine units.

   The initial x, y chromaticity color coordinates of the pigment shall be within the rectangle defined by the sets of coordinates shown below.

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.490</td>
<td>0.455</td>
</tr>
<tr>
<td>0.511</td>
<td>0.433</td>
</tr>
<tr>
<td>0.514</td>
<td>0.480</td>
</tr>
<tr>
<td>0.535</td>
<td>0.458</td>
</tr>
</tbody>
</table>

   Method of Test: The pigment shall be tested according to Texas SDHPT Test Method Tex-810-B.

   The formulation of the test using the pigment to be tested is as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>Parts by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color Pigment</td>
<td>54.0</td>
</tr>
<tr>
<td>Long Oil Alkyd Resin</td>
<td>31.5</td>
</tr>
<tr>
<td>4% Calcium Drier</td>
<td>0.6</td>
</tr>
<tr>
<td>6% Cobalt Drier</td>
<td>0.3</td>
</tr>
<tr>
<td>Anti-Livering Agent</td>
<td>0.1</td>
</tr>
<tr>
<td>Anti-Skinning Agent</td>
<td>0.2</td>
</tr>
<tr>
<td>Mineral Spirits (2)</td>
<td>13.3 (3)</td>
</tr>
</tbody>
</table>
(i) Alkyd resin solution meeting Federal Specification TT-R-2660D, Type I, Class A.
(ii) Mineral spirits meeting Petroleum Spirits (Mineral Spirits), ASTM Designation D 235, Type IV.
(iii) The amount of mineral spirits may be varied slightly to produce the desired grinding consistency.

Number of coats: Two

(C) Inert:
   (1) Talc, Paint-Grade Magnesium Silicate: Shall meet Magnesium Silicate Pigment, ASTM Designation D 605.

(2) Calcium Carbonate:
   \[ \text{CaCO}_3 \] Min. 97.0%
   \[ \text{H}_2\text{O} \] Max. 0.4%
   Specific Gravity 2.63 to 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.

(3) Calcine Kaolin (Aluminum Silicate, Anhydrous)

<table>
<thead>
<tr>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{Al}_2\text{O}_3 )</td>
<td>39.5</td>
</tr>
<tr>
<td>( \text{SiO}_2 )</td>
<td>51.0</td>
</tr>
<tr>
<td>( \text{Fe}_2\text{O}_3 )</td>
<td>1.0</td>
</tr>
<tr>
<td>( \text{TiO}_2 )</td>
<td>2.5</td>
</tr>
<tr>
<td>( \text{CaO} + \text{MgO} )</td>
<td>0.8</td>
</tr>
<tr>
<td>( \text{Na}_2 \text{O} + \text{K}_2\text{O} )</td>
<td>1.2</td>
</tr>
<tr>
<td>Ignition Loss:</td>
<td>1.0</td>
</tr>
</tbody>
</table>

   In addition, the X-ray diffraction pattern shall match the X-ray diffraction pattern on file at the Materials and Tests Division of the Texas State Department of Highways and Public Transportation.

   Materials having color requirements shall be tested according to Texas SDHPT Test Method 810-B.

(3) Resins.
   (A) Chlorinated Paraffin: Shall meet Federal Specifications MIL-C-429C, Type I.
   (B) Chlorinated Rubber: Shall be similar and equal to the standard sample submitted to the Texas State Department of Highways and Public Transportation 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.

(C) Traffic Paint Alkyd Resin Solution:

   (1) 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 3/4 full test tube at 80°F ± 5°F. This rubber-alkyd-solvent solution shall produce a clear film upon drying.

   (2) 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

(3) 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.

(3) Turbidity: In addition to the above requirements, the traffic alkyd resin shall meet the following % transmittance requirements when tested according to Texas SDHPT Test Method Tex-814-B, utilizing methyl isobutyl ketone as primary solvent and methyl alcohol as precipitating agent.

<table>
<thead>
<tr>
<th>% Transmittance</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>10.0%</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>70.0%</td>
<td></td>
</tr>
</tbody>
</table>

Calculate volume in milliliters of precipitating agent as follows:

\[ V_1 = \frac{V_x}{91x} \]

where: \[ V_1 = \text{volume of precipitating agent required for T}_1 \]
\[ x = \text{grams of alkyd resin solids} \]

and

\[ V_2 = 1.398V_1 \]

where: \[ V_2 = \text{additional volume of precipitating agent required for T}_2 \]

(4) Thinners.

(A) Methyl Ethyl Ketone: Methyl Ethyl Ketone, ASTM Designation D 740.

(B) Aromatic Naphtha:

- Appearance: Clear, free of sediment
- Color: Water, white
- Boiling Range, °F: 360 to 415
- Kauri Butanol Value: 88 min.
- Specific Gravity, 25°C: 0.884 - 0.894
- Flash Point, °F (TCC): 140 min.

(5) Additives and Chemicals.

(A) Driers: Liquid Paint Driers, ASTM Designation D 600.

(B) Additives must be approved by the OWNER prior to the use of coatings in which the additive is proposed for use.

(1) Stabilizer

- Thermolite 813, M&T Chemicals, Inc.
- Stanclere TM, Interstab Chemicals, Inc.

(2) Treated Bentonite Clay

- Bentonite 34, NL Industries
- Clayton 40, Southern Clay Products

(e) Thermoplastic Paint. The thermoplastic traffic line paint shall conform to one of the following:

(1) 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 strip 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 (204°C to 218°C) and a thickness
of 125 mils (1/8 in.) (3.175 mm) to 188 mils (7/10 in.) (4.762 mm), shall set to bear traffic in not more than two minutes when the air temperature is 50°F (10°C) and not more 10 minutes when the air temperature is 90°F (32°C).

(2) 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.

(f) 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 shall be completely dry in not more than three minutes when preheated to 110°F to 180°F (43°C to 82°C) 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.

(g) Ready-Mixed Paint. Where ready-mixed paints are specified, they shall be suitable for use on either asphalt concrete or portland cement concrete.

(h) 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 beds per gallon (0.72 to 0.96 kg per liter) 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 beds, two to three pounds (0.24 to 0.36 kg per liter) of beds 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 (0.12 kg per liter) of glass beads per gallon of paint.

All paint shall meet the requirements of the appropriate air pollution control district.

(i) Rejection. Raw materials and finished products which fail to meet any 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 paint taken during production, and upon tests made on finished paints 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.

2.9.2. GALVANIZING

(a) 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.

(b) 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 the 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 requirement.

(c) 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, threading, 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.
(d) Testing. 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.

<table>
<thead>
<tr>
<th>Material</th>
<th>ASTM Designation</th>
<th>Min. Weight of Coating oz/sq. ft. (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel product including structural shapes, tie rods, handrails, manhole steps, fence posts, braces, and miscellaneous items</td>
<td>A 123, Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip</td>
<td>2.00 (.61)</td>
</tr>
<tr>
<td>Hardware including casting, rolled, pressed, and forged articles</td>
<td>A 153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware</td>
<td>2.00 (.61)</td>
</tr>
<tr>
<td>Bolts, screws, nuts, and washers</td>
<td>A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware</td>
<td>1.25 (.38)</td>
</tr>
<tr>
<td>Chain link fence fabric (galv. after fabrication)</td>
<td>A 392, Zinc-Coated Steel Chain Link Fence fabric</td>
<td>1.20 (.37)</td>
</tr>
<tr>
<td>CMP culverts and underdrains</td>
<td>A 444, Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process for Culverts and Underdrains</td>
<td>1.00 (.31)</td>
</tr>
<tr>
<td>Steel pipe</td>
<td>A 120, Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses</td>
<td>1.80 (.55)</td>
</tr>
<tr>
<td>Iron or steel wire fencing</td>
<td>A 116, Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric</td>
<td>0.80 (.24)</td>
</tr>
<tr>
<td>Steel or iron sheets</td>
<td>A 525, General Requirements for Sheet Steel, Zinc-Coated (Galvanized) by the Hot-Dip Process</td>
<td>0.63 (.19)</td>
</tr>
<tr>
<td>Barbed wire</td>
<td>A 121, Zinc-Coated (Galvanized) Steel Barbed Wire</td>
<td>0.50 (.15)</td>
</tr>
<tr>
<td>Electrolier standards, 7-gauge steel and over</td>
<td>A 386, Zinc-Coated (Hot-Dip) on Assembled Steel Products</td>
<td>2.00 (.61)</td>
</tr>
<tr>
<td>Electrolier standards, under 7-gauge steel</td>
<td>A 386, Zinc-Coated (Hot-Dip) Assembled Steel Products</td>
<td>1.50 (.46)</td>
</tr>
</tbody>
</table>

(e) 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:

1. 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.

2. Metalizing 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 1/2 in. (12.7 mm).

Zinc wire containing not less than 99.98 percent zinc shall be used in the metalizing operation. A zinc coating shall be applied to the damaged area with a metalizing gun to a thickness of not less than 0.005 in. (0.01 mm) on the damaged area and shall taper to zero thickness at the edge of the blasted undamaged section.

3. 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 requirements 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.

(f) 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 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.

2.9.3. ALUMINIZING

(a) 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 or thicken in the container, or become granular or 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.

(b) 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.

(1) 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.

(2) Field Coats. The field coats shall be aluminum paint and shall conform to the specification for paint, described in Item 2.9.1.(c)(1)(E). The first field coat shall be tinted with four to six ounces of Prussian blue or chrome green pastes per gallon of paint as specified in AASHTO M69 to permit detection of incomplete application for ease in inspection.

(c) 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, thread cutting, 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.

(d) Testing. 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 designated 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.

(e) 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.

(f) Rejection. Raw materials and finished products which fail to meet all the requirements of these specifications shall be subject to rejection. Final acceptance or rejection shall be based upon results of tests on samples of raw materials and paint taken during production and upon tests made on finished paints 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.

2.9.4. CORROSION-RESISTANT COATINGS AND LINERS FOR SANITARY SEWERS AND APPURTE NANCES

(a) General. Coatings and liners are used as a protective barrier attached to the interior walls of concrete pipe or manhole sections, 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 appurtenance 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 tests, 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 the material to the pipe or appurtenances for acceptance, all tests must be met or certified 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 manufacture 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 (m) 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 in. long, 2 1/2 in. wide and 1 in. thick (125 mm x 56 mm x 25 mm), 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
(D) the containers shall be closed and held at 100°F (37.7°C) 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 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:

(1) make a test specimen by drilling a core hole through the protective material and the pile to produce a core sample 1 in. (2.5 cm) in diameter by 3/4 in. (1.9 cm) or more in depth. (This hole may be repaired and the pipe from which the sample was taken may be used.)

(2) check the protective material for thickness.

(3) cement the test specimens onto a solid wooden block at least 2 in. x 2 in. x 1 in. (5 cm x 5 cm x 2.5 cm) in thickness so that the protective material is cemented onto the wooden block.

(4) allow sufficient time for the cement to set.

(5) support the wooden block so that the test specimen is on its underside and hang a 40 pound (18.144kg) weight on the test specimen. This can be done using an ordinary wooden clamp.

(6) this test should be made at an ambient temperature of between 60°F and 90°F (15°C - 32°C).

(7) 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:

(1) using a large enough square footage (m²) 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 (3.6 kg/m²).

(2) for the adhesion test, either Item 2.9.4.(d)(3) or paragraph (1) above shall be used, 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 (30 cm) 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 (2700 grams) of gravel and three pounds (1360 grams) of water, and it shall be placed inside the test section and the test section shall be rotated so that the protective material...
has peripheral speed of four feet per second (122 cm 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 D635.

(c) 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 2.9.4.(d).

(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 2.9.4.(g).

(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 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, or

(4) it cannot be adequately repaired in the field.

2.9.5. 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.

(A) Low-density polyethylene film. Low density polyethylene film shall be 8 mils (0.008 in.) 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 D 1248, with the following characteristics:

- Flow Rate — 0.4 g/10 min., maximum
- Tensile Strength — 1200 psi (8.3 MPa) minimum
- Elongation — 300% minimum
- Dielectric Strength — volume resistivity, $10^{15}$ ohm-cm, minimum
- 800 Volts per mil thickness minimum

(B) High-density, cross-laminated polyethylene film. High-density, cross-laminated polyethylene film shall be 4 mil (0.004") thick with a minus tolerance of 10%. The polyethylene film shall be manufactured of virgin polyethylene material of Type III; Class A (natural color), B (colors), or C (black); Grade P-33; conforming to the requirements specified in Polyethylene Plastics Molding and Extrusion Materials, ASTM Designation D 1248, with the following characteristics:
Flow Rate — 0.4 to 0.5 g/10 min., maximum
Tensile Strength — 5000 psi (34.6 MPa) minimum
Elongation — 100% minimum
Dielectric Strength — volume resistivity, $10^{15}$ ohm-cm, minimum
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 in. (5 cm) wide plastic backed adhesive tape 10 mils (0.010 in.) thick. The tape shall be Polyken No. 900, Scotchwrap No. 50, or approved equal.

(c) Minimum Width of Film Tube (When Laying Flat).

<table>
<thead>
<tr>
<th>Nominal Pipe Size in. (mm)</th>
<th>Push-on Joint Flat Tube Width in. (mm)</th>
<th>Mechanical Joint Bell Flat Tube Width in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 (100)</td>
<td>14 (350)</td>
<td>16 (400)</td>
</tr>
<tr>
<td>6 (150)</td>
<td>17 (425)</td>
<td>20 (500)</td>
</tr>
<tr>
<td>8 (200)</td>
<td>21 (525)</td>
<td>24 (600)</td>
</tr>
<tr>
<td>10 (250)</td>
<td>25 (625)</td>
<td>27 (675)</td>
</tr>
<tr>
<td>12 (300)</td>
<td>29 (725)</td>
<td>30 (750)</td>
</tr>
<tr>
<td>14 (350)</td>
<td>33 (825)</td>
<td>34 (850)</td>
</tr>
<tr>
<td>16 (400)</td>
<td>37 (925)</td>
<td>37 (925)</td>
</tr>
<tr>
<td>18 (450)</td>
<td>41 (1035)</td>
<td>41 (1035)</td>
</tr>
<tr>
<td>20 (500)</td>
<td>45 (1135)</td>
<td>45 (1135)</td>
</tr>
<tr>
<td>24 (600)</td>
<td>53 (1335)</td>
<td>53 (1335)</td>
</tr>
</tbody>
</table>

(d) Rejection. Failure to meet any of the specifications contained in this section shall be cause for rejection of the materials.

ITEM 2.10. ELECTRICAL COMPONENTS

2.10.1. GENERAL REQUIREMENTS FOR ELECTRICAL COMPONENTS

(a) 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.

(b) 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, shown on the drawings, or noted on shop drawings, if they are necessary to make a complete installation, they shall be included in the materials required under these specifications.

(c) 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:

(1) National Board of Fire Underwriters (NBFU), National Fire Protection Association (NFPA) and National Electric Code (NEC)

(2) National Electrical Manufacturers Association (NEMA)

(3) Institute of Electrical and Electronic Engineers (IEEE)

(4) Insulated Power Cable Engineers Association (IPCEA)

(5) American National Standards Institute (ANSI)

(6) National Electrical Contractor’s Association (NECA)

(7) Association Edison Illuminating Companies (AEIC)
MATERIALS

(8) National Bureau of Standards (NBS (National Electrical Safety Code)
(9) Rural Electrification Administration (REA)
(10) Such other codes and standards as specified on the plans or in the contract specifications.

(d) Material General. 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.

(e) 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.

2.10.2. MATERIAL

(a) General. All electrical component materials provided shall be in accordance with the plans, special provisions, contract documents and these specifications.

(b) Luminaries. Luminaries shall be as shown on the plans and special provisions of the specifications. Lamps, housings, reflectors, mountings, ballast and other required items shall be provided to present a complete operable unit.

(c) 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.

(d) Conduit.


(2) Rigid Steel Conduit. All rigid steel galvanized conduit 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.

(3) Flexible Conduit. All flexible conduit shall be American Metal Hose with a neoprene jacket and Appleton Sealite fittings or other approved equals.

(4) Indoor Cable Tray. Cable 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.

(5) 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 in. (10 cm) 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 18 in. (50 cm) 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 3000F 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 1/2 in. (1.25 cm) 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 ft. 0 in. (1.5 m) 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.

(e) 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.

(f) Rejection. Electrical component materials specified in this section may be rejected for failure to meet all of the provisions of this specification or for any defect causing such materials to be unsuitable for their intended use.

ITEM 2.11. METAL FOR STRUCTURES

2.11.1. STRUCTURAL STEEL

(a) General. Unless otherwise indicated in the plans or contract 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 percent 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 (345 MPa) Minimum Yield Point to 4 in. 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 (4°C) 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 (20J) at plus 40°F (4°C) are consistently obtained. If these dates are 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 percent of the tests shall indicate values of not less than 25 foot-pounds (34J) at plus 40°F (4°C).

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 \( \frac{1}{16} \) in. (9.5 mm) in thickness, if the thickness of the lot does not exceed 2 in. (5 cm).
- Differing not more than one in. (2.5 cm) in thickness when the least thickness in the lot exceeds 2 in. (5 cm).

The governing thickness for wide flange, I, H, and T sections shall be the 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.

2.11.2. RIVETS

(a) General. Unless otherwise indicated on the plans or contract 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.
2.11.3. BOLTS

(a) General. Bolts shall be of the type and size specified on the plans and shall be furnished with suitable nuts and washers where required.

(b) Unfinished Bolts. Unfinished bolts shall meet the requirements of Carbon SteelExternally Threaded Standard Fasteners, ASTM Designation A 307, Grade A.

(c) High-Strength Bolts. High-strength bolts shall meet the requirements of High-Strength Bolts for Structural Steel Joints, ASTM Designation A 325 (A 325M).

(d) 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.

(e) 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.

2.11.4. 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.

2.11.5. 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. All castings shall be cast with an approved manufacturer's name and part number. Manufacturer shall certify that all castings conform to the following ASTM Designations as applicable:

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>ASTM</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray Iron Castings</td>
<td>A 48</td>
<td>Class 30 Minimum</td>
</tr>
<tr>
<td>Gray Iron Castings for Valves, Flanges, and Pipe Fittings</td>
<td>A 126</td>
<td>Class B</td>
</tr>
</tbody>
</table>

(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 arises shall be sharp and true.

(3) Coatings. Castings shall not be coated unless otherwise specified in the plans and contract documents.

(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.

2.11.6. BRONZE CASTINGS AND SHEET COPPER

(a) General. Bronze casting sand sheet copper shall meet the requirements specified herein and 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 Alloy Sand 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.

2.11.7. 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 document.

(b) Steel Railings. Steel railings shall be fabricated from Structural Steel, ASTM A 36, steel of either 10-gauge (0.1345 in., 3.4 mm, nominal thickness) or 12-gauge (0.1046 in., 2.6 mm, 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 (45,400 kg) for 10-gauge or 60,000 (27,240 kg) 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 Guard Railings. Flexible metal guard rail shall be 12 in. (30 cm) wide after bending and, unless otherwise designated on the drawings, shall be formed from 10-gauge or heavier metal. Connections shall be as shown on the drawings. When tested with a straight edge along either side of a sectional length of plate, the maximum deviation of the plate’s edge shall not exceed 1/2 in. (1.2 cm) at any point.

(d) Aluminum Railings. The rail element shall be aluminum alloy AA Alloy Alclad 2024 or ASTM Alloy Clad CG424 sheet, temper T3, meeting the requirements of Aluminum and Aluminum-Alloy Sheet and Plate, ASTM Designation B 209 (B 209M). The terminal sections shall meet the requirements for the rail element except that the temper shall be T42.

(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 said metal or material to be unsuitable for its intended use.

2.11.8. 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.
ITEM 2.12. UNDERGROUND CONDUIT AND RELATED MATERIAL

2.12.1. CLAY SEWER PIPE
(a) General. Clay sewer pipe shall conform to the current specifications for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated, ASTM Designation C 700, having compression joints and bell and spigot ends or compression couplings for plain-end pipe.

Clay pipe for tunneling, microtunneling, or sliplining shall conform to the current specification for Vitrified Clay Pipe and Joints for Use in Jacking, Sliping, and Tunnels, ASTM Designation C 1208 (C 1208M).

(b) Joints. Connecting gaskets both for pipes in straight alignment shall not be less than 119 millimeters (4 ½ inches) in diameter or in the curing crete Sewer, Storm Drain, and Culvert Pipe, ASTM Designation C 14 (C 14M), except that the steam curing time shall not be less than eight continuous hours. Pipe may be transported to the job three days after the prescribed steam curing period, provided it successfully meets all physical load test requirements.

(c) Minimum wall thicknesses and minimum strength shall conform to Class 2 pipe. The pipe class and joint length shall be as specified on the plans or specifications.

(d) For all pipe with internal diameters of 10 in. (250 mm) and larger, aggregates for the concrete shall consist of limestone aggregates in the proportion of at least 75 percent by weight of the total aggregates.

(e) Pipe furnished under this specification shall be steam cured in accordance with methods prescribed in Concrete Sewer, Storm Drain, and Culvert Pipe, ASTM Specification C 14 (C 14M), except that the steam curing time shall not be less than eight continuous hours. Pipe may be transported to the job three days after the prescribed steam curing period, provided it successfully meets all physical load test requirements.

(f) The pipe and connecting joints shall be subject to the hydrostatic tests set forth in the current specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, ASTM Designation C 443 (C 443M) both for pipes in straight alignment and for pipes in maximum deflected position, without leakage either in the pipe or in the joints.

(g) Joints. Connecting joints shall be made using a flexible watertight rubber type compression gasket. The rubber gasket shall be the sole element of the joint depended upon to provide watertightness.

ITEM 2.12. UNDERGROUND CONDUIT AND RELATED MATERIAL

2.12.2. CONCRETE SEWER PIPE, NONREINFORCED WITH RUBBER GASKET JOINTS
(a) General. Concrete sewer pipe manufactured under these specifications shall conform to the current specifications for Concrete Sewer, Storm Drain, and Culvert Pipe, ASTM Designation C 14 (C 14M), with the following additions:

(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 mechanical devices which shall assure a dense concrete in the finished product. Minimum wall thicknesses and minimum strength shall conform to Class 2 pipe. The pipe class and joint length shall be as specified on the plans or specifications.

(2) Aggregate for the concrete shall comply with requirements of Concrete Aggregates, ASTM Designation C 33, with the additional requirement that the aggregates shall have a minimum of 50 percent limestone aggregates.

(3) For all pipe with internal diameters of 10 in. (250 mm) and larger, aggregates for the concrete shall consist of limestone aggregates in the proportion of at least 75 percent by weight of the total aggregates.

(4) Pipe furnished under this specification shall be steam cured in accordance with methods prescribed in Concrete Sewer, Storm Drain, and Culvert Pipe, ASTM Specification C 14 (C 14M), except that the steam curing time shall not be less than eight continuous hours. Pipe may be transported to the job three days after the prescribed steam curing period, provided it successfully meets all physical load test requirements.

(5) The pipe and connecting joints shall be subject to the hydrostatic tests set forth in the current specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, ASTM Designation C 443 (C 443M) both for pipes in straight alignment and for pipes in maximum deflected position, without leakage either in the pipe or in the joints.

(b) Joints. Connecting joints shall be made using a flexible watertight rubber type compression gasket. The rubber gasket shall be the sole element of the joint depended upon to provide watertightness.
(1) Rubber Gaskets. All rubber-type gaskets shall be of the round O-ring design and shall be required to meet and be tested in accordance with specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, ASTM Designation C 443 (C 443M). 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.

(2) Joint Deflection. The joint design shall provide for the deflection of a pipe unit by opening one side of the outside perimeter of the joint 1/2 in. (12.4 mm) wider than the full “home” position without reducing its watertightness. Where greater deflections are required than provided by the joint design, beveled joints or elbows shall be provided.

(3) Joint Tolerance. The bell-and-spigot or tongue-and-groove ends of the pipe joints shall be accurately manufactured so that the width of the annular space between the gasket-bearing surfaces, when the joint has been fully closed, shall not vary at any point around the circumference of the pipe by more than plus six percent of the uncompressed thickness of the gasket from that provided in the design.

On pipe 12 in. (304 mm) diameter and larger, the joint design shall be such that the parallel surfaces upon which the gasket may bear during closure shall extend a distance of not less than 1 in. (25 mm) from the edge of the gasket seat toward the outer edge of the bell.

(4) Joint Approval. Joint designs and type of gaskets shall be approved by the OWNER prior to installation. The manufacturer shall furnish recommendations for deflections varying from Item 2.12.2.(b) and the maximum and minimum allowable opening of the joint in the laid condition. Joints other than the confined O-ring design must have prior approval by the OWNER.

(c) Specials. Component parts for all specials such as bends, wyes, tees, etc. shall be manufactured on machines and in the same manner as straight joint concrete sewer pipe under these specifications. The quality of the concrete, workmanship and bell-and-spigot joint detail for rubber gasket joints shall be subjected to the same requirements as straight joints of pipe.

(d) Tests. Tests for external load crushing strength, core strength, hydrostatic strength, permeability and freezing and thawing shall be made in accordance with the current standard methods of Concrete Pipe, Sections, or Tile, ASTM Designation C 497 (C 497M). If the OWNER requests that tests be made, then the specimens to be tested shall be selected by the OWNER or its representatives at the plant. The manufacturer shall furnish without charge specimens for testing up to 0.5 percent of the number of pipe of each size included in the order, except that in no case fewer than two specimens shall be furnished.

(e) Rejection. Pipe shall be subject to rejection on account of any of the following:

1. failure to pass all of the tests listed in these specifications;
2. variations in any dimension exceeding the permissible variations prescribed;
3. a piece broken out of the bell or spigot end of such size that the water tightness of the joint would be impaired;
4. blisters where the surface is broken or which project more than 1/8 in. above the surface;
5. any shattering or flaking of concrete or other conditions indicating an improper concrete mix;
6. cracks sufficient to impair the strength, durability or serviceability of the pipe;
7. failure to conform with any of the specifications herein set forth or referenced;
8. failure to give a clear ringing when placed on end and dry tapped with a light hammer;
9. insecure attachment of branches on spurs;
10. the complete absence of distinct weblike markings, which may be indicative of a deficiency of water in the concrete mix, from the external surface of pipe made by any process in which the forms are removed immediately after the concrete has been placed, unless specimens submitted for test that do not have such weblike markings shall have passed physical tests required by these specifications;
11. failure of pipe to go completely “home” due to binding of spigot against bell;
12. joint surfaces with spall, cracks, fractures or other imperfections that would adversely affect the performance of the joint;
13. gaskets shall be subject to rejection whenever they show surface checking, weathering or any other deterioration.
2.12.3. **REINFORCED CONCRETE CULVERT, STORM DRAIN, PIPE AND BOX SECTION**

(a) **Description.** This item shall govern reinforced concrete culvert, storm drain, pipe and precast reinforced concrete box sections.

### 2.12.3.1. **REINFORCED CONCRETE CULVERT, STORM DRAIN, AND PIPE**

(a) **General.** Reinforced concrete pipe shall conform to the current specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, ASTM Designation C 76 (C 76M) of the class as designed on the plans subject to the following modifications:

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 mechanical devices which shall assure a dense concrete in the finished product.
2. Sizes larger than 60 in. (1524 mm) diameter shall be manufactured, using two lines of circular reinforcement.
3. Where Class III pipe of sizes larger than 60 in. (1500 mm) diameter are specified, the manufacturer may at its option furnish pipe manufactured with either Wall “B” or Wall “C” minimum thicknesses and the applicable minimum steel area as listed for circular cages in Table II of Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, ASTM Designation C 76 (C 76M), provided tests strength requirements for Class III pipe are satisfactorily met.

(b) **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.

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Maximum Amount of Bevel or Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 12 in. (304 mm) to 27 in. (605 mm), inclusive</td>
<td>2 in. (50 mm)</td>
</tr>
<tr>
<td>From 30 in. (762 mm) to 51 in. (1295 mm), inclusive</td>
<td>3 in. (75 mm)</td>
</tr>
<tr>
<td>From 54 in. (1370 mm) to 84 in. (2133 mm), inclusive</td>
<td>4 in. (100 mm)</td>
</tr>
</tbody>
</table>

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.

Unless otherwise specified on the plans or in the special provisions, pipe joints shall be sealed with either of the following types of gaskets:

1. Cold-applied preformed plastic gaskets. Plastic gasket 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.
2. Expanded cellular rubber gaskets. Expanded cellular rubber gaskets shall be produced from a blend of nitrile and vinyl polymers meeting the physical requirements of ASTM D1056, Class 2C1. 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.

(c) **Tests.** The acceptability of the pipe in all diameters and classes shall be determined by the results of the three-edge bearing test for the load to produce a 0.01 in. (0.25 mm) crack; by such material tests as are required in Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, ASTM Designation C 76 (C 76M); 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.

Test specimens shall be selected on the basis of not more than 0.5 percent of the number of pipe of each size included in the order, except that in no case fewer than two specimens shall be furnished. Pipes that have been tested only to the formation of a 0.01 in. (0.25 mm) crack and that meet the 0.01 in. (0.25 mm) test load requirements shall be accepted for use. Tested pipe accepted for use shall be marked “TEST” or otherwise appropriately identified.
Should any of the test specimens fail to meet the test requirements, two consecutive joints in the same mix series shall be tested and results shall be a basis of accepting or rejecting the pipe of the series.

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 497 (C 497M).

(d) Rejection. Reinforced concrete pipe may be rejected for failure to meet any of the requirements of this specification.

2.12.3.2. 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 (C 789M), or Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers With Less Than 2 Feet of Cover Subject to Highway Loadings, ASTM Designation C 850 (C 850M). 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, unless otherwise specified, shall conform to the requirements of Item 7.12., “Precast Concrete Units.”

2.12.4. REINFORCED CONCRETE SEWER PIPE WITH RUBBER GASKET JOINTS

(a) General. Reinforced concrete pipe manufactured under these specifications shall conform to the current specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, ASTM Designation C 76 (C 76M), or Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe, ASTM Designation C 655 (C 655M), with the following additions:

(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 mechanical devices which shall assure a dense concrete in the finished product.

(2) aggregates for the concrete shall comply with requirements Concrete Aggregates, ASTM Designation C 33, with the additional requirement that the aggregate shall have a minimum of 50 percent of calcium carbonate equivalent.

(3) minimum wall thicknesses shall be as listed under Wall “B.”

(4) minimum laying length of each joint shall be 6 ft. 0 in. (1.8 m) for sizes up to and including 15 in. (380 mm) and 7 ft. 7 in. (2.3 m) for sizes larger than 15 in. (380 mm) except for bends, wyes and other special fittings which may be required, or for special radius pipe.

(5) pipe furnished under this specification shall be steam cured in accordance with methods prescribed in ASTM Designation C 76 (C 76M) except that the steam curing time shall be not less than eight continuous hours. Pipe may be transported to the job three days after the prescribed steam curing period, provided it successfully meets all physical load test requirements.

(6) the pipe and connecting joints shall be subject to the hydrostatic tests set forth in the current specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, ASTM Designation C 443 (C 443M), both for pipes in straight alignment and for pipes in maximum deflected position without leakage either in the pipe or in the joints.

(b) Steel Reinforcement. All steel reinforcement shall be in accordance with Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, ASTM Designation C 76 (C 76M), and shall be circular in shape. No elliptical reinforcement shall be permitted. Where Class III pipe of sizes larger than 30 in. (750 mm) in diameter are specified, the manufacturer may, at its option, furnish pipe manufactured with either Wall “B” or Wall “C” minimum thicknesses, and the applicable minimum steel area as listed for circular cages in Table II of ASTM C 76 may be substituted, at the manufacturer’s option, for those listed in Table III of ASTM Designation C 76, provided test strength requirements for Class III pipe are satisfactorily met.

Where Class IV or V pipe is specified, the steel as called for in the wall as designated shall be furnished. Quadrant reinforcement shall be acceptable. As an alternate the pipe may be designed as detailed in the specifications for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe, ASTM Designation C 655 (C 655M). Proof of design must be submitted.

(c) Joints. Connecting joints shall be made using a flexible watertight rubber-type compression gasket. The rubber gasket shall be the sole element of the joint depended upon to provide watertightness.
(1) Rubber Gaskets. All rubber-type gaskets shall be of the round O-ring design. The rubber gasket shall be required to meet and be tested in accordance with specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, ASTM Designation C 443 (C 443M).

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.

(2) Joint Design. The joint design shall consist of a bell or groove on one end of a unit of pipe, and a spigot or tongue on the adjacent end of the joining pipe. The taper on the conic surfaces of the inside of the bell or groove and the outer surfaces of the spigot or tongue shall be parallel and shall not be more than three degrees of pipe sizes up through 15 in. (375 mm) diameter nor more than two degrees for larger sizes, measured from a longitudinal trace on the inside surface of the pipe.

(3) Joint Dimensions. The bell-and-spigot or tongue-and-groove of the joint shall be of such design that the joint shall withstand the forces caused by the compression of the gasket when properly jointed without cracking or fracturing. All surfaces of the joint upon or against which the gasket may bear shall be smooth, free of spalls, cracks or fractures, or imperfections that would adversely affect the performance of the joint. The thickness of the bell-and-spigot of the joints shall conform to the minimum dimensions as shown in Table No. 13, Reinforced Concrete Pipe Joint Dimensions.

(4) Joint Tolerance. The joint design shall be such that the parallel surfaces upon which the gasket may bear during closure shall extend a distance of not less than 1 inch (2.54 cm) from the edge of the gasket seat toward the outer edge of the bell.

(5) 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.

(d) Specials. Component parts for all specials such as bends, wyes, tees, etc. shall be manufactured on machines and in the same manner as straight joint concrete sewer pipe under these specifications, except that joint lengths may be shorter than minimum listed. The quality of the concrete, workmanship and bell-and-groove joint detail for rubber gasket joints shall be subjected to the same requirements as straight joints of pipe.

(e) Thick Wall Pipe. The basic physical dimensional design for thick wall pipe shall be identical to the next larger 3 in. (75 mm) increment standard pipe size covered by these specifications, reduced internally to the inside diameter as specified on the plans. The reinforcing steel shall be as listed in the tables for the next larger 3 in. (75 mm) increment internal diameter unless a special design is submitted under Section 10 of Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, ASTM Designation C 76 (C 76M), or under specifications for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe, ASTM Designation C 655 (C 655M). Proof of design must be submitted. The steel shall be placed as required for the next larger size to provide an additional sacrificial lining of 1.5 in. (38 mm) of concrete cover over the reinforcing steel.

<table>
<thead>
<tr>
<th>Pipe Size In. (mm)</th>
<th>Bell Thickness In. (mm)</th>
<th>Spigot Thickness In. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 (300)</td>
<td>2.000 (50)</td>
<td>1.375 (35)</td>
</tr>
<tr>
<td>15 (375)</td>
<td>2.125 (54)</td>
<td>1.563 (41)</td>
</tr>
<tr>
<td>18 (450)</td>
<td>2.250 (57)</td>
<td>1.688 (43)</td>
</tr>
<tr>
<td>21 (525)</td>
<td>2.500 (63)</td>
<td>1.813 (46)</td>
</tr>
<tr>
<td>24 (600)</td>
<td>2.750 (69)</td>
<td>1.938 (48)</td>
</tr>
<tr>
<td>27 (675)</td>
<td>2.875 (72)</td>
<td>2.000 (50)</td>
</tr>
<tr>
<td>30 (750)</td>
<td>3.000 (75)</td>
<td>2.063 (52)</td>
</tr>
<tr>
<td>33 (825)</td>
<td>3.250 (82)</td>
<td>2.125 (54)</td>
</tr>
<tr>
<td>36 (900)</td>
<td>3.500 (88)</td>
<td>2.250 (57)</td>
</tr>
</tbody>
</table>
TABLE NO. 13 (continued)

<table>
<thead>
<tr>
<th>Pipe Size In. (mm)</th>
<th>Bell Thickness In. (mm)</th>
<th>Spigot Thickness In. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>42 (1050)</td>
<td>4.250 (107)</td>
<td>3.563 (91)</td>
</tr>
<tr>
<td>48 (1200)</td>
<td>4.250 (107)</td>
<td>3.563 (91)</td>
</tr>
<tr>
<td>54 (1350)</td>
<td>4.250 (107)</td>
<td>3.563 (91)</td>
</tr>
<tr>
<td>60 (1500)</td>
<td>4.250 (107)</td>
<td>3.563 (91)</td>
</tr>
<tr>
<td>66 (1650)</td>
<td>4.250 (107)</td>
<td>3.563 (91)</td>
</tr>
<tr>
<td>72 (1800)</td>
<td>4.250 (107)</td>
<td>3.750 (94)</td>
</tr>
<tr>
<td>78 (1950)</td>
<td>4.375 (111)</td>
<td>3.750 (94)</td>
</tr>
<tr>
<td>84 (2100)</td>
<td>4.500 (113)</td>
<td>4.125 (105)</td>
</tr>
<tr>
<td>90 (2250)</td>
<td>4.750 (119)</td>
<td>4.500 (113)</td>
</tr>
<tr>
<td>96 (2400)</td>
<td>4.750 (119)</td>
<td>4.500 (113)</td>
</tr>
<tr>
<td>102 (2550)</td>
<td>5.250 (132)</td>
<td>4.750 (119)</td>
</tr>
<tr>
<td>108 (2700)</td>
<td>5.688 (144)</td>
<td>5.063 (127)</td>
</tr>
</tbody>
</table>

NOTE: Metric measurement based on ASTM Standard sizes (C 76M)

(f) Coatings and Linings

(1) General. Coatings and liners called for in the specifications or as indicated on the plans shall meet the requirements of Item 2.9.4., “Corrosion-Resistant Coatings and Liners for Sanitary Sewers and Appurtenances,” of this specification and shall be installed or applied by the pipe manufacturer.

(2) Types. All work for and in connection with the installation of the coatings and linings, including interlocking liner plates and epoxy lining in concrete pipe and the field sealing and welding of joints, shall be done in strict conformity with all applicable specifications, instructions and recommendations of the manufacturer.

(g) Repairs. Repairs shall be permitted as set out in ASTM Designation C 76 and/or ASTM Designation C 655 except field repairs shall be permitted only with prior approval of the OWNER. If, in the opinion of the OWNER, repairs should not be made, the section of pipe shall be rejected and removed from the construction site and not repaired or returned to any of the OWNER'S projects. Rejected pipe shall be marked in a manner mutually agreed upon by the OWNER and the pipe manufacturer.

Field repairs on damage to the gasket bearing area shall not be allowed without prior approval of the OWNER.

(h) Markings. Each length of pipe shall bear the initials or name of the person, company or corporation by whom manufactured; date of manufacture; and the class of pipe. The markings shall be indented or stenciled on the exterior or interior of the barrel near the bell and shall be plainly legible for purpose of identification.

(i) Tests. The pipe shall be required to meet and be tested in accordance with Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, ASTM Designation C 76 (C 76M), or Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe, ASTM Designation C 655 (C 655M) as they apply.

The connecting joints shall be subject to the hydrostatic tests set forth in the current Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, ASTM Designation C 443 (C 443M).

The rubber gasket shall be required to meet and be tested in accordance with ASTM Designation C 443 (C 443M).

(j) Rejection. The pipe may be rejected for having defects of failure to meet the requirements as follows:

(1) variations in any dimension exceeding the permissible variations prescribed,
(2) a piece broken out of the bell or spigot or tongue or groove end of such size that the watertightness of the joint should be impaired,
(3) a shattering or flaking of concrete or other conditions indicating an improper concrete mix,
(4) lack of uniformity in placement of steel which might preclude all joints being typical of those tested,
(5) cracks sufficient to impair the strength, durability or serviceability of the pipe.
(6) failure to conform with all of the specifications herein set forth or referenced,
(7) the complete absence of distinct web-like markings, which may be indicative of a deficiency of water in the concrete mix, from the external surface of the pipe made by any process in which the forms are removed immediately after the concrete has been placed, unless specimens submitted for test that do not have such web-like markings shall have passed the physical tests required by these specifications,
(8) failure of pipe to go completely “home” due to binding of spigot against bell or tongue against groove,
(9) failure to pass all of the tests in Item 2.12.4.(h),
(10) joint sections with spalls, cracks, fractures, or other imperfections that could adversely affect the performance of the joint,
(11) failure to meet the requirements for coatings and linings.

2.12.5. CONCRETE PRESSURE PIPE AND FITTINGS

(a) General. These specifications cover the manufacture of concrete pressure pipe designed for internal pressures from a minimum of 20 psi (1.4 kg/cm²) to a maximum of 350 psi (24.6 kg/cm²). The specifications cover six types of such pipe as follows:

<table>
<thead>
<tr>
<th>Item Reference No.</th>
<th>AWWA Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.12.5(e)</td>
<td>C302</td>
<td>Reinforced Concrete Pressure Pipe, Non-Cylinder Type, for Water and Other Liquids</td>
</tr>
<tr>
<td>2.12.5(f)</td>
<td>C300</td>
<td>Reinforced Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids</td>
</tr>
<tr>
<td>2.12.5(g)</td>
<td>C301</td>
<td>Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids</td>
</tr>
<tr>
<td>2.12.5(h)</td>
<td>C303</td>
<td>Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pretensioned, for Water and Other Liquids.</td>
</tr>
</tbody>
</table>

(b) General Requirements.

(1) The type of pipe to be supplied shall be as shown on the plan and/or in the special provisions for each project.

(2) The manufacturer shall submit a successful experience record in the design and construction of the type of concrete pressure pipe involved. Each type of pipe, with the exception of the pipe made in accordance with the AWWA Standard C302, shall have the complete approval of the Underwriters’ Laboratories, Inc., for the manufacture of the pipe specified and diameters required.

(3) Upon award of the contract, the CONTRACTOR shall furnish OWNER with shop drawings showing the pipe and fittings to be furnished and shall include a tabulated layout schedule with reference to the stationing of the contract drawings with plan and profile drawings. Such drawings shall be subject to the approval of the OWNER and fabrication of pipe and fittings shall not be commenced until such drawings have been approved by the OWNER. Such approval by the OWNER shall not relieve the CONTRACTOR of any responsibility of providing pipe and/or fittings in accordance with the OWNER’S plans and specifications.

(4) The pipe manufacturer shall furnish a factory-trained, job-experienced field representative who shall visit the project periodically during the course of installation. He shall also be subject to call by the CONTRACTOR and/or OWNER to advise and assist with the solution of field problems. During visits, the representative shall observe all phases of the project including location and condition of pipe, stockpiled and installed pipe, trench width, if applicable, bedding and backfill, assembly of pipe joints and protection of steel. If, in the opinion of the representative, any
phase of the installation is unsatisfactory to the extent of jeopardizing the performance of the pipe, he shall so advise the CONTRACTOR'S superintendent. If the condition is not corrected, the representative shall also advise the OWNER.

(5) The OWNER shall at all times have free access to the manufacturer's plant while production is in progress, and may at any time refuse to accept pipe made when the plant is failing to follow the stipulations of the specifications in regard to workmanship, or failing in provisions to insure a uniform product coming within the permissible variations of the specifications as to size, thickness, position of reinforcing steel and curing of the pipe. The OWNER may reject pipe if adequate means and methods are not provided so as to insure the manufacture of a product of uniform quality.

(6) All references to national specifications shall be the issue in effect on the date that the project is advertised for bids.

c) Fittings and Specials. The manufacturer shall furnish all fittings and special pieces required for closures, bends, branches, manholes, air valves, blowoffs and connections to mainline valves and other fittings shown on the contract drawings or as set out in the specifications. Fittings and specials shall be either "Type A" or "Type B." All openings in the pipe for fittings, manholes, taps, blowoffs, etc. shall have the interior and exterior surfaces of the steel lined and coated with mortar. The lining thickness shall be a minimum of 0.5 inches (12.5 mm) for sizes 16 in. (400 mm) and smaller, and 0.75 in. (19 mm) minimum lining thickness for sizes larger than 16 in. (400 mm). The minimum coating thickness shall be 1 in. (25 mm). The type of fittings and details covering the design of fittings and specials shall be furnished by the manufacturer and subject to the approval of the OWNER. The fittings and specials shall comply in all respects with the requirements of AWWA with modifications as herein set forth.

d) Tests. In addition to certification of all applicable tests required by governing AWWA Standards, the following tests or certifications of tests may be required.

(1) Steel Cylinder Pipe. The manufacturer shall submit for approval the specified details of materials and methods of welding he proposes to use before any welding is done.

The manufacturer shall furnish one specimen for tensile tests of welds from each 3,000 ft. (900 m) of pipe. If tests indicate the welding is unsatisfactory, additional samples as required shall be furnished. Two test cylinders out of each day's pour of the concrete used, or as required by the OWNER, shall be furnished for testing by an independent laboratory. The cost of such a test shall be borne by the OWNER. Certified test reports made by the manufacturer shall be acceptable in lieu of the test cylinders, provided such test certificates show that they cover pours from which the purchased pipe is made.

Mill test reports on each heat from which steel cylinders and reinforcing are rolled shall be furnished by the OWNER, if required.

Test certificates showing the physical properties of the compound used in the gaskets shall be furnished by the OWNER, if required.

The manufacturer of concrete cylinder pipe as specified in Items 2.12.5., 2.12.5.(a), 2.12.5.(f), 2.12.5.(g), and 2.12.5.(h) shall have demonstrated, or shall demonstrate as may be required, that the pipe when tested in a three-edge bearing test as described in Concrete Pipe, Sections or Tile ASTM Designation C 497 (C 497M) under a load equivalent to the design ditch load shall not deflect more than 0.1 percent. At the above specified load, there shall be no continuous cracks wider than 0.002 in. (0.7 mm) for a length of 12 in. (30 mm).

(2) Concrete Cylinder Fittings. Hydrostatic testing of fittings is not required unless specifically called for in the Project Specifications.

(e) Reinforced Concrete Pressure Pipe C302.

(1) General. The pipe shall consist of a reinforcing cage or cages of steel rods, a wall of dense centrifugally-spun concrete or a wall of dense vertically cast concrete covering the reinforcing cage or cages inside and out, an approved type of joint as shown on the plans or specified in the proposal with gaskets of rubber so designed that the joints shall be watertight under all normal conditions of service. Pipe manufacture shall be as specified on the plans or specifications or as approved by the OWNER.

The pipe shall comply in all respects with the requirements of the AWWA Standard for Reinforced Concrete Pressure Pipe, Non-Cylinder Type, for Water and Other Liquids, AWWA Standard C302, with modifications as herein set forth.
(2) Design Pressures and Stresses. The pipe as specified in Item 2.12.5.(e)(1) above shall be designed for an internal working pressure and for external loading as fixed by the plans and/or specified in the proposal or special provisions. The combined cross-sectional area of circumferential steel in the reinforcement cage or cages shall be computed in accordance with Appendix A of AWWA Standard C302.

The minimum internal pressure shall be 20 psi (1.4 kg/cm²). The maximum internal pressure, including transient pressure, shall be 65 psi (46.7 kg/cm²) for sizes 12 in. (300 mm) to 48 in. (1200 mm), inclusive; 55 psi (3.9 kg/cm²) for sizes 51 in. (1300 mm) to 57 in. (1450 mm), inclusive; and 43 psi (3.0 kg/cm²) for sizes 60 in. (1500 mm) and larger.

Pipe furnished under these specifications shall not be designed for internal pressure where used for sanitary sewer gravity flow. Pipe used for sanitary sewer, gravity flow, shall be designed for an external load in pounds per linear foot of pipe, which shall be designated on the plans and/or in the special provisions.

Fittings and specials shall be “Type B” except that the minimum coating thickness shall be 1 in.

The nominal length of each section of pipe shall be 8 ft. (2.4 m) with a maximum length of 16 ft. (4.9 m) for 39 in. (990 mm) and larger. Specially designed pipe with thicker walls and additional longitudinal steel may exceed above lengths.

(f) Reinforced Concrete Cylinder Pipe C300.

(1) General. The pipe shall consist of a welded sheet steel or plate steel cylinder with steel joint rings of the bell-and-spigot type welded to the ends of the steel cylinder, helically-wound steel rod reinforcement in one or two cages concentrically located with the steel cylinder, a wall of dense concrete completely surrounding the steel assembly and a self-centering joint with a preformed rubber gasket designed so that it shall be watertight under all normal conditions of service.

The pipe shall comply in all respects with the requirements of AWWA Standard for Reinforced Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids, AWWA Standard C300, with modifications as herein set forth.

(2) Design Pressures and Stresses. Reinforced concrete cylinder pipe as specified in Item 2.12.5.(f)(1) above shall be designed for an internal working pressure of 150 psi (10.5 kg/cm²), except where otherwise shown on the plans and/or specified in the proposal or special conditions. The combined cross-sectional area of steel in the cylinder and the reinforcement cage shall be computed as described in Appendix A of AWWA Standard C300.

(g) Prestressed Concrete Lined Cylinder Pressure Pipe C301.

(1) General. The pipe may be of two types of prestressed concrete steel cylinder pipe as specified on the plans and/or specifications or special conditions:

(A) the lined cylinder type with a core composed of a steel cylinder lined with concrete and subsequently wire-wrapped directly on the steel cylinder and coated with the mortar.

(B) the embedded cylinder type with a core composed of a steel cylinder encased in concrete and subsequently wire-wrapped on the exterior concrete surface and coated with concrete or mortar. A self-centering joint with a preformed gasket of rubber so designed that the joint shall be watertight under all normal conditions of service. The pipe shall comply in all respects with the requirements of the AWWA Standard for Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids, AWWA Standard C301, with modifications as herein set forth.

(2) Design Pressures and Stresses. Design pressure shall be that shown on plans and/or specifications. The size of the high-tensile wire and the spacing and tension under which it is wound shall be such that the conditions required by the design methods in Appendix A or B of AWWA Standard C301 are met.

Pipe shall be furnished in 16 ft. (4.9 m) lengths in accordance with the applicable provisions of AWWA Standard C301.

Concurrent with the application of the mortar coating, a cement slurry composed of one sack of portland cement to not more than 15 gallons (56.9 liters) of water shall be applied adjacent to the coating in such a manner as to coat evenly and uniformly the exposed surface of the steel assembly.

(h) Pretensioned Concrete Pressure Pipe C303.

(1) General. The pipe shall consist of a welded sheet-steel or plate-steel cylinder, manufactured by the spiral or straight seam method with joint rings attached, inside of which a cement mortar lining is centrifugally spun; a preten-
sioned rod spirally wrapped under measured tension on the steel cylinder and protective concrete coating applied to the outside of the cylinder and spirally-wrapped rod.

The pipe shall comply in all respects with the requirements of AWWA Standard for Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pretensioned, for Water and Other Liquids, AWWA Standard C303, with modification as herein set forth.

(2) Design Pressures and Stresses. Design pressure shall be that shown on the plans and/or specifications. Steel cylinder and bar reinforcement shall be designed in accordance with Appendix A of AWWA Standard C303.

The manufacturer shall furnish uniform lengths within a range of 24 ft. to 40 ft. (7.2 m to 12 m) unless shorter lengths are ordered as specials, except that 21 in. (525 mm) in diameter and smaller shall not exceed 32 ft. (9.6 m). If longer lengths are furnished, the cylinder thickness must be increased to provide the equivalent longitudinal bending resistance provided in a normal 32 ft. (9.6 m) length.

(i) Tests. All pipe shall be tested in accordance with applicable specifications.

(j) Rejection. Pipe shall be rejected for failure to meet any of the requirements of the specifications.

2.12.6. THERMOPLASTIC OR THERMOSETTING COATED CONCRETE PIPE AND FITTINGS

(a) General. This specification covers the plant application of a corrosion-resistant plastic in a liquid form to the interior walls of concrete pipe. The coating shall be specially formulated to resist corrosion and to adhere to the uncured or cured surface of the concrete pipe and shall be applied as recommended by the manufacturer.

(b) Material.

(1) Concrete Pipe. The concrete pipe shall meet the requirements of ASTM Designation C 76 (C 76M) or C 655 (C 655M) as called for in Item 2.12.4, or as called for on the plans or in the specifications.

(2) Coating. The coating shall consist of virgin or compounds of thermoplastic or thermosetting plastics, as may be recommended by the supplier to perform services intended.

(c) Application. The coating shall extend the full length of the barrel of the pipe. Thickness shall vary with the type of liquid plastic used, whether fillers are used and the required thickness to prevent holidays. Some of the common thicknesses are as follows:

- Mainstay - Coal-tar epoxy with silica filler — 90 - 100 mils minimum
- Centriline - Epoxy with silica filler — 90 - 100 mils minimum
- Wise Chemical - CTE-200 Coal-tar epoxy — 30 - 50 mils minimum

Other thicknesses of thermoplastic or thermosetting plastics shall be as called for on the plans or in the specifications or as approved by the owner.

(d) Physical and Chemical Properties.

(1) Holidays. The applied material shall be continuous, free of pinholes, voids and holidays and shall be tested with an electrical holiday detector that shall produce the required voltage based on the thickness and density of the material applied.

(2) Chemical Resistance. The resistance of the applied material to chemical degradation shall meet the standards established in Item 2.9.4., “Corrosion-Resistant Coatings and Liners for Sanitary Sewers and Appurtenances.”

(3) Adhesion. The adhesion of the applied material shall meet the standards established in Item 2.9.4.(d)(3).

(4) Resistance to Temperature Changes. The resistance of the applied material to physical degradation due to temperature changes shall meet the standards established in Item 2.9.4.(d)(4).

(5) Resistance to Abrasion. The resistance of the applied material to abrasion shall meet the standards established in Item 2.9.4.(d)(5).

(6) Resistance to Fire. The resistance of the applied material to fire shall meet the standards established in Item 2.9.4.(d)(6).

(e) Joint Area of the Pipe. A protective coating shall be applied to all joint areas of sufficient thickness to provide a continuity of corrosion protection to such surface areas. Other materials to protect the joint shall be acceptable if approved by the owner.

A jointing compound shall be applied to the joints to provide a continuity of corrosion protection to such surface areas when the joint is fully made up, if required by the type of joint protection utilized or otherwise as approved by the owner.
(f) Patching. The materials used to repair the applied coating in the field shall be of a material that shall provide an equal protection to the pipe.

The patching procedure shall consist of removing the applied material from the damaged area by mechanical means (grinding or chipping) and feathering the applied material around the edge of the damaged area for a minimum of \(\frac{1}{2}\) in. (12.5 mm). A properly mixed primer, if required, shall be scrubbed by brush into the surface extending to cover the feathered applied material.

Immediately over the wet primer, if used, shall be applied the patching material. The finished patch shall be of sufficient thickness to rebuild the applied material to its original thickness and contour.

(g) Handling. Care shall be exercised to prevent damage to the interior barrier when end caps which are utilized in manufacturing the concrete pipe are removed. Fork lifts, chain slings, pipe hooks and other pipe handling equipment utilized shall be cushioned as required to prevent any damage to the interior surface of the pipe. Lift holes shall not be used in handling the pipe.

(h) Inspection. Pipe sections shall be checked for surface continuity by means of approved holiday type detectors. Pipe sections shall be visually inspected to determine that the corrosion protected surfaces of the pipe have not been damaged before or during installation in the field. There shall be no damaged pipe installed.

(i) Tests. The installed coating shall withstand all applicable tests detailed in Item 2.9.4., "Corrosion-Resistant Coatings and Liners for Sanitary Sewers and Appurtenances."

(j) Rejection. The coating may be rejected for failure to meet any of the requirements of this specification.

2.12.7.  GRAY IRON PRESSURE PIPE AND FITTINGS

(a) General. Gray iron pressure pipe 3 in. (75 mm) in diameter and larger shall conform to the current issue of any one of the following specifications or standards:


Gray iron pipe less than 3 in. (75 mm) in diameter shall conform to the American Standard Specifications for 2 in. and 2\(\frac{1}{4}\) in. Gray Iron Pipe, Centrifugally Cast, for Water or Other Liquids, AWWA C-112 (ASA A21.12).

(b) Physicals for 3 In. and Larger Pipe. Pipe shall be produced with mechanical properties of not less than 21,000 psi (1476 kgf/cm\(^2\)) bursting tensile strength and not less than 45,000 psi (3164 kgf/cm\(^2\)) modulus of rupture when tested in accordance with the above listed specifications or standards.

Pipe shall be designed for 200 psi (14.0 kgf/cm\(^2\)) working pressure or as called for in proposal or bid request, laying condition "B" and 8 ft. (2.4 m) maximum depth or cover in accordance with the U.S.A. Standard for Thickness Design of Gray Iron Pipe, AWWA H1 (USAS A21.1) with \(\frac{21}{4}\) strength iron. The minimum nominal wall thickness and standard thickness class for each size pipe shall be as follows:

<table>
<thead>
<tr>
<th>Pipe Size in. (mm)</th>
<th>CLASS 200 Nominal Wall in. (mm)</th>
<th>Thickness Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (75)</td>
<td>.32 (81)</td>
<td>22</td>
</tr>
<tr>
<td>4 (100)</td>
<td>.35 (90)</td>
<td>22</td>
</tr>
<tr>
<td>6 (150)</td>
<td>.35 (90)</td>
<td>21</td>
</tr>
<tr>
<td>8 (200)</td>
<td>.38 (96)</td>
<td>21</td>
</tr>
<tr>
<td>10 (250)</td>
<td>.44 (112)</td>
<td>22</td>
</tr>
<tr>
<td>12 (300)</td>
<td>.48 (122)</td>
<td>22</td>
</tr>
<tr>
<td>14 (350)</td>
<td>.59 (150)</td>
<td>24</td>
</tr>
<tr>
<td>16 (400)</td>
<td>.63 (160)</td>
<td>24</td>
</tr>
<tr>
<td>18 (450)</td>
<td>.63 (160)</td>
<td>23</td>
</tr>
<tr>
<td>20 (500)</td>
<td>.67 (170)</td>
<td>23</td>
</tr>
<tr>
<td>24 (600)</td>
<td>.79 (200)</td>
<td>24</td>
</tr>
</tbody>
</table>
(c) Joints. All gray iron pressure pipe shall be furnished with one of the following types of joints and as described in the proposal or bid request:

<table>
<thead>
<tr>
<th>Type Joint</th>
<th>AWWA Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell &amp; Spigot Caulked Joint</td>
<td>AWWA C106 or C108</td>
</tr>
<tr>
<td>Push-on Joint</td>
<td>AWWA C111</td>
</tr>
<tr>
<td>Mechanical Joint</td>
<td>AWWA C110</td>
</tr>
<tr>
<td>Flanged Ends</td>
<td>AWWA C606</td>
</tr>
<tr>
<td>Grooved Ends</td>
<td>AWWA C606</td>
</tr>
</tbody>
</table>

Bolts and nuts for mechanical joints or flanged ends (if used underground) shall be of a high-strength low-alloy corrosion resistant steel and shall conform to High-Strength Bolts for Standard Steel Joints, ASTM Designation A 325 (A 325M) (Type B).

(d) Coating and Lining. All gray iron pipe shall be cement-mortar lined inside with seal coat in accordance with American National Standard for Cement-Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water, AWWA Standard C104 (ANSI A21.4) and shall be bituminous coated outside.

(c) Fittings. Fittings for gray iron from 3 through 48 in. (75 to 1200 mm) in diameter 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), unless specified in the proposal, special specification or on the plans.

All fittings shall be rated for a minimum of 250 psi (2069 kpa) working pressure.

Bolts and nuts for mechanical joints or flanged ends shall be of a high-strength, corrosion-resistant low-alloy steel and shall conform to ASTM Designation A 325 (A 325M) (Type B).

Special fittings using end condition combinations of bells, spigots, mechanical or push-on joints, flanges or special internally locked joints shall be to dimensions in accordance with AWWA Standard C110 (ANSI A21.10).

Fittings shall be cement-lined with a seal coat.

(f) Underwriter’s Approval. Gray iron pipe shall be approved by the Underwriters’ 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.

(g) Tests. All gray iron pipe and fittings shall be tested in accordance with the applicable provisions of the specifications relating thereto.

(h) Rejection. Gray iron pipe and fittings may be rejected for failure to meet any of the requirements of this specification.

2.12.8. DUCTILE-IRON PRESSURE PIPE AND FITTINGS

(a) General. Ductile-iron pressure pipe 3 in. (75 mm) in diameter and larger shall conform to the current American National Standard for Ductile-Iron Pipe Centrifugally Cast for Water or Other Liquids, AWWA Standard C 151.

(b) Design Requirements. The ductile-iron pipe shall conform in all respects to the specifications set forth in ASTM Designation A 377 (A 377M), Standard Index of Specifications for Ductile Iron Pressure Pipe. The specific grade of ductile-iron used shall be Grade 60-42-10, with Minimum Tensile Strength of 60,000 psi, a Minimum Yield Strength of 42,000 psi, and a Minimum Elongation in 2 in. of 10 percent.

Pipe shall be specified by either Thickness Class or Pressure Class, in accordance with AWWA Standard C150 and AWWA Standard C 151 and shall be so designated in the plans and contract documents.

(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:

<table>
<thead>
<tr>
<th>Type Joint</th>
<th>AWWA Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push-on</td>
<td>AWWA C111</td>
</tr>
<tr>
<td>Mechanical Joint</td>
<td>AWWA C111</td>
</tr>
<tr>
<td>Flanged Ends</td>
<td>AWWA C110 or AWWA C115</td>
</tr>
<tr>
<td>Grooved Ends</td>
<td>AWWA C606</td>
</tr>
</tbody>
</table>
Bolts and nuts for mechanical joints or flanged ends (if used underground) shall be of a 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 threaded flanges shall be ductile iron.

(d) Coating and Lining. All ductile-iron pipe shall be bituminous coated outside and cement-mortar lined inside with seal coat in accordance with AWWA Standard C104.

(e) Fittings. Fittings shall be of gray or ductile-iron and shall conform to the current American National Standard for Gray-Iron and Ductile-Iron Fittings, 3 In. through 48 In., for Water and Other Liquids, AWWA Standard C110 or American National Standard for Ductile-Iron Compact Fittings, 3 In. through 16 In. for Water and Other Liquids, AWWA Standard C153, unless otherwise specified in the proposal, special specification or in the plans.

Use of Ductile Iron Compact Fittings is prohibited if soil resistivity measurements are less than 1000 ohms/cm³.

(f) Underwriters’ Approval. Ductile-iron pipe shall be approved by the Underwriters’ 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.

(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.

2.12.9. STEEL PIPE AND FITTINGS

(a) General. Steel pipe, fittings and specials shall conform to the details as shown on the plans or included in the specifications and as specified below.

(b) Applicable Standard Specifications. Except as modified or supplemented herein, all steel pipe, fittings and specials shall conform to the applicable requirements of the following standard specifications, latest edition:

<table>
<thead>
<tr>
<th>AWWA Standards</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C200</td>
<td>Steel Water Pipe 6 In. and Larger</td>
</tr>
<tr>
<td>C203</td>
<td>Coal Tar Protective Coatings and Linings for Steel Water Pipeline — Enamel and Tape — Hot Applied</td>
</tr>
<tr>
<td>C205</td>
<td>Cement-Mortar Protective Lining and Coating for Steel Water Pipe — 4 In. and Larger — Shop Applied</td>
</tr>
<tr>
<td>C206</td>
<td>Field Welding of Steel Water Pipe</td>
</tr>
<tr>
<td>C207</td>
<td>Steel Pipe Flanges for Waterworks Service — Sizes 4 In. through 144 In.</td>
</tr>
<tr>
<td>C208</td>
<td>Dimensions for Steel Water Pipe Fittings</td>
</tr>
<tr>
<td>C209</td>
<td>Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines</td>
</tr>
<tr>
<td>C214</td>
<td>Tape Coating Systems for the Exterior of Steel Water Pipelines</td>
</tr>
<tr>
<td>C602</td>
<td>Cement-Mortar Lining of Water Pipeline — 4 In. and Larger — in Place</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ASTM Designations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A 283</td>
<td>Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars</td>
</tr>
<tr>
<td>A 139</td>
<td>Electric-Fusion (Arc)-Welded Steel Pipe (Sizes 4 In. and over)</td>
</tr>
</tbody>
</table>
(c) Pipe and Fittings Requirements.

1. Diameter. Nominal pipe diameter shall be as specified in the plans. Nominal diameters for steel pipe sizes under 30 in. (76.2 cm) are outside diameters and for sizes 30 in. (76.2 cm) and over are inside diameters per AWWA Standard M11.

2. Wall Thickness. The pipe wall thickness shall be as specified in the plans.

3. Pipe Lengths. Pipe sections shall be furnished in not less than 40 ft. (12 m) lengths except for specials and closures sections as may be required.

4. Material. Fabricated pipe and fittings shall be made of steel plate conforming to ASTM Designation A 283, Grade D, or A 139, Grade B or C, in accordance with AWWA Standard C200. Mill-type pipe and fittings shall be Grade B conforming to AWWA Standard C200.

5. Hydrostatic Testing. All pipe shall be hydrostatically tested to one and one half the working pressure as indicated on the plans. Fittings fabricated from hydrostatically tested pipe shall not require shop hydrostatic testing. Fittings made from nonhydrostatically tested pipe or fabricated from steel plate shall require hydrostatic testing or X-ray inspection or other ASTM nondestructive testing.

(d) Joints. Steel pipe and fittings shall be joined with any of the end types as specified below, unless a particular end type is specified. Flange ends shall be used only where specifically noted on drawings.

Welded joints shall conform to and be tested in accordance with the AWWA Standard for Field Welding of Steel Water Pipe, AWWA Standard C206.

Grooved and shouldered joints shall conform to, and be tested in accordance with AWWA Standard for Grooved and Shouldered Joints, AWWA Standard C606.

Mechanically coupled joints shall consist of Dresser Couplings Style 38 or equal or as specified on the drawings.

Flanged joints shall conform to the AWWA Standard for Steel Pipe Flanges for Waterworks Service — Size 4 In. through 144 In., AWWA Standard C207, Class D. The thickness of flanges shall be as specified in Table 1 or 2 of AWWA Standard C207, or as specified on the drawings.

(e) Lining and Coating. Steel pipe and fittings shall be lined in accordance with any of the following standards unless a particular specification is shown on the plans:

<table>
<thead>
<tr>
<th>AWWA C203</th>
<th>Coal Tar Protective Coatings and Linings for Steel Water Pipeline — Enamel and Tape — Hot Applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWWA C205</td>
<td>Cement-Mortar Protective Lining and Coating for Steel Water Pipe — 4 In. and Larger — Shop Applied</td>
</tr>
<tr>
<td>AWWA C209</td>
<td>Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines</td>
</tr>
<tr>
<td>AWWA C214</td>
<td>Tape Coating Systems for the Exterior of Steel Water Pipelines</td>
</tr>
<tr>
<td>AWWA C602</td>
<td>Cement-Mortar Lining of Water Pipeline — 4 In. and Larger — in Place</td>
</tr>
</tbody>
</table>

The exterior surface of steel pipe and fittings to be installed underground shall be coated in accordance with AWWA Standard C203, or in accordance with AWWA Standard C214. If coated in accordance with AWWA C214, then the fittings will be coated in accordance with AWWA Standard C209.

The exterior surface of steel pipe and fittings to be installed above ground shall be cleaned, primed and painted, all in accordance with AWWA Standard C203, Section 1.2, Paragraph 3.

(f) Rejection. Steel pipe and fittings shall be rejected if they fail to meet all requirements of applicable specifications.

2.12.10. (Deleted)

2.12.11. (Deleted)
2.12.12. ABS AND PVC COMPOSITE PIPE FOR SANITARY SEWERS
(a) General. Composite pipe shall conform to the current specification for Acrylonitrile-Butadiene-Styrene (ABS) and PVC Composite Sewer Piping, ASTM Designation D 2680.
(b) Couplings and Fittings.
   (1) Chemically Welded Joints. If the pipe is plan ended with couplings, the pipe shall be delivered prebelled. Sufficient primer and solvent cement shall be provided. The solvent cement shall conform to Type II cement as described in Solvent Cement for ABS and PVC Plastic Pipe and Fittings, ASTM Designation D 2235.
   (2) O-Ring Joints. If the pipe is prebelled with an enlarged coupling, an O-Ring shall be provided for each joint. The physical properties of the gasket shall be at least equal to the requirements of Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, ASTM Designation C 443 (C 443M).
   Wyes or tees with saddle shall be provided as indicated on the plans. Adapters to other types of pipe shall be supplied as indicated on the plans.
(c) Tests. The pipe stiffness at five percent vertical deflection shall be at best equal to or exceed 200 lb/in. (3612 g/cm) of deflection for each diameter as determined by External Loading Properties of Plastic Pipe by Parallel-Plate Loading, ASTM Designation D 2412. They physical test may be the 3-Edge Bearing Method under applicable ASTM Designation if preferred.
(d) Rejection. ABS and PVC composite pipe and fittings may be rejected for failure to meet any of the requirements of this specification.

2.12.13. POLYVINYL CHLORIDE (PVC) SEWER PIPE AND FITTINGS WITH MODIFIED WALL PROFILES AND PERFORMANCE STANDARDS
(a) General. This specification designates requirements for PVC plastic gravity sewer pipe for the conveyance of domestic sewage with various modified wall profiles and performance requirements. Engineering evaluations of specific installation requirements is recommended.
(b) Stiffness. Minimum pipe stiffness at five percent deflection shall be 46 psi for sanitary sewer and 10 psi for storm sewer applications as specified for all sizes when calculated in accordance with ASTM Designation D 2412.
(c) Joint Tightness. Joint tightness shall be tested in Accordance with ASTM Designation D 3212.
(d) Pipe Classification.
   (2) ASTM Designation F-794, “PVC Ribbed Gravity Sewer Pipe and Fitting Based on Controlled Inside Diameter,” sizes 4 in. through 48 in.
   (3) ASTM Designation F-949, “PVC Corrugated Sewer Pipe with Smooth Interior and Fittings,” sizes 4 in. through 36 in.
(e) Installation. Pipe produced to these specifications shall be installed in accordance with ASTM Designation D 2321. The internal diameter of the installed barrel 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. Pipe shall be tested for flattening, impact resistance and extrusion quality as specified in the applicable ASTM Designations.

2.12.14. 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 for 4 in. through 15 in. diameter and ASTM Designation F 679 for greater than 15 in. diameter. Engineering evaluations of specific installation requirements is recommended.
(b) Pipe Sizes.
   (1) For pipe sizes 4 through 15 in. diameter. The pipe shall be Type PSM SDR-35 or SDR-26 as specified in ASTM Designation D 3034.
   (2) For pipe sizes greater than 15 in. diameter. The pipe shall be Type T-1 A and T-2 B as specified in ASTM Designation F 679.
(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) 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.

(e) 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.

(f) Dimensions:

<table>
<thead>
<tr>
<th>Nominal Size</th>
<th>Outside Diameter (In.)</th>
<th>Minimum Wall Thickness (In.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Tolerance (±)</td>
</tr>
<tr>
<td>ASTM D 3034</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4.215</td>
<td>0.009</td>
</tr>
<tr>
<td>6</td>
<td>6.275</td>
<td>0.011</td>
</tr>
<tr>
<td>8</td>
<td>8.400</td>
<td>0.012</td>
</tr>
<tr>
<td>10</td>
<td>10.500</td>
<td>0.015</td>
</tr>
<tr>
<td>12</td>
<td>12.500</td>
<td>0.018</td>
</tr>
<tr>
<td>15</td>
<td>15.300</td>
<td>0.023</td>
</tr>
<tr>
<td>ASTM F 679</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>18.701</td>
<td>0.028</td>
</tr>
<tr>
<td>21</td>
<td>22.047</td>
<td>0.033</td>
</tr>
<tr>
<td>24</td>
<td>24.803</td>
<td>0.037</td>
</tr>
<tr>
<td>27</td>
<td>27.953</td>
<td>0.042</td>
</tr>
<tr>
<td>30</td>
<td>31.496</td>
<td>0.047</td>
</tr>
<tr>
<td>33</td>
<td>35.433</td>
<td>0.053</td>
</tr>
<tr>
<td>36</td>
<td>39.370</td>
<td>0.059</td>
</tr>
</tbody>
</table>

2.12.15. POLYETHYLENE PLASTIC PIPE — NONPRESSURE TYPE — FOR SLIP-LINING

(a) General. The pipe and fittings shall conform to the material and physical properties as described in Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter, ASTM Designation D 3035, unless otherwise herein or in the special specifications.

(b) Requirements.

(1) Material. Pipe and fittings shall be made of polyethylene resin which conforms to Polyethylene Plastics Molding and Extrusion Materials, ASTM Designation D 1248. The polyethylene plastic shall be classified as Type II or Type III, Grade 3, Class C, unless otherwise specified in the plans, contract documents or purchase request.

(2) Dimensions. Dimensions shall be determined in accordance with Dimensions of Thermoplastic Pipe and Fittings ASTM Designation D 2122.

The outside diameter and wall thickness and the tolerance shall be as shown in the following table. Diameters and wall thicknesses other than those shown may be used if specifically called for in the plans, contract documents or purchase request.

(c) Joints. Pipe shall be joined to one another and to polyethylene fittings by butt or socket thermal fusion joints in accordance with Heat Joining of Polyolefin Pipe and Fittings, ASTM Designation D 2657 and as recommended by the pipe manufacturer. Dependent upon installation requirements and site location, joining shall be performed within or outside the excavation.
Tests.

General. Tests for compliance with this specification shall be made as specified herein and according to the applicable ASTM Standard. A certification of compliance with this specification, along with a report of each test, shall be furnished by the manufacturer for all material furnished under this specification. In addition, the OWNER may, at his own expense, witness inspection and test of the materials.

Tensile Properties. The tensile strength, yield strength, elongation and elastic modulus of the material shall be determined in accordance with Tensile Properties for Plastics, ASTM Designation D 638 (D 638M). This standard shall be used to determine that the thermal butt fusion joints are stronger than the materials joined. The long term hydrostatic strength rating as determined by Hydrostatic Design Basis for Thermoplastic Pipe Materials, ASTM Designation D 2837, shall be 1250 psi (87.9 kg/cm²) or greater.

Melt Index. The melt index of the polyethylene plastic, as determined in accordance with Flow Rates of Thermoplastics by Extrusion Plastometer, ASTM Designation D 1238, shall have melt indexes of 2.5 g/10 min. maximum and 0.25 g/10 min. minimum.

Density. The density of the polyethylene plastic, as determined in accordance with the Density of Plastics by the Density - Gradient Technique, ASTM Designation D 1505, shall have specific base resin densities of 0.941 g/cc minimum and 0.965 g/cc maximum.

Environmental Stress Cracking Resistance. The environmental stress cracking resistance (ESCR) of the material shall withstand not less than 200 hours in 33 percent solution Igepal CO-630 before reaching a 50 percent failure point (F50).

Deviations. If a supplier chooses to submit a bid for material that does not meet all the requirements of this specification, his bid shall include a description of the deviation with data that shows the magnitude of the deviation. Such deviations to this specification shall be accepted when specified in the plans, contract documents or purchase request.

Rejection. Polyethylene plastic pipe and fittings may be rejected for failure to meet any of the requirements of this specification.
2.12.16. CORRUGATED METAL PIPE OR PIPE ARCH SHAPES

(a) General. This item shall govern the furnishing of corrugated metal pipe for culverts and storm sewer for the locations and designations as shown on the plans and contract specifications as herein outlined.

(b) Designation. The following information shall be designated on the plans and/or contract specifications as further defined herein.

1. Shell Data. This shall specify diameter, classification (Type), material, gage and corrugation.

2. Coating Data. This shall specify post applied coatings.

3. Lining Data. This shall specify post applied linings.

(c) Pipe Manufacture. Corrugated metal pipe or pipe arch shapes shall meet the requirements of ASTM Designation A 760 (A 760M) for corrugated steel pipe, ASTM Designation B 745 (B 745M) for corrugated aluminum pipe, or ASTM Designation A 742 (A 742M) for corrugated metal polymeric pipe. All pipe shall be manufactured with a minimum of two re-rolled ends.

(d) Classification (Type). Corrugated metal pipe shall be classified on the plans and/or specifications with the following notations set forth in ASTM Designation A 760 (A 760M), ASTM Designation B 745 (B 745M) and ASTM Designation A 742 (A 742M):

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Pipe with a full circular cross section with a singular thickness of corrugated sheet, fabricated with annular or helical corrugations.</td>
</tr>
<tr>
<td>Type IA</td>
<td>Pipe with a full circular cross section, with an outer shell of corrugated sheet fabricated with helical corrugations and an inner liner of smooth (uncorrugated) sheet attached to the shell at helical lock seams as described in Section (I), Subsection (L-5).</td>
</tr>
<tr>
<td>Type IR</td>
<td>Pipe with a full circular cross section, with a single thickness of smooth sheet, fabricated with helical ribs projecting outward.</td>
</tr>
<tr>
<td>Type II</td>
<td>Type I pipe which has been reformed into a pipe-arch, having an approximately flat bottom.</td>
</tr>
<tr>
<td>Type IIA</td>
<td>Type IA pipe which has been reformed into a pipe-arch, having an approximately flat bottom.</td>
</tr>
<tr>
<td>Type IIR</td>
<td>Type IR pipe which has been reformed into a pipe-arch, having an approximately flat bottom.</td>
</tr>
<tr>
<td>Type III</td>
<td>Type I pipe which has been perforated to permit the inflow and outflow of water, intended for use as underdrains.</td>
</tr>
<tr>
<td>Type IIIA</td>
<td>Pipe shall consist of semi-circular cross section having a smooth bottom with a corrugated top shield which has been perforated, intended for use as deck drains.</td>
</tr>
</tbody>
</table>

(e) Material. Corrugated metal pipe or pipe arch shapes shall be fabricated from corrugated sheets conforming to one of the following:

| GALV | Galvanized Steel | ASTM A 444 (A 444M) |
| ALT2 | Aluminized Type 2 Steel | ASTM A 819 (A 819M) |
| POLY | Polymeric Steel | ASTM A 762 (A 762M) Grade 10/10 |
| ALUM | Aluminum Alloy | ASTM B 744 (B 744M) |

(f) Gage. Where reference is made to gage of metal, the reference is to U.S. Standard Gage for uncoated sheets in ASTM Designation A 444 (A 444M) and ASTM Designation A 819 (A 819M) for thicknesses of coated steel sheets, and ASTM Designation B 744 (B 744M) for thicknesses of clad aluminum sheets. Unless otherwise shown on the plans or contract specifications, gages shall be minimum as required by the Texas Department of Transportation, Height of Cover Tables, latest edition.

(g) Corrugation. Corrugated configurations shall be governed by dimensional tolerances set forth in ASTM Designation A 760 (A 760M). The following corrugations shall only be valid with their respective classifications:

<table>
<thead>
<tr>
<th>Type</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>2 7/32 in. x 1 7/32 in.; 3 in. x 1 in.; 5 in. x 1 in. (68 mm x 13 mm; 75 mm x 25 mm; 125 mm x 25 mm)</td>
</tr>
<tr>
<td>Type IA</td>
<td>2 7/32 in. x 1 7/32 in.; 3 in. x 1 in. (68 mm x 13 mm; 75 mm x 25 mm)</td>
</tr>
</tbody>
</table>
### MATERIALS

#### Item 2.12.16.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type IR</td>
<td>( \frac{3}{4} \text{ in.} \times \frac{3}{4} \text{ in.} \times \frac{7}{2} \text{ in.}; \frac{3}{4} \text{ in.} \times 1 \text{ in.} \times 11\frac{1}{2} \text{ in.} )</td>
<td>( (19 \text{ mm} \times 19 \text{ mm} \times 190 \text{ mm}; 19 \text{ mm} \times 25 \text{ mm} \times 292 \text{ mm}) )</td>
</tr>
<tr>
<td>Type II</td>
<td>( 2\frac{1}{3} \text{ in.} \times \frac{1}{2} \text{ in.}; 3 \text{ in.} \times 1 \text{ in.; 5 in.} \times 1 \text{ in.} )</td>
<td>( (68 \text{ mm} \times 13 \text{ mm}; 75 \text{ mm} \times 25 \text{ mm}; 125 \text{ mm} \times 25 \text{ mm}) )</td>
</tr>
<tr>
<td>Type IIA</td>
<td>( 2\frac{1}{3} \text{ in.} \times \frac{1}{2} \text{ in.; 3 in.} \times 1 \text{ in.} )</td>
<td>( (68 \text{ mm} \times 13 \text{ mm}; 75 \text{ mm} \times 25 \text{ mm}) )</td>
</tr>
<tr>
<td>Type IIR</td>
<td>( \frac{3}{4} \text{ in.} \times \frac{3}{4} \text{ in.} \times \frac{7}{2} \text{ in.}; \frac{3}{4} \text{ in.} \times 1 \text{ in.} \times 11\frac{1}{2} \text{ in.} )</td>
<td>( (19 \text{ mm} \times 19 \text{ mm} \times 190 \text{ mm}; 19 \text{ mm} \times 25 \text{ mm} \times 292 \text{ mm}) )</td>
</tr>
<tr>
<td>Type III</td>
<td>( 2\frac{1}{3} \text{ in.} \times \frac{1}{2} \text{ in.; 3 in.} \times 1 \text{ in.} )</td>
<td>( (68 \text{ mm} \times 13 \text{ mm}; 75 \text{ mm} \times 25 \text{ mm}) )</td>
</tr>
</tbody>
</table>

#### (h) Post Applied Coatings.

| C-1 | Fully Coated. The coating shall be applied to a minimum thickness of 0.05 in. (1.3 mm) measured from the crest of corrugations, on the top of ribs (as in Type IR pipe), or on the smooth inside surface of the pipe. The coating shall be uniform Class B (bituminous) or Class M (mastic) material applied to the interior and exterior of the pipe per ASTM Designation A 849 (A 849M). |
| C-2 | Half Coated. The coating shall be applied to a minimum thickness of 0.05 in. (1.3 mm) as measured in C-1. The coating shall be uniformly applied to the interior and exterior of the pipe covering at least 50 percent of the circumference on the lower portion of the pipe as installed. The coating shall be Class B (bituminous) or Class M (mastic) material per ASTM Designation A 849 (A 849M). |
| C-3 | Exterior Coated. The coating shall be uniformly applied to the exterior of the pipe to a minimum thickness of 0.05 in. (1.3 mm) as measured in C-1. The coating shall be Class M (mastic) material per ASTM Designation A 849 (A 849M). |
| C-4 | Interior Coated. The coating shall be uniformly applied to the interior of the pipe to a minimum thickness of 0.05 in. (1.3 mm) as measured in C-1. The coating shall be Class M (mastic) material per ASTM Designation A 849 (A 849M). |

#### (i) Post Applied Linings.

| L-1 | Invert Paved Bituminous. The paving in the lower portion of the interior of the pipe as installed shall provide an abrasion resistant smooth flow line. The material shall be Class B (bituminous) and shall fill the corrugations and provide a minimum thickness of \( \frac{1}{8} \text{ in.} \) (3.2 mm) above the crests of the corrugations for at least 25 percent of the circumference of a round pipe and 40 percent of the circumference of pipe arch as installed per ASTM Designation A 849 (A 849M). |
| L-2 | Invert Paved Concrete. The concrete paved invert shall meet the requirements of ASTM Designation A 849 (A 849M). The concrete invert shall be placed after the pipe has been installed and backfilled. The paving shall have a minimum thickness of 3 in. (75 mm) for 28-day 3250 psi concrete, and a minimum of 1\( \frac{1}{2} \) in. (38 mm) for 28-day 9600 psi concrete. The paving shall cover at least 25 percent of the circumference of a round pipe and 40 percent of the circumference of pipe arch (the invert as installed). |
| L-3 | Fully Lined Bituminous. The Class B (bituminous) material shall be applied to fill the corrugations and provide a minimum thickness of \( \frac{1}{8} \text{ in.} \) (3.2 mm) above the crests of the corrugations on the pipe interior. The lining shall provide a smooth surface over the entire interior of the pipe. |
| L-4 | Fully Lined Concrete. The concrete shall conform to ASTM Designation A 849 (A 849M). The concrete lining shall be plant applied by a machine which places and mechanically trowels the concrete while one moves relative to the other. The rate of movement and application shall be |
(j) Coupling Bands. Except as may be otherwise required, coupling bands shall be of the same base material as the pipe. Coupling bands shall lap evenly on each of the pipes being connected and shall fit securely into at least one full circumferential corrugation to form a tightly closed joint.

All pipe shall be field jointed with corrugated locking bands. Connecting bands shall be drawn together by means of not less than two bolts not less than \( \frac{1}{2} \) in. (13 mm) diameter through angles or bar and strap device suitably welded or riveted. Coupling bands shall not be more than three nominal sheet thicknesses lighter than the pipe to be connected and in no case thinner than 0.052 in. (1.32 mm).

(k) Rejection. Corrugated metal pipe or pipe arch shapes may be rejected for failure to meet any of the requirements of this specification.

2.12.17. STRUCTURAL PLATE STRUCTURES

(a) General. Structural plate pipe, pipe arch, box culverts and special shapes shall meet the requirements of Texas Department of Transportation specification Item 461 for structural plate structures and be in accordance with ASTM Designation A 761 for galvanized steel structures and ASTM Designation B 221 for aluminum alloy structures.

(b) Corrugations. Corrugations for steel structures shall have a pitch of 6 in. (150 mm) with a tolerance of \( \frac{1}{4} \) in. (6 mm) and a depth of 2 in. (50 mm) with a tolerance of \( \frac{1}{8} \) in. (3 mm). The radius on the inside of the corrugations shall be at least \( \frac{11}{16} \) in. (26 mm) for steel structures. Corrugations for aluminum alloy structures shall have a pitch of 9 inches (228.5 mm) with a tolerance of \( \frac{3}{8} \) in. (9.5 mm) and a depth of \( 2\frac{1}{2} \) in. (63.5 mm) with a tolerance of \( \frac{1}{8} \) in. (3 mm). The radius of the inside of the corrugation shall be at least 2 in. (51 mm) for aluminum alloy structures.

(c) Gauge Determination and Tolerances. The gauge and tolerances of aluminum plates shall conform to those in ASTM Designation B 221. The thickness of galvanized steel plates shall conform with those in ASTM Designation A 444.

(d) Rejection. Structures on which the spelter coating has been bruised or broken either in the shop or in shipping, or which shows defective workmanship, shall be rejected. The requirement applies not only to the individual plates but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual culvert plate or in general in any shipment shall constitute sufficient cause for rejection:

1. elliptical shaping,
2. variation from a straight centerline,
3. ragged edges,
4. unevenly lined or spaced bolt holes,
5. illegible brands,
6. bruised, scaled or broken spelter coating,
7. dents or bends in the metal itself, or
8. uneven laps.

2.12.18. (Deleted)

2.12.19. TUNNEL LINER PLATES

(a) General. This specification covers the material, galvanizing, coating, shapes and gauge requirements of tunnel liner plates for use in tunneling under railroads, highways and streets.
(b) Material.

(1) Plates. The plates shall be fabricated from steel sheets conforming to the requirements of Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality, ASTM Designation A 569. In addition, the flat plates shall have the following minimum mechanical properties before cold forming:

- Tensile Strength = 42,000 psi
- Yield Strength = 28,000 psi
- Elongation, 2 in. (51 mm) = 30 percent

(2) Bolts and Nuts. Bolts used with lapped seam type (2 flange) liner plates shall be not less than 5/8 in. (15 mm) diameter. Bolts shall conform to Quenched and Tempered Steel Bolts and Studs, ASTM Designation A 449 for plate thickness equal to or greater than 0.209 in. (5 mm) and to Carbon Steel Externally Threaded Standard Fasteners, ASTM Designation A 307 for plate thickness less than 0.209 in. (5 mm). The nuts shall conform to ASTM Designation A 307.

Bolts and nuts used with the four-flanged type shall be not less than 1/2 in. (12 mm) for 7 gauge plates and lighter and not less than 5/8 in. (15 mm) diameter for plates heavier than 7 gauge. The bolts and nuts shall be quick acting coarse thread and shall conform to ASTM Designation A 307, Grade A.

(c) Fabrication. The plates shall be new and unused prior to fabrication. All plates shall be punched for bolting on both longitudinal and circumferential seams or joints and shall be so fabricated as to permit complete erection from the inside of the tunnel. All plates shall be of uniform fabrication and those intended for one size tunnel shall be interchangeable.

(d) Grout Holes. One half of the total number of the top plates shall be equipped with 2 in. (50 mm) diameter grout holes to facilitate grouting above and around the tunnel liner conduit. All grout holes shall be equipped with screw type galvanized plugs for final watertight closure of the grout holes.

(e) Galvanizing. After the plates are formed to shape and after all holes are punched, the plates shall be galvanized on all surfaces by the hot-dip process. A coating of prime western spelter or equal shall be applied in accordance with current ASTM Designation A 123. Spelter coating shall be of first-class commercial quality free from injurious defects such as blisters, flux and uncoated spots. All nuts shall be galvanized to conform with current ASTM Designation A 153.

(f) Bituminous Coating. The plates shall be given a bituminous coating meeting the current American Railway Engineering Association specification or current ASTM Designation A 849. Bituminous protected corrugated metal pipe or plates may be spray-coated in the field with a minimum dry film thickness of 0.05 in. (1.3 mm) prior to installation.

(g) Rejection. Structures on which the spelter coating has been bruised or broken either in the shop or in shipping or which shows defective workmanship shall be rejected. The requirement applies not only to the individual plates but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual liner plate or in general in any shipment shall constitute sufficient cause for rejection:

1. uneven laps,
2. elliptical shaping,
3. variation from a straight centerline,
4. ragged edges,
5. unevenly lined or spaced bolt holes,
6. illegible brands,
7. bruised, scaled or broken spelter coating, or
8. dents or bends in the metal itself.

(h) Section Properties. Section properties shall conform to those specified in Section 16, Steel Tunnel Liner Plates of AASHTO “Standard Design Specifications for Highway Bridges.”
2.12.20. 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 or AWWA Standard for Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameter 14 In. through 36 In., AWWA Standard C905, with cast-iron outside dimensions. Laying lengths shall be 20 ft ± 1 in. (2.5 cm).

(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.

<table>
<thead>
<tr>
<th>Nominal Size In. (cm)</th>
<th>Dimension Ratio (DR)</th>
<th>Outside Diameter* In. (cm)</th>
<th>Min. Wall Thickness In. (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 (10.2)</td>
<td>18</td>
<td>4.80 (12.2)</td>
<td>0.267 (0.68)</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>4.80 (12.2)</td>
<td>0.343 (0.87)</td>
</tr>
<tr>
<td>6 (15.2)</td>
<td>18</td>
<td>6.90 (17.5)</td>
<td>0.383 (0.97)</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>6.90 (17.5)</td>
<td>0.493 (1.25)</td>
</tr>
<tr>
<td>8 (20.3)</td>
<td>18</td>
<td>9.05 (23.0)</td>
<td>0.503 (1.28)</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>9.05 (23.0)</td>
<td>0.646 (1.64)</td>
</tr>
<tr>
<td>10 (25.4)</td>
<td>18</td>
<td>11.10 (28.2)</td>
<td>0.617 (1.57)</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>11.10 (28.2)</td>
<td>0.793 (2.01)</td>
</tr>
<tr>
<td>12 (30.5)</td>
<td>18</td>
<td>13.20 (33.5)</td>
<td>0.733 (1.86)</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>13.20 (33.5)</td>
<td>0.943 (2.40)</td>
</tr>
<tr>
<td>14 (35.6)</td>
<td>25</td>
<td>15.30 (38.9)</td>
<td>0.612 (1.55)</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>15.30 (38.9)</td>
<td>0.850 (2.16)</td>
</tr>
<tr>
<td>16 (40.6)</td>
<td>25</td>
<td>17.40 (44.2)</td>
<td>0.696 (1.77)</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>17.40 (44.2)</td>
<td>0.967 (2.46)</td>
</tr>
<tr>
<td>18 (45.7)</td>
<td>21</td>
<td>19.50 (49.5)</td>
<td>0.929 (2.36)</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>19.50 (49.5)</td>
<td>1.083 (2.75)</td>
</tr>
<tr>
<td>20 (50.8)</td>
<td>21</td>
<td>21.60 (54.9)</td>
<td>1.029 (2.61)</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>21.60 (54.9)</td>
<td>1.200 (3.05)</td>
</tr>
<tr>
<td>24 (61.0)</td>
<td>21</td>
<td>25.80 (65.5)</td>
<td>1.229 (3.12)</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>25.80 (65.5)</td>
<td>1.433 (3.64)</td>
</tr>
<tr>
<td>30 (76.2)</td>
<td>25</td>
<td>32.00 (81.3)</td>
<td>1.280 (3.25)</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>32.00 (81.3)</td>
<td>1.524 (3.87)</td>
</tr>
<tr>
<td>36 (91.4)</td>
<td>25</td>
<td>38.30 (97.3)</td>
<td>1.532 (3.89)</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>38.30 (97.3)</td>
<td>1.824 (4.63)</td>
</tr>
</tbody>
</table>

*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) or AWWA Standard for Polyvinyl Chloride (PVC) Pressure Fittings for Water, 4 In. through 8 In., AWWA Standard C907, unless otherwise specified. Fittings joints shall be push-on or mechanical joints. Bolts and nuts for mechanical joints shall be of a 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 Underwriters’ 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...
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.

2.12.21. (DELETED)

2.12.22. POLYETHYLENE (PE) LARGE DIAMETER SEWER PIPE WITH MODIFIED WALL PROFILES AND PERFORMANCE STANDARDS

(a) General. High Density Polyethylene gravity sewer pipe and fittings in nominal sizes 18 in. through 120 in. with integral bell joints shall conform to current ASTM Designation F 894. Engineering evaluations of specific installation requirements are recommended.

(b) Materials. The pipe and fittings shall be made of high density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248 Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

(c) Stiffness. Minimum pipe stiffness at five percent deflection shall be 10 psi for sanitary sewer as specified for all sizes when calculated according to Appendix XI, “Relation of RSC To Pipe Properties and Pipe Stiffness” of ASTM Designation F 894.

(d) Joint Tightness. Joint tightness shall be tested in accordance with ASTM Designation D 3212.

(e) Installation. Installed pipe produced to these specifications shall be installed utilizing an envelope of standard crushed rock bedding materials, Item 2.1.8., to a minimum of 6 in. above the crown of the pipe. The internal diameter of the installed barrel of pipe must not be reduced by more than 5 percent of its base inside diameter when measured not less than 30 days following completion of installation.

(f) Testing. Pipe shall be tested for flattening, quality and ring stiffness as specified in the applicable ASTM Designsations.

2.12.23. FIBERGLASS (GLASS-FIBER REINFORCED THERMOSETTING — RESIN) SEWER PIPE

(a) General. This specification designates requirements for fiberglass glass-fiber reinforced thermosetting-resin pipe (RTRP) sizes from 8 in. to 144 in. for the conveyance of domestic sewage and shall conform to ASTM Designation D 3262 for gravity application and ASTM Designation D 3754 for force main applications. Engineering evaluations of specific installation requirements are recommended.

(b) Stiffness. Minimum pipe stiffness at 5 percent deflection shall be 36 psi for gravity and pressure sanitary sewers and 18 psi for gravity sliplining applications as specified for all sizes when calculated in accordance with ASTM Designation D 2412.

(c) Joint Tightness. Joint tightness shall be tested in accordance with ASTM Designation D 4161.

(d) Installation. Installed pipe produced to these specifications shall be installed utilizing an envelope of standard crushed rock bedding materials, Item 2.1.8., to a minimum of 6 in. above the crown of the pipe. The internal diameter of the installed barrel of the pipe must not be reduced by more than 3 percent of its base inside diameter when measured not less than 30 days following completion of installation. The long term deflection shall not exceed 5 percent.

(e) Testing. Pipe shall be tested for inside and outside diameter, wall thickness, squareness of pipe ends, chemical requirements, stiffness, beam strength as specified in the respective ASTM Designations D 3681, D 2412, and D 3262.

2.12.24. POLYETHYLENE (PE) CORRUGATED AND CORRUGATED SMOOTH LINED STORM SEWER AND DRAINAGE PIPE AND FITTINGS

(a) General. High Density Corrugated and Corrugated Smooth Lined Polyethylene storm sewer tube/pipe and fittings shall conform to current AASHTO Designations as follows: AASHTO M-252, Corrugated Polyethylene Drainage Tubing (3"-10") or AASHTO M-294, Corrugated Polyethylene Pipe (12"-36"). Engineering evaluations of specific installation requirements are recommended.

(b) Materials. The tube/pipe and fittings shall be made of high density, high molecular weight polyethylene tube material meeting the requirements of Type III, Category 4 or 5, Grade P33 or P34, Class C as defined in ASTM D 1248 Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
(c) Stiffness. Minimum tube/pipe stiffness at 5 percent deflection shall be 50 psi for 3"-10" diameters and as outlined in Section 7.4 of AASHTO M-294 for other diameters.

(d) Joint Integrity. Joint integrity shall be tested in accordance with ASTM Designation F 667 Section 9.8.

(e) Installation. Installed tube/pipe produced to these material specifications shall be installed according to the standard practice of ASTM Designation D 2321, Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications except where installations are under proposed or existing paving. Such installations must utilize an envelope of standard crushed rock bedding materials, Item 2.1.8, to a minimum of 6 in. above the crown of the pipe. In either case, the internal diameter of the installed barrel of the tube must not be reduced by more than 5 percent of its base inside diameter when measured not less than 30 days following completion of installation.

(f) Testing. All polyethylene tubing shall be tested for elongation, brittleness, joint separation, quality and ring stiffness as specified in the applicable ASTM Designations.

(g) Rejection. This pipe and fittings may be rejected for failure to meet any of the requirements of this specification and may be retested to establish conformity in accordance with agreement between the OWNER and seller.

### 2.12.25. POLYVINYL CHLORIDE (PVC) PRESSURE-RATED PIPE (SDR SERIES):

(a) General. PVC pressure-rated pipe shall conform to the current ASTM Designation D 2241, for 4 inch through 36 inch diameter. An engineering evaluation of specific installation requirements is recommended.

(b) Material. The pipe shall be made of PVC plastic having cell classifications of 12454-B, 12454-C or 14333-D.

(c) Installation. Pipe produced to this specification and when used in a wastewater application, 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 thirty (30) days following completion of installation.

(d) Joint Tightness. Joint tightness shall be tested in accordance with ASTM D 3139.

(e) Testing. All pipe shall meet ASTM requirements for sustained pressure test, accelerated regression test, burst pressure, flattening and impact resistance.

(f) Rejection. PVC pressure-rated pipe shall be rejected for failure to meet all the requirements of this specification.

### 2.12.26. POLYETHYLENE (PE) PRESSURE PIPE AND FITTINGS - FOR WATER DISTRIBUTION:

(a) General. Polyethylene (PE) pressure pipe and fittings shall conform to current AWWA Standard C906, Polyethylene (PE) Pressure Pipe and Fittings, 4 in. through 63 in., For Water Distribution. Engineering evaluations of specific installation requirements is recommended.

(b) Materials. The pipe and fittings shall be made of polyethylene material meeting the requirements of ASTM D3350 and ASTM D2337.

(c) Design. Operating pressure shall be less than the working pressure rating (WPR) established at actual peak flow velocity or the standard 5 feet per second design velocity, whichever is greater.

<table>
<thead>
<tr>
<th>Dimension Ratio</th>
<th>WPR</th>
<th>WPR + Surge</th>
<th>Hydrotest</th>
<th>Burst (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR 21.0</td>
<td>80  psi</td>
<td>120 psi</td>
<td>120 psi</td>
<td>320 psi</td>
</tr>
<tr>
<td>DR 17.0</td>
<td>100 psi</td>
<td>150 psi</td>
<td>150 psi</td>
<td>400 psi</td>
</tr>
<tr>
<td>DR 13.5</td>
<td>130 psi</td>
<td>200 psi</td>
<td>200 psi</td>
<td>520 psi</td>
</tr>
<tr>
<td>DR 11.0</td>
<td>160 psi</td>
<td>240 psi</td>
<td>240 psi</td>
<td>640 psi</td>
</tr>
</tbody>
</table>

(d) Joints. PE piping shall be joined by thermal butt-fusion, flange assemblies, PE mechanical joint adapters, or other mechanical methods as specified by the OWNER based upon manufacturer’s recommendations.

(e) Installation. The PE pipe and fittings shall be installed per the burial-design guidance of ASTM D 2321 for thermoplastic pipe.

(f) Testing. All pipe shall meet ASTM requirements for sustained pressure test, accelerated regression test, and burst pressure.

(g) Rejection. This PE pipe and fittings may be rejected for failure to meet any of the requirements of this specification.
ITEM 2.13. VALVES

2.13.1. GATE VALVES FOR ORDINARY WATERWORKS SERVICE

(a) General Description. All gate valves 3 in. (7.6 cm) through 48 in. (121.9 cm) shall conform to the AWWA Standard for Gate Valves — 3 In. through 48 In. NPS — for Water and Sewage Systems, AWWA Standard C500, except for changes or specified alternatives as detailed in this specification or as shown on the plans and contract specifications.

Gate valves larger than 48 in. (121.9 cm) shall be a special consideration. Tests and design data may be as designated on the plans and contract specifications.

The OWNER shall hydrostatically test all gate valves larger than 48 in. (121.9 cm) for a reasonable period after receipt of a specified test pressure.

All gate valves shall be iron body, bronze mounted, double disc, parallel seat, nonrising stem, internal wedging type. Valves must embody the best workmanship and finish. Valve design shall effect minimum torque designs effectively reducing friction and drag through thrust collar design and trackage for gates.

(b) Bonnet Bolting. Body bolts, studs and nuts shall conform to AWWA Standard C500 except that plating shall be one of the following:

<table>
<thead>
<tr>
<th>ASTM B 633 Type LS</th>
<th>Electrodeposited Coatings of Zinc on Iron and Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM A 123 Type LS</td>
<td>Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.</td>
</tr>
</tbody>
</table>

(c) Drawings. The CONTRACTOR shall have on file with the OWNER for approval a detail drawing of each type and size of valve to be furnished under these specifications and shall refer to the specific drawing number in his bid. Offering having exceptions or modifications to these specifications must be accompanied by new detailed drawings and statement of changes effected. Failure to meet these requirements shall be sufficient cause for rejection.

Drawings furnished under this requirement shall show principal dimensions, including metal thickness, construction details, materials used in all parts of the valve with ASTM designations and structural properties. Failure to furnish as shown on these drawings shall obligate the CONTRACTOR to remove or modification in stores or installed.

(d) Ends. Valves shall have flanged, push-on, or mechanical-joint ends, or any combination of these as may be specified.


Push-on joint ends shall conform to AWWA Standard C111 (ANSI A21.11).

Flanged ends 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), Class 250 lb. (112.5 kg.).

Bolts and nuts for mechanical joints shall be of a high-strength, low-alloy corrosion-resistant steel conforming to High-Strength Bolts for Structural Steel Joints, ASTM Designation A 325 (Type 3) (A 325M). All mechanical-joint glands shall be cast iron.

(e) Gates and Rings. Gates and rings shall conform to AWWA Standard for Gate Valves — 3 In. through 48 In. NPS — for Water and Sewage Systems, AWWA Standard C500 except as follows:

All gates above 4 in. (10.2 cm) shall be cast iron with bronze-gate rings, and gates 4 in. (10.2 cm) and smaller may be solid bronze. Gates 3 in. (7.6 cm) and smaller shall be solid bronze.

(f) Wedging Device. Wedging devices shall conform to the requirements of AWWA Standard C500 with the following exceptions.

1. gate valves 4 in. (10.2 cm) and smaller shall have solid bronze wedges.

2. valves above 4 in. (10.2 cm) may be solid bronze or cast-iron bronze mounted wedges. The bronze mounting shall be built as an integral unit mounted over or supported on a cast-iron base and shall be of sufficient dimension to be structurally sound and adequate for the forces which shall be imposed upon it. Thin plates or shapes doweled or screwed into cast-iron surfaces in such a manner that the screws or dowels shall carry the load shall not be accepted.
(3) Wedging surfaces on valves up to 16 in. (40.6 cm) shall be bronze to cast iron. Wedging surfaces on valves 16 in. (40.6 cm) and larger shall be bronze to bronze. Other moving surfaces integral to the wedging action shall be bronze to iron.

(g) Rollers and Tracks and Scrapers for Horizontal Valves. Rollers and tracks and scrapers for horizontal valves shall conform to AWWA Standard C500 with the following exception:

Handwheels shall not be acceptable.

(h) Valve Stems and Nuts. Stem and nuts shall be in accordance with AWWA Standard C500 except as follows:

(1) stem nuts shall be of a nongalling, high-grade red brass or bronze and shall have threads of sufficient length to develop the full strength of the stem.

(2) stems as received shall meet the minimum strengths as specified.

(3) upset stems on valves larger than 16 in. (40.6 cm) shall not be permitted under these specifications. Upset stems shall conform to the requirements of AWWA Standard C500.

(i) Stuffing Boxes. Stuffing boxes shall conform to the requirements of AWWA Standard C500, with the following exceptions:

(1) all valves 2 in. (5.1 cm) through 16 in. (40.6 cm) shall be equipped with double O-rings, provided arrangement is made for replacement under pressure of the upper O-ring when the valve is fully open. All geared valves shall be equipped with conventional packing in the main stuffing box.

(2) all horizontal valves shall have attached stuffing boxes as per the above AWWA Standards.

(3) stuffing box bolts and nuts shall be plated by one of the following ASTM Designations:

\[\text{ASTM B 633 Type LS (electrodeposited Zn)}\]
\[\text{ASTM A 123 Type LS (galvanized hot-dip)}\]

(j) Glands and Gland Bolts and Nuts. Glands, gland bolts and nuts shall conform to the requirements of AWWA Standard C500 with the following exceptions:

(1) gland flanges or followers that are a separate part may be cast iron or bronze.

(2) glands for valves over 12 in. (30.5 cm) in diameter shall be solid bronze or cast-iron bronze bushed.

(3) gland bolts and nuts shall be either bronze or Type 302 stainless steel. For either choice both bolts and nuts shall be of the same material.

(k) Hand Wheels and Operating Nuts. All valves 2 in. (5.1 cm) in diameter and above shall be nut operated unless otherwise ordered. All operating nuts shall be ductile iron or cast iron. Handwheels shall be furnished only when called for on plans or in the contract specifications. All valves shall open by turning counterclockwise.

(l) Gearing. Gearing shall be in accordance with AWWA Standard C500. Spur or bevel gearing as called for on the plans or as applicable shall be provided on all valves 18 in. (45.7 cm) in diameter and larger.

(m) Gear Cases. Gear cases shall be furnished on all geared valves.

All geared valves shall be equipped with extended type gear cases, with cast iron side plates.

Stuffing boxes shall be located on top of the bonnet and shall be outside the gear case.

Gear cases shall be lubricated and enclosed with oil seal or O-ring at all shaft openings to prevent the entrance of water which may be in the manhole. Valves equipped with ball or roller type thrust bearings inside the grease case shall have all shaft openings sealed with double O-rings.

Gear cases shall be cast iron.

(n) 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 in. (45.7 cm) 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 in. (10.2 cm) shall have the same physical qualities as for 30 in. (76.2 cm) and larger.

(o) Cast Iron. All cast iron shall conform to the requirements of Gray-Iron Castings for Valves, Flanges, and Pipe Fittings, ASTM Designation A 126, Class B.

(p) Horizontal Valves. All valves over 16 in. (40.6 cm) in diameter shall be designated for horizontal installation in a horizontal pipeline unless shown otherwise on the plans. All other valves are to be vertical.
(q) Valves for Installation in Vertical Pipeline: Valves 14 in. (35.6 cm) and larger ordered for installation in vertical pipeline shall be equipped with bronze shoes and slides. Valves 4 in. (10.2 cm) through 12 in. (30.5 cm) shall be double disc, square-bottom valves.

(r) Tapping Valves and Tapping Sleeves.
   (1) Tapping Valves. Tapping valves shall conform to the requirements of AWWA Standard C500 and the other requirements of this section with the following exceptions.
      (A) tapping valves shall have oversize seat rings to permit entry of standard tapping machine cutters.
      (B) in the open position, valve gates shall be clear of the ports so that the cutter shall pass through without making contact with the gates.
      (C) valves shall have an inlet flange conforming to AWWA Standard C110 (ANSI A21.10) Class 125, with a machined projection or recess to mate with tapping sleeve outlet flange to assure correct alignment.
      (D) valves shall have standard mechanical joint outlet and shall fit any standard tapping machine.
   (2) Tapping Sleeves. The material for tapping sleeve bodies shall be cast iron or ductile iron in accordance with AWWA Standard C110 (ANSI 21.10) or Pressure Vessel Plates, Carbon Steel, Low-and Intermediate-Tensile Strength, ASTM Designation A 285, Grade C carbon steel, in two sections or halves to be bolted together with high-strength, corrosion-resistant, low-alloy steel bolts conforming to AWWA Standard C111 (ANSI A21.11).
      Cast-iron and ductile-iron tapping sleeves shall be mechanical joint, or as specified, or dimensions to secure proper fit on the type and class of pipe on which they are to be used. Bolts, nuts and glands for mechanical-joint ends shall conform to the requirements of Item 2.13.1(d), “Ends.”
      Steel sleeves shall be restricted to use on pipe sizes 12 in. (30.5 cm) and larger and subject to the following additional specifications:
      Flange shall conform to AWWA Standard for Steel Pipe Flanges for Waterworks Service — Sizes 4 In. through 144 In. AWWA Standard C207 Class D, ANSI 150 lb. (68.0 kg) drilling. Gasket shall be affixed around the recess of the tap opening in such a manner as to preclude rolling or binding during installation.
      All steel sleeves shall be fusion bonded epoxy coated to an average of 12 mil (0.012 in.) thickness. Finished epoxy coat shall be free of laminations and blisters, shall not peel and shall remain pliable and resistant to impact.
      Steel sleeves shall be provided with a 3/4 in. (1.9 cm) NPT test opening so that test can be made prior to tapping. Opening shall be provided with a 3/4 in. (1.9 cm) bronze plug.
      Steel sleeves shall not be used for taps greater than 75 percent of the pipe diameter. Use of steel sleeves for “size-on-size” taps is prohibited.
      All steel sleeves shall be crated in wooden crates that shall provide protection from damage to epoxy coating during transport and storage.
      Branch outlet of tapping sleeves shall be flanged with a machined projection or recess to mate with tapping valve inlet flange to assure correct alignment.
   (s) Test. All valves shall be tested by the manufacturer in accordance with AWWA Standard C500. Any leaking at the test pressure through any casting or between the bronze ring and the cast iron body shall cause the said casting to be rejected. No plugging or patching to stop any leakage shall be allowed.
   (t) Inspection and Rejection. When requested, the CONTRACTOR shall furnish test coupons on each heat of ferrous or nonferrous metal going into the valves. Such specimen shall be furnished upon sworn affidavit by the manufacturer.
      When requested at any time, notarized reports of physical tests performed on materials used in the manufacture of valves furnished hereunder shall be provided.
      Such reports or coupons furnished shall be identified by purchase order or contract. The material shall also be identified as to location within the valve and specification or composition.
      Valves may be rejected for failure to comply with all of the requirements of this specification.

2.13.2. 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 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 in. (7.6 cm) and smaller shall be self-contained in one unit. Air valves larger than 3 in. (7.6 cm) 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 in. (5.1 cm) and smaller and flanged for 3 in. (7.6 cm) and larger. Outlets shall be threaded through 4 in. (10.2 cm).

(e) Operating Pressure and Testing. The valves shall be designed to operate under an operating pressure of 200 psi (1379 kPa) and shall be tested to $1\frac{1}{2}$ times that pressure.

(f) Rejection. Air valves may be rejected for failure to conform to the requirements of this specification.

2.13.3. 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 (861.8 kPa) saturated steam working pressure and 200 psi liquids and gases up to $150^\circ$F (65.6°C).

(c) Tests. Each valve furnished under these specifications shall be tested at a hydrostatic pressure of 250 psi (1,723.5 kPa) 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 hydrostatic pressure of 250 psi (1,723.5 kPa) 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.

(3) Material Specifications. The materials used in the manufacture of these valves shall equal or exceed the specifications shown in the following table:

<table>
<thead>
<tr>
<th>PART</th>
<th>SPECIFICATION/DESIGNATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packing</td>
<td>Teflon impregnated asbestos or approved equal</td>
</tr>
<tr>
<td>Body</td>
<td>ASTM Designation B 62 for Bronze</td>
</tr>
<tr>
<td>Bonnet</td>
<td>ASTM Designation B 62 for Bronze</td>
</tr>
<tr>
<td>Gates</td>
<td>ASTM Designation B 62 for Bronze</td>
</tr>
<tr>
<td>Handwheel</td>
<td>ASTM Designation B 62 for Bronze</td>
</tr>
<tr>
<td>Handwheel Nut</td>
<td>Bronze</td>
</tr>
<tr>
<td>Gland &amp; Packing Nut</td>
<td>ASTM Designation B 16 for Brass</td>
</tr>
<tr>
<td>Stem</td>
<td>ASTM Designation B 62 for Bronze, 50,000 psi (344,700 kPa) min</td>
</tr>
<tr>
<td></td>
<td>imum tensile strength</td>
</tr>
</tbody>
</table>

(f) Stem. Stem shall be completely free of visible flaw, and matching 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 $1/16$ in. per foot (0.5 cm per m). Thread shall be chamfered approximately to the major diameter of the thread at the face of the valve at an angle approximately $45^\circ$ 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 blow holes, 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.

2.13.4. BUTTERFLY VALVES

(a) General. Butterfly valves and actuators shall conform to AWWA Standard for Rubber-Seated Butterfly Valves, AWWA Standard C 504, 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 actuator torque (To) in foot-pounds for each butterfly valve based on the specified operating conditions of pressure and flows.
5. seating-unseating torque (To) in foot-pounds required for each butterfly valve.
6. rated torque capability of each butterfly valve actuator.

The following data shall be furnished if not previously available to the OWNER:

1. experience: evidence of at least five years satisfactory experience building butterfly valves to AWWA Standards.
2. torque tests in accordance with rubber seated butterfly valves, AWWA Standard C504.
3. proof of design tests in accordance with AWWA Standard C504.

(c) 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 A 21.10), Class 250 lb. (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).

(d) Actuators.

1. Manual Actuators:

(A) all actuators shall be located as follows, unless otherwise noted, looking in the direction of flow:
(1) at the right end of a horizontal shaft.
(2) 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 actuators shall be totally enclosed worm gear type and traveling-nut 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 actuators shall be Limitorque, Type HBC or approved equal.
(F) each valve actuator shall be sized for the maximum valve torque requirements based on the operating
pressures and flow rates as specified.

(2) Electric Motor Actuator. Each electric actuator 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 trinagear 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
actuator 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 will 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 shall
permit a variation of approximately 40 percent in torque setting. Switches shall have a rating of not less than 6 am-
peres at 120 volts a.c. and 2.2. amperes at 115 d.c. The torque switches shall be in series with the opening and clos-
ing coils of the starter.

The torque switches shall be factory adjusted by the manufacturer for this application.

A handwheel for manual operation shall be provided. Motor shall not rotate when handwheel 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 actuator housing. Furnish a push-button station NEMA-4 with red and
green indicating lights separate from the valve actuator. Space heaters shall be provided to protect the motor, re-
versing starter and limit switch compartments from moisture condensation. Valve control wiring diagrams shall be
furnished with submittal data.

Valve actuators 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 Actuators. Other types of actuators shall conform to AWWA Standard C504.
(e) Shipment and Storage Requirements. Electric motor actuated valves shall be shipped to bonded covered ware-
house 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.
(f) Tests. All butterfly valves shall be tested by the manufacturer in accordance with AWWA Standard C504. Test
results shall be furnished to the OWNER.
(g) Rejection. Any butterfly valve may be rejected for failure to meet all of the requirements of this specification.

ITEM 2.14. FIRE HYDRANTS

2.14.1. GENERAL

Fire hydrants which are to be installed as shown on the plans or to be furnished for general installation shall be dry-
barrel traffic model that conform to AWWA Standard for Dry-Barrel Fire Hydrants, AWWA Standard C502, except
for changes and/or additions specified as follows or as shown on the plans or in the contract specifications.
2.14.2. SUPPLEMENTARY DETAILS SPECIFIED
(a) Type of Shut-Off. The type of shut-off may be either of the following:
   (1) compression type with the flow.
   (2) compression type against the flow.

   The valve action shall provide positive shut-off at minimum closing torque. Wedge action closing gates shall not be permitted, and the scissors type main valves shall not be permitted unless approved by the OWNER.
(b) Inlet Connection. Inlet connection shall be mechanical joint unless otherwise specified and shall be for a 6 in. cast iron pipe with minimum net valve opening of 5 1/4 in. unless otherwise specified.
(c) Delivery Classification. Number and size of pumper and hose nozzles shall be as shown on the plans and contract specifications.
(d) Bury Length. Ground to bottom of connecting pipe shall be five feet or as specified by the OWNER.
(e) Diameter Outlet Connections. Hose and pumper nozzle threads shall be of the size and type shown on the plans.
(f) Harnessing Lugs. Harnessing lugs shall be furnished with the hydrants.
(g) Nozzle Cap Gasket. Gaskets shall be furnished on all nozzle caps and shall be long life, black rubber meeting Rubber Products in Automotive Applications, ASTM Designation D 2000 or equal.
(h) Drain Valve and Outlet. Hydrants shall be equipped with two drainholes and provided with an automatic and positively operating noncorrodible drain or dip valve so as to drain the hydrant completely when the main valve is shut.
(i) Direction to Open. Direction is to be specified in the contract specifications.
(j) Finish Paint Above Ground Line. After shop priming, the outside of the hydrant above the finished ground line shall be thoroughly cleaned and thereaf ter painted in the shop with two coats of primer.
(k) Shape and Size of Operating and Cap Nuts. Unless otherwise specified in the special provisions or in the plans, the operating and nozzle cap nuts shall be tapered pentagon nuts with faces not less than 1 in. (2.5 cm) high.

2.14.3. TURNS TO OPEN
The number of turns to open shall be in accordance with AWWA Standard C502, Section 2.9.3.

2.14.4. BREAKABLE TYPE HYDRANTS
(a) Breakable or Sleeve Type Couplings. The body of the hydrant between the elbow and the top cap must be made in two parts connected by a swivel flange or breakable flange which shall permit facing of the nozzles in any desired direction in increments of 45° or less. The complete hydrant shall be of such design that when the hydrant barrel is broken through traffic collision or otherwise, it may be replaced without disturbing the bottom of the hydrant.

   (1) the valve body flange gaskets shall be fabricated from "Accopac" CS-301 manufactured by the Armstrong Cork Company or an equal material which shall have OWNER approval prior to substitution unless otherwise specified in the plans.

   (2) provision shall be made in the design of the stem to disconnect the stem from the hydrant parts above the standpipe break point in the event of traffic accidents. If breakable or sleeve type couplings are used, they shall have sufficient torsional strength such that a torsional failure of the stem shall occur at some point other than at the coupling. Design of the coupling shall be such that when the coupling is broken, no parts shall come loose and fall into the hydrant barrel, and the break shall not occur through the pins or bolts holding the coupling to the stem.

2.14.5. MAIN VALVE SEATS
Main valve seats shall be of such design that incorrect positioning is impossible.

2.14.6. GASKETS — GROUND LINE
The valve body flange gaskets shall be fabricated from "Accopac" CS-301 manufactured by Armstrong Cork Company or an equal material which shall have OWNER approval prior to substitution. They shall be full face or ring type with the lower flange recessed to hold the gasket in place.
2.14.7. NOZZLE CAP CHAINS
When required by the OWNER, the nozzle cap chains shall be in accordance with AWWA Standard C502, Section 3.2.8.2.

2.14.8. FLANGES
All flanges other than break flanges shall be equipped with mechanical joints. Gland bolts shall be high-strength, low-alloy, corrosion-resistant steel conforming to ASTM Designation A 325, Type 3.

2.14.9. OPERATING STEMS
The spindle of the operating stem and the stem nuts for hydrants having the operating threads located in the barrel or waterway shall be manganese bronze, Everdur or other high-quality noncorrosible metal.

All working parts in the waterway, except for sliding stem support mechanisms, shall be bronze to bronze or bronze to iron unless otherwise specified in the special provisions or in the plans.

2.14.10. O-RING
Hydrant stem packing boxes, where needed, shall be provided with O-ring grooves and sealed with O-rings. O-rings shall be furnished in lieu of stem packing. They shall be of the double O-ring type designed so that the rubber rings shall move against a bronze, stainless steel or other noncorrosible metal surface. O-ring shall be in accordance with Rubber Products in Automotive Applications, ASTM Designation D 2000.

2.14.11. EXTENSIONS
Fire hydrants shall be designed to accept a 6 in, 12 in. or 18 in. extension.

2.14.12. HYDRANT HEADS
The hydrant shall be constructed so that the nozzles may be faced in any desired direction.

2.14.13. DRAWINGS
Proposals shall be accompanied by catalogue cuts, photographs or drawings in duplicate showing complete detailed dimensions of the hydrants when requested by the OWNER.

2.14.14. EXPERIENCE RECORDS
Fire hydrants shall not be acceptable to the OWNER unless they are produced by a manufacturer which has been regularly producing fire hydrants which have been in satisfactory operation in municipal water systems comparable with existing hydrants in use or one who can demonstrate a design and operation in full compliance with this specification which is acceptable to the OWNER.

2.14.15. UPPERSTEM THREAD LUBRICATION
Upperstem thread lubrication may be accomplished with oil or grease. When oil is used, it shall be in conjunction with a functional oil reservoir and an oil filler port. They hydrant shall be factory filled with Lubriplate No. 3-V (SAE 20) or equal. Means for field check of oil lubrication level shall be provided.

When grease is used, the hydrant shall be factory lubricated with Lubriplate No. 630-AA (medium soft) or equal. Means for field lubrication without disassembly shall be provided.

2.14.16. AFFIDAVIT OF COMPLIANCE
Technical manufacturing drawings or test certification records relating to fire hydrants for contract installation must be supplied by the CONTRACTOR to OWNER not later than two weeks after beginning construction when identical hydrants have previously been approved by the OWNER, or prior to installation when identical hydrants have not previously been approved by the OWNER.

Technical manufacturing drawings or test certification records must be supplied for all hydrants purchased by the OWNER. Technical drawings or certification records shall have the OWNER’S approval before final payment shall be made.
2.14.17. TESTS
Manufacturers shall be required to furnish the OWNER two certified copies of physical tests of all metals used in the manufacture of the fire hydrants and hydrostatic tests made on each hydrant.

Tests on manganese bronze operating stem, ASTM Designation B 584, shall be performed on a coupon cut from the finished stem stock (not as outlined in ASTM Designation B 208) and shall in all cases meet the requirements for “Operating Stem and Mechanism” set forth in AWWA Standard C502, except as specified above.

When required, a certificate of composition shall be furnished by the manufacturer. Sample stems may also be required for testing in an independent laboratory.

2.14.18. SAMPLE HYDRANT
The OWNER may purchase one sample hydrant for verification of compliance with these and manufacturer’s specifications. The OWNER may test this sample; and, if it fails to meet any of the specifications, the hydrant shall be returned to CONTRACTOR at CONTRACTOR’S expense. CONTRACTOR shall refund to the OWNER the full purchase price of the hydrant.

2.14.19. REJECTION
Fire hydrants or materials specified in this section may be rejected for failure to meet any of the provisions of this specification or for any defects causing them to be unsuitable for their intended use.

ITEM 2.15. MATERIALS FOR SEEDING AND SODDING

2.15.1. TURFGRASS
(a) General. All material for Turfgrass provided shall be in accordance with these specifications and as noted in the plans and contract documents.
(b) Bermuda grass Seed. Turfgrass 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 following 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.

(1) Certificate Submittal. Prior to planting, provide the OWNER with the State of Texas Certificate stating analysis of purity and germination of seed.
(c) Ryegrass Seed. Turfgrass 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.

(1) Certificate Submittal. Prior to planting, provide the OWNER with the State Certificate stating analysis of purity and germination seed.
(d) Sprigs. Turfgrass sprigs and stolons shall be “Cynodon Dactylon” (Common 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.
(e) Sod. Turfgrass 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 in. (2 cm). 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 so that the height of the grass shall not exceed two in. (5 cm). 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.

(1) Dimensions. All sod shall have been machine cut to uniform soil thickness of 1 in. (2.54 cm) ± 1/4 in. (6 mm). 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.

2.15.2. FERTILIZER
(a) 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 or has become caked or otherwise damaged, making it unsuitable for use, shall be rejected.
(b) Initial Planting Application. Fertilizer for the initial planting application shall be of an organic base containing by weight the following (or other approved) percentages of nutrients: 15-10-5 (N-P-K) and 10-15 percent sulphate and traces of iron and zinc as required and approved by the OWNER.

(1) Specification Submittal. Submit a sample label or specification of the fertilizer proposed to be used for the OWNER’S approval.

(c) 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.

(1) Specification Submittal. Submit a sample label or specification of the fertilizer proposed to be used for the OWNER’S approval.

2.15.3. HYDRO MULCH MATERIALS
(a) General. All mulch shall be manufactured from hardwoods only and shall be refined specifically for lawn hydro-mulch applications. Use “Conwed” or an approved equal.

(b) Adhesive Agents. Adhesive agent for mulch shall be asphalt conforming to Texas Department of Highways and Public Transportation 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.

2.15.4. SOIL AMENDMENTS
(a) General. Where indicated on the plans and defined in the specifications, soil amendments shall be added as defined or as noted in these specifications.

(b) Sand. All sand is to be thoroughly washed, coarse grade construction or brick sand, free of clay balls, weeds or grass. So-called cushion sand, blow sand or creek silt are not acceptable.

(1) Sample Submittal. Submit a quart sample of the sand proposed to be used for the OWNER’S approval.

(c) Compost. All compost material is to be thoroughly composted, decomposed organics at least nine months of age. All compost is to be clean and free of fungus, disease, live plants, seed, excessive cotton lint and any harmful chemical elements. “New Life Soil Conditioner” or “Perma Green Compost” as specified below, or approved equal, shall be used. Raw organics are not acceptable.

(1) Soil Conditioners.

(A) for soil with an alkaline pH condition: use “New Life Acid Gro” (acid pH) soil conditioner as produced by Soil Building Systems of Dallas, or an approved equal.

(B) for soil with an acidic pH condition: use “Perma Green Compost” by Texas Earth Resources, Inc., of Dallas, or “New Life Natural Grower” (pH 8.0 to 9.0) by Soil Building Systems, Inc., of Dallas.

(2) Sample and Specification Submittal. Submit a producer’s specification and a quart sample of the compost proposed to be used for the OWNER’S approval.

(d) Elemental Sulfur. Sulfur shall be a commercially floured product of pure sulfur.

(e) Gypsum. Gypsum (calcium sulphate) shall be ground to the size specified on the plans.

(f) Lime. Lime shall be of finely ground or pulverized raw, commercial grade dolomitic limestone, all of which shall pass through a 10-(210 mm) mesh sieve-screen, and at least half of which shall pass through a 100-(150 mm) mesh sieve-screen.
mesh sieve-screen. Solomitic lime shall contain roughly equal portions of magnesium and calcium carbonates, which together total 90 percent or more of the value of neutralizing power or the calcium oxide equivalent.

(1) Specification Submittal. Submit a producer’s specification or a sample label of the lime proposed to be used for the OWNER’S approval.

2.15.5. REJECTION
Landscape materials may be rejected for failure to meet any of the requirements of this specification or as shown on the plans or in the contract specifications.

ITEM 2.16. BRASS STOPS, COCKS AND FITTINGS FOR WATERWORKS SERVICE

2.16.1. 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, except cast solder-joint fittings shall conform to alloy 83-4-6-7, ASTM Designation B 584. All stops, cocks and fittings shall be full size throughout the size specified.

Any pipe, fitting, solder 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 solders and flux containing not more than 0.2 percent lead; and pipes and pipe fittings containing not more than 8.0 percent lead.

2.16.2. PHYSICALS
Brass used shall have a tensile strength (as determined from test bars) of not less than 30,000 psi (206,820 kPa) when tested as prescribed by ASTM Designation B 208 (Fig. 5).

Fittings shall be designed for 200 psi (1,378.8 kPa) working pressure and, when subjected to hydrostatic test pressures 1/2 times working pressure or when subjected to a minimum of 85 psi (586.0 kPa) 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.

2.16.3. DESIGN FEATURES OF STOPS AND COCKS
Seating surfaces of the ground key type shall be tapered and shall be accurately fitted together by turning the key and reaming the body. Seating surfaces shall be lapped together using suitable abrasives to insure accurate fit. The large end of the tapered surface of the key shall be reduced in diameter for a distance that shall bring the largest end of the seating surface of the key into the largest diameter of the seating surface of the body, and the taper seat in the body shall be relieved on the small end, so that the small end of the key may extend through to prevent wearing of a shoulder and to facilitate proper seating of the key. The stem end of the key, key nut and washer shall be so designed that if the key nut is tightened to failure point, the stem of the key shall not fracture. The nut and the stem shall withstand a torque on the nut of at least three times the necessary effort to properly seat the key without failure in any manner.

The ball stop shall have a full-size round-way opening with straight-through flow, teflon coated bronze ball with a minimum of .5 mil thickness coating. The stop must be so constructed that it may be disassembled and the ball removed without special tools.

Plug type stop shall have full size round way opening with straight-through flow. Seating surfaces shall be brass (or teflon coated brass) to rubber O-rings, providing positive pressure seal without mechanical means. The stop must be so constructed that the plug may be removed without special tools. Material for rubber O-rings should conform to requirements of ASTM Designation D 450 (test method shall be Rubber O-Rings, ASTM Designation D 1414).

Inlet and outlet threads, of the types specified, shall conform to the applicable tables of AWWA Standard C300, and inlet threads shall be protected in shipment by a plastic coating or other equally satisfactory means. If used, coupling nuts shall have a bearing skirt machined to fit the outside diameter of the pipe for a length at least equal to the outside of the pipe.

Corporation stops shall be so designed as to rotate about the axis of the flow passageway within a circle of rotation small enough to properly clear the inside of any standard tapping machine of appropriate size.
The outlet side of \( \frac{3}{4} \) in. (1.9 cm) brass curb stops shall be female iron pipe with flared copper pipe, compression or female iron pipe thread on the inlet, as specified. The outlet side of \( 1\frac{1}{2} \) in. (3.8 cm) and 2 in. (5.1 cm) brass curb stops shall be female iron pipe with compression, streamline or female iron pipe thread on the inlet, as specified.

The outlet side of \( \frac{3}{4} \) in. (1.9 cm) and 1 in. (2.5 cm) corporation stops shall be flared copper pipe or compression with male AWWA "tapered" thread or male iron pipe thread on inlet side, as specified. The outlet side of \( 1\frac{1}{2} \) in. (3.8 cm) and 2 in. (5.1 cm) corporation stops shall be compression or streamline with male AWWA "tapered" thread or male iron pipe thread on inlet side, as specified.

### 2.16.4 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.
- Solder-joint fittings shall be smooth cast. Inside surfaces of solder-joint ends shall be machined smooth to proper inside diameter.
- 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:

- (a) for plastic or copper pipe and tubing, an approved restraining device.
- (b) for iron pipe, a stainless steel set screw to bite in and lock on the pipe.

### 2.16.5. TESTS

All brass fittings included in this section shall be tested in accordance with the applicable provisions of the specifications relating thereto.

### 2.16.6 REJECTION

Brass stops, cocks, and fittings may be rejected for failure to meet any of the requirements of this specification.

### ITEM 2.17. BRONZE SERVICE CLAMPS

#### 2.17.1. GENERAL

Service clamps shall be designed for tapping water pipe under normal service pressure. The clamp shall consist of a contoured saddle fastened to the pipe by one U-bolt for the single strap clamp and by two U-bolts for double strapped clamps or shall consist of two sections or halves which shall be fastened together with minimum of two bolts and nuts. The saddle shall be sealed against the pipe with a rubber gasket and shall have a heavy hub tapped with a corporation stop thread. The clamp shall be designed for 150 psi (1034 kPa) water working pressure.

#### 2.17.2. SADDLES

The saddles shall be shaped so as to provide approximately 180° coverage around the pipe.

- (a) Saddle Hubs. The saddle hub for single and double strap clamps shall have a wall thickness of not less than \( \frac{1}{2} \) in. (1.3 cm) including threads. The hub shall be tapped with a corporation stop thread of the size specified.

  The thread shall have a taper and pitch in accordance with AWWA Standard for Threads for Underground Service Line Fittings, AWWA Standard C800, latest edition. The hub shall be reinforced so that threads shall not be distorted by bending movements.

  Open slots for bolts shall not be allowed.

- (b) Clamps. Double strapped clamps 4 in. (10.2 cm) through 12 in. (30.5 cm) shall have not less than the following specified thickness from the point of the built-up hub segment to the segment immediately adjoining the holes for the saddle straps.
### MATERIALS

<table>
<thead>
<tr>
<th>CLAMP SIZE</th>
<th>MINIMUM THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>In. (cm)</td>
<td>In. (cm)</td>
</tr>
<tr>
<td>4 (10.2)</td>
<td>.190 (0.5)</td>
</tr>
<tr>
<td>6 (15.2)</td>
<td>.195 (0.5)</td>
</tr>
<tr>
<td>8 (20.3)</td>
<td>.195 (0.5)</td>
</tr>
<tr>
<td>10 (25.4)</td>
<td>.195 (0.5)</td>
</tr>
<tr>
<td>12 (30.5)</td>
<td>.215 (0.5)</td>
</tr>
</tbody>
</table>

(c) Markings. Saddles shall be distinctly marked with cast letters showing manufacturer’s name, type pipe saddle as designed for (cast iron, ductile, etc.) and minimum/maximum o.d. ranges.

#### 2.17.3. STRAPS

Straps shall be formed flat on one side to fit uniformly against the wall of the pipe. Rod diameter shall be not less than \(\frac{5}{8}\) in. (1.6 cm) flattened to \(\frac{1}{4}\) in. (1.9 cm) on one side.

Straps shall be threaded \(\frac{5}{8}\) in. (1.6 cm) 11-NC-2A for a distance such that \(\frac{1}{2}\) in. (1.3 cm) remains after clamp is fully tightened on pipe. Nuts are to be semi-finished heavy hexagon tapped \(\frac{5}{8}\) in. (1.6 cm) 11 NC-2B.

#### 2.17.4. GASKET

Gasket shall be of O-ring type, \(\frac{3}{16}\) in. (0.5 cm) thick and securely fastened to the saddle to facilitate installation.

#### 2.17.5. MATERIAL


(b) Straps. Straps shall be of materials conforming to latest editions of ASTM Designation B 124 and ASTM Designation B 98.

(c) Nuts. Nuts shall be of the same material as saddles or straps.

(c) Gaskets. Gaskets shall be of neoprene rubber. Shore hardness shall be 65 ± 5.

#### 2.17.6. HYDROSTATIC TEST

All products not previously approved for use shall be subject to hydrostatic test. Service clamps shall not leak or show any structural deformation under a hydrostatic test pressure of 300 psi (2068 kPa) for 30 consecutive days.

#### 2.17.7. REJECTION

All service clamps furnished under these specifications shall be subject to inspection by the OWNER. If any products are found not to conform with the specifications, the lot or any portion thereof may be rejected.

### ITEM 2.18. SEAMLESS COPPER TUBING

#### 2.18.1. GENERAL

These specifications pertain only to Type K, Class 1, annealed (soft) copper water tubing for use with solder, flared, or compression-type fittings. The copper tubing shall conform to Seamless Copper Water Tube, ASTM Designation B 88.

#### 2.18.2. QUALITY

The vendor shall be responsible for submission of a laboratory analysis of the products supplied. The manufacturer’s 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.
2.18.3. REJECTION
Seamless copper tubing may be rejected for failure to meet any of the requirements of this specification.

ITEM 2.19. PRECAST REINFORCED MANHOLE SECTIONS

2.19.1. GENERAL
These specifications cover precast reinforced concrete manhole sections conforming to precast reinforced concrete manhole sections, ASTM Designation C 478 (C 478M), with the following additions:

(a) 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 mechanical devices which shall assure a dense concrete in the finished product, except that reducer cones may be wet-cast.

(b) aggregates for the concrete shall comply with requirements of the current Concrete Aggregates, ASTM Designation C 33, with the additional requirement that the aggregate shall have a minimum of 50 percent of calcium carbonate equivalent.

(c) minimum wall thickness for the manhole risers shall be as listed under Wall “B” in the “Class Tables” of ASTM Designation C 76 (C 76M).

(d) unless otherwise noted, manhole steps shall not be furnished. If required, the steps shall be of the plastic or rubber coated steel type, with a clear cleat space of 10 in. (25.4 cm) minimum that shall support a concentrated load of 300 pounds (136.2 kg).

(e) Resilient connectors between reinforced concrete manhole structures and pipes shall meet the requirements of ASTM Designation C 923 or ASTM C 443. The resilient connector shall provide an airtight seal which eliminates infiltration and exfiltration.

2.19.2. JOINTS
Joints shall conform to the joint specification ASTM Designation C 478 (C 478M).

2.19.3. COATINGS AND LININGS
Coatings and linings called for in the specifications or shown on the plans shall meet the requirements as specified by the OWNER and shall be installed or applied by the manufacturer.

2.19.4. LIFTING DEVICES
Manhole sections and cones may be furnished with lift lugs or lift holes. If lift lugs are provided, they shall be 180° apart. Cast-in-place nuts must have clean threads capable of inserting lug bolts. The lift lug design must be approved by the OWNER. If lift holes are provided, they shall be plugged with a nonmetallic nonshrink grout approved by the OWNER. Field repairs shall not be allowed.

2.19.5. REJECTION
Manhole sections shall be subject to rejection on account of failure to conform to any of the requirements specified herein or having defects as follows:

(a) variations in any dimensions exceeding the permissible variation prescribed.

(b) a piece broken out of the bell, spigot, tongue or groove in such size that the watertightness of the joint should be impaired.

(c) any shattering or flaking of concrete or other conditions indicating an improper concrete mix.

(d) lack of uniformity in placement steel which might preclude all joints being typical of those tested.

(e) cracks sufficient to impair the strength, durability, or serviceability of the pipe.

(f) joint sections with spalls, cracks, fractures, or other imperfections that could adversely affect the performance of the joint.
ITEM 2.20. FIBERGLASS MANHOLES

2.20.1. 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.

2.20.2 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.

2.20.3. MANHOLE CONFIGURATION
The manhole shall be a circular cylinder with a minimum internal diameter of 4 ft. 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.

2.20.4. WATERTIGHT CONSTRUCTION
The manhole shall be of watertight construction to prevent infiltration and exfiltration. Fiberglass manholes shall be tested in accordance with Item 6.7.2.(c), "Tests and Television Inspections."

2.20.5. INSTALLATION
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 8 holes 7/6 in. in diameter shall be drilled around the periphery of the manholes, 4 in. from the bottom for use in inserting #4 reinforcing bars to be keys into the concrete base to prevent the manhole from floating.

2.20.6. 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.

2.20.7. REJECTION
Fiberglass manholes shall be subject to rejection as follows:
(a) any manhole shall be rejected for failure to conform with any of the requirements of these specifications.
(b) 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.

ITEM 2.21. PREFORMED FLEXIBLE JOINT SEALANT

2.21.1. GENERAL
This specification covers a cold-applied preformed flexible butyl rubber or plastic sealing compound for sealing interior and/or exterior space on concrete sewer pipe and manhole sections, where infiltration or exfiltration is a factor in the design.

2.21.2. APPLICABLE STANDARDS
Except as modified or supplemented herein, all preformed flexible joint sealants shall conform to the applicable requirements of the following standard specifications, latest edition:
2.21.3. BASIS OF ACCEPTANCE
The acceptability of the preformed flexible joint sealant shall be determined by the results of physical tests, by inspection and by approval of its experience record.

2.21.4. MATERIAL
The joint sealer shall be supplied in either extruded rope form of suitable cross-sectional area or flat tape form and shall be sized as recommended by the manufacturer and approved by the Engineer.

The joint sealer shall be protected by a suitable removable wrapper.

The joint sealer shall not in any way depend on oxidation, evaporation, or any other chemical action for either its adhesive properties or cohesive strength.

The joint sealer shall remain totally flexible without shrinking, hardening, or oxidizing regardless of the length of time it is exposed to the elements.

The manufacturer shall furnish an affidavit attesting to the successful use of the product as a preformed flexible joint sealant on concrete pipe and manhole sections for a period of at least 5 years.

2.21.5. INSTALLATION OF JOINT SEALANT
All surfaces to be in contact with the joint sealer shall be thoroughly cleaned of dirt, sand, mud or other foreign matter. A primer shall be applied to all surfaces prior to installing the joint sealer in accordance with recommendations by the manufacturer. The protective paper wrapper shall remain on the joint sealer until immediately prior to placement of the pipe in the trench. After removal of the protective paper wrapper, the joint sealant shall be kept clean.

Backfilling of pipe laid with this joint sealer may proceed after the joint has been inspected by the OWNER.

2.21.6. COMPLIANCE WITH SPECIFICATIONS
If requested by the OWNER, the CONTRACTOR shall provide results of above specified tests to insure product compliance with these specifications or shall supply an affidavit of compliance from the manufacturer insuring compliance with these specifications.

2.21.7. REJECTION
The preformed flexible joint sealant may be rejected for failure to meet any of the requirements of this specification.

ITEM 2.22. TUNNEL WOOD LAGGING

2.22.1. GENERAL
This specification covers the materials and requirements for steel ribs and wood lagging for use in tunneling under railroads, highways and streets.

2.22.2. MATERIAL
(a) Wood Lagging. Wood lagging shall have a minimum thickness of 2.75 in. (7.0 cm) and a minimum average ultimate stress capacity of 5,000 psi (34,470 kPa).

The ultimate stress capacity to be determined by Static Tests of Timbers in Structural Sizes, ASTM Designation D 198, flexure test on five randomly selected timbers from each shipment of lagging. The maximum load carried by each timber disregarding the highest and lowest one of the five timbers tested shall be averaged to determine the ultimate stress capacity of that shipment.
MATERIALS

(b) Steel Ribs. The ribs shall conform to Federal Specification QQ-S-741D-Steel Carbon; Structural Shapes; Plates; and Bars.

The ribs shall be of the size shown on the plans, special provisions or approved from a design load submittal. The ribs shall be bent by cold pressing in dies.

(c) Bolts and Nuts. The nuts shall conform to ASTM Designation A 307. The bolts shall conform to ASTM Designation A 449 for rib thickness equal to or greater than 0.209 in. (0.5 cm) and to ASTM Designation A 307 for rib thickness less than 0.209 in. (0.5 cm).

2.22.3. TESTS

Tests for compliance with this specification shall be as specified herein. A certification of compliance with this specification along with a report of each test shall be furnished to the OWNER.

2.22.4. REJECTION

The materials may be rejected for failure to meet any of the requirements of this specification.

ITEM 2.23. GEOTEXTILE

2.23.1. GENERAL

Geotextiles are woven or non-woven synthetic fabrics which are designed to be used for subsurface drainage, erosion control and soil stabilization applications, and non-woven synthetic fabrics designed for use in paving applications.

2.23.2. MATERIAL REQUIREMENTS

The geotextile fabric shall be inert to commonly encountered chemicals and hydrocarbons. The fabric shall be packaged, stored and handled in a manner to prevent damage or deterioration which may be caused by moisture, excess sunlight, rodents or other vermin.

2.23.3. GEOTEXTILES USED IN DRAINAGE, EROSION CONTROL AND STABILIZATION APPLICATIONS

The fabric shall conform to the following average roll minimum values (lot mean-2 standard deviations), as determined by Federal Highway Administration Task Force 25 guidelines cited below, measured in the weakest direction:

<table>
<thead>
<tr>
<th>Designation</th>
<th>Topic</th>
<th>Drainage *</th>
<th>Erosion *</th>
<th>Stabilization LOADING</th>
<th>PR</th>
<th>UPR</th>
<th>PR</th>
<th>UPR</th>
<th>Low</th>
<th>Med.</th>
<th>Hi</th>
<th>VHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D 4632</td>
<td>Grab Strength (lbs.)</td>
<td>80</td>
<td>180</td>
<td>90</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
<td>90</td>
<td>130</td>
<td>180</td>
<td>27</td>
</tr>
<tr>
<td>ASTM D 4632</td>
<td>Grab Elongation</td>
<td>NA</td>
<td>NA</td>
<td>15%</td>
<td>15%</td>
<td></td>
<td></td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>ASTM D 4533</td>
<td>Trapezoidal Tear (lbs.)</td>
<td>25</td>
<td>50</td>
<td>30</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>ASTM D 751</td>
<td>Burst (psi)</td>
<td>130</td>
<td>290</td>
<td>140</td>
<td>320</td>
<td></td>
<td></td>
<td></td>
<td>145</td>
<td>210</td>
<td>290</td>
<td>430</td>
</tr>
<tr>
<td>ASTM D 751</td>
<td>Puncture (psi)</td>
<td>25</td>
<td>80</td>
<td>40</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>40</td>
<td>75</td>
<td>110</td>
</tr>
</tbody>
</table>

ASTM D 4751 | Equivalent Opening Size (EOS) (mm) - soil retention.

For Soils in Which:

- 50% or less passes a #200 mesh sieve: Greater than a #30 sieve
- More than 50% passes a #200 mesh sieve: Greater than a #50 sieve

ASTM D 4491 | Permeability (k):

<table>
<thead>
<tr>
<th>Type of Application</th>
<th>Required Permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical/Severe:</td>
<td>k (fabric) &gt; 10 k (soil)</td>
</tr>
<tr>
<td>Normal Applications:</td>
<td>k (fabric) &gt; k (soil)</td>
</tr>
</tbody>
</table>

* PR: Protected Application (used in conjunction with a buffer)

UPR: Unprotected Application (used with no protective buffer)
2.23.4. GEOTEXTILES USED IN SILT FENCING

The fabric should conform to the following properties, as determined by the Federal Highway Administration Task Force 25 Guidelines, as measured in the weakest direction:

<table>
<thead>
<tr>
<th>Test Designation</th>
<th>Topic</th>
<th>Average Roll Minimum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D 4632</td>
<td>Grab Strength</td>
<td>90 lbs. @ 12 in./minute</td>
</tr>
<tr>
<td>ASTM D 4632</td>
<td>Grab Elongation</td>
<td>15% @ 12 in./minute</td>
</tr>
<tr>
<td>ASTM D 4751</td>
<td>Equivalent Opening Size (EOS)</td>
<td>U.S. sieve No. 20</td>
</tr>
<tr>
<td>ASTM D 4491</td>
<td>Permittivity</td>
<td>&gt; .01 sec. -1</td>
</tr>
<tr>
<td>ASTM D 4355</td>
<td>U.V. Resistance (500 hrs. exposure)</td>
<td>70%</td>
</tr>
</tbody>
</table>

2.23.5. GEOTEXTILES USED IN PAVING APPLICATIONS

The fabric should conform to the following properties, as determined by the Federal Highway Administration Task Force 25 Guidelines using ASTM Test Methods, except where noted:

<table>
<thead>
<tr>
<th>Test Designation</th>
<th>Topic</th>
<th>Average Roll Minimum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D 4632</td>
<td>Grab Strength</td>
<td>80 lbs. @ 12 in./minute</td>
</tr>
<tr>
<td>ASTM D 4632</td>
<td>Elongation @ Break</td>
<td>50% @ 12 in./minute</td>
</tr>
<tr>
<td>Texas SDHPT 3002</td>
<td>Asphalt Retention</td>
<td>0.5 oz./sq. ft.</td>
</tr>
<tr>
<td>ASTM D 276</td>
<td>Melting Point</td>
<td>300°F</td>
</tr>
</tbody>
</table>

2.23.6. CERTIFICATION

The manufacturer, if required by the OWNER, shall provide documents setting for the name and manufacturer, the chemical composition of the filaments or yarns and test values of the properties of the geotextile. The manufacturer must certify that the material meets or exceeds these specifications.

2.23.7. CONSTRUCTION METHODS

Construction methods for each type unit shall be provided by the manufacturer and approved by the OWNER based on the site specific use.

2.23.8. REJECTION

Geotextile may be rejected for failure to meet any of the requirements of this specification.

ITEM 2.24. GABION STRUCTURES

2.24.1. GENERAL

Gabions consist of rectangular, compartmented wire baskets filled with stone used for slope or bank protection and erosion control on open channels. Construction methods shall be in accordance with Item 8.16. "Gabion Structure Assembly."

2.24.2 GABIONS

Gabion baskets shall consist of uniform hexagonal wire mesh, woven in double twist pattern with openings fabricated in such a manner as to be nonraveling, or uniform rectangular welded mesh 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.
Welded wire mesh shall be composed of a series of longitudinal and transverse steel wires arranged substantially at right angles to each other and welded together at the points of intersection by the process of resistance welding to form fabricated sheets with a mesh opening of 3 in. x 3 in. (7.5 cm x 7.5 cm).

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 (30.5cm). 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 for twisted wire mesh gabions are subject to tolerance limit of five percent.

All dimensions for welded wire mesh gabions are subject to tolerance limit of one percent.

Wire shall conform to the following requirements in accordance with current Federal Specification QQW-461 Class 3 — Finish 5 — Soft.

<table>
<thead>
<tr>
<th>Wire for Fabric (dia.) – PVC coated</th>
<th>0.106 in. (2.70 mm) +/- 0.003 in (0.076 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire for Fabric (dia.) – galvanized</td>
<td>0.120 in. (3.00 mm) +/- 0.003 in (0.076 mm)</td>
</tr>
<tr>
<td>[US Guage 12]</td>
<td></td>
</tr>
<tr>
<td>Wire for Selvedges and Corners (dia.) – galvanized or PVC coated</td>
<td>0.148 in. (3.76 mm) +/- 0.003 in (0.076 mm)</td>
</tr>
<tr>
<td>[US Guage 9]</td>
<td></td>
</tr>
<tr>
<td>Wire for Binding and Connecting (dia.) – galvanized or PVC coated</td>
<td>0.087 in. (2.20 mm) +/- 0.003 in (0.076 mm)</td>
</tr>
<tr>
<td>[US Guage 13.5]</td>
<td></td>
</tr>
<tr>
<td>Wire for Spiral Binders (dia.) – galvanized or PVC coated</td>
<td>0.106 in. (2.70 mm) +/- 0.003 in (0.076 mm)</td>
</tr>
<tr>
<td>[US Guage 12]</td>
<td></td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>60,000 - 75,000 psi (414,000 – 517,000 kPa)</td>
</tr>
<tr>
<td>Elongation of twisted wire mesh</td>
<td>&gt; 12%</td>
</tr>
<tr>
<td>Weight of zinc coating for all wire</td>
<td>0.80 oz/ft² (0.244 kg/m²)</td>
</tr>
</tbody>
</table>

2.24.3. STONE

The stone shall be graded from 3 to 8 in. (7.6 cm to 20.3 cm in diameter) and shall meet the requirements of Item 2.1.8.(a)(1). The stone shall have a specific gravity of at least 2.40 and shall have a percent of wear not more than 40 when tested in accordance with Texas SDHPT Test Method TEX-410-A.

2.24.4. GEOTEXTILE FABRIC

Geotextile fabric for use as a filter media shall be placed along the gabion structure as shown in the plans. The geotextile fabric shall be placed with a minimum overlap of 18 in. Fabric shall be secured as necessary by pins or other suitable means before placing gabion baskets.

2.24.5. PROTECTIVE AGGREGATE FILTER LAYER

As an alternate to Geotextile Fabric, a protective aggregate filter layer may be utilized. The filter shall be designed by a registered professional engineer specializing in geotechnical engineering.

2.24.6. REJECTION

Gabions may be rejected for failure to meet any of the requirements of this specification.
This page was intentionally left blank.
PART III

Construction Methods
This page was intentionally left blank.
## PART III. CONSTRUCTION METHODS

### DIVISION 3. SITE PREPARATION

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Preparing Right-of-Way</td>
</tr>
<tr>
<td>3.2</td>
<td>Clearing and Grubbing</td>
</tr>
<tr>
<td>3.3</td>
<td>Unclassified Street Excavation</td>
</tr>
<tr>
<td>3.4</td>
<td>Parkways</td>
</tr>
<tr>
<td>3.5</td>
<td>Unclassified Channel Excavation</td>
</tr>
<tr>
<td>3.6</td>
<td>Borrow</td>
</tr>
<tr>
<td>3.7</td>
<td>Embankment</td>
</tr>
<tr>
<td>3.8</td>
<td>Top Soil</td>
</tr>
<tr>
<td>3.9</td>
<td>Sodding</td>
</tr>
<tr>
<td>3.10</td>
<td>Seeding</td>
</tr>
<tr>
<td>3.11</td>
<td>Fertilizer</td>
</tr>
<tr>
<td>3.12</td>
<td>Temporary Erosion, Sediment and Water Pollution Control</td>
</tr>
</tbody>
</table>
This page was intentionally left blank.
DIVISION 3 SITE PREPARATION

ITEM 3.1. PREPARING RIGHT-OF-WAY

3.1.1. DESCRIPTION
This item shall consist of preparing the right-of-way for construction operations by the removal and 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 be considered to include remains of houses not completely removed by others, foundations, floor slabs, concrete, brick, lumber, plaster, septic tanks, basements, abandoned utility pipes or conduits, underground service station tanks, equipment or other foundations, fences, retaining walls, outhouses, shacks and other debris.

This item shall also include the removal of trees, stumps, bushes, vegetation, roots, shrubs, curb and gutters, 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. 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 in the plans and specifications.

3.1.2. CONSTRUCTION METHODS
The entire right-of-way for this project 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, as defined above, except for trees or shrubs specifically designated by the OWNER for preservation. Trees and shrubs designated for preservation shall be carefully trimmed as directed and shall be protected from scarring, barking or other injuries during construction operations. Exposed ends of pruned limbs larger than 2 in. (50 mm) in diameter shall be treated with an approved asphaltic material. Unless otherwise indicated on plans, all foundations and underground obstructions shall be removed to the following depths:

(a) in areas to receive embankment, 2 ft. (.6 m) below natural ground.
(b) in areas to be excavated, 2 ft. (.6 m) below the lower elevations of the excavation.
(c) all other areas, 1 ft. (.3 m) below natural ground.

All basement walls and floors, septic tanks and storage tanks within the limits of the right-of-way 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.

3.1.3. MEASUREMENT AND PAYMENT
"Preparing right-of-way" shall be measured on a lump sum basis, unless indicated otherwise. Measurement for payment shall be made only on areas indicated and classified on the plans as "Preparing right-of-way." All work performed and measured as prescribed by this item shall be paid for at the lump sum price bid for "Preparing right-of-way" unless indicated otherwise, which price shall be full compensation for furnishing all labor, equipment, tools, supplies and incidentals necessary to complete the work.

JANUARY 1998
ITEM 3.2. CLEARING AND GRUBBING

3.2.1. 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 area.

3.2.2. CONSTRUCTION METHODS
The designated area shall be cleared of all trees, brush, shrubbery, plants, etc., not designated by the OWNER or indicated on the plans to be preserved. 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 2 in. (50 mm) in diameter shall be treated by painting the exposed ends with an approved asphaltic material. 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 3 ft. (1 m) of embankment. On areas required for borrow sites and material, 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 disposed of by the CONTRACTOR. 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.

3.2.3. MEASUREMENT AND PAYMENT
Clearing and grubbing shall be measured for payment either in acres or by lump sum. Measurement for payment shall be made only on areas indicated and classified on plans as clearing and grubbing. Clearing and grubbing shall be paid for at the contract unit price per acre or at the lump-sum price, as the case may be, as provided in the proposal and contract. 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.

ITEM 3.3. UNCLASSIFIED STREET EXCAVATION

3.3.1. DESCRIPTION
Unclassified street excavation shall consist of all the required excavation within the limits of the right-of-way and areas adjacent thereto (except excavation specifically described and provided for elsewhere in the specifications); 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.

3.3.2. CLASSIFICATION
Without regard to materials encountered, all street excavations shall be unclassified and shall be designated as "Unclassified Street Excavation," which shall include all materials excavated. It is to be distinctly understood that any reference to rock or other material on the plans and/or in this specification is solely for the OWNER’S and CONTRACTOR’S information and is not to be taken as an indication of classification of excavation.

3.3.3. CONSTRUCTION METHODS
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 6 in. (150 mm) and to backfill with select material compacted as required.

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

### 3.3.4. 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 neglecting to provide for either natural or artificial drainage which his work may have interrupted.

### 3.3.5. EXCESS EXCAVATION

Excavation in excess of that needed for construction shall be disposed of by the CONTRACTOR. In general, suitable excess street excavation shall be used in construction 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 should ask approval of the OWNER as to disposition site and method.

### 3.3.6. MEASUREMENT AND PAYMENT

All authorized street excavation shall be measured in its original position and the volume in cubic yards (m$^3$) determined by the average end area method. All work performed as prescribed by this item shall be paid for at the contract bid price per cubic yard (m$^3$) for unclassified street excavation, which price shall constitute payment in full for 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. Dragging, pushing or scraping of material along or across the surface of the complete concrete improvements or pavements shall not be permitted.

### ITEM 3.4. PARKWAYS

#### 3.4.1. DESCRIPTION/CONSTRUCTION METHODS

Parkways shall be finished as shown on plans. Whenever the adjacent property is lower than the design curb grade and drains away from the street, the parkway grade 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.

#### 3.4.2. MEASUREMENT AND PAYMENT

Acceptable work prescribed for the item shall not be measured directly, and payment for work performed for finishing of parkways shall be made as a subsidiary item to Item 3.3. The price bid for unclassified street excavation shall be full compensation for furnishing and operating all equipment, all loading, hauling, unloading, furnishing all labor, fuel, materials, tools and implements incidental to the satisfactory performance of the work.

### ITEM 3.5. UNCLASSIFIED CHANNEL EXCAVATION

#### 3.5.1. DESCRIPTION

Channel excavation shall consist of required excavation for channels within the limits of the OWNER’s right-of-way or designated easements; the removal and proper utilization or disposal of all excavated materials; and constructing, shaping and finishing of all earthwork involved in conformity with the required lines, grades and typical cross sections in accordance with specification requirements herein outlined.
3.5.2. **CLASSIFICATION**
All authorized channel excavation shall be unclassified.

3.5.3. **CONSTRUCTION METHODS**
All suitable materials removed from the excavation shall be used, insofar as practicable, in the formation of embankments as required by Item 3.7, “Embankment,” 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.

Unsuitable channel excavation and suitable channel excavation in excess of that needed for construction shall be known as “waste” and, unless specified otherwise, shall become the property of the CONTRACTOR to be disposed of by him outside the limits of the right-of-way. Disposal method and location must be cleared with OWNER’s representatives.

3.5.4. **MEASUREMENT AND PAYMENT**
All authorized channel excavation shall be measured in its original position and the volume in cubic yards (m$^3$) determined by the average end area method. All work performed as prescribed by this item shall be paid for at the contract unit price per cubic yard (m$^3$) for unclassified channel 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.

All work required for disposing of waste, including haul, shall not be paid for directly but shall be considered as subsidiary work pertaining to various contract items, and such costs shall be included in the unit prices bid for these items.

**ITEM 3.6. BORROW**

3.6.1. **DESCRIPTION**
Borrow shall consist of required excavation, removal, and proper utilization of materials obtained from designated or approved sources.

3.6.2. **CLASSIFICATION**
All authorized borrow shall be unclassified unless otherwise noted.

3.6.3. **CONSTRUCTION METHODS**
All suitable materials removed from the excavation shall be used, insofar as practicable, in the formation embankment as required by the governing item for embankment; or shall otherwise be utilized as indicated on the plans or as directed. The completed work shall conform to the established alignment, grades and cross sections. Payment shall not be allowed for excavation for any material which is used for purposes other than those designated. Site of the borrow operations shall be left in a suitable and sightly condition, such as to provide proper drainage where practicable. Where indicated on the plans, the sides and/or ends of borrow pits shall be sloped to the dimensions indicated on the plans.

3.6.4. **SELECTION OF MATERIALS**
Where shown on the plans, selected materials shall be utilized in the formation of embankment or to improve the roadbed, in which case the work shall be performed in such manner and sequence that suitable material may be selected, removed separately and deposited in the roadway within limits and all elevations required. When required, acceptable borrow material, tested by standard laboratory methods, shall meet the requirements indicated on the plans.

3.6.5. **MEASUREMENT AND PAYMENT**
Borrow shall be measured in a compacted condition in its final position and the volume computed in cubic yards (m$^3$) by the method of average end areas, or as specified otherwise. All work performed as required herein and in the Item
3.7. "Embankment," and measured as provided in this item shall be paid for at the unit price bid. The unit price shall be full compensation for furnishing all labor, for materials, tools, equipment, hauling and incidentals necessary to complete the work, as well as for all royalties.

**ITEM 3.7. EMBANKMENT**

**3.7.1. DESCRIPTION**

Embankment shall consist of the placement and compaction of all suitable materials obtained from street excavation, borrow or any other excavation in the construction of streets.

**3.7.2. CONSTRUCTION METHODS**

Prior to the placing of any embankment, all clearing and grubbing and site preparation 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 of plowing to a depth of not less than 4 in. (100 mm) 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 the 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 4 in. (100 mm) and the embankment built up in successive layers, as hereinafter specified, to the level of the old road bed 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 embankments for road beds 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.

Embankments 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.

Earth embankments shall be constructed in successive layers, for the full width of specified depth or cross sections; and in such lengths 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 6 in. (150 mm) in depth for pneumatic tire rolling or 8 in. (200 mm) in depth for rolling with other types of rollers.

Earth embankment placed adjacent to and over pipes, culverts, arches and bridges shall be of 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 embankments adjacent to structures where it is impracticable to obtain compaction by rolling, the embankment material shall be placed in layers not exceeding 6 in. (150 mm) 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 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 6 in. (150 mm) 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 earth embankments.

Rock embankments 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 18 in. (450 mm) 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 4 in. (100 mm) 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 embankment 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 embankment shall be constructed 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 embankment 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 3/10 ft. (300 mm) from the established cross section or elevation after proper compaction and shall be finished as necessary to receive the select material.

3.7.3. DENSITY
For each layer of earth embankment and selection material, the relative compaction of the embankment shall be as shown on the plans. After each section of earth embankment 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.

3.7.4. MEASUREMENT AND PAYMENT
Embarkment shall not be measured or paid for as a separate contract pay item, but the cost of construction of the embankment complete in place shall be included in such contract pay items as described in standard specifications Item 3.6., “Borrow.” The contract pay items provided shall be full compensation for the furnishing of all labor, material, tools, equipment and incidentals necessary to complete the embankment, including cost of water, sprinkling or wetting, rolling, etc., in accordance with the plans and specifications.

ITEM 3.8. TOPSOIL

3.8.1. 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.

3.8.2. CONSTRUCTION METHODS
Topsoil shall be secured from borrow sources as required to supplement material secured from street excavation. All excavated material which is suitable for top soil shall be used before any top soil is obtained from a borrow source. Top soil material secured from excavations shall be stockpiled at locations approved by OWNER.

3.8.3. MEASUREMENT AND PAYMENT
Topsoil secured from borrow sources shall be measured by the square yard (m²) in place on the project site. Measurement for payment shall be made only on topsoils secured from borrow sources. 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.

All labor, equipment, tools and incidentals necessary to place salvage topsoil as specified shall be included in the price bid for Item 3.3., “Unclassified Street Excavation.” All excavation required by this item in cut section shall be measured in accordance with provisions for the various excavation items involved with the provision that excavation shall be measured and paid for once only, regardless of the manipulations involved.

ITEM 3.9. SODDING

3.9.1. DESCRIPTION
Sodding shall consist of furnishing and planting grass as designated on the plans and in accordance with the requirements of this specification and special conditions.
3.9.2. MATERIALS
Sod shall consist of live and growing grass secured from sources where the soil is fertile. Sod to be placed during the dormant stage of these grasses shall be inspected by the OWNER to verify that the grass is acceptable.

The sod shall be free from obnoxious weeds or other grasses and shall not contain any matter deleterious to its growth or which might affect its subsistence or hardness when transplanted. Sod to be placed between curb and walk and on terraces shall be the same type grass as adjacent grass or existing lawn.

Care shall be taken at all times to retain native soil on the roots of the sod during the process of excavating, hauling and planting. Sod material shall be kept moist from the time it is dug until planted. When so directed by the OWNER, the sod existing at the source shall be watered to the extent required prior to excavating. Sod material shall be planted within 3 days after it is excavated.

3.9.3. CONSTRUCTION METHODS
After the designated areas have been completed to the lines, grades and cross sections shown on the plans and as provided for in other items of the contract, sodding of the type specified shall be performed in accordance with the requirements hereinafter described. Sodding shall be either spot or block.

(a) Spot Sodding. Furrows parallel to the curb line or sidewalk lines, 12 in. (300 mm) on centers or to the dimensions shown on the plans, shall be opened on areas to be sodded. In all furrows, sod approximately 3 in. square (75 mm) shall be placed on 12 in. (300 mm) centers at proper depth so that the top of the sod shall not be more than 1/2 in. (13 mm) below finished grade. Holes of equivalent depth and spacing may be used instead of furrows. Soil shall be firm around each block; then the entire sodded area shall be carefully rolled with a heavy, hand roller developing 15 to 25 lb. per square inch (100 to 170 kPa) compression. Hand tamping may be required on terraces.

(b) Block Sodding. At locations on the plans, or where directed, sod blocks shall be carefully placed on the prepared areas. Sod shall be so placed that the entire designated areas shall be covered. Any voids left in the block sodding shall be filled with additional sod and tamped. The entire sodded area shall be rolled and tamped to form a thoroughly compact solid mass. Surfaces of block sod which, in the opinion of the OWNER, may slide due to the height or slope of the surface or nature of the soil, shall, upon direction of the OWNER, be pegged with wooden pegs driven through the sod block to the firm earth, sufficiently close to hold the block sod firmly in place.

When necessary, the sodded areas shall be smoothed after planting has been completed and shaped to conform to the cross section previously provided and existing at the time sodding operations were begun. Any excess dirt from planting operations shall be spread uniformly over the adjacent areas or disposed of as directed by the OWNER, so that the completed surface shall present a sightly appearance.

Sodded areas shall be thoroughly watered immediately after they are planted and shall be subsequently watered at such time and in a manner and quantity directed by the OWNER until completion and final acceptance of the project by the OWNER.

3.9.4. MEASURE AND PAYMENT
Spot sodding and block sodding shall be measured for payment in square yards (m²) of sodded area completed in accordance with the plans and specifications. Spot sodding or block sodding, as the case may be, shall be paid for at the contract unit price per square yard (m²), 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, tools and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

ITEM 3.10. SEEDING

3.10.1. DESCRIPTION
Seeding shall consist of preparing ground, providing and planting seed or a mixture of seed of the kind specified along and across such areas as may be designated on the plans and in accordance with these specifications.
3.10.2. PLANTING SEASON
All planting shall be done between the dates specified for each type except when specifically authorized in writing. The seeds planted per acre shall be of a type specified with the mixture, rate and planting dates as follows:

Type I — Bermuda Grass — hulled, 8 lb. (3.6 kg) — March through September.
Type II — Rye Grass — 35 lb. (15.9 kg) — September through February.
Type III — Bermuda Grass — unhulled — 12 lb. (5.4 kg) — September through February.

3.10.3. CONSTRUCTION METHODS
After the designated areas have been completed to the lines, grades and cross sections shown on the plans and as provided for in other items of this contract, seeding of the type specified shall be performed in accordance with the requirements hereinafter described.

(a) Watering. Seeded areas shall be watered as directed by the OWNER so as to prevent washing of the slopes or dislodgment of the seed.
(b) Finishing. Where applicable, the shoulders, slopes and ditches shall be smoothed after seedbed preparation has been completed and shaped to conform to the cross section previously provided and existing at the time planting operations were begun.

3.10.4. 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.

3.10.5. DISCED SEEDING
Soil over the area shown on the plans as directed to be seeded shall be loosened to a minimum depth of 3 in. (75 mm). All particles in the seedbed shall be reduced to less than 1 in. (25 mm) in diameter, or they shall be removed. The area shall then be finished to the line and grade as specified under “Finishing” in Item 3.10.3.(b).

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 1/8 in. (3 mm). 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.

3.10.6. ASPHALT MULCH SEEDING
Soil over the area shown on the plans, or as directed to be seeded, shall be loosened to the minimum depth of 3 in. (75 mm). All particles in the seedbed shall be reduced to less than 1 in. (25 mm) in diameter; or they shall be removed. The area shall then be finished to line and grade as specified under “Finishing” in Item 3.10.3.(b). Water shall then be applied to the cultivated area of the seedbed until a minimum depth of 6 in. (150 mm) is thoroughly moistened.

After watering, when the ground has become sufficiently dry to be loose and pliable, the seed or seed mixture specified shall then be planted at the rate required, and the application shall be made uniformly. If the sowing of seed is by hand rather than mechanical methods, the 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 1/4 in. (6 mm).

The planted area shall then be rolled with a smooth roller, developing 15 to 25 psi (100 to 170 kPa) contract pressure upon the planted surface area and giving a smooth surface without ruts or tracks. In between the time compacting is completed and asphalt is applied, the planted area shall be watered sufficiently to assure uniform moisture from the surface to a minimum of 6 in. (150 mm) in depth. Application of asphalt shall follow the last watering as rapidly as possible. Asphalt shall be of a type and grade as shown on the plans and shall conform to requirements of Item 2.4.2., “Oil Asphalt.” If the type of asphalt to be used is not shown on the plans, or if plans are not included, then MS-2 shall be used. Application of asphalt shall be at a rate of 3/10th gallons (1.13 liters) per square yard (1.35 L per
m²). Asphalt shall be applied to the area in such a manner so that a complete film is obtained and the finished surface shall be comparatively smooth.

3.10.7. HYDRO MULCHING

Seed or seed mixture, in the quantity specified, 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 Item 2.15.2., “Fertilizer.” After planting, the seed shall be raked or harrowed into the soil to a depth of approximately 1/4 in. (6 mm). The planted area shall then be rolled with a smooth roller, developing 15 to 25 psi (100 to 170 kPa) contract pressure upon the planted surface area and giving a smooth surface without ruts or tracks. After compacting is completed, the planted area shall be watered sufficiently to assure uniform moisture from the surface to a minimum of 6 in. (150 mm) in depth.

3.10.8. MEASUREMENT AND PAYMENT

Acceptable material for broadcast seeding, disced seeding, asphalt mulch seeding and hydro mulching shall be measured by the square yard (m²) or by the acre (m²) 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 much seeding or hydro mulching of the type specified, as the case may be. The price shall be full compensation for furnishing all materials, including water for seed-fertilizer slurry and hydraulic mulching, and for performing all operations necessary to complete the work except as follows: All fertilizer shall be measured and paid for in accordance with the provisions governing Item 3.11., “Fertilizer.”

Water for sprinkling the cultivated area or seedbed when required shall meet the requirement of and shall be measured and paid for in accordance with the provisions governing Item 4.1., “Sprinkling for Dust Control.”

ITEM 3.11. FERTILIZER

3.11.1. 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 acre shall equal or exceed that specified for each nutrient.

3.11.2. 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.

Unless otherwise indicated on the plans, the manufacturer’s recommendation as to rate of application for type of grass and season shall be followed.

3.11.3. MEASUREMENT AND PAYMENT

Work and acceptable material for fertilizer shall be measured by the ton of two thousand pounds (1000 kg), as determined by approved scales or guaranteed weight of sacks shown by the manufacturer. Work performed and materials furnished and measured, as provided for in this item, shall be paid for at the unit price bid for “Fertilizer” of the analysis specified, which price shall be full compensation for the furnishing of all materials and performing all operations necessary to complete the work.
ITEM 3.12. TEMPORARY EROSION, SEDIMENTATION, AND WATER POLLUTION PREVENTION AND CONTROL

3.12.1. DESCRIPTION
This item shall govern the control measures necessary to prevent and control soil erosion, sedimentation, and water pollution which may degrade receiving waters including rivers, streams, lakes, reservoirs, groundwater, and wetlands. The control measures contained herein shall be installed and maintained throughout the construction contract and coordinated with any permanent or temporary pollution control features specified elsewhere on the plans and in the specifications to assure effective and continuous water pollution control throughout the construction and post construction periods. These control measures shall not be used as a substitute for the permanent pollution control measures unless otherwise directed by the OWNER’S representative in writing. The controls may include silt fences, straw bale dikes, rock berms, diversion dikes, interceptor swales, sediment traps and basins, pipe slope drains, inlet protection, stabilized construction entrances, seeding, sodding, mulching, soil retention blankets, or other structural or non-structural storm water pollution controls. Additional information regarding these controls can be found in NCTCOG’s guidance manual entitled Storm Water Quality Best Management Practices for Construction Activities — North Central Texas.

3.12.2. ITEMS OF WORK AND MATERIALS
The items, estimated quantities, and locations of the control measures will be shown on the plans; however, the OWNER’S representative may increase or decrease the quantity of these items as the need arises. The materials will be shown on the plans and in the specifications. The OWNER’S representative may allow, in writing, the use of other materials and work methods as the need arises.

3.12.3. PRECONSTRUCTION SUBMITTALS
Prior to the start of construction, the CONTRACTOR shall submit to the OWNER’S representative for acceptance schedules for accomplishment of the storm water pollution control measures in accordance with the erosion and sediment control plan or the Storm Water Pollution Prevention Plan (SWPPP). Work on the project shall not begin until the schedules for implementation of the controls and methods of operations have been reviewed and accepted, in writing, by the OWNER’S representative. The CONTRACTOR shall provide the OWNER’S representative, for information purposes, proposed methods of storm water pollution control for CONTRACTOR operations in areas which are outside the right of way (such as construction and haul roads, field offices, equipment and supply storage areas, portable process plants, and source material storage), as well as a plan for disposal of waste materials.

3.12.4. CONSTRUCTION REQUIREMENTS
(a) The CONTRACTOR shall provide control measures to prevent or minimize the impact to receiving waters as required by the plans and/or as directed by the OWNER’S representative in writing.

In any disturbed area where construction activities have ceased, permanently or temporarily, the CONTRACTOR shall initiate stabilization of the area by the use of seeding, mulching, soil retention blankets or other appropriate measures within 14 days, except in areas where construction activities are scheduled to resume within 21 days.

The CONTRACTOR shall effectively prevent and control erosion and sedimentation on the site at the earliest practicable time as outlined in the approved schedule. Control measures, where applicable, will be implemented prior to the commencement of each construction operation or immediately after the area has been disturbed.

The CONTRACTOR shall limit the amount of disturbed earth to the area(s) shown on the plans or as directed by the OWNER’S representative. The OWNER’S representative has the authority to limit the disturbed surface area exposed by construction operations. If, in the opinion of the OWNER’S representative, the CONTRACTOR is not able to effectively control soil erosion and sedimentation resulting from construction operations, the OWNER’S representative will limit the amount of disturbed area to that which the CONTRACTOR is able to control.

Should the control measures fail to function effectively, the CONTRACTOR shall act immediately to bring the erosion and sedimentation under control by maintaining existing controls or by providing additional controls as directed by the OWNER’S representative. When, in the opinion of the OWNER’S representative, the site is adequately stabilized, the control measures, except mulches and soil retention blankets, will be removed and properly disposed of by...
the CONTRACTOR. Soil retention blankets shall be removed only when, in the opinion of the OWNER'S representative, final permanent perennial seeding would be adversely affected by the presence of an existing soil retention blanket.

All erosion, sediment, and water pollution controls will be maintained in good working order. A rain gauge provided by the CONTRACTOR will be located at the project site. Within 24 hours of a rainfall event of 0.5 in. or more as measured by the project rain gauge, the CONTRACTOR and OWNER'S representative will inspect the entire project to determine the condition of the control measures. Sediment will be removed and devices repaired as soon as practicable but no later than 7 days after the surrounding exposed ground has dried sufficiently to prevent further damage from equipment operations needed for repairs.

In the event of continuous rainfall over a 24 hour period, or other circumstances that preclude equipment operation in the area, the CONTRACTOR will install additional backup devices, as determined by the OWNER'S representative, by other appropriate methods. The CONTRACTOR will remove silt accumulations and deposit the spoils in an area approved by the OWNER'S representative as soon as practical. Any corrective action needed for the control measures will be accomplished in the sequence directed by the OWNER'S representative; however, areas adjacent to receiving waters shall generally have priority, followed by devices protecting storm sewer inlets.

(b) The CONTRACTOR shall also conform to the following practices and controls. All labor, tools, equipment, and incidentals to complete the following work will not be paid for directly but shall be considered as subsidiary work to the various items included in the contract.

(1) Disposal areas, stockpiles, and haul roads shall be constructed in a manner that will minimize and control the amount of sediment that may enter receiving waters. Disposal areas shall not be located in any floodplain or receiving waters. Construction roads may not be located in or cross any receiving waters without prior approval of the OWNER'S representative and shall be done in compliance with applicable rules and regulations.

(2) Construction operations in receiving waters shall be restricted to those areas where it is necessary to perform the work shown on the plans. Wherever streams are crossed, temporary bridges, timber mats, or other structures shall be used.

(3) Protected storage for paints, chemicals, solvents, fertilizers, and other potentially toxic materials will be provided by the CONTRACTOR at a location approved by the OWNER'S representative.

(4) Construction staging areas and vehicle maintenance areas shall be constructed by the CONTRACTOR in a manner to minimize the runoff of pollutants and at a location approved by the OWNER'S representative. The CONTRACTOR shall prevent pollution of receiving waters with petroleum products or other hazardous or regulated substances. When work areas or material sources are located adjacent to a receiving water, control measures such as diversion dikes or rock berms shall be used to keep sediment and other contaminants from entering the adjacent receiving water. Care shall be taken during the construction and removal of such barriers to minimize down-gradient sedimentation.

(5) All receiving waters shall be cleared as soon as practicable of temporary embankment, temporary bridges, matting, falsework, piling, debris, or other obstructions placed during construction operations that are not a part of the finished work.

(6) Disturbance of vegetation shall be minimized and limited to only what is shown on the construction plans or as directed by the OWNER'S representative in writing.

(7) The CONTRACTOR shall clean paved surfaces, as necessary, to remove sediment which has accumulated on the roadway.

(c) The project will not be accepted until the CONTRACTOR has cleaned up all areas listed in Item 3.12.4.(b) to the satisfaction of the OWNER'S representative. The project will also not be accepted until the CONTRACTOR provides a uniform perennial vegetative cover with a density of 70 percent of adjacent undisturbed areas or, if in the opinion of the OWNER'S representative, permanent measures (such as riprap, gabions, or geotextiles), supplemented by temporary measures (such as mulching with seed, straw bale dikes, silt fences, earth dams, etc.) have been employed that will control erosion, sedimentation, and water pollution until sufficient vegetative cover can be established.

3.12.5. MEASUREMENT AND PAYMENT

If the CONTRACTOR is required to install temporary erosion, sediment, and water pollution control measures due to his negligence, carelessness, lack of maintenance, or failure to install permanent controls as a part of the work scheduled, and measures are ordered in writing by the OWNER'S representative, such work shall not be measured for pay-
Item 3.12.5. SITE PREPARATION

ment but shall be performed at the CONTRACTOR’S expense. All labor, tools, equipment, and incidentals to complete the work specified under Item 3.12.4.(b) will not be paid for under applicable contract bid items but will be considered subsidiary to the various items.

When the need for control measures cannot be attributed to the CONTRACTOR’S negligence, carelessness, lack of maintenance, or failure to install permanent water pollution control measures and these measures are shown on the plans and/or directed by the OWNER’S representative, these measures shall be measured and paid for in accordance with the applicable contract bid items. For work performed under the requirements of this item which is not comparable to work performed under contract bid items, such work shall be performed by agreed unit prices or lump sum basis. Removal of control measures not incorporated as permanent control measures shall be measured and paid for in accordance with applicable contract bid items.

In case of failure on the part of the CONTRACTOR to prevent and control soil erosion, sedimentation, and water pollution which may degrade receiving waters, the OWNER’S representative reserves the right to employ outside assistance or to use OWNER forces to provide the necessary corrective measures. All costs including engineering costs will be deducted from any monies due or to become due to the CONTRACTOR.
PART III. CONSTRUCTION METHODS

DIVISION 4. SUBGRADE, SUBBASE AND BASE COURSES

Definitions
Item 4.1. Sprinkling for Dust Control
Item 4.2. Rolling
Item 4.3. Subgrade Preparation
Item 4.4. Gravel Base Course
Item 4.5. Flexible Base (Crushed Stone)
Item 4.6. Lime Treatment
Item 4.7. Portland Cement Treatment
Item 4.8. Asphalt Treatment
Item 4.9. Portland Cement Modification of Subgrade Soils
This page was left intentionally blank.
DIVISION 4. SUBGRADE, SUBBASE AND BASE COURSES

DEFINITIONS
Modification: The physical change of a soil to improve the soil's characteristics.
Stabilization: The addition to a soil to achieve minimum strength and durability under freeze/thaw and wet/dry conditions.

ITEM 4.1. SPRINKLING FOR DUST CONTROL

4.1.1. 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.

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

4.1.3. 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.

4.1.4. MEASUREMENT AND PAYMENT
Sprinkling performed as provided above shall be measured by the 1,000 gallons (liters) as delivered on the project. Sprinkling provided in the proposal and the contract as a separate pay item shall be paid for in accordance with the contract unit price. When sprinkling is not classified separately for payment, then such sprinkling shall be considered as incidental work and shall not be paid for as a separate item; the cost thereof shall be included in such contract pay items as are provided. In either case, such pay items shall be the total compensation for all labor, materials, tools, machinery, equipment and incidentals necessary to complete the work in accordance with the plans and this specification.

ITEM 4.2. ROLLING

4.2.1. 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.

4.2.2. STEEL WHEEL ROLLER
Steel wheel rollers shall be of the three wheel, self-propelled type, weighing not less than 10 tons (9,000 kg) and shall provide a pressure on the rear wheels of not less than 325 lb. per linear in. (6 kg per linear mm) of wheel width. All wheels shall be flat. Rear wheels shall have a diameter of not less than 48 in. (1.2 m), and each shall have a tire width of not less than 20 in (0.5 m).

4.2.3. TAMPPING ROLLERS
Tamping rollers shall consist of two metal rollers, drums or shells of not less than 40 in. (1 m) in diameter, each not less than 42 in. (1 m) in length and unit mounted in a rigid frame in such a manner that each roller may oscillate independently of the other. Each roller, drum or shell shall be surmounted by metal studs with tamping feet projecting not less than 7 in. (18 cm) from the surface and spaced not less than 6 in. (15 cm) nor more than 10 in. (25 cm) measured diagonally center to center. The cross-sectional area of each tamping foot shall be not less than 5 sq. in. (160 cm²) nor more than 8 sq. in. (400 cm²).
4.2.6. ROLLING METHODS

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 (.86 MPa) to 175 psi (1.21 MPa) of cross-sectional area. The CONTRACTOR may use heavier rollers with compression valves up to 500 psi (3.4 MPa) 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.

4.2.4. 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 The distance between the front and rear axles shall be not less than 5 ft. (1.5 m) nor more than 10 ft. (3 m). 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 in. (1.5 m). It shall be so designed that, by ballast loading, the load may be varied uniformly from not less than 100 lb. per in. (.69 MPa) of width of tire tread to 325 lb. per in. (2.24 MPa) of width of tire tread. The CONTRACTOR may use a heavier roller with wheel bases up to 18 ft. (5.5 m) 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. The pneumatic tire roller shall be drawn by either an approved crawler-type tractor, a pneumatic tire tractor, or a truck of adequate tractive effort or may be self-propelled, and the roller, when drawn or propelled by either type of equipment, shall be considered a pneumatic tire roller unit.

4.2.5. VIBRATORY ROLLERS

Rollers with vibrating drums may be used for compaction of embankment or subgrades when approved by the OWNER.

4.2.6. ROLLING 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 \( \frac{1}{2} \) the width of the rear wheel on the power roller, \( \frac{1}{2} \) the width of the tamping roller unit and \( \frac{1}{2} \) 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 super-elevated 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 2 and 3 miles per hour (3 to 5 km/hr.). The speed of the pneumatic tire unit, unless otherwise directed by the OWNER, shall be between 4 and 12 miles per hour (6 to 21 km/hr.) for asphalt surfacing work and between 2 and 6 miles per hour (3 to 10 km/hr.) for all other compaction.

4.2.7. MEASURE AND PAYMENT

Rolling provided in the proposal and contract, as a separate contract pay item, shall be measured for payment by the actual hour the roller is in operation, as ordered by the OWNER. Rolling provided in the proposal and the contract, as a separate pay item, shall be paid for in accordance with the contract unit price. When rolling is not classified separate for payment, then such rolling shall be considered as incidental work and shall not be paid for as a separate item. The cost thereof shall be included in such contract pay items as are provided. In either case, such pay items shall be the total compensation for all labor, materials, tools, machinery, equipment and incidentals necessary to complete the work in accordance with the plans and this specification.
ITEM 4.3. SUBGRADE PREPARATION

4.3.1. 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 the pavement is to be placed and including 12 in. (30 cm) beyond the back of the curb for streets which are to be paved with concrete.”

4.3.2. 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.

(a) Subgrade Planer. An approved subgrade planer shall be provided, mounted on visible rollers riding on the forms, having adjustable cutting blades which shall trim the subgrade to exact sections shown on the plans. Planer frames shall be heavy enough to remain on the forms at all times and shall be of such strength and rigidity that, under a test made by changing the support from the wheels to the center for the type pavements as set out under “Subgrade Planer,” they shall not develop a deflection of more than 1/8 in. (3.2 mm). Tractive power equipment used on the subgrade to pull the planer shall not be such as to produce ruts or indentations in the subgrade.

(b) Subgrade Template. The template for checking the contour of the subgrade shall be provided and operated by the CONTRACTOR. The template shall rest upon the side forms and shall be of such strength and rigidity that, under a test made by changing the support to the center, it shall not develop a deflection of more than 1/8 in. (3.2 mm). It shall be provided with accurately adjustable rods projecting downward to the subgrade at 1 ft. (30 cm) intervals, and these rods shall be adjusted to the required cross-section when the template is resting on the side forms.

(c) Compaction Equipment. Compaction equipment shall conform to the requirements of Item 4.2., “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 5 tons (4,500 kg.).

4.3.3. CONSTRUCTION METHODS
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 Item 4.2., “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 before the application of base or pavement, the subgrade planer shall be operated from approved forms in a manner to finish the subgrade to the required section. The subgrade shall then be tested with the approved template, operated and maintained by the CONTRACTOR. All irregularities which develop in excess of 1/2 in. in a length of 16 ft. (12.5 mm in 5 m) 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 D698. Moisture content shall be within minus 2 to plus 4 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 2 in. (5 cm) 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.
4.3.4. MEASUREMENT AND PAYMENT
Preparation of subgrade shall not be measured for payment as a separate contract pay item. 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 these specifications.

ITEM 4.4. GRAVEL BASE COURSE

4.4.1. DESCRIPTION
This item shall consist of gravel for streets, driveways, cement stabilized base, foundation courses, surface courses, other base courses, sidewalks, driveway approaches and/or curb and gutter.

4.4.2. MATERIALS
Materials for gravel base courses shall conform to the requirements of Item 2.1.3.(a) and may consist of one or more courses.

4.4.3. CONSTRUCTION METHODS
Preparation of the subgrade shall be in conformity with the requirements of Item 4.3., “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 (9,000 kg) rollers. All rollers shall comply with the requirements of Item 4.2., “Rolling.”

One roller unit of the type required by the OWNER shall be provided for each 100 cubic yards (75 m³), 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 Item 4.2., “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 1/4 in. (6 mm), 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 92 percent of the maximum density determined by ASTM D 1557. Moisture content shall be within minus 2 to a plus 4 of optimum.

4.4.4 MEASUREMENT AND PAYMENT
Gravel base, when provided for as a separate contract pay item in the proposal and contract, shall be measured for payment in square yards of the compacted thickness shown on the plans. Gravel base, when provided for as a separate contract pay item, shall be paid for at the contract unit price per square yard, complete in place. The contract
price shall be the total compensation for the furnishing of all labor, tools, materials, equipment and incidentals necessary to compete the work, including preparation of the subgrade, rolling finish and disposal of surplus materials, all in accordance with the plans and these specifications.

ITEM 4.5. FLEXIBLE BASE (CRUSHED STONE)

4.5.1. 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; and shall meet the requirements of Item 2.1.3.(b), “Flexible Base.”

4.5.2. CONSTRUCTION METHODS
(a) Preparation of Subgrade. The preparation of the subgrade shall be in conformity with the requirements of Item 4.3., “Subgrade Preparation.”
(b) Thickness. Where the base course exceeds 6 in. (15 cm) in thickness, it shall be constructed in two or more courses of equal thickness as indicated on the typical section.
(c) 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 coarse or 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 fully 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 1/2 in. in cross section and in a length of 16 ft. (12.5 mm in 5 m) measured longitudinally shall be corrected by loosening, adding or removing material, reshaping and recompingcting 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 recompingcting by sprinkling and rolling.

Should the base course, due to any reason or cause, lose the required stability, density and finish before the surface is complete, it shall be recompedcted and refinished at the sole expense of the CONTRACTOR.
(d) Density. The density required under this item shall not be less than 92 percent compaction as determined by ASTM D 1557. Moisture content shall be within minus 2 to plus 4 of optimum.
(e) 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 Item 8.2., “Concrete Curb and Gutter.”
4.5.3. MEASUREMENT AND PAYMENT

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 (m²) 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.

ITEM 4.6. LIME TREATMENT

4.6.1. DESCRIPTION

This item shall consist of treating subgrade, subbase, 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 subbase 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.

4.6.2. MATERIALS

(a) Base and Subbase Materials. Base and subbase materials shall meet the requirements shown on the plans or in the pertinent specifications.

(b) Lime. The lime shall meet the requirements of Items 2.5.2. and 2.5.3., “Hydrated Lime,” 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 before changing from one grade to another.

(c) If the minimum design strength or percent lime to be used for the treated subgrade, existing base, new subbase or new base is specified, it shall be determined by preliminary laboratory tests at the OWNER’S expense.

4.6.3. EQUIPMENT

(a) 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.

All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

(b) 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. Hydrated lime bags shall be stored in weatherproof buildings with adequate protection from ground dampness.

(c) 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.

(d) Bags. If lime is furnished in bags, each bag shall bear the manufacturer’s certified weight. Bags varying more than 5 percent by weight may be rejected, and the average weight of the bags in any shipment, as shown by weighing 50 bags taken at random, shall not be less than the manufacturer’s certified weight.

4.6.4 CONSTRUCTION METHODS

(a) 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.

(1) Treatment for Materials in Place. Materials to be treated shall be excavated to the secondary grade (proposed bottom of lime treatment) and removed or windrowed 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 windrow 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.

(2) Treatment for New Materials. The base and subbase 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.

(b) 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.

(1) 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.

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 lime. The material shall be sprinkled until proper moisture content has been secured.

(2) Slurry Placing. Lime shall be mixed with water and applied as a thin water suspension or slurry. 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 shall be attained by successive passes over a measured surface of roadway until the proper moisture and lime content have been secured.

(c) Mixing. Mixing procedure shall be the same for "dry placing" or "slurry placing" as hereinafter described.

(1) 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 homogeneous, 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 1 to 4 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 1 3/4 in. (45 mm) | 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.

(2) Treatment of New Material. The base or subbase 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 homoge-
neous, 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 lime water mixture is applied; 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.

(d) Compaction. Compaction of the mixture shall begin immediately after final mixing and in no case later than 3 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 D698. Moisture content shall be within minus 2 to plus 4 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.

4.6.5. 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 7 days before further courses are added or any traffic permitted, unless otherwise directed by the OWNER. In cases where subgrade treatment or subbase sets up sufficiently to prevent objectionable damage from traffic, such layers may be opened to traffic 2 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 (0.5 and 1.0 liters per m²), 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.

4.6.6. 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.

4.6.7. MEASUREMENT AND PAYMENT

Lime treatment shall be measured for payment in square yards (m²) for the thickness shown in the plans for the surface area of completed and accepted work. The measurement for lime shall be by the ton of 2000 pounds (900 kg) dry weight. Lime treatment shall be paid for at the contract unit price per square yard (m²), 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 measured as provided in the this item shall be paid for at the unit price bid for "lime material" which price shall be full compensation for furnishing the material; for all freight involved; for all unloading, storing and handling; and for all labor, equipment, fuels, tools and incidentals necessary to complete the work.

The measured tonnage of (dry) Quicklime shall be multiplied by the conversation factor 1.25 to give the equivalent quantity of hydrated lime (dry) which shall be the basis of payment.

**CAUTION:** HANDLING AND USE OF QUICKLIME CAN BE DANGEROUS. QUICKLIME SHOULD BE PRESCRIBED BY A REGISTERED PROFESSIONAL ENGINEER FAMILIAR WITH ITS USE.
ITEM 4.7. PORTLAND CEMENT TREATMENT

4.7.1. DESCRIPTION
This item shall consist of the treatment of the base, subbase, or subgrade 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 subbase, the base or subbase shall be constructed as herein specified and in conformity with the items governing the base or subbase courses.

4.7.2. MATERIALS
(a) Portland Cement. Cement shall be conform to the requirements of Item 2.2.1., “Cement.”
(b) Water. Water shall conform to the requirements of Item 2.2.4., “Water.”
(c) 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, 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.

4.7.3. 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.

4.7.4. CONSTRUCTION METHODS
(a) 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 subbase, 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°F (5°C) and falling, but may be mixed or placed with the air temperature is above 35°F (2°C) and rising, the temperature being taken in the shade and away from artificial heat, and with the further provisions that cement stabilize base shall be mixed or placed only when weather conditions, in the opinion of the OWNER, are suitable.

(1) 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 passes a 1 in. (25 mm) 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 2 in. (50 mm) sieve.

(b) 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 6 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.

(c) Mixing and Processing. The following method of mixing and processing may be used at the option of the CONTRACTOR.

1. Multiple Pass Traveling Mixer. After the cement has been applied, it shall be dry-mixed with the soil. Mixing shall continue until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied. Any mixture of soil and cement that has not been compacted and finished shall not remain undisturbed for more than 30 minutes.

Immediately after the dry-mixing of soil and cement is complete, water as necessary shall be uniformly applied and incorporated into the mixture. The pressurized equipment and the supply provided shall be adequate to insure continuous application of the required amount of water to sections being processed within 3 hours of the application of the cement. Proper care shall be exercised to insure proper moisture distribution at all times. After the last increment of water has been added, mixing shall continue until a thorough and uniform mix has been obtained.

2. Single-Pass Traveling Mixing Plant. After the cement has been applied, it shall be sufficiently dry-mixed with the soil to prevent the formation of cement balls when water is applied. Unpulverized soil lumps in the soil cement mixture immediately behind the mixture that are dry shall not be allowed. Should this condition prevail, the CONTRACTOR shall "prewet" the raw soil as necessary to correct this condition. The mixer shall be provided with means for visibly and accurately gauging the water application. The water shall be applied uniformly through a pressure spray bar.

After cement is spread, mixing operations shall proceed as follows:

The mixer shall, in one continuous operation, mix the air-dry soil and cement full depth; add the required moisture uniformly; thoroughly moist-mix the soil, cement and water; spread the completed soil cement mixture evenly over the machine-processed width of the subgrade; and leave it in a loose condition ready for immediate compaction. The soil and cement mixture shall not remain undisturbed after mixing and before compacting for more than 30 minutes.

3. Central Mixing Plant. The soil, cement and water shall be dry-mixed in a pugmill either of the batch or continuous-flow type. The plant shall be equipped with feeding and metering devices which shall add the soil, cement and water into the mixer in the specified quantities. Soil 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 soil, 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. Dumping of the mixture in piles or windrows upon the subgrade shall not be permitted.

(d) 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 4 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 2 percentage points above the specified optimum moisture content and shall be less than the 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 the 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 2 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 1/4 in. (6 mm), 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 2 hours, a smooth, closely knit surface, free of cracks, ridges or loose material, conforming to the drawn grade and line shown on the plans.

4.7.5. PROTECTION AND COVER
After the roadway has been finished as specified herein, it shall be immediately protected against rapid drying by applying 2/10 (0.2) gallon per yard (1L per m²) RC-2 cut-back 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 7 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.

4.7.6. 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 7 days.

4.7.7. MAINTENANCE
The CONTRACTOR shall be required within the limits of his contract to maintain the soil-cement treatment in good condition from the time he first starts work until all work shall have 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.

4.7.8. MEASUREMENT AND PAYMENT
This work shall be measured by the square yard (m²) of completed and accepted cement stabilized base course. Measurement for cement shall be by the ton, 2000 lb. (900 kg) 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 soil-cement treated base, subbase, or subgrade course, which price shall be full compensation for pulverizing the soil material; handling, hauling and spreading cement; 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 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.

ITEM 4.8. ASPHALT TREATMENT

4.8.1. DESCRIPTION

This item shall consist of a treated course composed of a combination of soil and liquid asphaltic material uniformly mixed, compacted and finished in accordance with these specifications and shaped to the lines, grades, thickness and typical cross section shown on the plans, or as directed by the OWNER.

4.8.2. MATERIAL

(a) Asphaltic Material. The asphaltic material shall be of the type and grade shown on the plans and shall conform to requirements for the grade specified, as described in Item 2.4., “Bituminous Materials.”

(b) Water. Water shall conform to the requirements of Item 2.2.4., “Water.”

(c) Soil. Soil shall consist of approved soil, free from vegetation or other objectionable matter, and may be either the material encountered in existing roadbed; the material secured from sources shown on the plans or approved by the OWNER; or of a combination of existing material and additional soil from approved sources, all as shown on the plans.

4.8.3. EQUIPMENT

(a) General. Equipment necessary for the proper construction of work shall be on the project, in first class working condition, and shall be approved by the OWNER, both as to type and condition, prior to the beginning of construction operations. The CONTRACTOR shall at all times provide sufficient equipment to insure continuous prosecution of the work and its completion in the required number of working days. If in the opinion of the OWNER, additional pieces of equipment are required for the mixing, aerating, compacting and finishing of the asphaltic mixture or to achieve a rate of progress which shall insure completion of the work in the required number of working days, the CONTRACTOR shall, upon written request of the OWNER, immediately secure and place in operation the required equipment. Any machine, combination of machines or equipment which shall pulverize the soil, apply the asphalt, mix the component materials and compact and finish the mixture in conformance with these specifications may be used upon approval of the OWNER.

(b) Mixing Plants. The use of a traveling plant for the mixing of soils and/or the mixing of the asphaltic material with the soil shall be permitted, provided the CONTRACTOR makes a written request for the use of this type of equipment and such request is approved in writing by the OWNER. The CONTRACTOR'S request shall describe in full the equipment desired to be used, stating the make, type, size and capacity of such equipment and citing its successful use on similar work. Such an approval of change in type of equipment shall in no way modify the results required by this specification.

4.8.4. CONSTRUCTION METHODS

The roadbed shall be excavated and shaped as required herein and in other pertinent specification items.

Asphalt shall not be applied to a course for stabilization when the air temperature is below 60°F (16°C) and is falling but may be mixed when the air temperature is above 50°F (10°C) and rising, the temperature being taken in the shade and away from artificial heat, and with the further provision that the asphaltic mixture shall be mixed or placed only when weather conditions, in the opinion of the OWNER, are suitable.

Where required by the plans or directed by the OWNER, additional soil shall be delivered and emplaced on the road in the quantity ordered by the OWNER to provide a soil of the characteristics desired for the construction of the treated course. Such soil shall be delivered in approved vehicles of a uniform capacity. It shall be the responsibility of the CONTRACTOR that the required amount of material shall be delivered to secure the proper thickness of com-
completed soil-asphalt course. The material shall be spread uniformly over the width of the roadbed. When the method of mixing requires the use of windrows, they shall be of uniform section.

The soil to be stabilized shall be loosened to a sufficient depth and width to achieve the compacted thickness shown on the plans. All roots, sod and other deleterious material shall be removed from the loose soil. The soil, exclusive of aggregate, shall be pulverized until not less than 80 percent passes a No. 4 sieve before any asphalt is applied. If the CONTRACTOR desires, sprinkling the soil to assist in pulverizing shall be permissible.

Prior to the application of asphaltic material, the moisture content of the loose soil shall be uniform throughout the width and depth. The moisture shall in no case be sufficiently great to prevent proper dispersion of the asphaltic material and, if necessary, the soil shall be dried before the asphaltic material is applied.

The soil may be sprinkled with water to assist in the proper dispersion of asphaltic material if the CONTRACTOR so desires.

(a) Mixing. When mixed-in-place methods are used prior to the application of asphalt, the loose soil shall be shaped to the approximate cross section shown on the plans. Asphalt shall not be applied to loose soil when the subgrade or secondary subgrade shall not support, without displacement, the construction equipment.

(1) Blade Mixing. In blade mixing, the asphalt shall be distributed uniformly in such amounts as are determined by the OWNER. It shall be applied at the temperature prescribed for the particular asphalt being used. Immediately behind the distributor, after each application of asphalt, shall follow the mixing equipment, partially mixing the soil and the asphalt so as to leave as little free asphalt as possible. The intervals between application shall be as directed by the OWNER. After the last application of asphalt and partial mixing, the entire mass of asphalt and soil shall be windrowed on the road surface and then mixed as specified by blading the mix from side to side across the roadbed, or by a manipulation producing equivalent results, until the whole mass has a uniform color and texture. The mixture shall be free from fat and lean spots. During the mixing operations, care shall be taken to avoid cutting into the underlying course or contaminating the mixture with raw soil or other extraneous matter.

Where the plans show a depth greater than 6 in. (15 cm), the mixing operations shall be divided into two or more equal courses, except where traveling plants are used. After mixing has been completed, the material shall be brought together in a windrow. The OWNER shall then determine the suitability of the mixture for laying. If the mixture is not suitable for laying, the CONTRACTOR shall perform such additional manipulation or make such modifications as the OWNER may require.

At the end of each day's work, or when the work is interrupted by weather conditions, all loose material shall be bladed into the proper cross section or into a windrow as directed by the OWNER. No mixture shall be spread on a subgrade or secondary subgrade that has become unstable due to weather conditions or from other causes.

(2) Mixing Plants. When a traveling plant is used, the existing foundation shall be prepared, conditioned and the moisture content adjusted as previously outlined.

If the machine is equipped to operate from windrows, the pulverized soil shall be thrown up into windrows and the windrows shall be struck off to a uniform volume by the use of an equalizer or other approved means. After the material has been mixed and deposited in the windrows by the traveling plant, the OWNER shall determine its suitability for laying and compacting. If additional mixing is necessary, it shall be accomplished by reuse of the machine, by blading or other approved methods.

When a central mixing plant is used, the soil and aggregates shall be pulverized to conform to the aforementioned requirements. The proportions of soil and asphalt shall be measured and introduced into the mixer in accordance with the OWNER'S directions and the whole mass mixed until a uniform mixture is secured.

After the soil and asphalt have been mixed, the mixture shall be aerated until the total liquid content is within the limits required to insure proper compaction, after which it shall be spread and compacted as specified below.

(b) Compaction. Upon the completion of mixing of the entire quantity of material required to produce the complete course or the layers of the course as specified hereinbefore, the mixed material shall be spread to the required section, shaped, compacted and finished in conformity with the typical sections shown on the plans and the line and grade established by the OWNER. The shaping and compacting operations shall be continued until the course is uniformly compacted to the extent that it shall support loaded trucks and other construction equipment without appreciable displacement. Compaction shall be accomplished by blading and rolling the material at the proper moisture content to
the end that a uniform mass without laminations or cleavage planes in the completed layer is obtained, having an apparent dry density of not less than 90 percent of the maximum dry density of such material.

The maximum dry density shall be determined from a moisture-density curve-run on road-mix samples in accordance with Texas SDHPT Test Method Tex-119-E. The shaping and compaction of the soil-asphalt course or of a layer of the soil-asphalt course shall be continuous, and the compaction and finishing of the course shall be completed within the daylight hours of that day on which such work is begun, unless unforeseen conditions prevent such completion. Along curbs and at other places not accessible to the rollers, or in such positions that shall not allow thorough compaction with the usual equipment, the mixture shall be compacted to the required density by the use of lightly oiled hand tamps. Construction joints, formed at the end of each day’s work or due to unavoidable interruption of operations, shall be placed in such manner that a satisfactory riding surface shall be secured.

The completed soil-asphalt course shall be allowed to dry as thoroughly as possible and to the satisfaction of the OWNER. During the drying period, traffic shall be allowed to use the completed course. The course shall be sprinkled, bladed and rolled as directed and maintained true to the required sections and to the established lines and grades until a subsequent base or surface course is placed. In no case shall the drying period for each course be less than 10 days. Any portion of the treated course which, after compaction, fails to meet the requirements for apparent dry density and stability, as specified above, shall be scarified and recomputed at the CONTRACTOR’S entire expense.

4.8.5. MAINTENANCE

The CONTRACTOR shall be required at his own expense to maintain in good condition and satisfactory to the OWNER the entire roadway, within the limits of his contract, from the time he first starts work until all work shall have been completed.

Maintenance shall include immediate repairs of any defects that may occur either before or after the subsequent course is applied. Such work shall be done without cost to the OWNER and repeated as often as may be necessary to keep the pavement continuously intact until final acceptance by the OWNER. Repairs are to be made in a manner which shall insure restoration of a uniform surface. Durability of the part required shall be measured in its final position and the volume computed in cubic yards (m³) by the method of average end area.

Soil-asphalt course shall be measured by the square yard (m²) of surface area of completed and accepted work based on the width of the soil-asphalt course as shown on the plans or as established by the OWNER. Asphaltic material of the type and grade shown on the plans shall be measured in gallons (liters) at the applied temperature at the point of application on the road.

Work performed and materials furnished as prescribed and measured by this item shall be paid for at the unit prices bid for soil-asphalt course and additional soil, which prices shall be full compensation for cleaning the roadbed or the surface of the previously completed base course; for furnishing all materials; for loosening, excavating, loading, hauling and delivering additional soil on the road; for loosening, mixing and pulverizing of the soil; for shaping, sprinkling and compacting the subgrade; for all processing, mixing, drying, incorporation of asphaltic material, aerating and drying, spreading, sprinkling, shaping, compacting, and finishing; for maintaining under traffic; and for all manipulations, labor, equipment, fuels, tools and incidentals necessary to complete the work as herein after provided.

Asphaltic material measured as provided in this item shall be paid for at the unit price bid for asphaltic material, which price shall be full compensation for furnishing the material; for all freight involved; for all unloading, storing, heating, hauling and applying on the road; and for all labor, equipment, fuels, tools and incidentals necessary to complete work.

ITEM 4.9. PORTLAND CEMENT MODIFICATION OF SUBGRADE SOILS

4.9.1 DESCRIPTION

This item shall consist of the treating of 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.
4.9.2 MATERIALS

(a) Portland Cement. Cement shall conform to the requirements of Item 2.2.1., "Cement."
(b) Water. Water shall conform to the requirements of Item 2.2.4., "Water."
(c) Soil. The subgrade shall consist of the in-situ soil or approved soil, free of roots and other objectionable matter.

4.9.3 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.

4.9.4 CONSTRUCTION METHODS

(a) 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 subbase, 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.

(b) 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.

(c) 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.

<table>
<thead>
<tr>
<th>Minimum Passing</th>
<th>Sieve</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 3/4 in.</td>
<td>100%</td>
</tr>
<tr>
<td>Minimum Passing</td>
<td>No. 4 Sieve</td>
<td>60%</td>
</tr>
</tbody>
</table>

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.
(d) Compaction. Compaction shall begin after mixing and after gradation and moisture requirements have been met. The material shall be compacted to at least 95 percent of the maximum density as determined by ASTM D 698. Moisture content shall be within minus 2 to plus 4 of optimum. The material shall be aerated or wetted as necessary to provide optimum moisture. Moisture tolerances shall be as described below.

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.

<table>
<thead>
<tr>
<th>Description</th>
<th>Density, Percent</th>
<th>Moisture, Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>For cement treated subgrade that will receive subsequent courses.</td>
<td>Not less than 95, except when shown otherwise on the plans.</td>
<td>Within 2.5 of optimum unless otherwise shown on the plans.</td>
</tr>
</tbody>
</table>

In-Place Density tests shall be as outlined in ASTM D 2922. In-Place Density tests shall be performed at the rate of one per 300 linear ft. 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.

(e) 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.

4.9.5 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 2 in., filling the area with treated material and compacting.

4.9.6. MEASUREMENT AND PAYMENT

This work shall be measured by the square yard (m²) of completed and accepted cement-modified soil. Measurement for cement shall be by the ton, 2,000 lb. (900 kg) 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, handling, hauling, and spreading the dry or slurry cement mixture; 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 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.
PART III. CONSTRUCTION METHODS

DIVISION 5. PAVEMENT AND SURFACE COURSES

Item 5.1. Asphalts, Oils and Emulsions
Item 5.2. Gravel Surface
Item 5.3. Prime Coat
Item 5.4. Emulsified Asphalt Treatment
Item 5.5. Single Bituminous Surface Treatment (Seal Coat)
Item 5.6. Double Bituminous Surface Treatment
Item 5.7. Hot-Mix Asphalt Concrete Pavement
Item 5.8. Portland Cement Concrete Pavement
This page was intentionally left blank.
DIVISION 5. PAVEMENT AND SURFACES COURSES

ITEM 5.1. ASPHALT, OILS AND EMULSIONS

5.1.1. DESCRIPTION
This item establishes the requirements for oil asphalts, road oils, emulsified asphalts, asphaltic cement and other miscellaneous asphaltic materials and latex additives.

5.1.2. MATERIALS
When tested, the various materials shall meet the applicable requirements of Item 2.4., “Bituminous Materials.”

5.1.3. STORAGE, HEATING AND APPLICATION TEMPERATURES
Asphaltic material should be applied at the temperature which provides proper and uniform distribution and within practical limits, avoiding higher temperatures than necessary. Satisfactory application usually should be obtained within the recommended ranges shown in Item 2.4.12(a), Table No. 12. No material shall be heated above the maximum temperatures.

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 same. The CONTRACTOR shall be responsible for any fires or accidents which may result from heating the asphaltic materials.

5.1.4. 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.

ITEM 5.2. GRAVEL SURFACE
See Item 4.5., “Flexible Base.”

ITEM 5.3. PRIME COAT

5.3.1. 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 of the plans.

5.3.2. MATERIALS
(a) Asphalt. The asphaltic material used for the prime coat shall be of the type and grade as stated in the contract and when tested by approved laboratory methods shall meet the requirements of Item 2.4.2., “Oil Asphalt,” and Item 2.4.8., “Emulsified Asphalt.”

(b) 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.

5.3.3. CONSTRUCTION METHODS
If required by the plans or the OWNER, a combination of asphaltic material and sand shall be used as specified herein; otherwise, only asphaltic material shall be used.

Prime coat shall not be applied when the air temperature is below 50°F (10°C) and falling, but it may be applied when the air temperature is above 40°F (5°C) 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.

(a) Asphaltic Material Only. When, in the opinion of the OWNER, the base is thoroughly dry and is satisfactory to receive the prime coat, the surface shall be cleaned by sweeping or other approved methods. The asphaltic material
shall then be applied to the cleaned base at the approximate rate of \( \frac{3}{10} \) (0.2) to \( \frac{1}{2} \) (0.5) gallons per square yard (1 to 2 L per m²) 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 distribution, 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 the 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 2.4.2., “Oil Asphalt.” The CONTRACTOR shall apply the asphalt at a temperature within 15°F (3°C) 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 material or the gases of same. The CONTRACTOR shall be responsible for any fires or accidents which may result from heating the asphaltic materials.

(b) Asphaltic Material and Sand. Native sand, as specified above, shall be hauled in vehicles of uniform capacity and placed on shoulders at spacings 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 (a), “Asphalt Material Only,” shall also apply.

5.3.4. 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.

ITEM 5.4. EMULSIFIED ASPHALT TREATMENT

5.4.1. DESCRIPTION

Emulsified asphalt treatment shall consist of one or more applications of a mixture of emulsified asphalt (of the type specified on the plans) and water. It is to be used as a base treatment, earthwork seal, prime coat or dust preventative. This mixture may be applied to the base course, subgrade, shoulders or detours at the locations and to the extent shown on plans or as directed by the OWNER.

5.4.2. MATERIALS

The amount of emulsified asphalt in the mixture, expressed as a percent by volume of the total mixture, shall be within the limits specified on the plans. When tested by approved laboratory methods, the emulsified asphalt used shall meet the requirements of Item 2.4.2., “Oil Asphalt.” The water used shall be clear, free from industrial wastes and other objectionable matter.
5.4.3 CONSTRUCTION METHODS

The emulsified asphalt and water mixture shall be applied by a self-propelled sprinkler meeting the requirements of Item 4.1., “Sprinkling for Dust Control,” so operated as to uniformly distribute the mixture in the quantity determined by the OWNER.

The emulsion and water may be mixed in the sprinkler tank. The CONTRACTOR shall make suitable provisions for agitating the two materials sufficiently to produce a uniform blend. The sprinkler tank 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 emulsion applied appear to be in error, the distributor shall be recalibrated in a manner satisfactory to the OWNER, before proceeding with the work.

5.4.4 MEASUREMENT AND PAYMENT

Emulsified asphalt shall be measured by the gallon (liter) prior to mixing with water. The work performed and the emulsified asphalt furnished as prescribed by this item and measured as provided in this item shall be paid for at the unit price bid for “Emulsified Asphalt” of the type specified, which price shall be full compensation for furnishing all required materials including mixing water for application; all freight involved; all hauling, mixing, and distributing the mixture as specified; and all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 5.5 SINGLE BITUMINOUS SURFACE TREATMENT (SEAL COAT)

5.5.1 DESCRIPTION

This item shall consist of a surface treatment composed of a single application of asphalt covered with aggregate for the sealing of existing pavements in accordance with these specifications.

Seal coats shall not be applied when the air temperature is below 50°F (10°C) and is falling but may be applied when the air temperature is above 40°F (5°C) and is rising, the air temperature being taken in the shade and away from artificial heat. Asphaltic material shall not be placed when, in the opinion of the OWNER, general weather conditions are not suitable.

5.5.2 MATERIALS

(a) Asphaltic Material. The asphaltic material used for seal coating shall be of the type and grade as stated in the contract or as directed by the OWNER and shall meet the requirements of Item 2.4.2., “Oil Asphalt.”

| WARNING TO CONTRACTOR: | 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 same. The CONTRACTOR shall be responsible for any fires or accidents which may result from heating the asphaltic materials. |

(b) Aggregate. The aggregate shall be composed of sound, durable particles of gravel, stone, or steel slag having a percent of wear of not more than 35 when tested in accordance with the current Method of Test for Abrasion of Coarse Aggregate by Use of Los Angeles Machine, ASTM Designation C 131. The aggregate shall be free from organic matter, clay, loam, or coated pebbles and shall contain not more than five percent of slate, shale, schist, or soft particles.

Aggregate when tested by standard laboratory methods shall meet the following grading requirements of percentages by weight:

<table>
<thead>
<tr>
<th>FINE GRADED SURFACE COURSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 7/8 in. sieve</td>
</tr>
<tr>
<td>Passing 1/2 in. sieve</td>
</tr>
<tr>
<td>Passing 3/8 in. sieve</td>
</tr>
<tr>
<td>Passing No. 10 sieve</td>
</tr>
</tbody>
</table>
5.5.3. CONSTRUCTION METHODS
All storage tanks, piping, retorts, booster tanks, and distributors used in storing or handling asphalt shall be kept clean and in good operating condition at all times. They shall be operated in such a manner that there shall be no contamination of the asphalt with foreign material.

Asphalt shall not be heated above 350°F (175°C). The asphalt shall be applied at a temperature within the recommended range shown in Item 2.4.2., “Oil Asphalt.”

The surface to be treated shall be cleaned of dirt, dust or other deleterious matter by sweeping or other approved methods. If found necessary by the OWNER, the surface upon which the asphalt is to be applied shall be lightly sprinkled just prior to the first application of asphaltic material. Asphaltic material shall be applied on the clean surface by an approved type of self-propelled pressure distributor so operated as to distribute the asphalt in the quantity specified, evenly and smoothly under a pressure necessary for proper distribution. All necessary facilities for determining the temperature of the asphalt in all of the heating equipment and in the distributor, for determining the rate of application and for insuring uniformity at the junction of two distributor loads shall be provided. 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 appear to be in error, the distributor shall be recalibrated in a manner satisfactory to the OWNER before proceeding with the work.

Asphaltic material may be applied for the full width of the seal coat in one application unless the width exceeds 26 ft. (8 m). Asphaltic material shall not be applied until immediate coverage with aggregate is assured.

Aggregate shall be immediately and uniformly applied and spread by mechanical spreading devices of approved design at the approximate rates given in the following table and as directed by the OWNER. After the work has been completed as specified, the surface shall be broomed, bladed or raked as required by the OWNER and shall be thoroughly rolled with both pneumatic tire and steel wheel (3 to 6 tons) (2700 kg to 5400 kg) rollers to insure proper embedding into the bitumen. The rolling shall be continued until no more aggregate can be worked into the surface. Rolling equipment shall meet the governing specifications for Item 4.2., “Rolling.”

The CONTRACTOR shall be responsible for the maintenance of the surface and the distribution of the excess aggregate until the work is accepted by the OWNER. All holes or failures in the seal coat surface shall be repaired by use of additional asphalt and aggregate. All fat or bleeding surfaces shall be covered with approved cover material in such a manner that the asphaltic materials shall not adhere to or be picked up on the wheels of vehicles.

Asphalt shall be applied at the maximum rate of 0.25 gallon per square yard (1 liter per square meter) of surface and aggregate shall be applied at the rate of 1 C.Y. per S.Y. (1 m³ per m²) of surface or as otherwise specified.

5.5.4. MEASUREMENT AND PAYMENT
Asphalt shall be measured in gallons (liters) at the applied temperature at the point of application on the project.

Aggregate shall be measured by the cubic yard (m³) in the vehicle on the project or at the place of stockpile.

Rolling shall not measured for payment but shall be considered as subsidiary to the Items of “Asphalt” and “Aggregate,” which price shall be full compensation for cleaning and sprinkling the existing surface; for furnishing, preparing, hauling and placing all materials; for all blading, brooming and rolling; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 5.6. BITUMINOUS SURFACE TREATMENT

5.6.1. DESCRIPTION
This item shall consist of a wearing surface composed of one, two or three applications of asphaltic materials, each covered with aggregate, constructed on the prepared base course or surface in accordance with the requirements as shown on the plans and these specifications.

5.6.2. MATERIALS
(a) Asphaltic Materials. The asphaltic materials used shall be of the type and grade as stated in the contract or as directed by the OWNER and shall meet the requirements of Item 2.4.2., “Oil Asphalt.”

(b) Aggregate. The aggregate shall be composed of sound, durable particles of gravel, stone, or steel slag having a percent of wear of not more than 35 when tested in accordance with the current Method of Test for Abrasion of
Coarse Aggregate by Use of Los Angeles Machine, ASTM Designation C 131. The aggregate shall be free from organic matter, clay, loam, or coated pebbles and shall contain not more than five percent of slate, shale, schist, or soft particles.

Aggregate when tested by standard laboratory methods shall meet the following grading requirements of percentages by weight:

**SMALLER AGGREGATE**

<table>
<thead>
<tr>
<th>Small Aggregate “SB” (First Application)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained on 3/8 in. sieve</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Retained on 1/2 in. sieve</td>
<td>0 — 10%</td>
<td></td>
</tr>
<tr>
<td>Retained on 3/4 in. sieve</td>
<td>70 — 100%</td>
<td></td>
</tr>
<tr>
<td>Retained on No. 10 sieve</td>
<td>95 — 100%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Small Aggregate “ST” (Second Application)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained on 3/8 in. sieve</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Retained on 1/2 in. sieve</td>
<td>2 — 20%</td>
<td></td>
</tr>
<tr>
<td>Retained on No. 10 sieve</td>
<td>70 — 100%</td>
<td></td>
</tr>
<tr>
<td>Retained on No. 20 sieve</td>
<td>95 — 100%</td>
<td></td>
</tr>
</tbody>
</table>

**LARGER AGGREGATE**

<table>
<thead>
<tr>
<th>Large Aggregate “LB” (First Application)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained on 1 in. sieve</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Retained on 3/8 in. sieve</td>
<td>15 — 45%</td>
<td></td>
</tr>
<tr>
<td>Retained on 1/2 in. sieve</td>
<td>85 — 100%</td>
<td></td>
</tr>
<tr>
<td>Retained on 3/4 in. sieve</td>
<td>98 — 100%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Large Aggregate “LT” (Second Application)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained on 3/8 in. sieve</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Retained on 1/2 in. sieve</td>
<td>0 — 10%</td>
<td></td>
</tr>
<tr>
<td>Retained on 3/4 in. sieve</td>
<td>65 — 85%</td>
<td></td>
</tr>
<tr>
<td>Retained on No. 10 sieve</td>
<td>90 — 100%</td>
<td></td>
</tr>
<tr>
<td>Retained on No. 20 sieve</td>
<td>98 — 100%</td>
<td></td>
</tr>
</tbody>
</table>

(c) Rates of Application. The asphalt and aggregates shall be applied at the approximate rates indicated on the plans within the following limits, as directed by the Engineer.

<table>
<thead>
<tr>
<th>SMALLER AGGREGATE</th>
<th>Asphalt (Gal. per Sq. Yd.)</th>
<th>Aggregate (Cu. Yd. per Sq. Yd.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>First, Aggregate “SB”</td>
<td>0.20</td>
<td>0.30</td>
</tr>
<tr>
<td>Second, Aggregate “ST”</td>
<td>0.30</td>
<td>0.40</td>
</tr>
</tbody>
</table>
The CONTRACTOR shall be responsible for the maintenance of the surface and distribution of the excess aggregate until final completion and acceptance of the entire project by the OWNER.

(d) Aggregate. The aggregate used shall be of the type and grade or types and grades selected from those prescribed in Item 5.2., “Gravel Surface.” The particular type and grade or types and grades shall be as provided on the plans or as required by the OWNER.

5.6.3. CONSTRUCTION METHODS

No surface treatment course or courses shall be applied when the air temperature is below 50°F (10°C) and is falling but may be applied when the air temperature is above 40°F (5°C) and is rising. Air temperature shall be 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.

The area to be treated shall be cleaned of dirt, dust or other deleterious matter by methods. If it is found necessary by the OWNER, the surface shall be lightly sprinkled just before the asphaltic material is applied. Asphaltic material of the type and grade shown on the plans shall be applied on the clean surface by an approved type of self-propelled pressure distributor so operated as to distribute the material in the quantity specified, evenly and smoothly, under a pressure necessary for proper distribution. The CONTRACTOR shall provide all necessary facilities for determining the temperature of the asphaltic materials in all of the heating equipment in the distributor, for determining the rate at which they are applied, and for securing uniformity at the junction of two distributor loads. 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 materials appear to be in error, the distributor shall be recalibrated in a manner satisfactory to the OWNER before proceeding with the work.

Asphaltic materials for each course may be applied for the full width of the surface treatment in one application, unless the width exceeds 26 ft. (8 m). No traffic or hauling shall be permitted over the freshly applied asphaltic materials. Asphaltic materials shall not be applied until immediate covering is assured.

Aggregate, of the type and grade shown on the plans for the first course, shall be immediately and uniformly applied and spread by an approved calibrated mechanical spreaders, operated on the rear of the aggregate trucks or as a separate power-driving unit. These spreader units shall be approved by the OWNER prior to the start of the work. The aggregate shall be applied at the approximate rates indicated on the plans and as directed by the OWNER. The entire surface shall then be broomed, bladed or raked as required by the OWNER and shall be thoroughly rolled with both pneumatic tire and steel wheel (3 to 6 tons) (2,700 kg to 5,400 kg) rollers to insure proper embedding into the bitumen. The rolling shall be continued until no more aggregate can be worked into the surface. Rolling equipment shall meet the governing specifications for Item 4.2., “Rolling.”

Where double or triple surface courses are specified on the plans, each succeeding course shall be constructed as hereinbefore prescribed for the first course. The amount of asphaltic material and aggregate for multiple-course construction shall be as shown on the plans or as directed by the OWNER.

The CONTRACTOR shall be responsible for the maintenance of the surface until the work is accepted by the OWNER.

Temporary stockpiling of aggregates on the roadways shall be permitted, provided the stockpiles are spaced not less than 1,000 ft. (300 m) apart and are so placed that they neither obstruct traffic nor interfere with roadway drainage. The CONTRACTOR shall be responsible for the proper preparation of all stockpile debris necessary for protection of the aggregate and to prevent any combination thereof.

---

<table>
<thead>
<tr>
<th>Application</th>
<th>Asphalt (Gal. per Sq. Yd.)</th>
<th>Aggregate (Cu. Yd. per Sq. Yd.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>First, Aggregate “LB”</td>
<td>0.25</td>
<td>0.35</td>
</tr>
<tr>
<td>Second, Aggregate “LT”</td>
<td>0.35</td>
<td>0.45</td>
</tr>
</tbody>
</table>
All storage tanks, piping, retorts, booster tanks and distributors used in storing or handling asphaltic materials shall be kept clean and in good operating condition at all times; and they shall be operated in such 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 OWNER shall select the temperature of application based on the temperature-viscosity relationship that shall permit application of the asphalt with the limits recommended in Item 2.4.2., "Oil Asphalt." The CONTRACTOR shall apply the asphalt at a temperature within 15°F (8°C) of the temperature selected.

5.6.4. MEASUREMENT AND PAYMENT
Asphaltic surface treatments shall be measured by the square yard (m²) of surface area of completed and accepted per "One, Two, or Three Course Surface Treatment."

Rolling shall not be measured for payment but shall be considered as subsidiary to the Items of "Asphalt" and/or "Aggregate." Work performed and materials furnished as prescribed by this item and measured as provided in this item shall be paid for at the unit price bid for "One, Two, or Three Course Surface Treatment," which price shall be full compensation for cleaning and sprinkling the base; for furnishing, preparing, hauling and placing all materials; for all blading, brooming, rolling; and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 5.7. HOT-MIX ASPHALTIC CONCRETE PAVEMENT

5.7.1. 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, subbase 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.

5.7.2. ASPHALTIC MATERIALS
(a) Paving Mixture. Asphalt for the paving mixture shall be of the type and grade of asphaltic cement as determined by the OWNER and shall meet the requirements of Item 2.4.2., "Oil Asphalt." 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.

(b) Prime Coat. The asphaltic material for prime coat shall be of type and grade as shown on the plans or as directed by the OWNER and shall conform to the requirements of Item 2.4.2., "Oil Asphalt."

(c) Tack Coat. The asphaltic material for tack coat shall be of the type and grade as shown on the plans or as directed by the OWNER and shall conform to the requirements of 2.4.2., "Oil Asphalt."

5.7.3. 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.

(a) 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 text.

(b) Rollers.

(1) Pneumatic Tire Roller. This roller shall consist of not less than 7 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 contract pressures up to 90 lb. per square inch (0.62 MPa) 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.

(2) Two Axle Tandem Roller. This roller shall be acceptable power-driven, steel-wheel, tandem roller weighing not less than 8 tons (7,200 kg). 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.

(3) Three Wheel Roller. This roller shall be an acceptable power-driven, all steel 3 wheel roller weighing not less than 10 tons (9,000 kg). 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.

(4) Vibratory Steel Wheel Roller. If approved for use by the OWNER, this roller shall have a minimum weight of 6 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 recommendations.

(c) Straightedges. The CONTRACTOR shall provide acceptable 16 ft. (5 m) 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.

5.7.4. CONSTRUCTION METHODS

(a) General. The prime coat, tack coat or the asphaltic mixture shall not be placed when the air temperature is below 50°F (10°C) and is falling but may be placed when the air temperature is above 40°F (5°C) 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.

(b) Prime Coat. If required, a prime coat shall be applied to the completed subgrade, subbase or base, in accordance with Item 5.3., "Prime Coat." The type and grade of asphaltic material and the application rate shall be as shown on the plans or as directed by the OWNER.

(c) Tack Coat. A tack coat shall be applied when the surface to be paved is Portland cement concrete, brick or asphaltic pavement. When a tack coat is required, it shall consist of an application of the asphaltic material indicated and shall be at the rate specified on the plans or as directed by the OWNER, but not to exceed \( \frac{1}{10} \) (0.10) gallons per square yard (0.5 L per m²) of surface area. 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.

(d) Compacted Thickness of Asphaltic Concrete Surface Courses and Base Courses.

(1) 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 2 in. (5 cm) compacted depth, same shall be placed in multiple courses of equal depth, each of which shall not exceed 2 in. (5 cm) 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 as in Item 5.7.4.(a)(3), and at the rate as directed.

(2) 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 in. (10 cm), 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.

(e) 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.

(f) Temperature. The asphaltic mixture shall be at a temperature between 225 and 350°F (104°C to 177°C) when dumped from the mixer. The OWNER shall determine the temperature, within the above limitations. The mixture when dumped from the mixer shall not vary from this selected temperature more than 30°F (17°C) plus.
(g) 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, be smooth and 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.

(h) Compaction. Rolling with the 3-wheel and tandem roller 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 the surface course when it has not been fully compacted and allowed to cool. To prevent 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 Texas State Department of Highways and Public Transportation Bulletin C-14.

(i) 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 ft. (5 m) straightedge placed parallel to the centerline of the roadway, the finished surface shall have no deviation in excess of 1/16 in per foot (5 mm per m) from the nearest point of contact. The maximum ordinate measured from the face of the straightedge shall not exceed 1/4 in. (6 mm) at any point. Any point in the pavement surface not meeting these requirements shall be immediately corrected.

(j) 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 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.

5.7.5 MEASUREMENT AND PAYMENT
Prime coat and 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.

Hot-mix asphaltic concrete material shall be measured by the ton complete in place, of 2,000 lb. (900 kg), computed at 110 lb./S.Y. per inch or by the square yard (m²) 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 in the proposal, which price shall be payment in full for quarrying, furnishing all materials, heating, mixing, hauling, cleaning existing base course or pavement, placing asphaltic mixtures, rolling and finishing, and 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.
ITEM 5.8. PORTLAND CEMENT CONCRETE PAVEMENT

5.8.1. 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.

5.8.2. CONSTRUCTION METHODS

(a) Subgrade. When manipulation or treatment of subgrade is required on the plans, the work shall be performed in proper sequence with the preparation of the subgrade for pavement.

The roadbed shall be excavated and shaped in conformity with the typical sections and to the lines and grades shown on the plans or established by the OWNER. Material excavated in the preparation of the roadbed in excess of that needed to properly construct the subgrade, shoulders, slopes or parkway shall be wasted. If additional material is required, it shall be secured from sources indicated on the plans or designated by the OWNER. All holes, ruts and depressions shall be filled with suitable material and, if required, the subgrade shall be thoroughly wetted and reshaped. Irregularities of more than 1/16 in. (12.5 mm), as shown by straightedge or template, shall be corrected. The subgrade shall be uniformly compacted to at least 95 percent of the maximum density as determined by ASTM D 698. Moisture content shall be within minus 2 to plus 4 of optimum. The prepared subgrade shall be wetted down sufficiently in advance of placing the pavement to insure its being in a firm and moist condition for at least 2 in. (5 cm) below the surface. Sufficient subgrade shall be prepared in advance to insure satisfactory prosecution of the work. No hauling or equipment shall be permitted on the finished subgrade.

(b) Foundation Course. The foundation course shall be of a new material as specified in Item 5.2., “Gravel Surface,” and shall be compacted to at least 92 percent of the maximum density as determined by ASTM D 1557. Moisture content shall be within minus 2 to plus 4 of optimum.

(c) Placing and Removing Forms. Forms shall be set to line and grade at least 200 ft. (60 m), where practicable, in advance of the paving operations. They shall be adequately staked with at least three pins per 10 ft. (3 m) 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.

(1) Settling. When forms settle over 1/8 in. (3 mm) 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.

(2) Cleaning and Oiling. Forms shall be thoroughly cleaned after each use and well oiled before reuse.

(3) Removal. Forms shall remain in place until the concrete has taken its final set. At the time the forms are removed, earth shall be banked against the sides of the slab and immediately and thoroughly wetted.

(4) Curb. Superimposed or monolithic curb shall be formed from the flowline of the gutter to the top of the curb. All expansion joints in the curbs shall conform to the joint locations in the slab.

(d) Placing Reinforcing Steel, Tie, and Dowel Bars. When reinforcing steel, welded wire mesh, tie bars, dowels, etc., are required, they shall conform to the provisions set out under Items 2.2.5., 2.2.6. 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 the alternate intersections and all splices and shall be securely wired to each intersection dowel and load-transmission unit intersected. All bars shall be installed in their require disposition 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 trans-
verse 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) Welded Wire Mats. Where welded wire fabric reinforcement mats are required by the plans, or permitted as an alternate by the OWNER, the concrete shall be placed and struck off by means of a template to the depth below the finished surface as specified for the location of the mesh. Welded wire mats, conforming to the specified side lap and end splice requirements as detailed on the plans, shall be placed upon the struck surface. The remainder of the concrete shall be placed thereupon with finishing operations proceeding immediately. There shall be no loading imposed upon the mesh mats after installation in the slab concrete.

(3) 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.

(e) Joints.

(1) 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 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 lb. per cubic foot (.5 gm/cm³). 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.

(A) 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 1/2 in. (12.5 mm) 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 1 1/2 in. (37.5 mm) 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.

(B) 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.

(C) 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.

(D) 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.

(2) 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 1/4 in. (6 mm) 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 the 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 5 to 12 hours after the concrete slab is poured, including the sealing operation, Item 2.2.10. The sawed groove shall be thoroughly cleaned for the full depth and width of the joint and filled, Item 2.2.10. The type of equipment and method for performing this work shall be approved by the OWNER.

(3) 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 1 1/2 in. (37.5 mm). 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 $\frac{1}{4}$ in. (6 mm) 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 8 ft. (2.4 m) 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.

(4) Longitudinal Parting Strips. Longitudinal parting strips or planes of weakness, when required, shall be accurately placed as shown on the plans.

(5) 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 ft. (7.2 m), unless specifically authorized or directed by the OWNER in writing.

(f) Mixing. The concrete shall be mixed in an approved method conforming to the requirements of this specification. Ready-mix concrete shall be permitted in lieu of the paver-mixer. When ready-mix concrete is used, sampling provisions of ASTM Designation C 94 Alternate Procedure 2 shall govern. If fiber-reinforced concrete is used, mixing shall be in accordance with the current specification for Fiber-Reinforced Concrete and Shotcrete, ASTM Designation C 1116. All materials for concrete placed in pavements shall conform to the requirements of the governing item of this specification.

(1) Batch Mixing Including Material Transportation. The concrete shall be mixed in a batch mixer, as hereinbefore prescribed, and only in such quantities as are required for immediate use. The mixing of each batch, after all materials are in the drum, shall continue until it produces a thoroughly mixed concrete of uniform mass as determined by established mixer performance ratings and inspection, or appropriate uniformity tests as described in ASTM Designation C 94. The mixer discharge gate shall be locked by the automatic timing device until the required time has elapsed. The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch. Retempering or remixing shall not be permitted.

(A) Transportation. Batch boxes, containers or vehicle bodies used in transporting material from the proportioning plant to the mixers shall be tight and of a sufficient size to hold a batch of maximum size with a margin of safety to prevent spillage. The batch when so hauled must be protected so as to positively prevent any loss of material and minimize loss of moisture by evaporation. On long length hauls, this may require tarpaulin covers. Partitions intended to separate batches shall be adequate and effective in preventing material spilling from one compartment into another while in transit or when being dumped.

(B) Emptying from Bags. When cement is transported in the original package, it shall not be emptied from the bags at a greater distance from the mixer than 1000 ft. (300 m).

(C) Mixer. The mixer shall produce a concrete of uniform consistency and appearance. Spilling at either end of the mixer shall be corrected by reducing the size of the batch. When a 27-E mixer or other size mixers are used, a maximum overload of 20 percent above the rated capacity of the mixer shall be permitted. Pickup and throw-over blades inside the mixer drum shall be replaced when worn down $\frac{3}{8}$ in. (19 mm).

(D) Initial Set and Mixing. Concrete which has developed initial set or has been mixed longer than 30 minutes shall not be used.

(E) Cleaning. The mixer shall be cleaned thoroughly each time when out of operation for more than 30 minutes.

(2) Transit Mixing. When transit mixing is used, the transit mixer shall be of an approved revolving drum or revolving blade type so constructed as to produce a thoroughly mixed concrete with a uniform distribution of the materials throughout the mass and shall be equipped with a discharge mechanism which shall insure the discharging of the mixed concrete without segregation.

(A) Prevention of Leaking. The mixer drum shall be watertight when closed and shall be equipped with a locking device which shall automatically prevent the discharging of the mixer prior to receiving the required number of revolutions.

(B) Mixing. The entire quantity of mixing water shall be accurately measured by a visible calibrated mechanism. Leaking water valves shall be considered as ample reason for condemnation of the mixer unit and removal from the job by the OWNER. Each batch shall be mixed not less than 70 nor more than 100 revolutions at the rate of
rotation specified by the manufacturer as mixing speed. Any additional mixing shall be done at a slower speed specified by the manufacturer for agitation and shall be continuous until the batch is discharged.

(C) Counters. Truck mixers shall be equipped with actuated counters by which the numbers of revolutions of the drum may be readily verified. The counters shall be actuated at the time of starting mixing at mixing speeds.

(D) Delivery. The rate of delivery of the mixed concrete shall be such that the interval between loads shall not exceed 10 minutes. The concrete shall be delivered to the site of the work and discharged from the mixer within a period of 90 minutes, or before the drum has been revolved 300 revolutions, whichever comes first after the introduction of the mixing water with the dry materials.

(3) Central Mixing Plant. A central mixing plant shall be allowed, provided the method of mixing and handling has first been approved by the OWNER.

(4) Commercial Concrete Plants. In the event the CONTRACTOR elects to use concrete produced by a commercial concrete plant, an agreement shall be drawn and executed by the responsible executive management of said plant granting the OWNER ingress and egress to all parts of the plant with full authority to make any and all required tests of aggregates and to regulate and control all batching plant and/or central mixing plant operations. This regulatory control shall be applicable only to the concrete produced by the commercial plant for the payment herein specified.

(g) 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 or wire mesh reinforcing is specified, see Item 5.8.2.(d)(1) and (d)(2) hereof 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 8 ft. (2.4 m) from the last regularly established joint. If the length is less than 8 ft. (2.4 m), the concrete shall be removed back to the last regularly established joint (refer to Item 5.8.3. hereof).

(1) 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 the pavement, revealed by the removal of the side forms, may be cause for rejection of the section of slab in which the defect occurs.

(2) Weather Conditions. Except by specific written authorization of the OWNER, no concrete shall be placed when the air temperature is less than 40°F (4°C) and falling but may be placed when the air temperature is above 35°F (2°C) and rising, the temperature being taken in the shade away from artificial heat. When and if 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 50°F (10°C) for a period of at least 5 days. It is to be distinctly understood that the CONTRACTOR is responsible for the quality and strength of the concrete placed under any weather conditions. No concrete shall be placed on a frozen subgrade.

(3) Time. Concrete shall not be placed before the time of sunrise and shall not be placed later than shall permit the finishing of the pavement during sufficient natural light.

(4) Passes. Unless otherwise shown on plans, when the paving of concrete is accomplished in two passes (double strike-off method) to allow placing the reinforcement in the form or bar mats after the first pass, the first pass shall be uniformly spread and/or struck off so that the final position of the longitudinal steel shall be within 1/2 in. (12.5 mm) of the position dimensioned on the plans. The second pass shall be placed as soon as the reinforcing is in place prior to initial set. In no case shall the concrete be placed later than 20 minutes after completion of the first pass.

If, in the opinion of the OWNER, the temperature, wind and/or humidity conditions are such that the quality of the concrete shall not be adversely affected, the specified placing time may be extended to a maximum of 45 minutes.

When wire fabric reinforcement is used, the placement shall be accomplished in two passes (double strike-off method) unless authorized otherwise by the OWNER in writing.

(h) Finishing.

(1) Machine. When the concrete has been deposited, it shall be approximately leveled and then struck off to such elevation that, when mechanically screeded and tamped, the concrete shall be thoroughly compacted and fin-
ished to the required line, grade and section with all surface voids filled. Where bar mats or wire mesh reinforcing is specified, see Item 5.8.2.(d)(1) and (d)(2) for method of procedure.

(A) Tolerance Limits. While the concrete is still workable, it shall be tested for irregularities with a 10 ft. (3 m) straightedge placed parallel to the centerline of the pavement so as to bridge depressions and to touch all high spots. Ordinates measured from the face of the straightedge to the surface of the pavement shall at no place exceed \( \frac{1}{16} \) inch per foot (1 mm per 20 cm) from the nearest point of contact. In no case shall the maximum ordinate to a 10 ft. (3 m) straightedge be greater than \( \frac{1}{8} \) in. (3 mm). Any surface not within the tolerance limits shall be reworked and refinished.

(B) Belting. While the concrete is still workable, the surface shall be given final belting in order to produce a uniform surface of gritty texture. This belting shall be of short, rapid transverse strokes combined with a longitudinal sweeping motion. When the burlap drag is permitted in lieu of the belting, the burlap drag finish shall be accomplished by drawing a wet drag over the surface in a longitudinal direction to produce a uniform surface of gritty texture.

(C) Edging. 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 the concrete begins to take its "set" and becomes non-workable. All such work shall be left smooth and true to lines.

(D) Stamp or Die. All concrete including curbs, curb with gutter, sidewalks, alleys, driveways and structures shall be marked by means of a substantial stamp or die so designed to make an impression in the finish of the concrete. The stamp or die shall designate the firm name or CONTRACTOR and the month and year in which the work was done. The design of the stamp or die shall be approved by the Engineer.

(2) Hand. Hand finishing shall be permitted only in intersections and areas inaccessible to a finishing machine. The addition of one sack of cement per cubic yard shall be required for all hand finish 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 straightedge, belting and joint finishing shall be as hereinabove prescribed.

(i) 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 2.2.11. 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.
<table>
<thead>
<tr>
<th>Time</th>
<th>Retained Moisture (Min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>After 24 hours</td>
<td>97%</td>
</tr>
<tr>
<td>After 3 days</td>
<td>95%</td>
</tr>
<tr>
<td>After 7 days</td>
<td>91%</td>
</tr>
</tbody>
</table>

(j) Opening Pavement to Traffic. All traffic shall be excluded from the pavement for a period of not less than 14 days unless the OWNER directs that sections be opened to traffic at an earlier date. On sections of the pavement where the use of Type III cement is required or permitted, the pavement may be opened to traffic after 4 days. Should tests of the beam specimens show a flexural strength of not less than 500 psi (3.44 MPa), the OWNER may direct that the pavement so represented be opened to traffic in less than 14 days; and for Type III cement in less than 4 days. In all cases the pavement shall be cleaned and joints shall be filled and trimmed before being opened to traffic.

(1) 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 same.

(2) 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.

(k) 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 flat. 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 forms 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.

(l) Superimposed Curb. When sawed joints are used, curbs shall be dowelled as shown on the plans and poured after sawing. Dowelled curbs which are placed with an extrusion machine and the mixture shall conform to Item 5.8.2.(f).

(m) 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 5.8.2.(h).

5.8.3. EQUIPMENT

(a) General. 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.

(b) Field Laboratory. A field laboratory structure shall be required only when specifically required and provided for in the special provisions.
Item 5.8.3. PAVEMENT AND SURFACES COURSES

(c) 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 $\frac{1}{8}$ in. (3 mm).

A template shall be provided having adjustable rods projecting downward at 1 ft. (30 cm) 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 $\frac{1}{8}$ in. (3 mm) should the support be transferred to that point.

Automatic subgrade trimmer may be used, if approved by OWNER, in lieu of above equipment.

(d) Mixer. Unless otherwise provided for or approved by the OWNER, the paving mixer shall be of a capacity of not less than a 27-E paver, mixing rating to be established by the Mixer Manufacturers' Bureau of the Associated General Contractors of America. The paving mixer shall be provided with a broom and bucket for placing concrete or with a full-width mechanical spreading or placing machine of approved design. The motor shall be provided with a governor to regulate the speed of the mixer drum within a limit of 16 to 20 revolutions per minute. The mixer shall be equipped with an automatic attachment for satisfactorily timing the mix and locking the discharging device so as to prevent the discharging of the mixer until the materials have been mixed together for the minimum time required. This attachment shall be operated independently of the drum and shall have a bell in operation at all times to indicate the completion of the mixing time. The bell shall be such that it can be plainly heard at a distance of 50 ft. from the mixer.

(1) Dual Drum Mixers. Dual drum mixers may be used, provided that their operations shall be properly synchronized so as to permit a minimum mixing time of 50 seconds exclusive of the time required to transfer the materials from the first to the second drum.

(2) Bucket. The distribution bucket shall be tightly constructed and of a sufficient capacity to hold an entire batch of concrete. The discharge gate shall be so constructed as to give a uniform distribution of the concrete on the subgrade without segregation.

(3) Water Measuring Device. The paver shall be equipped with a water measuring device of sufficient accuracy so that it shall measure the water within 1 percent of the amount required per batch. The measuring device shall be so constructed that it shall be open to atmospheric pressure when the measured amount of water is in it and shall be so placed and constructed that the measured amount of water required for a single batch of concrete can be discharged into a calibrated tank or weighing device. The water measuring device shall be checked daily for accuracy.

(4) Alternate Mixer. When the use of a mixer of a capacity less than a 27-E paver is permitted, it shall be of an approved type and so designed as to positively insur the uniform distribution of the materials throughout the mass and to insure the discharge of the batch without segregation.

(e) 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 ft. (3 m) 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 8 in. (20 cm) for a form 8 in. (20 cm) 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 ft. (3 m) length of forms shall be provided with at least 3 pins for securely staking in position. Sufficient forms shall be provided for satisfactory prosecution of the work. Ten ft. (3 m) metal form sections shall be used in forming curves with a 250 ft. (75 m), and larger radius. For curves with a radius of less than 250 ft. (75 m), acceptable flexible metal forms or wood forms may be used upon approval by the OWNER.

(f) 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 a manner as not to interfere with the transverse or longitudinal joints.

The internal-type vibrators shall be spaced at not more than 24 in. 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 vibrator 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 a most important requirement of this specification. Cores taken as required by Item 5.8.6. 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.

(g) 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 paragraph (h), "The Transverse Finishing Machine," shall be acceptable.

(h) 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 or 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.

(i) Miscellaneous Finishing Equipment. The CONTRACTOR shall furnish a broom of the push broom type not less than 18 in. (45 cm) 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 ft. (3 m) steel straightedges and all necessary finishing and edging tools as may be required to complete the pavement in accordance with the plans and specifications.

5.8.4. 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:

Alley paving shall be constructed to one of the typical cross sections shown on the plans.

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 ft. (180 m). 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 5.8.2.(e), "Joints."
5.8.5. 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.

5.8.6. PAVEMENT TESTING

(a) 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.

(b) 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 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 additional coring test shall be at the same rate charged by commercial laboratories.

Where the average thickness of pavement in the area found to be deficient in thickness by more than 0.2 in. (5 mm), but not more than 0.50 in. (12.5 mm), payment shall be made at an adjusted price as specified in the following table:

<table>
<thead>
<tr>
<th>CONCRETE PAVEMENT DEFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deficiency in Thickness Determined by Cores</td>
</tr>
<tr>
<td>Inches</td>
</tr>
<tr>
<td>0.00 — 0.20</td>
</tr>
<tr>
<td>0.21 — 0.30</td>
</tr>
<tr>
<td>0.31 — 0.40</td>
</tr>
<tr>
<td>0.41 — 0.50</td>
</tr>
</tbody>
</table>

Any area of pavement found deficient in thickness by more than 0.5 in. (12.5 mm) but not more than .75 in. (19 mm) or 1/10 of the plan thickness, whichever is greater, shall be evaluated by the OWNER. If, in the judgment of the OWNER, the area of such deficiency should not be removed and replaced, there shall be no payment for the area retained. If, in the judgment of the OWNER, the area of such deficiency warrants removal, the area shall be removed and replaced, at the CONTRACTOR’S entire expense, with concrete of the thickness shown on the plans. Any area of pavement found deficient in thickness by more than .75 in. (19 mm) or more than 1/10 of the plan thickness, whichever is greater, shall be removed and replaced, at the CONTRACTOR’S entire expense, with concrete of the thickness shown on the plans.

No additional payment over the contract unit price shall be made for any pavement of a thickness exceeding that required by the plans.

(c) Pavement Strength Test. During the progress of the work, the CONTRACTOR 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 2 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 7 days; then, if, in the opinion of the OWNER, the 7-day test results are low enough, the other 2 cylinders in each set may be tested in 28 days.
If the 28 day test results indicate deficient strength, the CONTRACTOR may, at his option and expense, core the pavement in question and have the cores tested by an approved laboratory to override the results of the cylinder tests. Pavement not meeting the minimum specified strength shall be subject to the money penalties or removal and replacement at the CONTRACTOR's expense as shown in the following table:

<table>
<thead>
<tr>
<th>Percent Deficient</th>
<th>Percent of Contract Price Allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater Than 0% - Not More Than 5%</td>
<td>95 percent</td>
</tr>
<tr>
<td>Greater Than 5% - Not More Than 10%</td>
<td>90 percent</td>
</tr>
<tr>
<td>Greater Than 10% - Not More Than 15%</td>
<td>80 percent</td>
</tr>
<tr>
<td>Greater Than 15%</td>
<td>60 percent or removed and replaced at the entire cost and expense of CONTRACTOR as directed by OWNER.</td>
</tr>
</tbody>
</table>

The amount of penalty shall be deducted from payment due to CONTRACTOR; such penalty deducted is to defray the cost of extra maintenance.

These requirements are in addition to the requirements of Item 5.8.7.(2).

The strength requirements for structures and other concrete work are not altered by this special provision.

No additional payment over the contract unit price shall be made for any pavement of strength exceeding that required by plans and/or specifications.

5.8.7. MEASUREMENT AND PAYMENT

"Concrete Pavement" shall be measured by the square yard (m²) of completed and accepted pavement. The price bid per square yard (m²) 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 yard (m²) measured in its final position.

The work performed and material furnished by this item and measured as provided in this item shall be paid for at the unit price bid per square yard (m²) for concrete pavement or the adjusted unit price for pavement of deficient thickness 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.
This page was intentionally left blank.
PART III. CONSTRUCTION METHODS

DIVISION 6. UNDERGROUND CONDUIT CONSTRUCTION

Item 6.1. General
Item 6.2. Excavation and Backfill
Item 6.3. Foundation
Item 6.4. Jacking, Boring or Tunneling
Item 6.5. Street Cut Excavation and Repair Standards
Item 6.6. Street, Highway and Railroad Crossing
Item 6.7. Underground Conduit Installation
This page was intentionally left blank.
DIVISION 6. UNDERGROUND CONDUIT CONSTRUCTION

ITEM 6.1. GENERAL

6.1.1. DESCRIPTION
This part of the specification shall govern 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, with the details shown on the plans, and 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.

6.1.2. MATERIALS
All materials used in the construction of work specified in this division shall conform to the applicable sections of Division 2 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.

6.1.3. MATERIAL STORAGE
Materials delivered to the site of the work in advance of their use shall be stored in a 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.

6.1.4. 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 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.

6.1.5. 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.

6.1.6. SIGNS
The required public information signs shall be placed at locations approved by the OWNER prior to the start of construction.

6.1.7. 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.

6.1.8. 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.
6.1.9. CONNECTIONS

The connections of conduits or appurtenances to conduits 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 conduit shall project beyond the inside surface of other conduits or appurtenances, except in case of pipe laid through a manhole.

6.1.10. GRADES

The grade line shown on the profile is the elevation of the invert or flow line of the conduit. The OWNER shall establish bench marks, base lines and other principal control points for use in 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 ft. (3 m), 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 CONTRACTOR 48 hours 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; 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.

If a profile is not furnished for a water main, the main shall be constructed with a minimum cover as follows unless directed otherwise by the OWNER:

<table>
<thead>
<tr>
<th>Main Size</th>
<th>Minimum Cover (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unimproved Streets</td>
</tr>
<tr>
<td>4 in. through 12 in.</td>
<td>5 ft.</td>
</tr>
<tr>
<td>14 in. through 18 in</td>
<td>6 ft.</td>
</tr>
<tr>
<td>20 in. and larger</td>
<td>7 ft.</td>
</tr>
</tbody>
</table>

The CONTRACTOR shall keep the OWNER informed at a reasonable time 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.

6.1.11. CLEANUP

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. 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 the construction or better. Cleanup shall be finished prior to acceptance of the project by OWNER.

6.1.12. 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 arrangements 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.
6.1.13. 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.

**ITEM 6.2. EXCAVATION AND BACKFILL**

6.2.1. 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, wood 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.

6.2.2. SITE PREPARATION

The construction site shall be prepared for construction operations by the removal and disposal of all obstructions and objectionable materials from the designated construction area. Such obstructions and objectionable materials shall include the removal of designated trees, bushes, grass, miscellaneous stone, brick, concrete, scrap iron and all rubbish and debris whether above or below ground level. It is the intent of this specification to provide for the removal and disposal of all objectionable materials not specifically provided for elsewhere by the plans and specifications. The removal of such items shall be accomplished prior to the grading and excavation operations. The removal and disposal of such items shall not be measured or paid for as a separate contract pay item. Such items shall be considered as incidental work and the cost thereof shall be included in such contract pay item as provided in the proposal and contract.

6.2.3. 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 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 Item 1.29.2., "Public Convenience and Safety," the CONTRACTOR shall have 24 hours in which to comply.
Item 6.2.3. UNDERGROUND CONDUIT CONSTRUCTION

with the instructions from 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.

6.2.4. BORINGS
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.

6.2.5. EXISTING STRUCTURES
All existing structures, improvement 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 plans that utilities are to be moved by others, any cost of temporarily or permanently relocating 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 with out 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.

(b) Sewer House Services. All house sewer services 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, if being replaced by a utility CONTRACTOR; however, in all cases, repair 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 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, storm sewers, power conduits, gas mains, gas service laterals and other appurtenances encountered during construction shall be supported or replaced as detailed on the plans.

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 another utility, a representative of that utility shall be notified to decide method and work to be done. The CONTRACTOR shall make satisfactory arrangements with other utilities for the required cutting or adjustments at the CONTRACTOR'S own expense, other than for items that may be provided in the contract for such work. No extra compensation shall be paid due to delays caused by removal of public utility structures.

(f) Street Sign Posts and Signs. The CONTRACTOR shall be responsible for all damage to street sign posts and signs within the limits of his operations that remain in place or are removed and replaced. In the event that street sign posts 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.

6.2.6. 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. 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.

6.2.7. PROTECTION OF TREES, PLANTS, SHRUBBERY, ETC.
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 the limbs from, damage or attach guy cables to them. 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; the costs thereof shall be included in such pay items as are provided for in the proposal and contract.

6.2.8. 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 6.2.9.(c).

(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.
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 6.3., "Foundation," or with other material satisfactory to the OWNER and thoroughly compacted in place to finish grade elevation in a manner satisfactory to the OWNER.

(3) Excess Trench Width. When the maximum trench width as defined in Item 6.12.(a)(1) is not maintained to a point of 1 ft. (0.3 m) above the top of the pipe, the CONTRACTOR shall provide at his expense the next higher class of 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 the requirement, the OWNER may stop the pipe laying until the requirements are met.

(5) Excavation for Altered Grade. If excavation for the conduit or appurtenance due to the altered grade is altered more than 1 ft. (0.3 m) 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.

(b) 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.

(c) 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. Certification by the proper authorities for personnel involved with the actual use of explosives is 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 State Department of Highways and Public Transportation, the railroad involved and 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 ft. (150 m) 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 Item 6.4.

(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 times 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 filled, 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, or 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 complete 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.

(d) 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. Suitable selected bedding or backfill material shall be provided at no additional cost to the OWNER. In accordance with Division 1, 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.

(e) 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. No water shall be allowed to flow through or over unset concrete or through the completed line. All water removed from excavations shall be disposed of in an approved man-
ner, so as not to create unsanitary conditions, injure persons or property, damage the work in progress, and/or 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.

6.2.9. 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: (1) areas not subject to vehicular traffic; and (2) areas subjected directly to, or influenced by, vehicular traffic.

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 conduit 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, as follows:

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 Subjected to or Influenced by Vehicular Traffic. The trench backfill shall be mechanically compacted to the top of the subgrade in 6 in. lifts to at least 95 percent of maximum density as determined by ASTM 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 as outlined in Item 6.2.9.(c).

2. Densities — Areas Not Subjected to or Influenced by Vehicular Traffic. The trench backfill shall be placed in layers not more than 10 in. in depth (loose measurement) and shall be compacted by whatever means the CONTRACTOR chooses, subject to the restrictions outlined in Item 6.2.9.(b)(5), to a density comparable with the adjacent undisturbed material.

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 6.2.9.(c).

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 25 percent of the pipe laid, or until an approval to proceed with pipe installation has been given by the OWNER.

5. Compaction Methods. The method of compaction shall be left to the discretion of the CONTRACTOR with the following exception, unless otherwise specified, provided the degree of compaction is obtained and provided that the pipe is not damaged in the process. If any potential damage to the pipe due to a method of compaction exists, in the opinion of the OWNER, that method of compaction shall not be allowed.

Compaction of any backfill material by flooding or jetting shall not be permitted unless authorized by the OWNER.

Hand-operated mechanical tampers may be used with approval of the OWNER for compacting backfill.

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 be-
Outside compaction will be specified. The stone shall then be brought in uniform layers on either side of the pipe. 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.

(2) Flexible Pipe. 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.

(3) Class "A" Embedment. The embedment consists of a concrete cradle and a cap of select material or granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{4}D$, minimum of 3 in. (minimum of 6 in. in rock), the pipe shall be laid to grade on supporting brick or concrete block and jointed as specified. A compressible strip shall be placed between the pipe and the support. The pipe shall be restrained, if required, to prevent flotation. Type "B" concrete shall be poured on either side of the pipe to form the bedding under the pipe and up the sides of the pipe $\frac{1}{4}B_c$. The concrete placed under the pipe shall have a sufficient fluidity so it can flow under the haunches and be puddled to insure even support.

The embedment backfill layer shall be select material or granular material and shall be brought to a point 12 in. above the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

(4) Class "A-1" Embedment. The embedment consists of a crushed stone cradle and a cap of concrete.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{4}B_c$, 3 in. minimum (6 in. minimum in rock), the bedding layer shall be brought to a point slightly above grade with compacted standard gradation crushed stone. Bell holes shall be formed, if required, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone shall then be brought up in uniform layers on either side of the pipe $\frac{1}{2}B_c$.

Type "B" concrete, plain or reinforced as specified in the plans, shall be poured over the top of the pipe and bells to cover the pipe with a thickness of $\frac{1}{4}D$, 4 in. minimum.

(5) Class "B" Embedment. The embedment consists of a crushed stone cradle and a cap of select or granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{6}B_c$, 3 in. minimum (6 in. minimum in rock), the bedding shall be brought up to a point slightly above the grade with rock cuttings or crushed stone, standard gradation. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The crushed stone or rock cuttings shall then be brought up the sides of the pipe in uniform layers $\frac{1}{2}B_c$.

The embedment backfill shall consist of select or granular material. The material shall be placed on top of the crushed stone in uniform layers on either side of the pipe to a point above the pipe as shown on the plans and compacted to at least 90 percent of maximum density as determined by ASTM D 698.

JANUARY 1998

229
(6) Class "B+" Embedment. The embedment consists of a cradle of fine crushed stone and a cap of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of \( \frac{1}{8} B_c \), 3 in. minimum (6 in. minimum in rock), the bedding shall be brought up to a point slightly above grade with fine crushed stone. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The stone shall then be brought up in uniform layers on either side of the pipe \( \frac{1}{8} B_c \).

The embedment backfill shall consist of granular material. The material shall be placed on top of the stone and shall be brought up in uniform layers on either side of the pipe to a point 12 in. above the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

(7) Class "B-1" Embedment. The embedment consists of a cradle of fine crushed stone and a cap of select material or granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of 3 in. for PVC pipe or 4 in. for RTP pipe, the bedding shall be brought up to a point slightly above grade with fine crushed stone. Bell holes shall be formed and the pipe laid and jointed as specified. The stone shall then be brought up in uniform layers on either side of the pipe \( \frac{3}{4} B_c \).

The embedment backfill shall consist of compacted select or granular material brought up to a point 6 in. above the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

(8) Class "B-2" Embedment. The embedment consists of a cradle of fine crushed stone and a cap of select or granular material.

After the trench has been cut to a depth below the barrel of the pipe 3 in. for PVC pipe and 4 in. for RTP pipe, the bedding layer shall be brought up to a point slightly above grade with compacted fine crushed stone. Bell holes shall be formed, if required, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone bedding layer shall then be brought up in uniform layers on either side of the pipe \( \frac{3}{4} B_c \).

The embedment backfill shall consist of compacted select or granular material and shall be brought to a point 12 in. above the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

(9) Class "B-3" Embedment. The embedment consists of sand.

After the trench has been cut to a depth below the barrel of the pipe a distance of 3 in., the bedding shall be brought to a point slightly above grade with compacted sand. Bell holes shall be formed, if required, a trough scooped out to grade, and the pipe laid and jointed as specified. The sand shall then be brought up in uniform layers on either side of the pipe and over the pipe to a point 12 in. above the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

(10) Class "B-4" Embedment. The embedment consists of sand.

After the trench has been cut to a depth below the barrel of the pipe a distance of 3 in., the bedding shall be brought to a point slightly above grade with compacted sand. Bell holes shall be formed, if required, a trough scooped out to grade and the pipe laid and jointed as specified. The sand shall then be brought up to uniform layers on either side of the pipe and over the pipe to a point 6 in. above the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

(11) Class "C" Embedment. The embedment is a cradle of crushed stone or rock cuttings and a cap of select or granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of \( \frac{1}{8} B_c \), 3 in. minimum (6 in. minimum in rock), the bedding shall be brought up to a point slightly above grade with rock cuttings or standard crushed rock. Bell holes shall be formed, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone shall then be brought up in uniform compacted layers on either side of the pipe \( \frac{1}{8} B_c \).

The embedment backfill shall be select or granular material and shall be brought up in uniform compacted layers to a point 6 in. above the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

(12) Class "C+" Embedment. The embedment consists of a cradle of fine crushed rock and a cap of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of \( \frac{1}{8} B_c \), 3 in. minimum (6 in. minimum in rock), the bedding layer shall be brought up to a point slightly above grade with fine crushed stone. Bell
holes shall be formed, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone shall then be brought up in uniform, compacted layers on either side of the pipe \(1/6\) Bc. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

The embedment backfill shall be granular material and shall be brought up in uniform, compacted layers to a point 6 in. above the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

(13) Class “C-1” Embedment. The embedment shall consist of a cradle of sand and cap of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of \(1/6\) Bc, 3 in. minimum (6 in. minimum in rock), the bedding layer shall be brought up to a point slightly above grade with sand. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The sand shall then be brought up in uniform compacted layers on either side of the pipe \(1/6\) Bc. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

The embedment backfill shall be granular material and shall be brought up in uniform, compacted layers to a point 6 in. above the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

(14) Class “C-2” Embedment. The embedment consists of sand.

After the trench has been cut to a depth below the barrel of the pipe a distance of \(1/6\) Bc, 3 in. minimum (6 in. minimum in rock), the bedding layer shall be brought to a point slightly above grade with compacted sand. Bell holes shall be formed, if required, a trough scooped out to grade and pipe laid and jointed as specified. The sand shall then be brought up in uniform layers on either side of the pipe and over the pipe to a point 6 in. above the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

(15) Class “D+” Embedment. The embedment consists of select material.

After the trench has been cut to a depth below the barrel of the pipe a distance of \(1/6\) Bc, minimum of 3 in. (6 in. minimum in rock), the embedment shall be brought up to a point slightly above grade with select material. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The material shall then be brought up in uniform compacted layers to a point 6 in. over the top of the pipe. Density shall be at least 90 percent of maximum density as determined by ASTM D 698.

(16) Class “G” Embedment. The embedment consists of Class “B” concrete.

After the trench has been cut to a depth below the barrel of the pipe a distance of \(1/4\) D, 4 in. minimum (6 in. minimum in rock), the pipe shall be laid and jointed as specified. The pipe shall be supported by brick or concrete block. A compressible strip shall be placed between the pipe and support. The pipe shall be restrained, if required, to prevent flotation. Type “B” concrete shall be poured on either side of the pipe to form the embedment under the pipe, up the sides and over the top of the pipe and bells with a minimum thickness of 4 in. The concrete placed under the bell shall have a sufficient fluidity so it can flow under the haunches and be puddled to insure even support.

(17) Class “G-1” Embedment. The embedment consists of Class “G” embedment as specified above and a trench backfill of concrete, Class “B” or stabilized backfill, whichever is specified in the plans, and a 6 in. thick Class “B” concrete cap.

6.2.10 TRENCH BACKFILL

(a) Excavated Material. Excavated material may be used in the trench backfill, provided (1) that all hard rock and stones having any dimensions greater than 6 in. (15 cm) in diameter and frozen earth, debris and roots larger than 2 in. (5 cm) are removed, and (2) the material is approved for backfill by the OWNER.

(b) 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.

(c) 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.

(d) Select Backfill. Select backfill shall consist of an excavated material meeting the requirements of Item 2.1.8.(c)
(e) Granular Material Backfill. Granular material backfill shall meet the requirements of Item 2.1.8.(b).
(f) Sand Backfill. Sand backfill shall meet the requirements of Item 2.1.8.(f).
(g) Flowable Backfill. Flowable backfill shall meet the requirements of Item 2.1.5.(e).
(h) Modified Flowable Backfill. Modified flowable backfill shall meet the requirements of Item 2.1.5.(f).

6.2.11. CONDITIONS OF PAYMENT
The following items and/or other items not covered by specific bid items shall be included in the price bid per foot of various water and/or sanitary sewer pipe installed: excavation; furnishing, placing and compacting embedment material; disposal of excess material; placing backfill; compaction of backfill; labor, materials, and equipment required for taking density samples and restoring the trench afterwards; cleanup; replacing finish trench surfaces; sheeting, shoring and bracing; sod and pavement and other incidental work required by the specifications, plans or standards.

6.2.12. MEASUREMENT AND PAYMENT
(a) Measurement of Backfill Material. All backfill that is set out in the contract document as a separate bid item shall be measured as the number of cubic yards (m³) of material compacted in the trench, with trench dimensions computed as follows:

1. Width of Trench. The limiting trench width shall be as follows:
   (A) For 24 in. (0.6 m) pipe and smaller, the trench width shall be taken as 24 in. (0.6 m) or O.D. of the pipe plus 16 in. (0.4 m), whichever is greater.
   (B) For pipe larger than 24 in. (0.6 m) size, but not to exceed 72 in. (1.8 m), the trench width shall be taken as equal to the O.D. of the pipe installed plus 24 in. (0.6 m).
   (C) For pipe larger than 72 in. (1.8 m) size, the trench width shall be taken as equal to the O.D. times 1.25 plus 1 ft.
   (D) No extra allowance shall be made for backfill materials used around manholes, valve boxes, etc., but trench computations shall be carried through such structures. No allowance for waste shall be made.

2. Depth of Backfill Trench. It shall be measured from the top of the backfill material to the top of the embedment.

3. Depth of Embedment. Embedment shall be measured to the limits shown in Item 6.2.9.(c).

4. Embedment. The embedment measurements for payment shall be the width of trench as shown in Item 6.2.12.(a)(1) and the depth as shown in Item 6.2.12.(a)(3) and the length as described in Item 6.2.12.(a)(3), less the volume of pipe installed in the embedment using the outside diameter (O.D.) for the calculation, or, if the quantities are shown on the plans or standard sheets, they shall be used.

5. Length of Trench. It shall be the horizontal measurement along the centerline of the water or sewer facility installed, similar to the measurement for water or sewer pipe installed.

(b) Payment of Backfill. Payment shall be made at the contract unit price per cubic yard (cubic meter) only if a separate bid item is established in the contract. This shall include furnishing and placing all materials and for all labor, tools, equipment and incidentals necessary to complete the work, all in accordance with the plans and specifications. No allowance for waste shall be made.

1. 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 cubic yard (cubic meter), 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 over-excavates the trench width and the OWNER orders the next higher class of embedment to be used, the embedment shall be paid per cubic yard (cubic meter), compacted in place at the width specified in item 6.2.12.(a)(1) for the embedment originally specified if the original embedment was specified to be paid as a separate bid item. In lieu of a higher class embedment, the CONTRACTOR may elect to use a higher class pipe if approved by the OWNER. The pipe shall be paid for as specified in Item 6.7, at the unit price per linear foot (m) for the pipe originally specified if the original pipe was specified to be paid as a separate bid item.

   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, the embedment shall be paid per cubic yard (cubic meter), compacted in
place for the embedment originally specified if the original embedment were specified to be paid as a separate bid item.

(2) Trench Backfill.

If 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.

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.

ITEM 6.3. FOUNDATION

6.3.1. DESCRIPTION

During the progress of the work, should the foundation for the conduits be in soft, yielding or spongy materials, which are unsuitable for the subgrade of the conduit, and 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 as described in Item 2.1.8.(d), coarse crushed rock as described in Item 2.1.8.(a), or Class B concrete as described in Item 7.6. 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.

6.3.2. MEASUREMENT AND PAYMENT

(a) Measurement. Foundation material shall be measured for payment complete in place to the dimensions prescribed by the OWNER. Geotextile material shall be measured for payment complete in place to the dimensions prescribed by the OWNER.

(b) Payment. Foundation material shall be paid for at the contract unit bid price in cubic yards (cubic meters) as provided for in the contract. Geotextile material shall be paid for at the contract unit bid price per square yard (square meter) as provided for in the contract.

If a bid item is not established in the contract for foundation material and/or geotextile material, it shall be paid for as an extra.

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.

6.3.3. 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.

ITEM 6.4. JACKING, BORING OR TUNNELING

6.4.1. DESCRIPTION

This specification shall govern for the provision of the required opening for the installation of conduits by the methods of jacking, boring or tunneling as shown on the plans and in conformity with this specification.
6.4.2. MATERIALS

The encasement and carrier pipe shall be of the type and strength as indicated on the plans. All necessary materials shall conform to the applicable sections of Division 2 of these specifications.

6.4.3. CONSTRUCTION METHODS

(a) 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 conduit. 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.

(b) 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 roadway 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 manner as to support the section of 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 subjected 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 1/3 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 2 in. (5 cm) shall not be permitted. All voids between the pipe and the earth shall be filled with grout per ASTM 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 2 ft. (.6 m). 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 permitted only to the extent of 1 in. per 10 ft. (25 mm per 3 m), provided that such variation shall be regular and only in one direction and that the final grade of the flow line shall be in the direction indicated on the plans.

Once jacking of pipe is 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 jacking 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 the 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.

(c) 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 2 in. (5 cm) 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. The 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 soil is removed by augers. Bentonite may only be used as a lubricant. Casing shall be new or used steel conduit approved by the OWNER, with a minimum inside diameter sufficiently larger than the outside diameter of the carrier pipe or ducts to accommodate placement or removal.

All carrier pipe installed by boring shall be supported by a quarter point cradle of Class B concrete 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 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 6.4.3.(b), "Construction By Jacking," in regard to the construction of trench, tolerance in line and grade, method of operations, backfilling, etc. shall govern for construction by boring.

(d) 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 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.

JANUARY 1998
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 6.4.3(b), "Construction by Jacking."

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 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 plans 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.

(e) Joints. If corrugated galvanized metal pipe is used, joints may be made by field bolting or by connecting bands, whichever is feasible. When reinforced concrete pipe 24 in. (0.6 m) 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.

6.4.4. MEASUREMENT AND PAYMENT

Openings provided by jacking, boring or tunneling shall be measured for payment in linear feet (m) 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 (m) 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.

ITEM 6.5. STREET CUT EXCAVATION AND REPAIR STANDARDS

6.5.1. GENERAL REQUIREMENTS

(a) Marking. All concrete cut repairs shall be marked with the CONTRACTOR'S name if required by the OWNER.

(b) 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 3 ft. 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 1 1/2 in.

(1) Measurement of Sawed Breakout Groove. Sawed breakout groove shall be measured for payment in linear feet (meters) of groove actually cut in accordance with the specifications and as directed by the OWNER.

(2) Payment for Sawed Breakout Groove. Sawed breakout groove shall be paid in linear feet (meters) as specified in the bid item.
(c) Thoroughfares. No interference with traffic flow on the 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 Friday, 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 major or collector 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.

Exceptions to these specifications must be approved by the OWNER.

(d) 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 2 ft. in a paved street or alley.

(e) Specified Trench Width. The specified trench width for payment shall be the maximum trench width as specified in Item 6.2J2.(a)(1).

6.5.2. STREET SURFACES

(a) General Construction Requirements. Repairs are to be made as rapidly as possible. Use of fast setting concrete and similar techniques are encouraged. Completion of the job, including replacement of pavement and cleanup, shall normally be accomplished within 10 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, exclusively excluding gravel or flexbase 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 with Class A concrete unless specified otherwise by the OWNER.

(1) Measurement for Replacement of Curb, Gutter, Sidewalk, Drives, Etc. Measurement for payment shall be for the 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) Replacing Reinforced Concrete Pavement. The existing pavement shall be sawed in accordance with Item 6.5.1.(b) and removed to a line 12 in. back of the firm banks of the trench. The concrete replacement shall be reinforced with like-size bars as the existing pavement, #3 minimum, lapping 30 diameters on splices, and spaced on a minimum of 24 in. centers each way. The replacement concrete shall match the thickness of the existing concrete pavement, minimum of 6 in. thick.

The new concrete pavement shall be protected from vehicular traffic for a minimum of 7 days or until a flexural strength of 500 psi (3.447 kPa) is obtained or until a compressive strength of 3000 psi (20.684 kPa) is obtained.

The concrete shall be Class A unless specified otherwise by the OWNER.

If the limiting trench width occurs within three feet of an expansion joint, construction joint or dummy joint, the OWNER may order the pavement removed and replaced to the existing joint.

(1) Measurement of Reinforced Concrete Pavement. Replacement of the reinforced concrete pavement shall be measured at the specified trench width plus 2 ft., thickness in inches, and length in linear feet. Additional reinforced concrete pavement ordered by the OWNER to be placed will be measured as the thickness in inches; and length and width in linear feet.

(d) Replacing Asphaltic Concrete Pavement with a Concrete Base. The existing pavement shall be removed to a neat line at least 12 in. back of the firm banks of the trench. The concrete base shall be reinforced with #3 bars on 24 in. centers, lapping 30 diameters on splices. The concrete base shall be replaced to match the existing thickness of the concrete base, minimum of 6 in. The concrete shall be Class A.

The final 1 1/2 in. over the concrete base shall be asphaltic concrete.

JANUARY 1998
(1) Measurement of Asphaltic Concrete Pavement with a Concrete Base. Replacement of the asphaltic concrete pavement shall be 1 1/2 in. thick, specified ditch width plus 2 ft., and the length measured in linear feet. The concrete base shall be measured at the specified thickness, specified ditch width plus 2 ft., and the length measured in linear feet.

(e) Replacement Asphaltic Concrete Pavement on a Natural Soil Base. Unless otherwise specified by the OWNER, the existing asphaltic concrete shall be cut back to produce a vertical edge for the full depth of the paving. The cut shall extend 12 in. back from the fill banks of the trench. The cut shall be replaced with reinforced concrete base. The reinforcement shall be #3 bars on 24 in. centers, lapping 30 diameters on splices. The concrete shall be Class A. The concrete base shall be 6 in. thick.

The final 1 1/2 in. over the concrete base shall be asphaltic concrete.

(1) Measurement for Asphaltic Concrete Pavement and Concrete Base. Asphaltic concrete pavement shall be 1 1/2 in. thick, specified ditch width plus 2 ft. and the length measured in linear feet. The concrete base shall be measured at the specified trench width plus 2 ft., 6 in. thick, and the length as measured in linear feet.

(f) Replacing Asphaltic Concrete Pavement on a Flexible Base. Unless otherwise specified by the OWNER, the existing asphaltic concrete shall be sawed 12 in. back from the fill banks of the trench. The cut shall be replaced with a compacted flexible base, as specified in Item 2.1.3 (b), to match the existing thickness of the base, 6 in. minimum.

The final 2 in. over the flexible base shall be asphaltic concrete.

(1) Measurement for Asphaltic Concrete Pavement on a Flexible Base. Asphaltic concrete pavement shall be 2 in. thick, specified ditch width plus 2 ft., and the length measured in linear feet. The flexible base shall be measured at the specified trench width only, 6 in. thick or the depth of the existing flexible base, and the length measured in linear feet.

(g) Replacing One or Two Course Surface Treatment or Penetration Type Pavement. Unless otherwise specified, the pavement shall be replaced with 6 in. of compacted flexible base and a surface treatment. The surface shall be either a two-course surface treatment or 1 1/2 in. compacted thickness of asphaltic concrete.

(1) Two-Course Surface Treatment. The prime coat shall be MC-30 applied at a rate of 0.25 gal./square yard and cut back with native sand at a rate of 1 cubic yard/300 square yards.

The first course shall be Type AC-10 asphalt applied at a rate of 0.35 gal./square yard with an aggregate of Type A, Grade 2, applied at a rate of one cubic yard/80 square yards.

The second course shall be Type AC-10 asphalt with Type B, Grade 4, aggregate applied at a rate of 1 cubic yard/100 square yards.

Aggregate Type A, Grade 2, and Type B, Grade 4, are defined in Texas SDHPT Standard Specification for Construction of Highways, Streets and Bridges.

Construction methods are outlined in Item 5.5.3.

(2) Asphaltic Concrete. The asphaltic concrete shall be placed to a depth of 1 1/2 in.

(3) Measurement for Replacement of One or Two-Course Surface Treatment or Penetration Type Pavement. The flexible base shall be measured at the specified trench width plus 2 ft., same as existing but not less than 6 in. thick and the length as measured in feet. The surface shall be measured in square yards regardless of the option selected, measured at the specified trench width plus 2 ft. and the length as measured in ft.

(h) Replacing Gravel Pavement on a Dirt Base. The existing gravel pavement shall be replaced with compacted flexible base, as specified in Item 2.1.3.(b). The minimum thickness of flexible base shall be 8 in.

The flexible base shall be measured at specific trench width only, 8 in. thick, and the length measured in linear feet.

6.5.3. PAYMENT FOR PAVEMENT REPLACEMENT

The replacement of concrete pavement, concrete base, rock for flexible base and gravel for flexible base shall be paid at the contract unit price per cubic yard, complete in place.

Asphaltic concrete pavement shall be paid at the contract unit price per ton (kg), complete in place, computed as 110 lbs./in./square yard (16.4 kg/cm/sq. m).

The replacement of one or two-course surface treatment or penetration type pavement surface shall be paid at the contract unit price per square yard complete in place.

Curb and curb and gutter shall be paid at the contract unit price per linear feet (m) complete in place.
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.

ITEM 6.6. STREET, HIGHWAY AND RAILROAD CROSSINGS

6.6.1. GENERAL
This specification shall govern for the construction of 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.

6.6.2. STATE HIGHWAY CROSSINGS
All crossings shall conform to the Texas State Department of Highways and Public Transportation (Texas SDHPT) Utility Accommodation Policy Manual Special Specifications. All state highway crossings shall be permitted by the Texas SDHPT.

6.6.3. STREET AND ALLEY CROSSINGS
The construction of underground conduits 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 Item 6.4., “Jacking, Boring or Tunneling.” If open-cut method is indicated or specified, the construction operations shall be conducted in accordance with the requirements of Item 6.2.

6.6.4. RAILROAD CROSSINGS
All railroad crossings shall conform to these specifications and the following requirements:

Railroad crossings for all sanitary sewer lines and for water lines 12 in. (30.5 cm) and under shall require an encasement pipe at least 2 in. (5.1 cm) greater than the largest outside diameter of the carrier pipe. The diameter of the encasement pipe for water lines over 12 in. (30.5 cm) shall be shown on the plans. Encasement pipe shall be corrugated metal pipe, sectional liner plate or reinforced concrete to suit conditions of the crossing. The encasement pipe shall be on a minimum of 2.5 percent slope. Encasement for water lines over 12 in. (30.5 cm) shall be plugged with concrete at the lower end with a manhole for entrance. Encasement pipes for water lines 12 in. (30.5 cm) and under shall be plugged at the upper end with concrete and at the lower end with a clay core to prevent the entrance of excessive ground water but shall allow water to leak out in case of a pressure leak in the carrier pipe. Where conditions are favorable, a drain shall lead out of the encasement pipe to a free outfall. For all sewer lines, voids between the encasement and carrier pipe shall be grouted per ASTM C 476.

The top of the encasement pipe shall be a minimum of 5.5 ft. (1.7 m) below the base of the rails and must be a minimum of 3 ft. (0.9 m) below the flow line of any ditch in railroad right-of-way. The length of encasement pipe shall extend each side from the centerline of the outside tract, measured at right angles, a minimum distance of 11 ft. (3.4 m) + 1.5 D + 5 ft. (1.5 m), where D is the depth of the bottom of the encasement below subgrade. The encasement pipe shall be tightly joined to prevent leakage.

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 C 476. Timber supports shall not be permitted. Where the railroad right-of-way carries a minor volume of traffic and permission is granted by the railroad, open cutting may be used to install the encasement pipe to within 10 ft. (3.0 m) of the centerline of the outside rails.

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 A.T. & S.F. Railroad Company requires ASTM C 76 Class V, Wall “B,” reinforced concrete pipe for encasement pipes 48 in. (121.9 cm) and smaller and Class V, Wall “C,” for encasement pipes over 48 in. (121.9).
The CONTRACTOR must obtain insurance and other requirements of the railroad company prior to beginning any work within the railroad right-of-way.

6.6.5. MEASUREMENT AND PAYMENT OF CROSSING

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.

ITEM 6.7. UNDERGROUND CONDUIT INSTALLATION

6.7.1. GENERAL

(a) 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.

(b) 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 and shall be done in such a manner as to create no hazard to nor interference with traffic. 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.

(c) Laying Underground Conduit Pipe. Prior to being lowered into the trench, each pipe shall be carefully inspected; those not meeting specifications shall be rejected and either destroyed or removed from the job. All lumps or excrescences on the ends of conduit 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 hosting 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.

(d) 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 conduit under same and in placing backfill, except when the span is excessive. If directed by the OWNER, utilities shall be replaced with cast 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 the 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.

(1) Measurement for Utility Supports. Concrete for 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.

(2) Payment for Utility Supports. 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, stripping of forms, and disposal of surplus materials, in accordance with the plans and specifications.

(e) Location of Mains. The location of utility mains will be determined by the ENGINEER using generally accepted design criteria which includes the current guidelines of the Texas Department of Health in *Rules and Regulations for Public Water Systems and Design Criteria for Sewerage Systems*.

### 6.7.2 SANITARY SEWER

(a) Sewer Service Connections. Sewer service line shall be constructed as required and shown on the plans or when designated by the OWNER.

(b) Sanitary Sewer Joints. When specified in the special provisions or in the plans, a test tee shall be installed at the end of the service line (located in the parkway), with the branch in a vertical position.

(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 as a lever to push the pipe home. 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.

Unless otherwise specified in the special provisions or in the plans, for all sizes of concrete pipe larger than 24 in. (6 m) in diameter, the inside annular space provided for that purpose shall be completely filled with a plastic portland cement mortar (composed of 1 part cement to 2 1/2 parts sand), preformed flexible joint sealant in rope form, or trowelling type.

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 hereinafter described, that is resistant to acid alkali and gases and is compatible with rubber. The joint shall be finished smoothly and all surface materials removed.

(2) Chemically Welded Joints. The joint materials shall conform to the applicable specifications under which the pipe is supplied. The joint shall be installed per recommendations of the manufacturer. The ditch emplacement should be to grade, with the advance bell hole scooped out prior to paying so that the pipe shall be to grade as the joint is made.
(3) Compression Joints. The joint materials shall conform to the applicable specifications under which the pipe is supplied. The bells and spigots must be thoroughly clean. Extreme care must be exercised to prevent damage to the joint. The spigot end shall be inserted into the bell and pushed home after a suitable lubricant, as recommended by the pipe manufacturer, is applied. Petroleum lubrication shall not be permitted. The ditch embedment should be to grade, with the advance bell hole scooped out prior to laying so that the pipe should be to grade as the joint is made.

(4) Joints for Closure Sections. Spigot-to-spigot closures: tile (4, 6 and 8 in.) (10, 15 and 20 cm) to tile (4, 6 and 8 in.) (10, 15 and 20 cm), cast iron soil pipe (4, 5 and 6 in.) (10, 12.5 and 20 cm) to tile (4 and 6 in.) (10 and 15 cm) and asbestos-cement pipe (4, 6 and 8 in.) (10, 15 and 20 cm) to tile (4, 6 and 8 in.) (10, 15 and 20 cm) shall be made using a synthetic rubber or plastic compressible type coupling as detailed on the appurtenance sheet that shall conform to Item 2.12.1.(c)(1). The two bands for patching the coupling shall be corrosion-resistant steel or stainless steel. The bank shall be tensioned to provide a residual compression of at least 30 psi between coupling and the pipe.

Closures of 4 in. (10 cm) tile bell to 4 in. (10 cm) cast iron spigot (for lateral cleanouts) and of 6 in. (15 cm) tile spigot to 6 in. (15 cm) concrete bell (rubber gasket type joint) shall be made, using compression type, wedge shaped synthetic rubber or plastic adapter rings, as detailed on the appurtenance sheet that shall conform to Item 2.12.1., “Clay Sewer Pipe.” The adapter shall be lubricated to facilitate making the joint after the ends and bells have been thoroughly cleaned. All closure section and sections jointed shall be sawed at right angles to the centerline of the section.

(5) 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.

(c) 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. Tests can be made by one of 3 methods as directed by the OWNER. Infiltration, exfiltration or air tests may be made on sections of the contract work to assure that contract performance is satisfactory.

(1) All sewer pipe shall be air tested upon completion of backfill.
(2) Sanitary sewer force mains shall be hydrostatically tested.
(3) Manholes shall be tested by infiltration or , or vacuum, as determined by the OWNER.

(A) The rate of infiltration or exfiltration for manhole testing shall not exceed 0.1 gallons per hour per foot of depth.

(B) Vacuum testing of manholes shall be performed by the CONTRACTOR in compliance with these specifications:

Manholes shall be tested after installation with all connections (existing and/or proposed) in place. Lift holes shall be plugged with an approved non-shrink grout prior to testing. Drop-connections and gas sealing connections shall be installed prior to testing. The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole. The plugs shall be installed in the lines beyond drop-connections, gas sealing connections, etc. The test head shall be placed inside the frame at the top of the manhole and inflated in accordance with the manufacturer's recommendations. A vacuum of 10 inches mercury shall be drawn, and the vacuum pump shall be turned off. With the valve closed, the level of vacuum shall be read after the required test time. If the drop in the level is less than 1-inch of mercury (final vacuum greater than 9 inches of mercury), the manhole will have passed the vacuum test. The required test time is determined from the following table:

<table>
<thead>
<tr>
<th>Height of MH</th>
<th>48&quot; MH</th>
<th>60&quot; MH</th>
<th>72&quot; MH</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 20'</td>
<td>0:40</td>
<td>0:50</td>
<td>1:00</td>
</tr>
<tr>
<td>22'</td>
<td>0:44</td>
<td>0:55</td>
<td>1:06</td>
</tr>
<tr>
<td>24'</td>
<td>0:48</td>
<td>1:00</td>
<td>1:12</td>
</tr>
<tr>
<td>26'</td>
<td>0:52</td>
<td>1:05</td>
<td>1:18</td>
</tr>
</tbody>
</table>
Manholes will be accepted with relation to vacuum test requirements if they meet the criteria above. Any manhole which fails the initial test must be repaired with a non-shrink grout or other suitable material based on the material from which the manhole is constructed. The manhole shall be retested as described above until a successful test is made. After a successful test, the temporary plugs shall be removed.

(4) Tunneled, bored or jacked sections of all pipe shall be tested by a method to be determined by the OWNER.

(5) 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.

(6) If a gravity main is specified to be hydrostatically tested, the test shall be in accordance with Item 6.7.3 (f), except that the test pressure, duration of the test, and allowable leakage shall be specified. The CONTRACTOR shall remove the water from the main after the test if required by the OWNER.

(d) Infiltration Test. The total seepage in infiltration or seepage of ground water as determined by test shall in no case exceed 50 gallons per inch of nominal diameter of pipe per mile (0.05 cubic meters per centimeter of nominal diameter of pipe per kilometer) over a 24-hour period, and shall be the same regardless of piping material used. The allowable leakage of each manhole, or other structure, shall be as specified on the plans. An infiltration test or tests shall be made on all sections of the project where air testing could not be adequately performed or if ordered by the OWNER and on each manhole individually before placing the system in service and before any connections are made to other sewers. If the quantity of the effluent into the sewer or sewers is in excess of the maximum quantity as hereinbefore specified, the joints shall be repaired or the sewer relayed, if necessary, or other remedial construction shall be performed by and at the expense of the CONTRACTOR, in order to reduce the quantity of ground water infiltration to an amount within limits as specified.

The test shall be made by utilizing ground water, if any, or flooding a section at a time. Observation from jetting is not acceptable.

(1) Using Existing High Ground Water. Where the natural ground water, after well points are removed, is above the top of the pipe for a section, the flowing of water in the pipe and the rate of seepage and infiltration for the section so submerged can be measured.

(2) Flooding by Sections. Backfill shall be brought up to at least 1 ft. (30 cm) over the pipe on the section to be tested. More cover may be required on larger pipes to prevent the pipe from floating out of grade. Dams or dikes are placed tightly around pipe at either end and the ditch filled with water to an average depth of 4 ft. (1.2 m) over the pipe. Flow at the lower end is measured for the section so submerged.

Dikes shall be placed around each manhole, and the area adjacent to the manhole shall be flooded to the top of the manhole and the flow into the manhole measured.

(3) Flushing or Jetting of Backfill. During jetting to settle the backfill, the flow at the lower manhole shall provide a control indication of possible infiltration which should be corrected.

(e) Exfiltration. A section of pipe below a manhole is bulkheaded at either end with a 6 in. (15 cm) pipe inserted into lower bulkhead and by use of a 90-degree bend. The 6 in. (15 cm) pipe is set in a vertical position. A 2 in. (5 cm) vent pipe is inserted in lower end and extended upward 4 ft. (1.2 m). The 6 in. (15 cm) pipe is filled with water, filling the sewer line until all air is forced out through the vent tube. When the water levels are level in the 2 in. (.5 cm) and 6 in. (15 cm) pipes, the drop in the 6 in. pipes (15 cm) due to exfiltration over a specific time shall be meas-
ured and the loss of water due to exfiltration calculated. This amount shall be reduced by 25 percent to obtain equivalent infiltration over a specific time and the loss of water due to exfiltration calculated. Conditions encountered in construction may vary this procedure slightly, but essentially this method shall be used.

(f) Low Pressure Air Testing.

(1) 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 in. to 33 in. circular sewer pipe lines utilizing gasketed jointed. Mains 36 in. and larger may be tested by the individual joint method.

(2) History. The low pressure air test was developed to enable detection of damaged pipe or improper jointing and is a test which determine 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.

(3) 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.

(A) 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.

(B) 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 blow out 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 guages 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 2 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 by 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 air flow in cubic feet per minute is read directly by means of a rotometer. The rate of air flow 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.

(C) 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 means of a rotometer. The rate of air flow 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.

(D) 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 psig. The air shall be allowed to stabilize for a period of 2 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 psig 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.)

<table>
<thead>
<tr>
<th>Pipe Diameter (In.)</th>
<th>Minimum Time (min: sec.)</th>
<th>Length for Minimum Time (ft.)</th>
<th>Specification Time for Length (L) Shown (min:sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>100 ft.</td>
<td>150 ft.</td>
</tr>
<tr>
<td>6</td>
<td>5:40</td>
<td>5:40</td>
<td>5:40</td>
</tr>
<tr>
<td>8</td>
<td>7:33</td>
<td>7:33</td>
<td>7:33</td>
</tr>
<tr>
<td>14</td>
<td>14:10</td>
<td>14:10</td>
<td>14:10</td>
</tr>
<tr>
<td>33</td>
<td>31:10</td>
<td>72.32</td>
<td>43:06</td>
</tr>
</tbody>
</table>

*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 cu. ft./min./sq. ft. 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.

(4) Individual Joint Test Method. **All concrete sewer mains 36 in. and larger in diameter shall be 100% air tested at each joint connection only. The method of testing shall be described in Item 6.7.2.(f). The time allowed for the pressure drop from 3.5 psi 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 been made may be cause for rejection.

(g) Deflection Testing. Upon completion of PVC sanitary sewer pipe installation, the CONTRACTOR shall pull a mandrel through the pipe to test for a maximum 5 percent deflection unless otherwise specified as 7 1/2 percent in the contract document. The mandrel shall be sized and constructed as listed on the applicable mandrel deflection table.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D 3034 DR 35</td>
<td>6</td>
<td>5.45</td>
<td>± 0.01</td>
<td>5 1/16</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>D 3034 DR 35</td>
<td>8</td>
<td>7.28</td>
<td>± 0.01</td>
<td>7 1/16</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>D 3034 DR 35</td>
<td>10</td>
<td>9.08</td>
<td>± 0.01</td>
<td>9 1/16</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>D 3034 DR 35</td>
<td>12</td>
<td>10.79</td>
<td>± 0.01</td>
<td>10 13/16</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>D 3034 DR 35</td>
<td>15</td>
<td>13.20</td>
<td>± 0.01</td>
<td>13 7/16</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

JANUARY 1998
(h) Sewer Appurtenances.

(1) 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.
(2) 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 Item 7.6., "Concrete Structures," 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 2 in. (5 cm) 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 7.6.10., "Finishing." 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 detailed in Item 2.9.4., "Corrosion Resistant Coatings and Liners for Sanitary Sewers and Appurtenances."

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 bi-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 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.

(3) Creek Crossings. Creek crossings using pier construction shall be made in accordance with the details shown on the plans.

(4) Measurement and Payment for 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 the 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.

(5) 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.

(6) Measurement and Payment for River Crossings, Siphons and Miscellaneous Pipe Structures. The structures shall be measured for payment for 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 specifications.

(7) Laterals. Laterals are classified as street laterals, alley laterals, and easement laterals. Laterals shall be located as indicated on the plans or as directed by the OWNER. Details of construction shall be shown on the plans. Laterals shall consist of a standard wye and bend or standard tee as specified by the OWNER and the necessary valve, cleanout and cleanout as shown on the plans.

If the CONTRACTOR is required to connect or reconnect the lateral to the house main, the connection shall be as shown on the plans. If the CONTRACTOR is not required to connect to the house main, the lateral shall be plugged and sealed.

The lateral shall be of the same pipe material as the main unless otherwise specified on the plans or in the contract or approved by the OWNER.

Laterals to property shall be marked under the ground surface by placing green metalized plastic tape with the word "SEWER" printed on the tape at regular intervals. One end of the tape shall be placed at the end of the lateral, and the other end shall be just under the ground surface projecting at least 1 ft. (30 cm) back of the proposed or existing curb.

(8) Measurement and Payment. Laterals shall be measured at the contract unit price per each, complete in place. The contract unit price shall be total compensation for the furnishing of all labor, materials, tools, equipment and in-
cidentals necessary to complete the work, including excavation, concrete encasement, if required, disposal of excess material, backfill, embedment, concrete blocking, paving and sod, all in accordance with the plans and specifications.

(i) Sanitary Sewer Manholes. Sanitary sewer manholes shall be fabricated in different configurations to meet the specific needs required in the sanitary sewer system.

(1) General. Unless otherwise specified, manholes shall have an inside diameter of four feet (1.2 m). Manholes constructed in advance of paving projects shall be constructed with the top of the concrete portion of the manhole 23 inches below the final finished grade. The ring and cover shall be placed on a built-up section of precast concrete grade rings and nonshrink grout. Manholes shall be watertight. The type and size, if other than four feet inside diameter, shall be shown on the plans for each location.

(A) Cast-In-Place. The base, wall and cone shall be Type “F” concrete poured and vibrated to assure a monolithic structure. Construction joints with waterstops must be approved by the OWNER.

(B) Precast. The base shall be Type “F” 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.

C) Fiberglass. The base shall be Type “F” concrete. The fiberglass portion of the manhole shall be delivered in one piece. Field jointing shall not be permitted.

(D) Brick. Brick manholes will not be permitted.

(E) 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.

(F) Type “A” Drop “A” manholes (altered manholes) shall be constructed in accordance with details shown on the plans.

(G) Type “S.” Type “S” manholes (sealed manholes) shall be constructed in accordance with details shown on the plans.

(H) Steps, Rings and Covers. Installation of steps, rings and covers shall be shown on the plans. Manhole steps shall only be used if specified on the plans or in the contract document. Where manhole steps are not used, the CONTRACTOR shall furnish a ladder for access for inspection. Manhole covers shall be detailed on the plans.

(2) Special Requirements.

(A) Invert. The invert of standard manholes shall be formed in a typical pattern regardless of the wall construction.

(1) Flow Channel. When specified in the special provisions or in the plans, the sanitary sewer pipe shall be laid through the manhole stations were possible, prior to concreting, so that the full depth of the pipe is embedded in concrete to form the flow channel.

(2) 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.

(3) Manhole Bottom. The manhole bottom from wall line to flow channels shall be sloped and troweled smooth on a grade of 1 in. per foot (2.5 cm per 30 cm) with a liberal radius applied at flow channel intercepts.

(B) First Full Joint. The first full joint of pipe extending from the manhole shall be cradled in concrete to the pipe joint in the same pour as that for the manhole base slab shown on the plans.

(C) Pick Slots. For all manhole installations in the streets, the manhole covers shall be provided with pick slots in lieu of pick holes. If the rim elevation above surrounding ground is prohibited by land use or other reasons, a cover with a pick slot as described for use in street locations shall be used.

(3) Measurement and Payment of 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, brick, 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 linear foot (m) of additional depth, measured to the nearest 1/10 ft. (3 cm) over the basic depth stipulated for the type manholes under bid. A standard manhole is 6 ft. deep measured from the top of the manhole cover to the flow line of the invert. A shallow manhole is less than 6 ft. deep as measured for Item 6.7.2(3).

(j) Cleanouts for Sanitary Sewers.
(1) Construction Methods. Cleanouts shall be constructed in accordance with the plans and these specifications for materials and construction.

(2) Measurement and Payment. Cleanouts shall be measured and paid for at contract unit price per each, complete in place, as provided in the proposal and contract. Cleanouts shall not be measured and paid for according to depth. 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 earth excavation, disposal of surplus materials and backfill, all in accordance with the plans and these specifications.

(k) Measurement and Payment for Sanitary Sewer Conduit Installation.

(1) 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 (m) 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. Conduits shall not be classified for payment according to depth.

(2) 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 (m), complete in place, as provided by the contract. The contract price per linear foot (m) 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.

6.7.3. WATER CONDUIT INSTALLATION

(a) Description. This work shall include the installation and construction, complete in place, of pipe conduits and fittings as specified herein and in conformity with the lines, grades, dimensions, materials and designs shown on the plans.

(b) Materials. 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 conduits and appurtenances shall be of the type as may be called for on the plans or in the special specifications.

Any pipe, fitting, solder 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 solders and flux containing not more than 0.2 percent lead, and pipes and pipe fittings containing not more than 8.0 percent lead.

(c) Laying Water Conduit. 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 in. (40 cm) 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 2 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. Deflec-
tion of the joint to form curves shall not exceed the limits of Table 2, AWWA C-600. 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.

(d) Pipe Joints. All joints in pipe conduits shall be thoroughly cleaned at the time the joint is made.
(e) 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 of fuels.

Rubber gasket joints for water mains consist of 4 general types:

(1) push-on type used for gray or ductile iron, steel and plastic pipe.
(2) mechanical type used for gray or 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 non-toxic, shall not support the growth of bacteria and shall have no deteriorating effect on the gasket. The lubricant shall not impart taste or odor in a pipe that has been flushed in accordance with Item 6.7.3. Care should be taken not to over-use the lubricant since it would then require excess effort to disinfect.

(f) Hydrostatic Test. Before being accepted, all gray iron, ductile iron, plastic and asbestos-cement pipe lines constructed shall be tested with a hydraulic test pressure of not less than 150 psi (1034.3 KPa), maintained over a period of not less than 4 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 design working pressure. The rate of leakage of all pipe tested shall not exceed 11.65 gallons per inch of nominal diameter per mile (0.01 cu. m. per km) 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 maintained over a period of not less than 4 hours. Refer to the provided table, “Allowable Leakage for 4 Hours at Test Pressure of 150 PSI,” to determine acceptable test values.

### ALLOWABLE LEAKAGE (GALS.) FOR 4 HOURS AT TEST PRESSURE OF 150 PSI

<table>
<thead>
<tr>
<th>Length (Ft.)</th>
<th>4</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>24</th>
<th>30</th>
<th>36</th>
<th>48</th>
<th>54</th>
<th>60</th>
<th>66</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes (Inches)</td>
<td>5</td>
<td>0.01</td>
<td>0.02</td>
<td>0.03</td>
<td>0.04</td>
<td>0.06</td>
<td>0.07</td>
<td>0.09</td>
<td>0.11</td>
<td>0.13</td>
<td>0.15</td>
<td>0.18</td>
<td>0.20</td>
<td>0.22</td>
<td>0.24</td>
</tr>
<tr>
<td>10</td>
<td>0.02</td>
<td>0.03</td>
<td>0.04</td>
<td>0.05</td>
<td>0.06</td>
<td>0.07</td>
<td>0.09</td>
<td>0.11</td>
<td>0.13</td>
<td>0.15</td>
<td>0.18</td>
<td>0.20</td>
<td>0.22</td>
<td>0.24</td>
<td>0.26</td>
</tr>
<tr>
<td>15</td>
<td>0.03</td>
<td>0.04</td>
<td>0.06</td>
<td>0.08</td>
<td>0.10</td>
<td>0.11</td>
<td>0.13</td>
<td>0.17</td>
<td>0.20</td>
<td>0.23</td>
<td>0.26</td>
<td>0.30</td>
<td>0.33</td>
<td>0.36</td>
<td>0.39</td>
</tr>
<tr>
<td>20</td>
<td>0.04</td>
<td>0.06</td>
<td>0.11</td>
<td>0.12</td>
<td>0.14</td>
<td>0.15</td>
<td>0.17</td>
<td>0.18</td>
<td>0.22</td>
<td>0.26</td>
<td>0.31</td>
<td>0.35</td>
<td>0.40</td>
<td>0.44</td>
<td>0.49</td>
</tr>
<tr>
<td>25</td>
<td>0.06</td>
<td>0.10</td>
<td>0.13</td>
<td>0.13</td>
<td>0.15</td>
<td>0.17</td>
<td>0.18</td>
<td>0.22</td>
<td>0.28</td>
<td>0.33</td>
<td>0.39</td>
<td>0.44</td>
<td>0.50</td>
<td>0.56</td>
<td>0.61</td>
</tr>
<tr>
<td>30</td>
<td>0.11</td>
<td>0.15</td>
<td>0.22</td>
<td>0.26</td>
<td>0.29</td>
<td>0.33</td>
<td>0.37</td>
<td>0.44</td>
<td>0.55</td>
<td>0.67</td>
<td>0.88</td>
<td>0.99</td>
<td>1.10</td>
<td>1.21</td>
<td>1.28</td>
</tr>
<tr>
<td>35</td>
<td>0.17</td>
<td>0.22</td>
<td>0.28</td>
<td>0.33</td>
<td>0.39</td>
<td>0.44</td>
<td>0.50</td>
<td>0.55</td>
<td>0.66</td>
<td>0.83</td>
<td>0.99</td>
<td>1.16</td>
<td>1.32</td>
<td>1.49</td>
<td>1.66</td>
</tr>
<tr>
<td>40</td>
<td>0.22</td>
<td>0.29</td>
<td>0.37</td>
<td>0.44</td>
<td>0.51</td>
<td>0.59</td>
<td>0.66</td>
<td>0.74</td>
<td>0.88</td>
<td>1.10</td>
<td>1.32</td>
<td>1.54</td>
<td>1.77</td>
<td>1.99</td>
<td>2.21</td>
</tr>
<tr>
<td>45</td>
<td>0.44</td>
<td>0.59</td>
<td>0.74</td>
<td>0.88</td>
<td>1.03</td>
<td>1.18</td>
<td>1.32</td>
<td>1.47</td>
<td>1.77</td>
<td>2.21</td>
<td>2.65</td>
<td>3.31</td>
<td>3.97</td>
<td>4.63</td>
<td>5.30</td>
</tr>
<tr>
<td>50</td>
<td>0.66</td>
<td>0.88</td>
<td>1.10</td>
<td>1.32</td>
<td>1.54</td>
<td>1.77</td>
<td>1.99</td>
<td>2.21</td>
<td>2.65</td>
<td>3.31</td>
<td>3.97</td>
<td>4.63</td>
<td>5.30</td>
<td>6.00</td>
<td>6.72</td>
</tr>
<tr>
<td>55</td>
<td>0.91</td>
<td>1.18</td>
<td>1.47</td>
<td>1.77</td>
<td>2.06</td>
<td>2.35</td>
<td>2.65</td>
<td>2.94</td>
<td>3.53</td>
<td>4.11</td>
<td>4.70</td>
<td>5.30</td>
<td>6.00</td>
<td>6.72</td>
<td>7.44</td>
</tr>
<tr>
<td>60</td>
<td>1.10</td>
<td>1.47</td>
<td>2.18</td>
<td>2.84</td>
<td>3.59</td>
<td>4.34</td>
<td>5.13</td>
<td>5.92</td>
<td>6.71</td>
<td>7.50</td>
<td>8.30</td>
<td>9.10</td>
<td>9.90</td>
<td>10.70</td>
<td>11.50</td>
</tr>
<tr>
<td>70</td>
<td>1.32</td>
<td>1.77</td>
<td>2.21</td>
<td>2.65</td>
<td>3.09</td>
<td>3.53</td>
<td>4.07</td>
<td>4.60</td>
<td>5.15</td>
<td>5.70</td>
<td>6.25</td>
<td>6.80</td>
<td>7.35</td>
<td>7.90</td>
<td>8.45</td>
</tr>
<tr>
<td>80</td>
<td>1.54</td>
<td>2.06</td>
<td>2.57</td>
<td>3.09</td>
<td>3.60</td>
<td>4.12</td>
<td>4.63</td>
<td>5.15</td>
<td>5.68</td>
<td>6.21</td>
<td>6.74</td>
<td>7.27</td>
<td>7.80</td>
<td>8.33</td>
<td>8.86</td>
</tr>
<tr>
<td>90</td>
<td>1.77</td>
<td>2.35</td>
<td>2.94</td>
<td>3.53</td>
<td>4.12</td>
<td>4.71</td>
<td>5.30</td>
<td>5.88</td>
<td>6.46</td>
<td>7.04</td>
<td>7.62</td>
<td>8.20</td>
<td>8.78</td>
<td>9.36</td>
<td>9.94</td>
</tr>
<tr>
<td>100</td>
<td>2.21</td>
<td>2.94</td>
<td>3.68</td>
<td>4.41</td>
<td>5.15</td>
<td>5.88</td>
<td>6.62</td>
<td>7.36</td>
<td>8.03</td>
<td>8.70</td>
<td>9.38</td>
<td>10.06</td>
<td>10.74</td>
<td>11.42</td>
<td>12.10</td>
</tr>
</tbody>
</table>

Valve Leakage Allowable = 0.0078 Gal./Hour/In. of nominal valve size

Test — Gray Iron, Ductile Iron, Plastic, and AC at 150 psi
— Concrete 120% of Design Pressure
— Steel 120% Min. to 150% Max. Design Working Pressure

Allowable Leakage (Gals.) for 4 hours = \[ \frac{SD}{133,200} \times 4 \]

Where

- \( S = \) Length of Pipe, Ft.
- \( D = \) Diameter of Pipe, In.
- \( P = 150 \) psi
- Height Correction = 0.43 psi/ft

JANUARY 1998
All newly laid pipe, or any valve section thereof, shall be subjected to the above test with the gauge located at the lowest point in the system to be tested. If the line cannot be tested at its lowest point, a correction factor of minus 0.43 lb./vert. ft. (0.64 kg/vert. m) shall be made.

If the tests indicate a leakage in excess of the above rate, then the CONTRACTOR shall be required to find the leak and repair same. Even if the test requirements are met, all apparent leaks shall be stopped. Allowance for valve leakage to the atmosphere may be determined as no more than 0.0078 gal./hr./in. (0.012 l/hr./cm.) of nominal valve size. The OWNER cannot guarantee that an old existing system valve shall hold the required pressure. The CONTRACTOR has the option of plugging the new main prior to tying onto the existing system and testing against the old valve. If the old valve does not hold against the test pressure, then the CONTRACTOR must cut and plug the new main, hydrostatic test the new main, and then complete the tie-in. Internal test plugs may be used in larger R.C. mains in lieu of plugging prior to making a tie-in.

The cost of testing and repairing the leaks, including all uncovering, repairing, backfilling and incidental work, shall be at the expense of the CONTRACTOR.

(g) Measurement and Payment for Water Conduit Installation.

(1) Measurement. Pipe, including corrosion protection if in place on the pipe, shall be measured for payment in linear feet (m) along the center line 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 line, the measurement shall be to the center of the fitting. Where a change in the size of the pipe occurs in line, the measurement shall be to the center of the reducer. Conduits shall not be classified for payment according to the depth of the cut.

(2) Payment. Pipe, including corrosion protection in placed on the pipe, shall be paid for at the contract unit price per linear foot (m), completed in place, as provided by the proposal and contract. The contract price per linear foot (m) 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.

(h) Water Conduit Appurtenances.

(1) Description. This section shall govern for the construction of all miscellaneous water main structures.

(2) Materials. All materials used in the construction of work specified in this section shall conform to the applicable sections of these specifications.

(3) Excavation and Backfill. In general, excavation and backfill shall conform to the requirements of Item 6.2., "Excavation and Backfill."

(4) Construction Requirements. The construction of reinforced concrete water main structures shall be performed in accordance with the requirements of Item 7.6., "Concrete Structures," and the following additional requirements:

All formed surfaces of the concrete exposed to public view shall be given a textured finish as shown on the plans. All other formed surfaces shall be given the "Ordinary Surface Finish" as described in Item 7.6.10, "Finishing."

(5) Creek Crossing. Creek crossing using pier construction shall be made in accordance with the details shown on the plans.

Creek crossing shall be measured for payment as a lump sum or in linear feet (m) of pipe furnished and placed, plus the cubic yard (m³) of concrete in place, or a combination of the 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.

(6) 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.

The structures shall be measured for payment per each or in linear feet (m) 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 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 incidents necessary to complete the work, including all excavation, disposal of surplus materials and backfill, in accordance with the plans and these specifications.

(i) Connections to Existing Water Mains.

(1) 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, and/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 back-up equipment, labor and materials available) to insure that time schedules are met without failure and subsequent set-back. 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.

(2) 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 connections. Such plugs and blocking shall be adequate to withstand an applicable test pressure.

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 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.

In the case where blow-off connections or fire hydrants are not provided for flushing, the CONTRACTOR shall be required to leave one end of the new main open for flushing and then plug and block the end for chlorination and testing.

(3) Measurement and Payment for Connection to Existing Mains. There shall be no separate pay item for connections to existing mains. Furnishing and placing of fittings, valves, pipe and concrete blocking are included elsewhere in the proposal and contract as separate pay items.

(j) Taps and Tap Assemblies in Water Mains.

(1) 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.

(A) Taps. Taps for transmission of water or air from the main into system service accessories can be either of two types as follows:

(1) Standard internal pipe threaded holes in wall of water mains. These taps may be either manufactured into the pipe or installed in the field.

(2) Tap installations that are made by clamping a bronze service clamp equipped with a sealed threaded port on the periphery of the main and 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.

(B) 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 1 ft. (30 cm) below ground surface with a brass gate valve as shown and detailed on the plans to serve as additional air release.

(1) When tap assemblies are an integral part of an air valve installation, measurement and payment shall be in accordance with Item 6.7.3.
(2) 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.

(3) 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 purification, 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.

(2) Tapping Cast Iron Pipe. Service taps, unless otherwise specified, shall be made in cast iron pipe by direct tapping of the pipe wall (without use of tap saddles) for tap sizes relative to pipe diameters as follows:

<table>
<thead>
<tr>
<th>Tap Diameter</th>
<th>Pipe Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 in. and 1 in.</td>
<td>4 in. and larger</td>
</tr>
<tr>
<td>1 1/2 in. and 2 in.</td>
<td>12 in. and larger</td>
</tr>
</tbody>
</table>

When direct tapping of cast iron pipe cannot be made within the limits as provided above, taps shall be made as set forth in this specification, utilizing bronze service clamps.

(3) 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 in. (2.5 cm) shall be provided with brass insert bushings. Taps 1 1/2 in. or larger (3.75 cm) shall be provided as flanged outlets with flange to thread insulator adapter kits.

(4) Tapping Asbestos Pipe. Taps to asbestos pipe can be made directly to the pipe with bronze double strap tapping saddle, to cast iron tapping tees, or to pre-tapped couplings with brass insert bushings. 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. A cast iron tapping tee shall be paid for as a fitting. If pre-tapped couplings are called for in the contract and proposal, a separate pay item shall be provided for each, classified as to size.

(5) Tapping of PVC Pipe. Service taps in AWWA C-900 PVC pressure pipe shall be made with a shell cutter assembly and the coupon removed for tap sizes relative to pipe class and diameter as follows:

<table>
<thead>
<tr>
<th>Tap Diameter</th>
<th>Pipe Diameter</th>
<th>Pressure Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 in.</td>
<td>6 in. to 12 in.</td>
<td>150 and 200</td>
</tr>
</tbody>
</table>

When direct tapping of PVC pipe cannot be made within the limits as hereinbefore provided, taps shall be made as set forth in this specification, utilizing bronze service clamps.

(6) Measurement and Payment. Measurement shall be for individual taps made by size, and payment shall be absorbed under Item 6.7.3. or 2.13.1. unless otherwise specified.

(k) Line Valve Installation.

(1) 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 7.4.8.

(2) 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.
(3) Measurement and Payment. 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 gear boxes 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.

(l) Air Release Valves.

(1) 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.

(2) Installing Air Release Valves. Air valves shall be installed in the manner shown on the appurtenance sheet unless otherwise indicated on the plans. The proper valve and fitting sizes shall be installed on mains in accordance with the following schedule unless otherwise specified:

<table>
<thead>
<tr>
<th>I.D. of Main (Inches)</th>
<th>Size of Valve and Fitting (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 and smaller</td>
<td>1</td>
</tr>
<tr>
<td>18 through 36</td>
<td>2</td>
</tr>
<tr>
<td>42 and larger</td>
<td>3</td>
</tr>
</tbody>
</table>

Matching taps shall be provided for and made in accordance with Item 2.12.2. Fittings required for mounting air valves shall be as specified in Item 6.7.3.(n). All fittings shall be tight, leak free and plumbed true to the required position.

(3) Measurement and Payment. 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.

(m) Fire Hydrants.

(1) General. Fire hydrants shall be installed as shown on the appurtenances sheets or as directed by the owner.

(2) Installation. The hydrant shall set truly vertical and be securely braced and blocked on well-compacted or undisturbed soil surrounded by clean gravel or stone (min. of 7 CF) to permit free draining of the hydrant, with the large stem nozzle facing the nearest curb.

Any adjustment needed after installation shall be made by the contractor without extra compensation.

(3) Measurement and Payment. 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 extensions and incidentals necessary to complete the work.

The hydrant lead shall be paid for at the unit price bid for installing pipe. The gate valve and box installed in leads shall be paid for at the unit price bid for installing gate valves and boxes.

Fire hydrant extensions shall be paid for at the unit price bid per foot if a separate pay item is established in the contract.

(n) Fittings.

(1) General. Cast Iron, Gray Iron, Ductile Iron or 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 are prohibited if soil resistivity measurements are less than 1000 ohms/cm.

(2) Measurement and Payment. 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, Gray Iron, Ductile Iron and Ductile Iron Compact Fittings shall be measured for payment per ton. No separations of sizes shall be made.

Special fittings and 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 a 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.

(o) Services and Bullheads.

(1) 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 serve two or more customers.

The details on installation and materials required are shown on the appurtenance sheets attached to the plans.

Services to property shall be marked under the ground surface by placing blue plastic tape. The word "WATER" shall be printed at intervals. One end shall be placed at end of service, the other just under the ground surface projecting at least 1 ft. (30 cm) back of proposed or existing curb.

(2) Measurement and Payment. 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. There shall be no extra pay for extra depth in the installation of service leads (deadheads).

The contract price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work.

(p) Pitot Outlets.

(1) General. Pitot outlets shall be of the type indicated on the plans or appurtenance sheet.

(2) Measurement and Payment. Pitot outlets shall be measured for payment for each.

Pitot outlets shall be paid for at the contract unit price per each.

(q) Facilities for Dewatering of Water Lines.

(1) 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 the dewatering of lines or sections of line.

(2) Standard Blow-Off and Drain. Where shown on the plans, standard blow-offs and drains shall be constructed.

(3) Measurement and Payment. 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.

(4) 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.

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.

(r) Blocking.
(1) General. Each change in direction of a pressure conduit and plugs in pressure conduits shall be blocked with Class B concrete as is detailed on the appurtenance 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.

(2) Measurement and Payment. Concrete blocking shall be measured for payment in cubic yards (m³) concrete in the amounts as shown on the appurtenance sheet, as may be detailed on the plans, or as directed by the OWNER.

(s) Purging and Sterilization of Water Mains:

(1) General. Before any newly constructed water main shall be permitted to be placed into service, it shall be flushed or purged, sterilized 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 OWNER’S personnel shall perform the actual purging, sterilization and testing activities unless the CONTRACTOR is specifically required to do this work as outlined in the contract. 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 sterilized and/or approved for that use by the OWNER.

(2) Procedure. When the entire pipeline or selected sections, as approved by the OWNER, have been completed, the line or section shall be disinfected according to the following procedures:

(A) Pre-sterilization. For convenience in certain locations, it may be directed by the OWNER that chlorinated lime (HTH) be placed in the pipe as laid. In such cases, the chlorinated lime shall be furnished by the OWNER.

(B) Purging. Purging may be accomplished by passing an appropriate sized “polly-pig(s)” through the pipe or by flushing, as determined by the OWNER.

(1) Polly-Pig Method. If the polly-pig method of purging is to be used, the CONTRACTOR shall be required to prepare the main for the installation and removal of “polly-pigs.” The OWNER shall purge the system unless the CONTRACTOR is specified to do the work. This method shall include the following:

(i) In general, this shall consist of furnishing all equipment, material, and labor to satisfactorily expose cleaning wye, remove cleaning wye covers, etc., as directed by the OWNER.

(ii) Where expulsion of the “polly-pig” is required through a dead-ended main, the CONTRACTOR shall make every effort to prevent back flow of purged water into the main after passage of the pig. On small pipe, such as cast iron pipe through 12 in. (30 cm), backwater re-entry into the pipe can be prevented by the temporary installation of mechanical joint shallow bends and pipe joints to provide a riser out of the trench. On larger pipe, additional excavation of the trench may serve the same purpose.

(iii) Where the pipe in the main forms a loop distribution system, every effort shall be made to sweep the entire system.

(iv) Short dead-end pipe sections not swabbed by the pig shall be flushed.

(v) Backflow water which has inadvertently entered the pipe under conditions similar to those described in Section II preceding shall be flushed from the system.

(vi) After passage of the “polly-pig,” flushing of all backwater from the pipe, and satisfactory test results, at the direction of the OWNER, the CONTRACTOR shall: secure test location openings by plugging and blocking, installing cleaning wye blind flanges, etc.; then backfill; and complete all appurtenant work necessary to secure the system, or proceed with sterilization.

(2) Flushing Method. If the “flushing” method of purging is used, the CONTRACTOR shall be required to prepare the main by installing blow-offs at locations and sized as directed by the OWNER.

(i) In general, this shall consist of furnishing all equipment, material and labor to satisfactorily install blow-offs of sizes shown in the following table:

<table>
<thead>
<tr>
<th>Size Main</th>
<th>Size Blow-Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 in. thru 8 in.</td>
<td>³/₄ in.</td>
</tr>
<tr>
<td>10 in. thru 12 in.</td>
<td>1 ³/₄ in.</td>
</tr>
<tr>
<td>16 in. and greater</td>
<td>2 in.</td>
</tr>
</tbody>
</table>

(ii) After flushing is complete and satisfactory test results are received at the direction of the OWNER, the CONTRACTOR shall secure the main, backfill, and complete all appurtenant work to secure the system, or proceed with sterilization.
(3) Water Sample Analysis. After purging, an analysis may be made on the water sample drawn from a chlorination blow-off and sampling point at the OWNER'S request. (Samples drawn from fire hydrants have in the past proved unreliable and except in extreme cases shall not be used for the purpose of analysis.) Should the analysis indicate that the bacteria count is below the limits of the established standards for purity, no further sterilization is necessary unless specifically required by the OWNER.

(C) Sterilization. Sterilization of the main shall be accomplished by the “continuous feed” method or the “slug” method as directed by the OWNER and described as follows: The free chlorine amounts shown are minimum. Higher rates may be required by the OWNER. Calcium hypochlorite granules shall be used as the source of chlorine.

(1) Continuous Feed Method. If the “continuous feed” method of chlorination is used, the following steps shall be taken:

(i) water from the existing distribution system or other approved source of supply shall be made to flow at a constant rate in the newly laid main.

(ii) at a point not more than 10 ft. downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine such that the water shall have not less than 25 mg/L free chlorine. Chlorine applications shall not cease until the entire main is filled with heavily chlorinated water.

(iii) the chlorinated water shall be retained in the main for at least 24 hours, during which time all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. Every effort shall be made to prevent the flow of chlorinated water into mains in active service. At the end of the 24-hour period, the treated water in all portions of the main shall have a residual of at least 10 mg/L free chlorine.

(iv) the heavily chlorinated water shall then be flushed from the main and disposed of in a manner and at a location specified by the OWNER.

(2) Slug Method. If the “slug” method of chlorination is used, the following steps shall be taken:

(i) water from the existing distribution system or other approved source of supply shall be made to flow at a constant rate in the newly laid main.

(ii) at a point not more than 10 ft. downstream from the beginning of the new main, water entering the main shall receive a dose of chlorine such that the water shall have not less than 100 mg/L free chlorine. The chlorine shall be applied continuously and for a sufficient time to develop a solid column or “slug” of chlorinated water that shall expose all interior surfaces to the “slug” for at least 3 hours.

(iii) as the chlorinated water flows past the fittings and valves, they shall be operated so as to disinfect the appurtenances. Every effort shall be made to prevent the flow of chlorinated water into mains in active service.

(iv) the heavily chlorinated water shall then be flushed from the main and disposed of in a manner and at a location specified by the OWNER.

(3) CONTRACTOR Requirements. No matter who performs the above described sterilization activities, the CONTRACTOR shall be required, as a minimum, to prepare the main for sterilization and secure same after chlorination is complete. This should include the following:

(i) in general, this shall consist of furnishing all equipment, material and labor to satisfactorily prepare the main for the sterilization method selected by the OWNER. The CONTRACTOR shall also be required to provide adequate provisions for sampling.

(ii) unless otherwise specified in the special contract documents, the CONTRACTOR shall make all necessary taps into the pipe to accomplish chlorination of a new line.

(iii) after satisfactory completion of the sterilization operation and on the direction of the OWNER, the CONTRACTOR shall remove surplus pipe at the chlorination and sampling points, plug the remaining pipe as indicated in Item 1.5.24.3., backfill and complete all appurtenant work necessary to secure the main.

(4) Sampling. Unless otherwise specified, the OWNER'S personnel or representative shall inject the chlorine disinfectant into the main, monitor the solution and perform the water analysis.

An OWNER'S representative shall then take water samples from a suitable tap (not through a fire hydrant) for analysis by the OWNER'S laboratory, unless otherwise specified in the special provisions or in the plans. If the tests show a satisfactory quality of water, the line may be placed into service. Unsatisfactory test results shall require a repeat of the disinfection process through retests. The process shall not terminate until a satisfactory sample is obtained.
6.7.4. STORM DRAIN CONDUIT INSTALLATION

(a) Description. This item shall govern and control the furnishing and placing of culvert pipe and/or conduits or drainage lines, including pipe fittings, connecting drain lines to curb inlets, all joints, all connections to new or existing pipe or headwalls, manholes, catch basins etc., to the lines and grades shown on the plans. All pipe and fittings shall be of the types, shapes, classes, sizes and dimensions as shown thereon; and as may be required to complete the work as shown on the plans.

6.7.4.1. REINFORCED CONCRETE CULVERT PIPE

(a) General. This item shall govern and control the furnishing and placing of reinforced concrete culvert pipe.

(b) Materials.

(1) General. Except as modified herein, materials, manufacture and design of pipe shall conform to 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.

(2) 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 Designa-
tion C 76 for Circular Pipe, C 506 for Arch Pipe or C 507 for Elliptical Pipe, except as modified as follows:

(A) 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.

(B) Sizes larger than 60 in. diameter shall be manufactured using two lines of circular reinforcement.

(C) When Class III pipe of sizes larger than 60 in. 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.

(3) 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 \(1/100\) in. 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 \(1/100\) in. crack only shall be performed on \(1/10\) (0.8) percent of the pipe joints. Three-edge-bearing tests for both the \(1/100\) in. crack and the ultimate load shall be performed on \(1/10\) (0.2) percent of the pipe joints.

Pipe which has been tested only to the foundation of \(1/100\) in. crack and meets the requirements of 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 in. 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.

(4) Sizes and Permissible Variations.

(A) 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.

(B) 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.

(5) 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.

(6) Curing. Pipe shall be cured in accordance with the applicable ASTM Specifications for each type of pipe as referred to above.

(7) Pipe Marking. The following information shall be clearly marked on each section of pipe:

(A) the class of pipe,

(B) the date of manufacture,

(C) the name or trademark of the manufacturer,

(D) 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.

(8) Rejection of Pipe. 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 meet the requirements of these specifications. Such rejected pipe shall be removed immediately from the site of the work.

(9) Jointing Materials. Unless otherwise specified on the plans or in the special provisions, pipe joints shall be made with one of the following:

(A) Cold applied preformed plastic gaskets.

The plastic 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, evaporating nor 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 sufficient to obtain the squeeze out as described under Part III, “Construction Methods.” The gasket joint sealer shall be protected by a suitable removable two-piece wrapper. The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half to facilitate application as noted below.

The chemical composition of the gasket joint sealing compound as shipped shall meet the following requirements when tested in accordance with the test methods shown:

<table>
<thead>
<tr>
<th>Composition</th>
<th>Test Method</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen (petroleum plastic content)</td>
<td>ASTM Designation D 4</td>
<td>50-70</td>
</tr>
<tr>
<td>Ash-Inert Mineral Matter</td>
<td>AASHTO Designation T-111</td>
<td>30-50</td>
</tr>
<tr>
<td>Volatile Matter at 325°F.</td>
<td>ASTM Designation D 6</td>
<td>2.0 Max.</td>
</tr>
</tbody>
</table>

The gasket joint sealing compound when immersed for 30 days at ambient room temperature separately in 5 percent solution of caustic potash, a mixture of 5 percent hydrochloric acid, a 5 percent solution of sulfuric acid and a saturated H₂S Solution, shall show no visible deterioration.

The physical properties of the gasket joint sealing compound as shipped shall meet the requirements shown in the following table:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Typical Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity at 77°F.</td>
<td>ASTM D 71</td>
<td>1.20 to 1.35</td>
</tr>
<tr>
<td>Ductility at 77°F. (cm) Min.</td>
<td>ASTM D 113</td>
<td>5.0 Min.</td>
</tr>
<tr>
<td>Softening Point at 77°F. Min.</td>
<td>ASTM D 36</td>
<td>320 F. Min.</td>
</tr>
<tr>
<td>Penetration: 32°F. (300 gms) 60 sec.</td>
<td>ASTM D 217</td>
<td>75 min.</td>
</tr>
<tr>
<td>77°F. (150 gms) 5 sec.</td>
<td>ASTM D 217</td>
<td>50 to 120</td>
</tr>
<tr>
<td>115°F. (150 gms) 5 sec.</td>
<td>ASTM D 217</td>
<td>150 Max.</td>
</tr>
<tr>
<td>Flash Point C.O.C. °F.</td>
<td>ASTM D 92</td>
<td>600°F.</td>
</tr>
<tr>
<td>Fire Point C.O.C. °F.</td>
<td>ASTM D 92</td>
<td>625°F.</td>
</tr>
</tbody>
</table>

(B) Expanded cellular rubber gaskets. Expanded cellular rubber gaskets shall be produced from tubular cross-sections of a blend of nitrile and vinyl polymers meeting the physical requirements of ASTM D1056, Class 2C1, as follows:

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, pcf (kg/m³)</td>
<td>5 to 7 (75 to 105)</td>
</tr>
<tr>
<td>Compression Deflection, 25% compression, psi (kPa)</td>
<td>2 to 5 (14 to 34)</td>
</tr>
<tr>
<td>Fluid Aging, Weight Change, 7 days / Fuel B, %</td>
<td>250 max</td>
</tr>
<tr>
<td>Oven Aging, Change in CD, 7 days / 158°F, %</td>
<td>+/- 30</td>
</tr>
<tr>
<td>Water Absorption Weight Gain, %</td>
<td>10 max</td>
</tr>
</tbody>
</table>
Each joint shall require one continuous gasket conforming to the joint shape. Gasket cross-sectional diameters and installation practices shall be in accordance with the manufacturer’s recommendations.

(c) Construction Methods.

(1) Excavation and Embedment. All excavation and pipe embedment shall conform to the requirements of Item 6.2.8, “Excavation,” and Item 2.1.7., “Pipe Bedding Material for Storm Sewers.”

(2) 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, etc., 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.

(A) Trench Location. All pipe and fittings shall be laid and jointed in a dry trench.

(B) 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 conduit. 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 5° from the vertical plane through the longitudinal axis of the pipe.

(3) Jointing shall be one of the following types:

(A) Cold applied preformed plastic gaskets. 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. Primer that shows cracking or flaking at time of installation shall not be accepted.

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 basket 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 onto 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 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.

(B) Expanded cellular rubber gaskets. Joints using expanded cellular rubber gaskets do not need to be primed. If they are primed, be certain the primer is cured and non-tacky before installing gaskets. Just before laying the pipe in the trench, stretch the gasket around the tapered tongue (or wedge it into the tapered groove) near the shoulder or hub of each pipe joint. Treat these low-tensile gaskets gently when handling. Box culvert gaskets have mitered corners and should be grasped by these corners when handling or stretching over tongues. When the tongue is correctly aligned with the flare of the groove, pull or push home with sufficient force and power (winch, ratchet hoist, chain hoist or backhoe shovel) to compress the gasket to the extent that the joint gap falls within the recommended range.

JANUARY 1998
around the entire pipe joint circumference. CAUTION: Do not close the joint flush, or completely flatten the gasket. The Contractor shall provide a copy of the manufacturer's installation instructions to the Engineer. Joint gap ranges for each gasket size are:

<table>
<thead>
<tr>
<th>Gasket Sizes as Printed on Parts</th>
<th>Joint Gap Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
</tr>
<tr>
<td>3/8&quot; x 3/8&quot;</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>1/2&quot; x 3/8&quot;</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>3/4&quot; x 3/8&quot;</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>1/2&quot; x 1/2&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>3/4&quot; x 1/2&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>7/8&quot; x 1/2&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>1-1/8&quot; x 1/2&quot;</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>1/2&quot; x 3/4&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>5/8&quot; x 3/4&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>3/4&quot; x 3/4&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>7/8&quot; x 3/4&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td></td>
<td>Max.</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>1-1/8&quot;</td>
<td>1-1/8&quot;</td>
</tr>
<tr>
<td>1-3/8&quot;</td>
<td>1-3/8&quot;</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>1-5/8&quot;</td>
<td>1-5/8&quot;</td>
</tr>
</tbody>
</table>

(4) Backfill. All backfill of pipe trenches shall be in accordance with Item 6.2.8., “Excavation,” and Item 2.1.7., Pipe Bedding Material for Storm Sewers."

(5) Fittings for Concrete Pipe.

(A) Poured Concrete Pipe Collars. At all changes in pipe sizes in the conduit line, except at manholes, a pipe collar, as shown in detail on the plans, shall be provided. The locations at which such collars are to be provided are shown on the plan-profile sheets, and their costs are to be included in the price bid for furnishing and installing reinforced concrete pipe. No extra payment shall be made for the installation of concrete pipe collars as shown on the plan-profile sheets.

(B) Shop and Field Fabricated Wyes, Tees, Crosses and Bends. Shop or field fabricated wyes, tees, crosses or bends shall be furnished and installed where indicated or required by the Engineer. Fittings for pipe, the largest size of which is less than 24 in. in diameter, shall be shop fabricated. Fittings for larger pipe, which is 24 in. in diameter and increasingly larger, may be field fabricated. Care shall be taken in the fabrication that the concrete walls of the pipe are broken back only enough to provide the required finishing opening. The reinforcing mesh or bars in each pipe shall be joined by bending, twisting or spot welding, which shall provide a rigid connection. Concrete or mortar (as hereinbefore specified) shall be wiped over the reinforcing wires connecting the two-pipe joints, compacted by light blows, shaped to the contour of the pipe barrels, lightly brushed for finish and cured under wet burlap.

(C) Poured Concrete Pipe Plugs. When conduit lines terminate at locations which do not include connection to drainage structures, the end of the pipe shall be plugged with a field-cast unit as shown on the plan-profile sheets, and the costs thereof are to be included in the price bid to furnish and install reinforced concrete pipe. No extra payment shall be made for the installation of concrete pipe plugs as shown on the plan-profile sheets.

(d) Measurement. The reinforced concrete culvert pipe shall be measured in linear feet along the longitudinal center line of each size pipe specified. Measurement shall begin at the initial beginning point as shown on the plan-profile sheet, continue through the specified pipe fittings, 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. Lateral lines shall be measured along the longitudinal center line thereof from the center of the connected main conduit to the termination of the lateral as shown on the plan-profile sheets. Structure leads, connecting curb inlets, boxes, etc. shall be measured along the longitudinal center line thereof from the center of the connected main or lateral conduit to the inside face of the structure.

(e) Payment. Pipe fittings and appurtenances, as herein specified, shall not be considered as a pay item, the cost of which shall be included in the price bid for furnishing and installing the particular pipe size. Manholes and other drainage structures shall be measured for payment in accordance with the appropriate pay item. Trench excavation,
including embedment and backfill, shall be measured for payment in accordance with the requirements of Item 6.2.8., “Excavation,” and Item 2.1.7., “Pipe Bedding Material for Storm Sewers.”

Payment for reinforced concrete culvert pipe shall be paid for at the unit price bid per linear foot, measured as hereinbefore provided, for the specified pipe size and shall be full compensation for furnishing and installing the specified diameter pipe and appurtenant fittings, for jointing, for connection to all drainage structures, and for all materials, tools, equipment, labor and incidentals necessary to complete the work.

(f) Storm Sewer Appurtenances.

1) Description. This section shall govern for the construction of all miscellaneous storm sewer structures such as junctions, transitions, special concrete manholes, creek crossings, river crossings, 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.

2) Materials. All materials used in the construction of work specified in this section shall conform to the applicable sections of Division 2 of these specifications.

Unless otherwise specified, all concrete shall have an average compressive strength at 28 days equal or greater than 3000 psi and shall conform to the requirements of Item 7.4., “Concrete for Structures.”

3) 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 Item 7.6., “Concrete Structures,” 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 2 in. (5 cm) before placing 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 7.6.10., “Finishing.” 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 2.9.4., “Corrosion Protection of Sewers and Appurtenances.”

4) Measurement and Payment for Appurtenances.

(A) Measurement. New pipe or pipe used to replace existing storm sewers shall be measured in linear feet (m) from end to end of the pipe.

Concrete for piers and beam supports shall be measured in cubic yards (m³) in place. The table on appurtenance sheet shall be a guide to determine quantities used.

No measurement or payment shall be made for reinforcing steel.

(B) Payment. There shall not be a pay item for a support as a unit, but the contract prices for the re-laid pipe and concrete, shall be the total compensation for the furnishing of all labor, tools, materials, equipment and incidentals necessary to complete the work including excavation, installation and removal of the temporary piping, construction of piers, stripping of forms, disposal of surplus materials, in accordance with the plans and specifications. Where a pay item is set up for length of ditch (for diagonal utilities), the contract price shall be the additional compensation for all excavation, labor, tools, and materials over and above the bid price for furnishing and installing, or laying, the conduit.

(g) Storm Sewer Manholes. Storm sewer manholes shall be fabricated in different configurations to meet with specific needs required in the storm sewer system.

1) General Construction. Unless specified otherwise, standard manholes shall be constructed as monolithic concrete structures or as precast reinforced concrete structures.

(A) Standard Manhole. Standard manholes shall meet the following requirements:

1) standard manholes shall be water-containment structures. Therefore, when precast reinforce concrete manhole sections are used, the precast sections shall be of the bell-and-spigot design incorporating trapped O-ring gaskets, or tongue-and-groove with premolded plastic gasket joint. Prior to placing each section of manhole riser or cone, the bells and spigots to be joined shall be thoroughly cleaned, the O-ring gasket properly placed, lubricated and the joint pushed home.
(2) In precast manhole construction, combinations of joint lengths shall be selected to minimize the number of individual segments required to provide the total depth specified. Long joints shall be used in the bottom with the shorter segments utilized for top adjustments.

(3) Poured-in-place manholes may be used in lieu of precast manholes. The base, wall and cone shall be poured and vibrated to assure a monolithic structure free from infiltration.

(4) Standard manhole shall be 4 ft. (1.2 m) inside diameter and shall be constructed to the proper elevation as required and to a depth of at least 6 ft. (1.8 m) above the invert of the sewer main(s) or lateral(s) in the system.

(B) Shallow Manhole. Shallow manholes shall be constructed for specific locations in a storm sewer system for depth less than 6 ft. (1.8 m) when specifically designated on the project plans, or when so directed by the owner. Pipe cradling, formed invert, etc. shall be constructed as described under "Standard Manhole" preceding.

(C) Drop Manhole. Drop manholes shall be constructed in accordance with the detail provided in the project documents. The basic construction for drop manholes shall be identical to that described for standard manholes preceding with special provisions incorporated to provide drop piping and appurtenances as detailed.

(D) Type "A" Manhole. Type "A" manholes (altered manholes) shall be constructed in accordance with the detail provided in the project documents. In general, Type "A" manholes shall be applicable in storm sewer systems consisting of sewer pipe 36 in. (9 m) in diameter and larger. Basic construction of these manholes is usually in two parts: the first consists of a reinforced concrete block poured around the pipe, and the second consists of completing the manhole structure from the concrete block to the specified rim elevation. The manhole structure shall conform to the requirements specified above for standard manholes.

(E) Type "S" Manhole. Type "S" manholes (sealed manholes) shall be constructed in accordance with the plans and these specifications for materials and construction. Type "S" manholes shall be measured for payment as a lump sum. They shall not be measured for payment according to depth. Type "S" manholes shall be paid for at the contract lump sum 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, materials, tools, equipment and incidental necessary to complete the work, including excavation, disposal of surplus materials and backfill, all in accordance with plans and these specifications.

(2) Specified Requirements. Specified requirements include the following:

(A) The first full joint of pipe extending from the manhole shall be cradled in concrete to the pipe joint in the same pour as that for the manhole base slab as shown on the plans.

(B) For all manhole installations in streets, the manhole covers shall be provided with pick slots in lieu of pick holes. If the rim elevation above the surrounding ground is prohibited by land use or other reasons, a cover with a pick slot as described for use in street locations shall be used.

(3) Brick Wall Construction. Brick construction shall be permissible only when specifically approved by the owner. When brick construction is allowed, the brick shall be laid up with full, flush joints of mortar. Bed joints shall be as nearly as possible of uniform thickness and shall be 1/4 in. (6 mm) to 3/8 in. (9 mm). Brick in round manholes shall be laid radially in such manner that the vertical joints are staggered and are not more than 1/4 in. (6 mm) wide on the inside of the wall. The vertical joints shall be complete filled with mortar. The entire outer surface of the manhole wall shall be plastered with at least 1/2 in. (12.5 mm) of mortar.

(4) Test Requirements. Each manhole or water-containment vault structure shall be required to contain water from rim elevation with a range of exfiltration as specified.

(5) Measurement and Payment. Measurement and payment for manhole structure shall be on a per each basis and shall cover all cost for structure complete in place as designed. Included shall be all excavation, castings, reinforcing steel, concrete, brick, 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 hereinafter defined.

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 linear foot (m) of additional depth measured to the nearest 1/10 ft. (3 cm) over the basic depth stipulated for the type manholes under bid.

(h) Measurement and Payment for Storm Sewer Conduit Installation.
(1) Measurement. Pipe, including corrosion protection if in place on the pipe, or unless otherwise covered by a separate bid item, shall be measured for payment in linear feet (m) along the center line 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. Conduits shall not be classified for payment according to the depth of the cut.

(2) 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 (m), complete in place, as provided by the proposal and contract. The contract price per linear foot (m) 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.

6.7.4.2 CORRUGATED METAL PIPE
(a) General. Unless otherwise specified on the plans or required herein, corrugated metal pipe may be aluminum, galvanized steel, aluminized steel, or precoated galvanized or aluminized steel. Pipe shall be full circle or pipe arch type as shown on the plans.

(b) Fabrication. Pipe having a design hydraulic head exceeding 5 ft. of water will have helical corrugations and the lock seam shall be either continuously welded or caulked with a neoprene or mastic seal during fabrication. Caulked helical pipe shall be fabricated by applying a uniform bead of neoprene or mastic compound to the lock seam in such a manner that the inner surfaces of the lock seam are free of voids.

(1) Steel Pipe. Galvanized or aluminized steel pipe shall be full circle or arch pipe conforming to AASHTO Designations: M36, Type I, Type II or Type III as specified in the plans.

(2) Aluminum Pipe. Aluminum pipe shall conform to the requirements of AASHTO Designations: M196, Type I, Type II or Type III pipe arch as specified on the plans.

Aluminum pipe may be placed bare of any precoating, but any portions of aluminum pipe that are to be in contact with a metal other than aluminum or in contact with concrete containing chlorides, shall be insulated from this other metal or concrete by a coating of bituminous material or a plastic coating, such as asphalt mastic or polymeric coating. The coating applied to the aluminum pipe or pipe arch to provide an insulation between the aluminum and other metal shall extend a minimum distance of 1 ft. beyond the area of contact.

(3) Precoated Galvanized or Aluminized Steel Pipe. Pipe shall be full circle or arch pipe conforming to AASHTO Designation: M245, Type I, Type II or Type III as specified in the plans.

(c) Repairs. All damage incurred in fabrication will be repaired at the fabrication location. Damage incurred during handling and placement will be repaired, inspected and approved by the OWNER prior to backfilling the pipe.

(1) Galvanized Steel Pipe. Damaged spelter coating shall be repaired by thoroughly wire brushing the damaged area and removing all loose, cracked or weld burned spelter coating. The cleaned area shall be painted with a zinc dust-zinc oxide paint conforming to Federal Specifications TT-P-641.

(2) Aluminized Steel Pipe. Damaged areas of aluminized coating, including saw cut ends and welds, shall be cleaned and repaired by brush coating of aluminized paint to the damaged, cut or welded area to a minimum thickness of .005 in. (0.127 mm).

(3) Precoated Pipe. Damaged or cut areas of polymeric coatings shall be repainted by the application of a polymeric coating similar and compatible with the polymeric coating on the pipe and to a minimum 10 mil thickness. Damaged areas of bituminous coated galvanized steel shall be repaired by repair of any damaged areas of spelter coatings in accordance with (c)(1) before repairing the bituminous coating by applying asphalt mastic to the same thickness as the original coating.

(d) Pipe Marking. The following information shall be clearly marked on each section of pipe:

(1) Date of manufacture of the pipe.
(2) The name or trademark of the manufacturer of the pipe.
(3) Gauge or thickness of metal.
(4) Alloy number (aluminum pipe only).

(e) Rejection of Pipe. 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.

(f) Coupling Bands. Coupling bands shall be made of the same base metal and coating (metallic or otherwise) as the pipe and shall lap equally on each of the pipes being connected to form a tightly closed joint after installation, maintain pipe alignment during construction and prevent infiltration of side material during the life of the installation. Connecting bands shall be placed with the clamping angles and bolts at the tops of the pipe. Pipe end circumferential corrugations shall be the corrugation width and depth as shown on the plans or as specified by the Engineer. The minimum width of the corrugated locking bands shall be as shown below for the corrugation which corresponds to the end circumferential corrugations on the pipe being joined:

- 10 1/2 in. wide for 2 1/2 in. x 1/2 in. corrugations
- 12 in. wide for 3 in. x 1 in. corrugations
- 18 in. wide for 6 in. x 1 in. corrugations

When it is necessary to join a new pipe of helical corrugations to an existing pipe which was installed with no circumferential end corrugations, the two pipes shall be field jointed with helically corrugated bands. The width of helically corrugated bands shall conform to the following minimum widths:

- 12 in. wide for 1/2 in. deep helical end corrugations
- 14 in. wide for 1 in. deep helical end corrugations

All coupling bands 12 in. wide or less will have a minimum of two 1/2 in. diameter bolts and coupling bands greater than 12 in. wide shall have a minimum of three 1/2 in. diameter bolts.

(g) Storm Sewer Appurtenances. Unless otherwise specified on the plans, all storm sewer structures such as junctions, transitions, manholes, cleanouts, wyes, elbows, tees, stoppers and such other miscellaneous structures or appurtenances which may be shown on the plans shall be made of the same base metal and coating (metallic or otherwise) as the pipe on which it is connected. All such structures or appurtenances field fabricated or otherwise will be repaired in accordance with paragraph (c) "Repairs."

(h) Construction Methods.

(1) Excavation. All excavation shall be in accordance with the requirements of the Item 6.2.8., “Excavation,” except where tunneling or jacking methods are shown on the plans or permitted by the Engineer. When pipes are laid in a trench, the trench when completed and shaped to receive the pipe shall be of sufficient width to provide free working space for satisfactory bedding and jointing and thorough tamping of the backfill and bedding material under and around the pipe.

The CONTRACTOR shall make such temporary provisions as may be necessary to insure adequate drainage of the trench and bedding during the construction operation.

(2) Bedding or Foundation. Unless otherwise indicated or specified on the plans, all pipe embodiment shall conform to the requirements of Item 2.1.7., “Pipe Bedding Material for Storm Sewers.”

(3) Laying Pipe. Unless otherwise authorized by the Engineer, the laying of pipes on the prepared foundation shall be started at the outlet end, and separate sections firmly joined together, with outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Any metal in joints which is not protected by galvanizing or aluminizing shall be coated with a suitable asphaltum paint. Proper facilities shall be provided for hoisting and lowering the sections of pipe in to the trench without damaging the pipe or disturbing the prepared foundation and the sides of the trench. Any pipe which is not in alignment or which shows any undue settlement after laying, or is damaged, shall be taken up and re-laid without extra compensation.

Multiple installations of corrugated metal pipe and pipe arches shall be laid with the center lines of individual barrels parallel. Unless otherwise indicated on the plans, the clear distances between outer surfaces of adjacent pipes listed in the following table shall be maintained.

<table>
<thead>
<tr>
<th>Distance</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 1/2 in.</td>
<td>2 1/2 in. x 1/2 in.</td>
</tr>
<tr>
<td>12 in.</td>
<td>3 in. x 1 in.</td>
</tr>
<tr>
<td>18 in.</td>
<td>6 in. x 1 in.</td>
</tr>
</tbody>
</table>
(4) Connections. Where new structures are constructed as extensions to structures in place or are jointed to existing structures, the construction shall include all work necessary to provide a proper connection between the new structure and the old as indicated on the plans, including coating of the connection when required.

(5) Reuse of Existing Headwalls. When existing headwalls and aprons are specified on the plans for reuse, the portion to be reused shall be severed from the existing pipe and moved to the new position previously prepared, by approved methods.

Connections shall conform to the requirements for joining sections of pipes as indicated herein or as shown on the plans. Any headwalls, aprons or pipe attached to the headwall damaged during moving operations shall be restored to their original condition at the CONTRACTOR’S expense. The CONTRACTOR, if he so desires, may remove and dispose of the existing headwalls and aprons and construct new headwalls at his own expense, in accordance with the pertinent specifications and design indicated on the plans or as furnished by the Engineer.

(6) Backfilling. Backfilling for the metal pipe structures is a critical phase of the construction and strict adherence of Item 6.2.9., “Backfill,” is required. Until a minimum cover over pipe of 12 in. is obtained, only hand operated tamping equipment will be allowed within vertical planes 2 ft. beyond the horizontal projection of the outside surfaces of the structure. Pipe damaged by the CONTRACTOR’S backfilling operation shall be removed and replaced by the CONTRACTOR at no additional cost to the OWNER.

Unless otherwise shown on the plans or permitted in writing by the Engineer, no heavy earth moving equipment will be permitted to haul over the structure until a minimum of 4 ft. of permanent or temporary, compacted fill has been placed thereon.

Prior to adding each new layer of loose backfill material, until a minimum of 12 in. of cover is obtained, an inspection will be made of the inside periphery of the structure for local or unequal deformation caused by improper construction methods. Evidence of such will be reason for such corrective measures as may be directed by the Engineer.

(i) Measurement. Corrugated Metal Pipe of the type specified will be measured by the linear foot. Such measurements will be made between the ends of the barrel along its flow line. Where spurs or branches or connections to existing pipe lines are involved, measurement of the spur or new connecting pipe will be made from the intersection of its flow line with the outside surface of the pipe into which it connects. Where inlets, headwalls, catch basins, manholes, junction chambers, or other structures are included in lines of pipe, that length of pipe tying into the structure wall will be included for measurement but no other portion of the structure length or width will be so included.

For multiple pipes, the measured length will be the sum of the lengths of the barrels, measured as prescribed above.

In the event of a change in design which either increases or decreases the quantity of pipe, the variation in quantity will be shown on the plans and the proposal will be increased as the case may be.
(j) Payment. Payment for "Corrugated Metal Pipe," measured as prescribed above, will be made at the contract unit price bid per linear foot for the various sizes of "Corrugated Metal Pipe" or "Corrugated Metal Pipe Arch" of the material and protective coating as indicated on the plans and proposal, and of the gauges shown on the plans.

Payment shall be full compensation for furnishing and transporting the pipe; for all required coatings and invert paving, site preparation, the preparation and shaping of beds, hauling, placing and joining of pipe; for all connections to existing structures; for moving and reusing headwalls where required by the plans; and for all other items of materials, labor, equipment, tools and incidentals necessary to complete the pipe installation in accordance with the plans and these specifications, except trench excavation, including embedment and backfill, which shall be measured for payment in accordance with the requirements of which Item 6.2.8., "Excavation," and Item 2.1.7., "Pipe Bedding Material for Storm Sewers." Where pipes are laid on a skew or where pipe ends are cut to the fill slope, full compensation for cutting the ends parallel with the center line of the street/road or the fill slope shall be considered as included in the price bid per linear foot for the designated item of pipe and no additional allowance will be made therefor.

6.7.5. STRUCTURAL PLATE CONDUIT

(a) General. This work shall consist of furnishing and installing structural plate pipes, pipe arches, arches, underpasses, box culverts and special shapes conforming to these specifications of the sizes, out dimensions, the minimum gage or thickness of metal, footing design, if required, and material required by plans, at the places designated on the plans or by the Engineer, in conformity with established lines and grades.

Unless otherwise shown on the plans, the structure(s) may be steel or aluminum. The plans will designate, when appropriate, the longitudinal stiffener designs for steel structures or a transverse stiffener design for aluminum structures.

(b) Plates. The plates used for construction of structural plate conduits shall conform to the specifications in Item 2.12.17, "Structural Plate Structures."

Steel plates shall consist of structural units of corrugated galvanized metal. Single plate shall be furnished in standard sizes to permit structure length increments of 2 ft. Plates will have approximately a 2 in. lip beyond each end crest, which results in the actual length of a given structure being approximately 4 in. longer than the nominal length, except when skewed or beveled. Footings for arches shall be designed and constructed to accommodate this additional length.

Aluminum plate shall consist of structural units of corrugated aluminum alloy. For aluminum alloy structures, cut plates shall be furnished on structure ends to permit structure length increments of 1 ft.

Plates shall be formed to provide bolted lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure will be as indicated on the plans. Joints shall be staggered so that not more than 3 plates are joined at any one point. Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be (a) staggered in rows 2 inches apart, with one row in the valley and one in the crest of the corrugations and not less than four bolts per foot for galvanized steel structures or (b) in rows 1 3/4 in. apart with 2 bolts in each valley and on each crest and not less than 16 bolts per three feet for aluminum alloy structures. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 in. The minimum distance from center of hole to edge of the plate shall be not less than 1 3/4 times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than 1/4 in. Plates for forming skewed or sloped ends shall be cut so as to give the angle of skew or slope specified. Burned edges shall be free from oxide and burrs and shall present a workmanlike finish and legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

(c) Fasteners. Fasteners for steel structural plate shapes shall be high strength bolts 7/4 in. diameter, hot-dip galvanized, meeting ASTM Designation A 449. Nuts shall conform to ASTM A 563, Grade C. Fasteners for aluminum structural plate shapes shall be 7/4 in. diameter, hot-dip galvanized steel, meeting ASTM A 307 with the zinc coating in accordance with ASTM A 153. Nuts shall conform to ASTM A 563, Grade A.

Bolt lengths shall be such as to result in at least "full nuts" when tightened in place.
(d) Anchor Bolts. Anchor bolts for anchoring the ends of structural plate conduits into concrete headwall, footings or toewalls, as shown on the plans, shall be 3/4 in. diameter conforming to ASTM Designation A 307 with the zinc coating in accordance with ASTM A 153. The length, shape and placement of these anchor bolts shall be as shown on the plans or approved by the Engineer.

(e) Metal Headwalls. The material for metal headwalls shall comply with requirements shown on plans.

When required, aluminum alloy inverts, toewalls footings and closure plates shall conform to the material requirements for Item 2.12.17., “Structural Plate Structures.” Extruded aluminum transverse stiffeners shall conform to ASTM Designation B 221, Alloy 6061-T6.

(f) Concrete. Concrete and reinforcing steel shall conform to Item 7.4. “Concrete for Structures,” and Item 2.2.6. “Steel Reinforcement.” Unless otherwise shown on the plans, concrete for footings and headwalls shall be Class “A.” Concrete for longitudinal stiffeners (thrust beams), when specified for steel structures, shall be class “B” and shall be reinforced in accordance with the plans. Concrete used in longitudinal stiffeners (thrust beams) on steel structures shall cure a minimum of 3 days before backfilling against or over the stiffener. Riprap for slope protection and for invert paving, when required, shall be Class “B” Concrete, with reinforcement as specified on the plans and shall conform to the requirements of Item 8.15., “Riprap.”

(g) Curing. Material for membrane curing shall conform to Item 2.2.11., “Curing Materials.”

(h) Visual Inspection. The CONTRACTOR shall furnish an itemized statement of the number and size of plates in each shipment. From this list a visual inspection shall include an examination of the plates for deficiency in size, radius of curvature specified, and any evidence of poor workmanship as outlined herein. The inspection may include the taking of samples for chemical analysis and determination of weight of spelter coating on steel plates. The plates making up the shipment shall fully meet the requirements of these specifications. Any plates failing to do so will be rejected.

(i) Mill and Factory Inspection. If the Engineer so elects, he may have the material inspected and sampled in the rolling mill or in the shop where fabricated. He may require from the mill the chemical analysis of any plate. The inspection, either in the mill or in the shop, shall be under the directions of the Engineer. The Engineer or his representative shall have free access to the mill or shop for inspection and every facility shall be extended to him for this purpose. Any material which has been previously rejected at the mill or shop and included in a later lot will be cause for rejection unless it has been satisfactorily repaired.

(j) Workmanship. Defective or damaged structural plates shall be rejected in accordance with Item 2.12.17., “Structural Plate Structures.”

(k) Identification. No plates shall be accepted unless the metal is identified by a stamp on each plate in accordance with AASHTO Designation M 167 for Steel Structural Plate and AASHTO Designation M 219 for Aluminum Alloy Structural Plates.

(l) Design. 

(1) Gage or Minimum Thickness and Corrugations for Structural Plate. The gage or minimum thickness and permissible corrugations of metal plates to be furnished for each structure shall be shown on the plans.

(2) Skewed Structures. The end skew shall not exceed 45°. When the skew of arches is more than 15°, the length of the structure shall be such that no portion of the live load will be carried by the cut portion of the arch end. Where right-of-way or other conditions do not permit the required length, the cut end shall be supported by a rigid headwall designed to meet the conditions. When the skew angle of pipes exceeds 20° and the structure has the ends cut to fit a slope, the ends shall be reinforced with concrete riprap or other suitable end treatment as indicated on the plans or as directed by the Engineer. If headwalls are required, the plates shall be anchored to the headwall with not less than 3/4 in. diameter by 6 in. minimum length bolts, at not over 19 in. centers. If structures are to have skewed ends, bevels, step-bevels or other special end treatment, this information will be shown on the plans.

(3) Multiple Structures Installed in Parallel Lines. The distance between multiple structures shall be shown on the plans with the minimum distance being that space required to permit adequate compaction of backfill material.

(m) Construction Methods. Structural plate conduits shall be constructed from the specified materials in accordance with the plans and this item.

(1) Excavation. Unless otherwise required, all structural excavation shall be in accordance with the requirements of Item 7.1., “Structural Excavation,” and the additional requirements herein. The excavation will be of sufficient
width to provide ample working space for erection and proper compaction of backfill and bedding material. The CONTRACTOR shall provide adequate drainage of the cut and bedding during the construction operation.

If the quality of the native soil is as good or better than the proposed backfill material, excavation shall be to the limits set forth in the Item 7.1., “Structural Excavation.” If the quality of the native soil is less than that of the proposed backfill material, the excavation shall extend, from each side of the barrel, a minimum horizontal distance of one-half the span or two-thirds of the rise, whichever is greater.

(2) Substructures for Structural Plate Arches. The substructure for structural plate arches shall be as detailed on the plans. Concrete footings, when required, shall be placed entirely on either rock or firm soil. When footing area is partially rock and partially soil, the rock shall be removed below grade and replaced with suitable materials so that a slightly yielding, compacted earth cushion is provided below the footing for a minimum of 12 in. When a thin layer of soil is partially covering rock within the bearing area and when practical to do so, the soil may be removed and the footings placed directly on rock in accordance with details shown on the plans.

Footings shall be formed and finished to true lines and grades as established by the Engineer. Anchors or slots shall be set to true line and grade when placing concrete for each substructure unit. No plates for arch structures shall be placed until the substructure has cured for a minimum of 3 days.

Any portion of an aluminum structure that is in contact with a metal other than aluminum or in contact with concrete containing chlorides shall be insulated from this other metal or concrete containing chlorides by a coating of bituminous material or a plastic coating, such as asphalt, mastic or polymeric coating. The coating shall be applied to the aluminum structure to provide an insulation between the aluminum and other metal or concrete containing chlorides and shall extend a minimum distance of one foot beyond the area of contact.

(3) Foundations for Structural Plate Conduits with Metal Inverts. Horizontal ellipses, box culverts, or other structural plate shapes with metal inverts shall be placed on a shaped bed of select granular material carefully and accurately shaped to fit the lower part of the structure for at least 10 percent of its overall height, except that the length of bedding arc need not exceed the width of the bottom plate. The granular material shall be at least 3 in. in thickness, so as to obtain uniform seating of the corrugations on the structure bed. For culverts, the bedding specified herein shall be the full width of the invert. Where rock, in either ledge or boulder formation, is encountered, it shall be removed below grade and replaced with a compacted earth cushion having a thickness of not less than \( \frac{1}{2} \) in. per foot height of fill over the top of the structure, with the minimum allowable thickness of 12 in. and a maximum of 24 in. under the structure. Where the soil encountered at the established grade is a quicksand, muck or similar unstable material, it shall be removed and replaced in accordance with the requirements of Item 7.1., “Structural Excavation.”

(4) Erection and Shape Control. When all plates of a structure are in position, all bolts not already in place shall be inserted and all nuts tightened progressively and uniformly, beginning at one end of the structure. All nuts shall be tightened a second time to a torque of not less than 150 ft.-lbs. nor more than 300 ft.-lbs. for steel structures and not less than 125 ft.-lbs. nor more than 150 ft.-lbs. for aluminum structures.

It is essential that bolts be well tightened. If an impact wrench is used, a sufficient number of bolts should be checked with a long-handled, structural or socket wrench or torque wrench to insure that they are properly tightened. All service bolts used in drawing the plates together shall be replaced with standard high strength bolts.

Lateral ties, struts and/or false-work may be required on some structures to maintain proper shape and alignment during the erection and backfill operations. Monitoring of the structure shape throughout erection and backfill requires careful observations of the symmetry and uniform curvature of the periphery of the structure. If there is any tendency toward loss of symmetry in shape or loss of curvature in the structure periphery, even though the structure is within the tolerances stated herein, construction involving the structure shall cease until a proper course of action is established.

The CONTRACTOR shall furnish acceptable devices for monitoring the horizontal and vertical shape of the structure. For box culverts and structures not requiring longitudinal or transverse stiffeners, the shape shall be kept within 2 percent of design measurements (span or rise, whichever is greater) or 5 in., whichever is less, during erection and backfilling. For structures requiring either longitudinal stiffeners or transverse stiffeners (except box culverts), a minimum of 5 monitoring devices shall be furnished at transverse sections, with one at each longitudinal stiffener, one at the top of the structure, and one at each mid span of the top arc. These shall be installed at each end and as a minimum on 24 ft. increments for the entire structure length.
For the shape factor furnished (shape factor = Rt/Rs, where Rt is the radius of the top arc and Rs is the radius of the side arc), unless otherwise shown on the plans, the allowable sag from design shape during erection, as a percentage of the rise shall not exceed:

<table>
<thead>
<tr>
<th>Shape factor of up to 2.74</th>
<th>4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape factor 2.75 through 3.24</td>
<td>2%</td>
</tr>
<tr>
<td>Shape factor 3.25 and greater</td>
<td>1%</td>
</tr>
</tbody>
</table>

Shape shall be checked at least after each two, one ft. compacted lifts of backfill, with the upward movement of the top of the structure during backfilling, not to exceed 2 percent of the rise, nor more than 50 percent loss of the mid-ordinate of the side plates, nor more than 25 percent deviation of any mid-ordinate of the top plates, all measured from the design shape. Selective top loading of the structure may sometimes be required to prevent distortion in excess of tolerances given herein.

(5) Backfilling. Backfilling and/or construction of the embankment around and over the structure is a critical phase of the construction, and strict adherence to these construction methods is required. Backfilling and/or embankment construction around the structure shall be performed in accordance with Item 6.2., “Excavation and Backfill,” except as modified herein.

(A) Structural Plate Conduits Without Longitudinal or Transverse Stiffeners and Box Culverts. Within vertical planes 2 ft. beyond the horizontal limits of the structure and until a minimum of 2 ft. of cover has been compacted over the structure, only hand operated, mechanical tamping equipment will be permitted.

Unless otherwise shown on the plans or permitted in writing by the Engineer, no heavy earth moving equipment will be permitted to haul over the structure until a minimum of 4 ft. of permanent or temporary compacted fill has been placed thereon. Plates or structures damaged by the CONTRACTOR’S equipment or backfilling operation shall be removed and replaced by the CONTRACTOR at his expense.

During the backfilling operations, extreme care shall be taken to avoid unequal pressures and to obtain uniformly compacted backfill material of uniform density throughout the length of the structure and to insure proper backfill under the structure.

The structure shall be backfilled so that when backfill is complete, the inside dimensions shall be within tolerances set forth in Subsection 6.7.5.(m)(4), “Erection and Shape Control.” Backfill material will be placed and completed in maximum 8 in. horizontal layers simultaneously along each side of the structure until the height of the backfill has reached the crown of the structure. Backfill shall continue to be placed in horizontal layers over the crown in maximum 12 in. layers extending laterally from the crown and compacted using hand operated or light compaction equipment until the design height is obtained.

For multiple structures the same backfill phases will be performed for all structures more or less simultaneously. Backfilling between the barrels will usually require that the material be placed with a crane and bucket or other suitable equipment. Backfill material shall not be dropped from a height or concentrated in such an amount prior to distribution over the top arc that damage to the flexible structure will result. Compaction of this backfill shall be with hand operated tampers or other acceptable equipment.

(B) Structural Plate Conduits Requiring Longitudinal or Transverse Stiffeners Except Box Culverts. The backfill material to be used adjacent to and over the structure to the minimum required cover (as shown on the plans) shall be a select granular type material such as:

1. a well graded sand and gravel, preferably sharp, rough or angular if possible, or
2. a uniform sand or gravel.

Plastic soils will not be permitted. The structure backfill material shall conform to one of the following soil classifications as follows and as defined in Table 1:

1. For height of fill less than 12 ft.: A-1, A-3, A-2-4 and A-2-5 may be used.
2. For height of fill of 12 ft. or greater: A-1 and A-3 may be used.
Table 1 - CLASSIFICATION OF SOILS AND SOIL-AGGREGATE MIXTURES

<table>
<thead>
<tr>
<th>GENERAL CLASSIFICATIONS</th>
<th>GRANULAR MATERIALS (35 Percent or Less Passing No. 200)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Classification</td>
<td>A-1</td>
</tr>
<tr>
<td>Sieve Analysis, Percent Passing:</td>
<td></td>
</tr>
<tr>
<td>(No. 10)</td>
<td>50 max.</td>
</tr>
<tr>
<td>(No. 40)</td>
<td>30 max..</td>
</tr>
<tr>
<td>(No. 200)</td>
<td>15 max.</td>
</tr>
<tr>
<td>Characteristics of Fraction Passing</td>
<td></td>
</tr>
<tr>
<td>0.425 mm. (No. 40)</td>
<td></td>
</tr>
<tr>
<td>Liquid limit</td>
<td>—</td>
</tr>
<tr>
<td>Plasticity index</td>
<td>6 max.</td>
</tr>
<tr>
<td>Usual Types of Significant Constituent Materials</td>
<td>Stone Fragments, Gravel and Sand</td>
</tr>
</tbody>
</table>

The backfill material shall be compacted to at least 95 percent of maximum density as determined by ASTM D 698. Moisture content shall be within minus 2 to plus 4 of optimum. It may not be possible to develop this compacted density in the first lift of material over the top arc (Phase 2) due to the influence of the flexible structure; therefore, density in at least the first lift over the top arc (Phase 2) will be the highest density attainable using equipment authorized herein.

The backfill pattern and sequence, up to at least the depth of minimum required cover, shall be in three phases.

The first phase of the backfill operation will be to backfill under the haunches and/or along the side-walls of the structure. Backfill material will be placed in maximum 8 in. horizontal layers simultaneously along each side of the structure until the height of backfill has reached the top of the longitudinal stiffeners or that longitudinal seam (edge of structure crown where the top arc plates connect to the side arc plates).

The second phase will be to work simultaneously symmetrically from both sides of the structure with light track type equipment pushing material over the crown until three 12 in. layers of backfill have been placed and compacted uniformly over the crown. The light track equipment shall not exceed 20,000 pounds gross weight with a track pressure less than 1700 pounds per square foot.

After the crown has been uniformly covered, Phase 3 will be to continue to place horizontal layers of backfill (maximum 12 in. layers, compacted) which extend laterally from the crown and compact over the crown and at the sides of the structure using hand operated or light tractor drawn compaction equipment working at the same time on each side of the structure at the same longitudinal location, until at least the minimum required depth of cover is attained. Wheel type equipment will not be allowed over the crown of the structure until Phase 3 is complete. For multiple structures the same backfill phases will be performed for all structures more or less simultaneously. Backfilling between the barrels will usually require that the material be placed with a crane and bucket or other suitable equipment. Backfill material shall not be dropped from a height or concentrated in such an amount prior to distribution over the top arc that damage to the flexible structure will result. Compaction of this backfill shall be with hand operated tampers or other acceptable equipment.

Any damage to the structure caused by equipment and/or backfill procedures not in compliance with this specification shall be corrected or replaced to the owner's satisfaction at the entire expense of the contractor.

(6) Measurement. Structural plate conduits of each size, gage or minimum thickness and type specified will be measured by the linear foot of each individual structure (each separate structure in case of multiple installations), along the structures flow line between the ends of the structure.

Metal Headwalls of each size and type will be measured by the square foot of the actual area of the headwall in place.
Until otherwise noted on the plans, concrete for any required headwalls will be measured by the cubic yard in accordance with Item 7.4., "Concrete Structures."

Unless otherwise noted on the plans, reinforcing steel for any required headwalls will be measured by the pound.

Concrete riprap, including reinforcement, will be measured by the cubic yard in accordance with Item 8.15., "Riprap."

Structural excavation will be measured by the cubic yard in accordance with Item 7.1., "Structural Excavation."

Concrete and reinforcing steel for longitudinal stiffeners, for foundations and/or for backfill between multiple structures, if required by the plans, will not be measured for payment.

Aluminum alloy inverts, toewalls, footings, closure plates and transverse stiffeners, when required, will be considered a part of the requirements of the structure and will not be measured for payment.

(7) Payment. Payment for structural plate conduits, measured as prescribed above, shall be made at the unit price bid per linear foot for the various sizes, gage or minimum thickness and types required by the plans and complete in place.

Payment for metal headwalls, measured as prescribed above, shall be made at the unit price per square foot of metal headwall.

Payment for concrete for headwalls, measured as prescribed above, shall be made at the unit price bid per cubic yard of the class of concrete specified for headwalls in accordance with Item 7.4., "Concrete for Structures."

Reinforced steel for headwalls, measured as prescribed above, shall be paid for at the unit price bid per pound.

Concrete riprap, including reinforcement, measured as prescribed above, will be paid for at the unit price per cubic yard in accordance with Item 8.5., "Riprap."

Payment for structural excavation, measured as prescribed above, shall be at the unit price per cubic yard in accordance with Item 7.1., "Structural Excavation."

This payment shall be full compensation for furnishing, transporting, and erecting the metal structure; for constructing foundations; for handling, placing and compacting of backfill material; for all bolts, nuts, washers, hooks, bolts, anchor channels and angles; for longitudinal stiffeners, and transverse stiffeners when required; for furnishing alignment control devices; for concrete, reinforcing steel and all other items of material, labor, equipment, tools and incidentals necessary to complete the various installations.
This page was intentionally left blank.
PART III. CONSTRUCTION METHODS

DIVISION 7.  STRUCTURES

Item 7.1.  Structural Excavation
Item 7.2.  Drilled Shaft Foundation
Item 7.3.  Driving Piling
Item 7.4.  Concrete for Structures
Item 7.5.  Lightweight Concrete for Structures
Item 7.6.  Concrete Structures
Item 7.7.  Prestressed Concrete for Structures
Item 7.8.  Prestressing
Item 7.9.  Pneumatically Placed Concrete
Item 7.10. Steel Structures
Item 7.11. Structural Bolting
Item 7.12. Precast Concrete Units
This page was intentionally left blank.
DIVISION 7. STRUCTURES

ITEM 7.1. STRUCTURAL EXCAVATION

7.1.1. DESCRIPTION

Structural excavation shall consist of the removal of material for the construction of foundations for bridges, retaining walls, head walls for culverts, or other structures and other excavation designated on the plans or in these specifications or in the special provisions as structural excavation, along with 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 excavation 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.

7.1.2. 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 judgment of the CONTRACTOR, the clearance provided on the plans between the outside line of the footing and any pipe 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 1 ft (30 cm) 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 of 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 2 ft. below the level (60 cm) 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.

7.1.3. CONSTRUCTION METHODS

(a) Excavation. Excavation shall include the following:
Item 7.1.3.

(1) 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. Seams in the rock shall be grouted under pressure or treated as the OWNER may direct. The cost thereof shall be included for payment in the quantities for the unit of the structure for which the excavation is made. 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.

(2) Excavated material required to be used for backfill may be deposited by the CONTRACTOR in storage piles at points convenient for the rehandling of the material during the backfill operations. The location of storage piles shall, however, by subject to the approval of the OWNER, who may require that the survey center line of the structure and the transverse or hub line of any unit of the structure be kept free of any obstruction.

(3) 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.

(4) 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 1 ft. (30 cm) 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.

(5) 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 6 in. (15 cm) below the footing grade and backfilled with a material similar to the compressible foundation used for the rest of the structure.

(6) 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.

(b) 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 7 days. No backfill shall be placed adjacent to box culverts until the top slab has been in place at least 4 days. When called for on the plans, special buckfill 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 4 in. (10 cm) in the 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.

7.1.4. 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 item 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 (m³) 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.
ITEM 7.2. DRILLED SHAFT FOUNDATIONS

7.2.1. DESCRIPTION
This item shall govern 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.

7.2.2. MATERIALS
All concrete materials and their preparations shall be in accordance with the requirements of Item 7.4., “Concrete for Structures,” and the additional requirements herein. All concrete shall be Class “A”, unless otherwise shown on the plans.

When casing of the shaft is required, the following shall apply.
(a) The maximum size coarse aggregate shall be 1 1/2 in. (3.75 cm).
(b) 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.
(c) 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 2.2.6., “Steel Reinforcement.”

7.2.3. CONSTRUCTION METHODS
(a) 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 1 1/2 in. (3.75 cm) for depths up to and including 10 ft. (3 m). 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. Blasting methods shall be used only with disturbance of the formation below or outside the limits of the proposed concrete shaft.

The plans indicate the expected depths and elevations at which satisfactory bearing material shall be encountered; 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, along with 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 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” 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 rather this area shall be filled with Class “A” 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 operations, the following criteria shall govern:

(1) if the upward movement is 1 in. (2.5 cm) 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.

(2) if the upward movement is greater than 1 in. (2.5 cm), 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 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 underreamed excavation when underreaming 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 5 ft. (1.5 m) 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 abutment shafts.

(b) 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 in. (30 cm) on centers to provide a rigid unit.

For cased shafts where the reinforcing steel cage is over 30 ft. (9 m) in length, the longitudinal bars shall be tied or tack-welded at each intersection of the spiral hooping for a distance of 1/8 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 instead metal “chair” type spacers shall be placed vertically at intervals around the steel cage to insure concentric spacing inside the casing.

(c) Concrete. The work shall be performed in accordance with the provisions of Item 7.6, “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,
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 Item 7.6., “Concrete Structures.”

7.2.4. 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.

7.2.5. TEST BELLS

When shown on the plan, 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.

7.2.6. MEASUREMENT AND PAYMENT

Acceptable drilled shafts in place of the specified diameter shall be measured by the linear foot (m). At interior bents and piers, shafts shall be measured from a point of 6 in. (15 cm) 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 (m³) 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 (m) 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 (m) 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:

(a) payment for individual completed shaft lengths, up to and including 5 ft. (1.5 m) in excess of the maximum plan length shaft as defined herein, shall be made at the unit price bid per linear foot (m) of the specified diameter of “drilled shafts.”

JANUARY 1998
(b) payment for that portion of individual completed shaft length in excess of 5 ft. (1.5 m) and up to and including 15 ft. (4.5 m) 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 (m) of the specified diameter of "drilled shafts."

(c) payment for individual completed shaft lengths, over 15 ft. (4.5 m) 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:

(1) Method "A." By unit prices agreed to in writing 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 to 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 (m³) for "bell footing."

Test holes, of the specified diameter, shall be paid for at the contract unit price bid per linear foot (m) for "test hole."

Test bells, of the specified diameter, shall be paid for at the contract unit price for each "test bell."

The foregoing unit prices shall be full compensation for making all excavations; 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.

ITEM 7.3. DRIVING PILING

7.3.1. DESCRIPTION
This specification shall govern 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.

7.3.2. 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.

7.3.3. TOLERANCE FOR DRIVING
Piling shall be driven to the vertical or batter line indicated. The allowable variation from the plan alignment shall not exceed 4 in. (10 cm) in any direction. If the center of gravity of a pile group varies by more than 3 in. (7.5 cm) 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 5 in. (12.5 cm), and the pile shall be in such position to permit proper placement and cover of reinforcing steel.

7.3.4. 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.
7.3.5. DRIVING 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 following table. The CONTRACTOR shall furnish the OWNER with a certified scale weight of the hammer to be used.

**SIZE OF DRIVING EQUIPMENT**

<table>
<thead>
<tr>
<th>Type Piling</th>
<th>Type Hammer</th>
<th>Minimum. Energy (Foot - Pounds) *</th>
<th>Weight Hammer or Ram (Power Hammer)</th>
<th>Maximum &quot;h&quot; in Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Timber</strong></td>
<td>Gravity</td>
<td>N/A</td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td></td>
<td>Power</td>
<td>6000</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Steel H and Metal Shell</strong></td>
<td>Gravity, Required bearing:</td>
<td>under 30 tons</td>
<td>N/A</td>
<td>2000 lb.</td>
</tr>
<tr>
<td></td>
<td>30 to 37 tons</td>
<td>N/A</td>
<td>5000 lb.</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>over 37 tons</td>
<td>N/A</td>
<td>2500 lb.</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Power</td>
<td>3000 lb.</td>
<td>5000 lb.</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>250 x R or 2^{1/2} x Wp (whichever is larger)</td>
<td>Open end diesel 2000 lb.</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td><strong>Concrete (all sizes)</strong></td>
<td>Gravity</td>
<td>N/A</td>
<td>1/2 Wp, but not less than 3000 lb.</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Concrete 15 in. or smaller</strong></td>
<td>Power</td>
<td>Single acting or open end diesel</td>
<td>10,000 but not less than 1 ft. lb. per lb. of Wp</td>
<td>Open end diesel 2000 lb.</td>
</tr>
<tr>
<td></td>
<td>Double acting or enclosed ram diesel</td>
<td>8000, but not less than 1 ft. lb. per lb. of Wp</td>
<td>Open end diesel 2000 lb.</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Concrete 16 in. or larger</strong></td>
<td>Power</td>
<td>Single action or open end diesel</td>
<td>15,000, but not less than 1 ft. lb. per lb. of Wp</td>
<td>Open end diesel 2700 lb.</td>
</tr>
<tr>
<td></td>
<td>Double acting or enclosed ram diesel</td>
<td>12,000, but not less than 1 ft. lb. per lb. of Wp</td>
<td>Open end diesel 2700 lb.</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* R = Design load in tons.
Wp = Weight of piling in pounds.
N/A - Not Applicable
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:
(a) reduced energy delivered to the piling. This may be reduced stroke, change in cushioning or a lighter ram.
(b) equivalent energy but with heavier or lighter ram with different stroke.
(c) smaller hammer for the easier initial driving.
(d) 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 is 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.

7.3.6. 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 is not required, the pile lengths shown shall be considered as the “plan penetration” and 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.)

7.3.7. BEARING RESISTANCE
The bearing resistance of all piling shall be determined by the following formulas:

For gravity hammers:
\[
\text{p} = \frac{2WH}{S + 1.0}
\]

When the energy delivered \((W \times H)\) by the gravity hammer is 24,000 foot pounds \((3264 \text{ M-Kg})\) or greater, and the penetration does not exceed \(\frac{1}{4}\) in. \((6 \text{ mm})\) per blow for the last 40 blows delivered (without increasing), the bearing resistance shall be determined by:

\[
\text{p} = \frac{2WH}{3S} \times N
\]

For single-acting hammers:
\[
\text{p} = \frac{2WH}{S + 0.1}
\]
For double-acting hammers:

\[
\frac{2E}{S + 0.1}
\]

where

- \( p \) = 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 in Item 7.3.6, the height of fall of the ram of the single-acting (open end) hammer shall be 7 ft. (2.1 m). The maximum energy rating allowed for the double-acting (enclosed ram) hammer shall be:

- Link Belt 312 - 15,000 foot-pounds (2040 m-Kg)
- Link Belt 520 - 26,000 foot-pounds (3536 m-Kg)

### 7.3.8. 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 (m) complete in place after cut-offs and build-ups have been made.

   Cut-offs shall be measured for payment by the linear foot (m). 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 (m) 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 (m²) 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 (m) or acceptable piling in place after all cut-offs and build-ups have been made, to which measurement shall be added 2 ft. (.6 m) 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 (m). The pay length of cut-offs 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, is driven to depths greater than required to 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 (m) 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 (m) 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 (m) 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 (m²) 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 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 (m) for the specified size of precast concrete piling.

Cut-off shall be paid for at one-half the contract unit price per linear foot (m) for precast concrete piling. Where cut-backs 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) in accordance with the provisions of Item 2.7.3.(b).

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.

ITEM 7.4. CONCRETE FOR STRUCTURES

7.4.1. DESCRIPTION
This section shall govern for the concrete used in bridges, box culverts and such other miscellaneous structures and incidentals necessary to complete the work.
7.4.2. EQUIPMENT

All machinery and equipment necessary for the prosecution of the work specified herein shall be on the project and shall be approved by the OWNER as to condition before the CONTRACTOR shall be permitted to begin operations on which the machinery or 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.

7.4.3. MATERIALS

All materials used in the concrete herein specified shall conform to the requirements of the applicable sections of Items 2.1. and 2.2. of these specifications and to additional requirements herein included.

7.4.4. CONCRETE MIX DESIGN AND CONTROL

The OWNER shall furnish plant control of the concrete by securing the services of an independent local testing laboratory. 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 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” in Item 7.4.5.

The dry loose volume of coarse aggregate shall not be more than $0.82/100$ cubic feet per cubic foot ($0.82m^3/m^3$) 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 $0.85/100$ cubic feet per cubic foot ($0.85 m^3/m^3$) of concrete.

If the strength required for the class of concrete being produced is not secured with the cement specified in the table “Classes of Concrete,” the CONTRACTOR may use, or the OWNER may require, an approved cement dispersing agent, or the CONTRACTOR shall furnish additional aggregates or aggregates with different characteristics which shall produce the required results. Additional cement may be required or permitted as a temporary measure until aggregates are changed and designs checked with the different aggregates or cement dispersing agent.

All material samples submitted to the OWNER shall be sufficiently large to permit laboratory batching for the construction of test beams to check the adequacy of the design. When the design mix has been approved by the OWNER, there shall be no change or deviation from the proportions thereof 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.

7.4.5. QUALITY OF CONCRETE

(a) Consistency. In general, the consistency of concrete mixtures shall be such that:

1. the mortar shall cling to the coarse aggregate,
2. the aggregate shall not segregate in concrete when it is transported to the place of deposit,
3. 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 the pile shall stand and not flow,
4. the concrete and mortar shall show no free water when removed from the mixer,
5. the concrete shall slide and not flow into place when transported in metal chutes at an angle of $30^\circ$ with the horizontal, and
6. 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.
Concrete Use | Avg. Slump (in.) | Max. Slump (in.)
--- | --- | ---
Structural Concrete | | |
(a) Cased Drilled Shafts and Thin-walled Sections (9 in. or less) | 4 | 5 |
(b) Slabs, Caps, Columns, Piers, Wall Sections Over 9 in., etc. | 3 | 4 |
(c) Slip Form Paving | | |
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.

(b) 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 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>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5.0</td>
<td>3000</td>
<td>500</td>
<td>6.5</td>
<td>2 - 3 - 4</td>
</tr>
<tr>
<td>B</td>
<td>4.0</td>
<td>2000</td>
<td>330</td>
<td>8.0</td>
<td>2 - 3 - 4</td>
</tr>
<tr>
<td>C*</td>
<td>6.0</td>
<td>3600</td>
<td>600</td>
<td>6.0</td>
<td>1 - 2 - 3 **</td>
</tr>
<tr>
<td>D</td>
<td>3.0</td>
<td>1500</td>
<td>250</td>
<td>11.0</td>
<td>2 - 3 - 4</td>
</tr>
<tr>
<td>E</td>
<td>6.0</td>
<td>3000</td>
<td>500</td>
<td>7.0</td>
<td>2 - 3</td>
</tr>
<tr>
<td>F</td>
<td>6.5</td>
<td>4200</td>
<td>700</td>
<td>5.5</td>
<td>2 - 3</td>
</tr>
<tr>
<td>S</td>
<td>6.0</td>
<td>3600</td>
<td>600</td>
<td>5.0</td>
<td>2 - 3</td>
</tr>
<tr>
<td>H***</td>
<td>6.5 - 8.0</td>
<td>As specified on plans</td>
<td>N.A.</td>
<td>5.5</td>
<td>3</td>
</tr>
</tbody>
</table>

* Entrained Air
** No. 1 coarse aggregate may be used in foundations only (except cased drilled shafts).
*** Prestressed Concrete
**** ASTM C 293 (Center Point).

Unless otherwise specified in the special provisions or in the plans for job site placement of concrete, two tests of 6-test cylinders or beams shall be required for each 40 cubic yards (31 m³) or portion thereof placed in each day’s placement. For small placements, tests may be made for each 25 cubic yards (19 m³) placed over a several day period. One set of cylinders or beams shall be tested at 7-day strength. Requirements shall be based on results obtained from trial batches.

The second set of three cylinders or beams shall be tested at 28 days and represent design strength.

All test specimens, beams or cylinders representing tests for removal of forms and/or false-work 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. Provisions shall be made to maintain the water in the curing tank at temperatures between 70°F (21°C) and 90°F (32°C).
7.4.6. MIXING

(a) General. Concrete shall be mixed in a machine, of approved design and capacity, which receives a complete charge of proportioned materials and thoroughly and evenly mixes the charge as a whole before any part is withdrawn from the machine. The mixing shall be continued until each particle of stone or gravel is completely covered with mortar and the batch is of uniform color and consistency. The manufacturer's recommended mixing time shall be adhered to or mixing shall continue until a uniform concrete mixture is obtained. The mixer shall be equipped with an attachment for satisfactorily locking the discharging device so as to prevent the emptying of the mixer until all the materials have been mixed together for the minimum time required. The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch.

(b) Transit Mix Concrete. Transit mix concrete shall meet the following conditions:

(1) all requirements otherwise specified for mixing on the job shall apply,

(2) sufficient transit mix equipment shall be assigned exclusively to the project as required for continuous operation.

(3) satisfactory evidence shall be furnished so that the delivery of concrete shall be continuous at regular and uniform intervals, without stoppages or interruption,

(4) the supplier of transit mix concrete shall furnish a written statement addressed to the OWNER, stating that the concrete shall be produced in accordance with these specifications and subject to the approval of the OWNER, and

(5) concrete shall not be placed on the job after a period of 1 1/2 hours after the cement has been placed in the mixer.

(c) Continuous Volumetric Mix Concrete. For all miscellaneous concrete placements, a mobile, continuous, volumetric mixer of the rotating paddle type may be used.

When approved by the Engineer or when specified for use, these mixers may be used.

These mixers shall be designed to receive all the concrete ingredients, including admixtures, required by the mix design in a continuous uniform rate and mix them to the required consistency before discharging. The mixers shall have adequate water supply and metering devices.

For continuous volumetric mixers, the materials delivered during a revolution of the driving mechanism, or in a selected time interval, will be considered a batch, and the proportion of each ingredient will be calculated in the same manner as for a batch type plant.

The mixing time shall be in accordance with the recommendations of the manufacturer of the mixer unless otherwise revised by the Engineer.

Calibration of these mixers will be required.

7.4.7. 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, or precast reinforced concrete pipe as detailed in Item 2.12.3. of the general specifications 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 as further defined in Item 2.12.3.

(2) vaults used for non-water containment construction, such as for valve installations, shall be either pour-in-place 2500# 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 6 in. (15 cm) thick.

(3) Top slabs shall normally be poured below final grade and grade rings used to achieve final grade ring elevations. On installations of 24 in. x 40 in. rectangular rings and lids, each brick lift used for grade adjustment shall be considered equal to one 2 in. (5 cm) grade ring under these specification requirements.

(4) Manhole steps, grade rings, covers, vents, etc. shall be installed as detailed in Item 6.7.2.(i) of the general specifications shown on project plans, or as directed by the OWNER.

(5) The vault top slab invert and inside wall shall be given a rubbed finish in accordance with Item 7.6.10., "Finishing."

(6) Water-containment vault structures shall be tested for exfiltration as required in Item 6.7.2.(e) of this specification. 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.

(c) Measurement and Payment for 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 further outlined as follows:

(1) 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.

(2) 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 more applicable for a specified project.

(3) 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.

(4) 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.

7.4.8. WATERSTOPS
Waterstops shall be of the type and kind designated on the plans and materials as specified under Division 2, "Materials." 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 method.

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.

7.4.9. MEASUREMENT AND PAYMENT
The quantity of concrete which constitutes the completed structure shall be measured by the cubic yard (m³) of accepted work in place. The dimensions used shall be those shown on the plans or ordered in writing by the OWNER.
No deductions in measurement shall be made for embedded reinforcing steel or for embedded portions of structural steel members.

The concrete quantities, measured as provided, shall be paid for at the unit price bid per cubic yard (m³) for concrete, which price shall be full compensation for furnishing, hauling and mixing all concrete materials, including trial batches; placing, curing and finishing all concrete; all grouting and joints; furnishing and placing all expansion and contraction joints, except as hereinafter provided; furnishing and placing metal flashing strips and waterstops; and all forms and false-work, 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 and control joints, or for steel, cast iron or cast bearing plates. Payment for these materials is provided for in Item 2.11., “Metal for Structures.”

The preceding provisions for payment shall not be interpreted to provide for concrete in railing, piling, precast prestressed concrete units or other concrete items for which provision is otherwise made in the contract.

**ITEM 7.5. LIGHTWEIGHT CONCRETE FOR STRUCTURES**

**7.5.1. DESCRIPTION**

This item shall govern the equipment used; 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, an air-entraining admixture and water, proportioned and mixed as hereinafter provided.

**7.5.2. 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 Texas State Department of Highways and Public Transportation 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>
<thead>
<tr>
<th>Class</th>
<th>Min. - Max. Bags Cement per C. Y.</th>
<th>Min. Comp. Strength 28 - Day psi</th>
<th>Max. Slump (in.)</th>
<th>Air-Dried Weight Max. * (lb.)</th>
<th>Total Air Content, %</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>5.5 - 7.5</td>
<td>3000</td>
<td>**</td>
<td>110</td>
<td>6 - 9</td>
<td>General Structural</td>
</tr>
<tr>
<td>Y</td>
<td>5.5 - 7.0</td>
<td>5000</td>
<td>3</td>
<td>115</td>
<td>6 - 9</td>
<td>Prestressed Concrete</td>
</tr>
<tr>
<td>Z</td>
<td>5.5 - 8.0</td>
<td>As specified on plans</td>
<td>3</td>
<td>118</td>
<td>6 - 9</td>
<td>Prestressed Concrete</td>
</tr>
</tbody>
</table>

* Air-dried weight shall be measured after 7 days moist curing at 100 percent relative humidity at 73 ±2°F (22.8±1.1°C) and stored for 21 days at 50 ±2 percent relative humidity.

** Class X concrete shall be placed so that the average slump shall be maintained at approximately 3 in. (7.5 cm). No concrete shall be permitted with a slump in excess of 4 in. (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.
7.5.3. QUALITY OF CONCRETE
(a) 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.
(b) 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, two tests (6-test cylinders) for each pertinent strength test required by the table in Item 7.5.2. shall be required for each separate stressing line of beams, spans, piling, etc., as the case may be.
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 (19 m³) 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.

7.5.4. MIXING
The following shall govern the mixing of lightweight concrete:
(a) the cement dispersing agent and at least ⅔ of the total mixing water shall be introduced in the mixer and mixed for 15 seconds,
(b) the fine and coarse aggregate shall be added and mixed for 45 second, and
(c) 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 3 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.

7.5.5. PLACING, CURING, AND FINISHING
The placing of concrete, including construction and removal of forms and false-work, curing and finishing shall be in accordance with Item 7.6.9., except that floats used in finishing shall be metal shod.

7.5.6. MEASUREMENT AND PAYMENT
Measurement and payment shall be in accordance with Item 7.4.6.

ITEM 7.6. CONCRETE STRUCTURES
7.6.1. 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 details shown on the plans, with the pertinent provisions of other applicable sections of the specifications, and with the requirements herein provided.
7.6.2. 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 Item 7.4., "Concrete for Structures," or Item 7.5., "Lightweight Concrete for Structures."

7.6.3. 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 false-work for concrete piers and concrete superstructure spans over 20 ft. (6 m) 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 required by the OWNER. The plans shall be prepared on standard 24 in. (.6 m) by 36 in. (.9 m) sheets. They shall show all essential details of the proposed forms, false-work and bracing so that a structural analysis may be made. Six sets of such plans shall be required.

Concurrence on the part of the OWNER in any proposed construction methods, approval of equipment or approval of form and false-work 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, false-work or erection equipment shall be placed on the substructure before the substructure concrete has attained a 500 psi (36 Kg/cm²) flexural strength or comparable strength in compression (table in Item 7.5.2) 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 2 days. Concrete may be placed in the wall or column as soon as the forms and reinforcing steel placement are approved.

The support tie beam and/or cap forms by false-work placed on previously placed tie beams is permissible, provided such supporting beams have attained 500 psi (36 Kg/cm²) flexural strength, curing requirements are completed, and the beams 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 for light construction traffic not to exceed a 3/4 ton (680 Kg) vehicle to pass over the structure.

Authorization may be given after the last slab of concrete has been in place at least 30 days for normal construction traffic and to the traveling public. Construction vehicles with a minimum of 3 axles may be operated across structures if the total gross load does not exceed 51,000 lbs. (23, 154 Kg). 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 (16 km/hr.).

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.

The placement of roadway slabs shall 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. If no placement sequence is specified in the contract plans and specifications, the CONTRACTOR shall use a placement sequence approved by the Engineer. During placement, 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
Item 7.6.3. STRUCTURES

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.

7.6.4. 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.

7.6.5. JOINTS

(a) Expansion Joints. Expansion joints and devices to provide for expansion and contraction shall be constructed where 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 when necessary after surface finishing, all projecting concrete shall be removed along exposed edges in order to secure full effectiveness of the expansion joints.

(b) Construction Joints. The joint formed by placing plastic concrete in direct contract 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, laitance, 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.

7.6.6. FALSEWORK

All false-work shall be designed and constructed to safely carry the maximum anticipated loads and to provide the necessary rigidity. Details of false-work construction shall be subject to review and approval by the OWNER in accordance with the provisions of Item 7.6.7. When the false-work is no longer required, it shall be removed. False-work piling shall be pulled or cut off a minimum of 6 in. (15 cm) below finished ground level. False-work 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.
7.6.7. FORMS

(a) 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 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 in. (1.2 m) widths and in uniform lengths of not less than 96 in. (2.4 m), 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 plys in the direction of the span. Where plywood is attached directly to the studs or joists, the panels shall not be less than 3/8 in. (1.5 cm) thick, and the studs or joists shall be spaced not more than 12 in. center to center. Plywood form panels otherwise conforming to the requirements specified herein may be used with a continuous backing of 3/4 in. (1.9 cm) 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 7.7.4.(a). Forms shall be designed for the pressure exerted by a liquid weighing 150 lb. per cubic foot (2432 g/m). 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 lb. per square foot (244 g/m²) shall be allowed on horizontal surfaces. The maximum unit stresses shall not exceed 125 percent of the allowable stresses used by the State Highway Department for the design of structures.

(b) Molding. Molding specified for chamfer strips and other uses shall be made of redwood, cypress or white pine materials of such grade that it 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.

(c) 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 1/2 in. (12.5 mm) 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 1 to 3 and the concrete shall be left smooth and even.

(d) 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 1/4 of an in. (6 mm) under size and reamed full size as provided for in Item 7.10, "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.
7.6.8. PLACING REINFORCEMENT

Reinforcement in concrete structures shall be placed carefully and accurately and rigidly supported as provided in Item 2.2.6., “Steel Bar Reinforcement,” and as shown on the plans.

7.6.9 PLACING CONCRETE

(a) General. The minimum temperature of all concrete at the time of placement shall be not less than 50°F (10°C). 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 (29°C) 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.

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 ensure that the concrete remains plastic in not less than 3 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 2.2. The retarding admixture shall be in accordance with the requirements of Item 7.6.3., “General Requirements.”

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>
<thead>
<tr>
<th>Air or Concrete Temperature</th>
<th>Nonagitated Concrete</th>
<th>Maximum Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>80°F or above</td>
<td>(26.6°C)</td>
<td>15 minutes</td>
</tr>
<tr>
<td>35°F or 79°F</td>
<td>(1.6 to 26.1°C)</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Agitated Concrete</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90°F or above</td>
<td>(32.2°C)</td>
<td>45 minutes</td>
</tr>
<tr>
<td>75°F — 89°F</td>
<td>(23.9 — 31.6°C)</td>
<td>60 minutes</td>
</tr>
<tr>
<td>35°F — 74°F</td>
<td>(1.6 — 23.3°C)</td>
<td>90 minutes</td>
</tr>
</tbody>
</table>

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 (11.5 m³) 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 medium 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 ap-
Concrete mixing, placing and finishing shall be done in daylight hours, unless adequate provisions are made to light the entire site of all operations.

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 7.6.9.(b) shall be applied.

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 of more than 3 ft. (.9 m) 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 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. (.9 m) 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. No 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 false-work where differential setting time may include stress cracking, placement in deep girder stems, etc., an approved retarder (cement dispersing agent) in accordance with Item 2.2.2., “Chemical Admixtures,” shall be used to control stress cracks and/or unauthorized cold joints.

Laitance 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 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 edges of the forms. Immersion type vibrators shall be inserted vertically, at points 18 to 30 in. (.45 m to .75 m) 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 al-
plowed 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 location 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 4 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, where permitted, such storage shall be limited to quantities and distribution that shall not induce excessive stresses.

(b) 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 (4.4°C), 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 (4.4°C) or when conditions indicate that the temperature may fall to 40°F (4.4°C) 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 5 days after placing. When the temperature of the air is above 85°F (29.4°C), an approved retarding mixture shall be required in all concrete used in superstructures, top slabs of direct traffic culverts and capped drilled shafts.

Concrete placement shall be stopped when rainfall is sufficient to cause damage to the work.

(c) 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 in. (25 cm), 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.

(d) 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 1 1/2 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.

JANUARY 1998
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 in Item 7.6.9.(a). 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 over-stressing of any of the supporting members shall be permitted subject to the approval of the OWNER.

On steel truss spans the false-work 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 7.6.10.

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 7.6.10. When the surface of the slab is to receive an 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.

(c) 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 side-walls are placed monolithically in culverts more than 4 ft. (1.2 m) in clear height, an interval of not less than 1 hour nor more than 2 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 for finishing roadway slabs in Item 7.6.10.(b). On a fill-type culvert which does not carry direct traffic, the top slab shall be given a reasonably smooth finish.

(f) 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 operations 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 1 hour nor more than 2 hours before proceeding.

7.6.10. FINISHING

(a) 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.

(b) 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 3) and at such intervals as to produce a uniform surface, true to grade and free of voids.

Spans over 50 ft. (15 m) 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 ft. (3 m) 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 \(\frac{1}{16}\) in. (1.6 mm) 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 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.

Rail support holes shall be filled with concrete and finished to match to top of the slab.

After the final set of the concrete, the roadway surface shall be tested again with a standard 10 ft. (3 m) 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 the 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 \(\frac{1}{16}\) in per ft. (1.6 mm per 30 cm) from the nearest point of contact and the maximum ordinate shall not be greater than \(\frac{1}{8}\) in (3.2 mm). 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 false-work, 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 \(\frac{1}{8}\) in. per 10 ft. (3.2 mm per 3 m) of span length, but not greater than \(\frac{1}{2}\) in. (1.25 cm). For concrete girder (CG) spans the additional camber for initial and final deflections shall be \(\frac{1}{2}\) in. for 30 ft. (2.5 mm per 9 m) spans and \(\frac{3}{4}\) in for 40 ft. (19 mm for 12 m) 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 \(\frac{1}{4}\) in. (6 mm).

Dead-load deflection shall be taken into account in the setting of headers and rail systems.
7.6.11. 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 4 days except as noted herein.

<table>
<thead>
<tr>
<th>Description</th>
<th>Required Curing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Surfaces of Bridge Roadway, Median and Sidewalk Slabs and Top Slabs of Direct Traffic Culverts</td>
<td>8 Curing Days</td>
</tr>
</tbody>
</table>

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 (10°C) for at least 19 hours, or the ambient temperature is 50°F or less; and if satisfactory provisions are made to maintain the temperature at all surfaces of the concrete above 40°F (4.4°C) 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 below and the requirements of this specification for each method of curing:

(a) Form Curing. When forms are left in contact with the concrete, other curing methods shall not be required except for cold weather protection.

(b) 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 Item 7.4., “Concrete Structures.”

1. 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 oz. (255 gm) 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 3 hours after finishing 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 to keep all surfaces of the concrete wet.

2. Water Spray. This method shall be accomplished by overlapping sprays or sprinklers, so that all unformed surfaces are kept continuously wet.

3. Ponding. This method requires the covering of the surfaces with a minimum of 2 in. (5 cm) of clean granular material, kept wet at all times, or water to a minimum depth of 1 in. (2.5 cm). Satisfactory provisions shall be made to provide a dam to retain the granular material or water.

(c) 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 9 gallons per 210 ft. (.0038 m² per 63m) 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.

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 re-application of membrane.
### STRUCTURE UNIT DESCRIPTION

<table>
<thead>
<tr>
<th>STRUCTURE UNIT DESCRIPTION</th>
<th>REQUIRED</th>
<th>PERMITTED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water for Complete Curing</td>
<td>Membrane for Interim Curing</td>
</tr>
<tr>
<td>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.).</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2. Top surface of precast and/or prestressed piling</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>3. All substructure concrete, culverts, box sewers, inlets, manholes, retainer walls, riprap</td>
<td>*X</td>
<td>*X</td>
</tr>
</tbody>
</table>

* 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.

#### 7.6.12. REMOVAL OF FORMS AND FALSE-WORK

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 1/2 day for high-early strength concrete, provided that the forms can be removed without damage to the concrete.

Forms for inside curb faces may be removed in approximately 3 hours, provided that the concrete has set sufficiently to permit form removal without curb damage.

Weight supporting forms and false-work for all bridge components, culverts and slabs shall remain in place a minimum of 4 curing days. Forms may be then be removed if the concrete has attained a flexural strength of 500 psi (36.3 g/cm²), 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 false-work which are required to be left in place for a longer period on other portions of the structures.

#### 7.6.13. 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 extra work or materials involved in repairing or replacing defective concrete.

#### 7.6.14. 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 1 Finish shall be required.

(a) Type 1 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 por-
tions only of variable depth caps), abutments, wing-walls 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 2 feet (.6 m) 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 wing-walls, 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 Item 7.6.10.

(b) Type 2 Finish. All concrete surfaces of railing, including the parapet types, the top and roadway faces only of curbs, and wing-walls of bridges shall be given a first and second rubbing. All other surfaces described under Type 1 Finish shall be given a first rubbing only. Lining of forms shall be as required in a Type 1 Finish.

(c) Type 3 Finish. All concrete surfaces of railing, including the parapet types, the top and roadway faces only of curbs, and wing-walls of bridges shall be given a first and second rubbing. All other surfaces described under Type 1 Finish shall not require rubbing but shall require lining of forms.

(d) Type 4 Finish. All concrete surfaces of railing, including the parapet types, the top and roadway faces of curbs, and wing-walls of bridges and culverts shall be given a first rubbing only. Form lining shall not be required. Rubbing of culvert wing-walls 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. Chambered 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 stripped 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 \( \frac{1}{16} \) to \( \frac{1}{8} \) in. (1.6 mm to 3.2 mm).

7.6.15. 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.

ITEM 7.7. PRESTRESSED CONCRETE FOR STRUCTURES

7.7.1. DESCRIPTION

This item shall govern the complete construction, prestressing and erection of precast prestressed concrete structures, in accordance with the plans.

7.7.2. 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 as 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.

(a) Erection Layout. An erection layout sheet showing information for field erection (location, type member, erection mark of member, bearing pads, etc.).

(b) Fabrication details. Complete information necessary for fabrication not shown on contract plans. (Member lengths, type, skew angle, dimensions for diaphragm holes, neoprene pad sizes, bevles and erection devices, inserts to be used in forming, etc.).

(c) 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.

(d) 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.

(e) Prestressing Details. For post-tensioned members, pre-tensioned members with draped strands, special and modified designs, job site fabrication, and cast-in-place members, the CONTRACTOR shall submit to the OWNER detailed fabrication plans showing details of the member and forms, devices for holding prestressed 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.

(f) 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.

7.7.3. MATERIALS

Materials for concrete shall be in accordance with Item 7.4., “Concrete for Structures,” and/or Item 7.5., “Lightweight Concrete for Structures.” Materials for prestressing shall be in accordance with Item 7.8., “Prestressing.” Reinforcing steel, not prestressed, shall be in accordance with Item 2.2.6., “Steel Reinforcement.” Structural steel bearing plates, fittings, etc. shall be in accordance with Item 7.10., “Steel Structures,” and Item 2.11., “Metal for Structures.” Bearing pads shall be in accordance with Item 2.2.12., “Elastomeric Materials,” 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 by flexural tests. Two tests (6 cylinders) shall be made for each pertinent strength test required. For determining “re-
lease strength” of prestressed concrete members, a test shall be defined as the average of the breaking strength of 2 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 false-work 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°F and 90°F (21.1°C to 32.2°C). 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.

### 7.7.4. CONSTRUCTION METHODS

Prestressing shall be in accordance with Item 7.8., “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.

(a) 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 requirements of Item 7.6.7.

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 Item 7.7.7. 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 \( \frac{1}{4} \) in. (6 mm) variation in any 50 ft. (15 m) 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 of such 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 \( \frac{1}{8} \) in. (3.2 mm) draft to permit ease of removal.

(b) 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 to working the coarse aggregate.
Item 7.7.4. Structures

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 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 that adequate provisions are made to prevent damage to the concrete.

(1) 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 that:

(A) the temperature of the concrete is not less than 50°F (10°C) nor more than 90°F (32.2°C) when placed in the forms.

(B) 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.

(C) the steam heat shall keep the air surrounding the concrete between 50°F (10°C) and 90°F (32.2°C) for a minimum of 2 hours prior to beginning the temperature rise which is required for steam curing.

(D) the temperature of the concrete shall not be less than 50°F (10°C) 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 (1.6°C) or greater. The temperature of the concrete at the time of placement in the forms shall not be less than 50°F (10°C) nor more than 90°F (32.2°C). The concrete shall not be placed in contact with any materials having a temperature less than 32 °F (0°C) or any material coated with frost.

Aggregate 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 (82.2°C) and/or the aggregate shall be heated to a temperature not to exceed 150°F (65.5°C). 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 (10°C) and 90°F (32.2°C) 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 (10°C) for the required total curing time as specified in Item 7.7.4.(e). 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.

(2) 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:

<table>
<thead>
<tr>
<th>Air or Concrete Temperature (Whichever is Higher)</th>
<th>Maximum Time To Placing in Forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-agitated Concrete</td>
<td></td>
</tr>
<tr>
<td>80°F (26.6°C) or above</td>
<td>15 minutes</td>
</tr>
<tr>
<td>35°F — 79°F (1.6 — 26.1°C)</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Agitated Concrete</td>
<td></td>
</tr>
<tr>
<td>90°F (32.2°C) or above</td>
<td>45 minutes</td>
</tr>
<tr>
<td>75°F — 89°F (23.9 — 31.6°C)</td>
<td>60 minutes</td>
</tr>
<tr>
<td>35°F — 74°F (1.6 — 23.3°C)</td>
<td>90 minutes</td>
</tr>
</tbody>
</table>

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.

(c) 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.

(d) 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 the initial set, laitance 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 1/8 in. (3.2 mm) 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.

(e) 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 has reached the strength designated on the plans. Prestressed concrete piling shall be steam-or water-cured for an additional 3 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 a calendar day when the temperature, taken in the shade away from artificial heat, is above 50°F (10°C) for at 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 (10°C) for the entire 24 hours.

All prestressed concrete members shall be steam- or water-cured except that membrane curing may be used as interim curing on the top surface of precast, prestressed concrete piles.

1) Water Curing. In water curing, all surfaces of the concrete shall be kept wet continuously for the required curing time. Water used for curing shall be from the OWNER’s mains or of an equivalent quality. Water curing shall be permitted as follows:

A) Wet Mat Method. For water curing by the wet mat method, cotton mats, polyethylene sheeting or polyethylene burlap blankets may be used.

The mats, sheets or blankets shall not be placed in contact with the prestressed concrete member until such time that damage shall not occur to the surfaces.

The mats, sheets or blankets shall be adequately anchored and weighted to provide continuous contact with all concrete surfaces. Any concrete surfaces which cannot be cured by contact shall be enclosed by mats, adequately anchored, so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all of the surfaces of the concrete wet for the required curing time.

B) Water Spray Method. For water curing by the water spray method, overlapping sprays or sprinklers shall be used so that all concrete surfaces are kept wet continuously.

2) Elevated Temperature Curing. Curing by elevated temperature methods shall be permitted as follows:

A) Steam Curing. Steam curing is defined as use of steam above 90°F (92.2°C) 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 (65.5°C).

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°F — 160°F for 60 minutes
161°F — 170°F for 30 minutes
171°F — 180°F for 15 minutes
Over 180°F NONE

All unobstructed air space of not less than 6 in. 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 2 hours. During the application of steam, the temperature inside the curing jacket should be raised uniformly at a rate not exceed 40°F per hour. Temperature decrease at the end of the curing operations shall not exceed the same rate.

B) 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.
7.7.4. WORKMANSHIP AND TOLERANCE

(C) Protection. Members shall remain protected until the difference between the temperature inside the jacket and the temperature of the outside air is 25°F (-3.8°C) 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 (-6.6°C).

7.7.5. 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 over-stressing 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.

7.7.6. 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 7 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 in. (1.6 mm) 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.

7.7.7. WORKMANSHIP AND TOLERANCE

(a) Prestressed Beams, Girders, Spans and Box Type Beams. Requirements shall include the following:

(1) variation from shop plan lengths: plus or minus 1 in. (± 2.5 cm).
(2) variation from plan height, box type beams: plus or minus 1/4 in. (± 6 mm). Others: plus or minus 1/8 in. (± 12.5 mm).
(3) maximum deviation of 1/4 in. per 10 ft. (6 mm per 3 m) of length. Box-type beams 1/8 in (1.9 cm) total deviation.
(4) out-of-square (vertical or horizontal) or deviation from plane skew angle: maximum 1/8 in. (3.2 mm) per ft. (30 cm) of dimension.
(5) bearings. Requirements include:
   (A) out-of-perpendicular with vertical axis: maximum 1/16 in. (1.6 mm).
   (B) honeycomb in bottom soffit of beams at the bearing shall not exceed 15 percent of the bearing area (width x length). No tendon shall be exposed and the maximum depth of honeycomb shall not exceed 1 in. (2.5 cm). Honeycomb shall be chipped out to sound concrete and repaired satisfactorily prior to acceptance.
(6) form fit-up. Where sections of forms are to be butt-jointed, an offset of 1/16 in. (1.6 mm) for flat surfaces and 1/8 in. (3.2 mm) for corners and bends shall be permitted.

(b) Repair. Small areas of honeycomb which are purely surface in nature (not over 1 in. (2.5 cm)) 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.
(c) Steel. Reinforcing steel shall not project above the top of the member more than \( \frac{1}{2} \) in. (12.5 mm) nor less than \( \frac{3}{4} \) in. (19 mm) 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 \( \frac{1}{4} \) in. (6 mm) or \( \frac{1}{12} \) of the spacing between bars, whichever is greater. In the plane of the steel perpendicular to the nearest surface of the concrete, bars shall not vary from plan placement by more than \( \frac{1}{4} \) in. (6 mm).

7.7.8. 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 (m) 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 (0.30 m) 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 Item 7.8, “Prestressing.”

(b) Payment. Precast, prestressed concrete beams or girders shall be paid for at the unit price bid per linear foot (m) 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 (m) 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 of Item 7.6.15., “Measurement and Payment.”

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 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.

ITEM 7.8. PRESTRESSING

7.8.1. DESCRIPTION
This item shall govern the furnishing, storing and handling of materials for prestressing, as well as the prestressing of structural units except as otherwise shown on the plans.

7.8.2. MATERIALS AND EQUIPMENT
(a) Concrete. All concrete shall conform to the provisions of Item 7.4., “Concrete for Structures” and/or Item 7.5., “Lightweight Concrete for Structures.” Cast-in-place concrete shall further conform to Item 7.6., “Concrete Structures.”

(b) Grout. The recommended composition of grout for post-tensioning tendons shall be:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>94 pounds (42.7 g)</td>
<td>Portland Cement: Type II</td>
</tr>
<tr>
<td>1 pound (.454 g)</td>
<td>Admixture: Interplast C as manufactured by Sika Chemical Company or Intrusion Aid as manufactured by Concrete Chemicals Company, or an approved equal</td>
</tr>
<tr>
<td>5 ( \frac{1}{2} ) Gallons Max.</td>
<td>Water</td>
</tr>
</tbody>
</table>

50 pounds (22.7 g.) maximum of fly ash with a maximum carbon content of 8 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.

(c) Reinforcing Steel. Reinforcing steel, not prestressed, shall conform to Item 2.2.6., “Steel Reinforcement.”
(d) Structural Steel. Structural steel bearing plates, fittings, etc. shall conform to Item 7.10., “Steel Structures,” and Item 2.11., “Metal for Structures.”

(e) Prestressing Steel.

(1) 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 3 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 anchor shall be lubricated for this test.
- Bearing and shim plates shall be structural steel in accordance with the provisions of Item 7.10., “Steel Structures,” and Item 2.11., “Metal for 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 7 wire strands, with each large diameter strand or reach bar having common end anchorage.

All tendons shall be identified by the heat number, or by reel in the case of 7 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 (9072 kg) of each heat. For 7 wire strand, one specimen shall be furnished from each reel up to a lot of 3 reels, or from each third reel for lots of 4 or more reels. These specimens are to be obtained at the casting yard or at the tendon fabrication plant. Each specimen shall be 4 ft. (1.2 m) in length.

When required by the OWNER, the CONTRACTOR shall furnish, free of charge, 2 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 5 ft. (1.5 m) 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.

(A) 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. Samples for testing shall be as specified in Item 7.8.2.

(B) 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 psi (15,980 kg/cm²), based upon the gross section of the tendon.

The minimum ultimate elongation over a gate length of 10 in. (25 cm) shall be 3 percent. After tendons are fabricated, such shall be pre-stretched 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.

(C) Prestressing Bars. The minimum ultimate tensile strength based on the gross section of the bar shall be 145,000 psi (10,532 kg/cm²). The minimum ultimate elongation in 20 bar diameters shall be 4 percent. Each bar shall be proof loaded by the manufacturer to 90 percent 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 percent of the required ultimate strength when tested with a 2° cold bend in the bar at the root of the thread or at the end of the splicing device.
(D) Manufactured Steel Seven-Wire Strand. Seven-wire strand used for post-tensioned tendons shall conform to the requirements of Item 7.8.2.(e)(2).

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.

(2) 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.

(A) 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. Samples testing shall be as specified in Item 7.8.2.(e).

(B) Manufactured Steel Seven-Wire Strand. Seven-wire strand shall conform to the requirements of ASTM Designation A 416, and as outlined for higher strength strand in Item 7.8.2.(e)(1)(D).

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 3. In lots of 4 reels or more, one sample shall be furnished from each third reel or fraction thereof. Each sample shall be 4 ft. (1.2 m) in length.

(C) Prestressing Bars. Bars shall not be allowed in the pretension method.

(f) Bearing Pads. Bearing pads shall conform to the requirements of Item 2.2.12., “Elastomeric Materials.”

(g) 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 in. (.25 mm). The CONTRACTOR shall furnish manufacturer’s data certifying that the conduit is capable of withstanding a crushing force of 600 pounds per square foot (2928 kg/m²). 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.

(h) Coating. Tendons not requiring grouting shall be completely coated with a non-volatile, low friction mineral oil base grease with a rust preventing additive having a relative uniform viscosity under temperature ranges of 20°C (-6.6°C) to 120°F (48.8°C). 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 6 in. (15 cm) in length and grease is prominent on tendon.

(i) 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.”

7.8.3 CONSTRUCTION METHODS

(a) 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 stress, 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.

(b) 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 the slab or beam to the bottom of the conduit, taking into account the position of the prestressing steel within the conduit. The conduit shall be supported at intervals of not more than 5 ft. (1.5 m) 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 ±1/4 in. (± 6 mm).

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 6 in. (15 cm) variation in the vertical position of the conduit. Tendon with less than 6 in. (15 cm) vertical variation shall
have grout ports at the far end at intervals between the far end and injection end not to exceed 100 ft. (30 m). Grout ports shall consist of \( \frac{1}{2} \) in. (12.5 mm) minimum diameter galvanized metal pipe with caps or other arrangements having a minimum port diameter of \( \frac{1}{2} \) in. (12.5 mm) as approved by the OWNER.

The tops of the grout ports shall be set approximately \( \frac{1}{2} \) in. (12.5 mm) 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 trimmed as shown.

The calculated elongation for that particular tendon shall be stressed and the anchorage is marked to determine elongation. 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 2 minutes before reducing to the post-tensioning force required. The sequence of post-tensioning the units shall be such as to prevent over-stressing 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 2 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.

(1) The tendons shall be tensioned in the sequence designated in the prestressing details.

(2) 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.

(3) After the initial tensioning, the tendons shall be reference marked to determine elongation.

(4) 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 operations shall be repeated until the necessary requirements are met.

(5) After stressing and anchoring all tendons and upon the OWNER’S approval, projecting tendons shall be trimmed as shown on the approved prestressing details.

(6) 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 (5.4 kg/cm²) 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 pre-stress 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 re-stressed to the correct final pre-stress force.

(c) Pretensioning. All tendons to be prestressed in a group shall be brought to a uniform initial tension of 1,000 pounds ± 50 lbs. (454 kg ± 22.7 kg) 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 1 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 5 percent of each other.

Means shall be provided for measuring the elongation to an accuracy of 1/16 in. (1.6 mm). In the event of apparent discrepancies of more than 5 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 5 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 average shall be within 5 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 (14°C). At the ends of members, the tendon ends and a minimum area of 1 in. (2.5 cm) 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.

(d) Combined Pre-tensioning and Post-Tensioning. Where plans call for a combination of pre-tensioning and post-tensioning, all of the requirements of both the pre-tensioning and post-tensioning shall apply, in this order, and the requirements shall overlap as necessary to fulfill the intent of this specification.

7.8.4. 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 7.7.8., “Prestressed Concrete Structures.”

(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 (m³) or by the pound (kg) 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.

**ITEM 7.9. PNEUMATICALLY PLACED CONCRETE (GUNITE)**

7.9.1. DESCRIPTION

Pneumatically placed concrete shall consist of premixed sand and portland cement pneumatically transported through a pipe or hose in a dry state to a nozzle where hydration takes place immediately prior to expulsion.

7.9.2. MATERIALS

The concrete shall conform to the requirements of Item 7.4., "Concrete for Structures." Bar reinforcement and wire fabric reinforcement shall conform to the requirements of Item 2.2.6., "Steel Reinforcement."

Expansion joints shall conform to the requirements of Item 2.2.9., "Joint Filler."

Steel drive pins or studs used for the attachment of reinforcing when covering designed portions of concrete structures with pneumatically placed concrete shall be capable of being driven to the specified depth without deforming or otherwise becoming unsuitable for the purpose intended. The pins shall have a minimum diameter of 1/8 in. (3.2 mm) and a minimum length of 2 in. (5 cm). Size and location of drive pins or studs and method of attachment of reinforcing shall be as specified herein or as detailed on the plans.

The equipment used for driving the pins or studs shall be of the type which uses an explosive for the driving force and shall be capable of inserting the stud or pin to the required depth without damage to the concrete. The OWNER may require that a test be made of equipment prior to approving it for use.

7.9.3. EQUIPMENT

The gun mechanism should be operated at a minimum air pressure of 45 psi (3.3 kg/cm²) on the gun tank when 100 ft. (30 m) or less of material hose is used and the pressure should be increased 5 lbs. (36 kg/cm²) for each additional 50 ft. (15 m) of hose required. Nozzles used for guniting shall have a maximum size of 1 1/8 in. (4.1 cm) unless otherwise permitted by the OWNER. Water used for hydration shall be maintained at a uniform pressure, which shall be at least 15 psi (101 kg/cm²) above air pressure at the gun.

7.9.4. PROPORTIONS AND MIXING

Unless otherwise specified, the concrete shall consist of a mixture of cement and sand in the proportions by volume of 1 part of cement to 4 1/2 parts of sand.

The sand shall contain not less than 3 or more than 6 percent moisture by weight. The sand and cement shall be mixed thoroughly in a power mixer for at least 1 1/2 minutes before placement in the chamber of the gun mechanism. The dry mixed material shall be used promptly after mixing. Any material that has been mixed for more than 45 minutes shall be rejected and removed from the worksite.

The mixer shall be cleaned at regular intervals to remove all adherent material from the mixing vanes and from the drum.

At the beginning of work the OWNER may require that cylinders be made to represent the quality of the pneumatically placed concrete. Additional cylinders shall be made during performance of the work as directed by the OWNER. If in the opinion of the OWNER, the cylinder strengths are indicating undesirable variation in the concrete, the CONTRACTOR may be required to change the mix design and/or method of placing so as to correct this condition.
The CONTRACTOR shall furnish specially constructed cylinders 6 in. (15 cm) in diameter and 12 in. (30 cm) high, made of \( \frac{3}{4} \) in. (19 mm) square mesh hardware cloth. Test cylinders for pneumatically placed concrete shall be shot with the same air pressure and nozzle tip as the pneumatically placed concrete. At the end of the first 24 hour curing period, the hardware cloth form shall be removed and the cylinders stored and cured as directed by the OWNER.

The use of approved admixtures conforming to the requirements of Item 7.4, shall be permitted at the option of the CONTRACTOR.

7.9.5. CONSTRUCTION METHODS

(a) Placement. Earth surfaces to which concrete is to be applied shall be neatly trimmed to line and grade and shall be free of all loose material. The surface need not be compacted by slope rolling or other measure unless required by the plans or special provisions.

No high subgrade shall be permitted. Excavation made below subgrade shall be backfilled with compacted fill or, at the CONTRACTOR's option, with concrete. However, no additional compensation shall be allowed for such compacted fill nor for increased thickness of concrete placed because of low subgrade.

Asphaltic concrete surfaces shall be thoroughly cleaned of any organic material, silt and clay, or any other material detrimental to the concrete and then washed with water under pressure. Masonry, rock and concrete surfaces shall be examined and all loose material removed therefrom. The surface shall be thoroughly cleaned with steel scrapers or brushes to remove all dust, dirt, mortar, grease or other deleterious substances and then washed with water. Whenever brushing and scraping do not secure suitable results, sandblasting may be required.

All surfaces shall be wetted with water before application of concrete. Concrete shall not be applied to surfaces on which free water exists.

The velocity of the material as it leaves the nozzle shall be maintained uniformly at a rate determined for given job conditions. Material which rebounds and does not fall clear of the work, or which collects on the surfaces, shall be blown off or otherwise removed. Rebound shall not be used in any portion of the work, and no payment shall be made for rebound or other concrete losses.

The nozzle shall be held at such distance and position that the stream of flowing material shall impinge at approximately right angles to the surface being covered. Any portion of the placed concrete which tends to sag or which shows soft or sandy pockets or is otherwise unsatisfactory shall be cut out and replaced with new concrete. Reinforcement damaged or destroyed by such repairs shall be replaced by trimming the concrete back and properly lapping and tying additional steel as may be required by the OWNER.

Reinforcement shall be firmly supported in the position shown on the plans. Mortar blocks, metal chairs, clips or spacers with wire ties or other acceptable means shall be used to anchor and place the reinforcement properly. Where material is placed on overhead surfaces, the amount of water used shall be so adjusted that approximately \( \frac{3}{4} \) in. (19 mm) of the placed material shall adhere without support. The limit of thickness shall be considered to have been exceeded when the material begins to sag or slough.

(b) Forms and Ground Wires. The forms shall be built in accordance with applicable provisions of the specifications, except all forms shall be built so as to permit the escape of air and rebound.

Ground wires shall be installed in such a manner that they accurately outline the finished surfaces as indicated on the plans. They shall be located at intervals sufficient to insure proper thickness throughout. Wire shall be stretched tight and shall not be removed prior to application of the finish coat.

Headers shall be required where the plans indicate a formed edge and at plane joints.

(c) Joints. Construction joints shall be sloped off at an angle of approximately 45° to the surface to which the concrete is being applied. Before applying concrete in the adjacent sections, the sloped portion shall be thoroughly cleaned and wetted by means of air and water blast.

The plane joints shall be formed in accordance with and placed in the locations designated on the plans.

(d) Finish. Upon reaching the thickness and shape outlined by forms and ground wire, the surface shall be rodded off to true lines. Any low spots or depressions shall be brought up to proper grade by placing additional concrete. Ground wires shall then be removed. Unless otherwise specified, the surface shall then be broom finished to secure a uniform surface texture. Rodding and working with a wood float shall be held to a minimum.

Rebound or accumulated loose sand shall be thoroughly cleaned up and disposed of by the CONTRACTOR. In no case shall they be floated into the surface of the work.
When a nozzle finish is specified on the plans, ground wires shall not be used, and the surface shall be left as uniform as possible without rodding. Nozzle finish shall not be permitted where the underlay has been floated.

Concrete shall not be applied to a surface containing frost or ice. Where standing or running water is encountered, it shall be removed before applying the concrete. No work shall be done without the permission of the OWNER when the temperature is lower than 40°F (4.4°C). After placing, the concrete shall be protected from freezing or quick drying.

(e) Curing. Pneumatically placed concrete shall be cured in accordance with Item 7.6., “Concrete Structures.”

(f) Workmen. Only experienced foremen, gunners, nozzlemen, and rodmen shall be employed, and satisfactory written evidence of such experience shall be furnished to the OWNER or his representative upon demand.

7.9.6. MEASUREMENT AND PAYMENT

Measurement for pneumatically placed concrete shall be made by the square foot (m²) in place. For encasement of structural steel members and covering portions of structures, the actual contact area shall be the basis for measurement.

Pneumatically placed concrete, measured as provided in this item, shall be paid for at the unit price bid per square foot (m²) for “pneumatically placed concrete” of the type specified. The unit price bid per square foot (m²) shall be full compensation for all cement, sand, water, reinforcement, furnishing and driving all steel drive pins, mixing and placing pneumatically placed concrete, and for all labor, tools, equipment and incidentals necessary to complete the work. Excavation for channel and canal lining shall be paid for in accordance with Item 3.5., “Unclassified Channel Excavation.” Shaping and fine grading of channel or canal slopes and floors are not to be paid for directly but shall be included in the unit price bid for “pneumatically placed concrete.” When header-banks upon which “pneumatically placed concrete” is to be placed have been built by prior contract, excavation for shaping of slopes shall be paid for in accordance with Item 7.1., “Structural Excavation.”

ITEM 7.10. STEEL STRUCTURES

7.10.1. DESCRIPTION

This specification shall govern the fabrication and erection of structural steel and other metals (except reinforcing steel), which are used for steel structures or steel portions of structures.

7.10.2. MATERIALS

The metal used for the various portions of the structure shall be as specified and shall conform to the requirements of Item 2.11., “Metal for Structures.”

7.10.3. """" BLANK ITEM """

7.10.4. 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 in. (.6 m x .9 m).

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.

7.10.5. 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.
7.10.6. 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 the progress, with full power to reject all materials or workmanship not conforming to the plans and specifications.

The CONTRACTOR shall give the OWNER 5 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 materials. 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.

7.10.7. 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.

Undercut gusset plates shall not be accepted. All sharp corners and edges, and edges that are marred, cut, or roughened in handling or erection, shall be slightly rounded by grinding or other suitable means.

7.10.8. 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 on the plans shall be in accordance with AASHTO Standard Specifications for Highway Bridges.

7.10.9. HOLES FOR BOLTS OR RIVETS

Holes shall be either punched full size, punched and reamed, or drilled. The finished hole shall be \( \frac{1}{16} \) in. (1.6 mm) 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 \( \frac{3}{32} \) in. (2.4 mm). Holes shall be as follows:

(a) holes for shop rivets shall be sub-punched or sub-drilled at the fabricator’s option, \( \frac{1}{4} \) in. (6 mm) less in diameter than that of the finished holes and shall be reamed to size with the parts assembled, with the following exceptions:

(1) holes in material thicker than \( \frac{7}{8} \) in. (2.2 cm) shall not be punched; however, at the fabricator’s option, they may be sub-drilled to the diameter specified for sub-punching or may be drilled full size with the parts assembled, provided that the parts are adequately bolted or clamped together.

JANUARY 1998
Steel parts shall be specified as follows:

7.10.10. REAMED WORK

(a) Drilled holes shall be reamed through both reamed plies 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 sub-punched for the fabricator’s convenience, or the assembled material is not over 5 plies thick, of which the main material consists of not more than 3 plies.

(b) Holes for field rivets shall be sub-punched or sub-drilled at the fabricator’s option. 3/8 in. (6 mm) 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:

1. 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 3 abutting sections assembled and with milled ends of compression chords in full bearing.

2. 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.

3. Field connections of lateral, longitudinal or sway bracing shall conform to the requirements of holes for shop rivets.

4. Holes in material thicker than 7/8 in. (2.2 cm) shall not be punched but shall be sub-drilled to the diameter specified for sub-punching or drilled full size with parts assembled.

The accuracy of the punching shall be such that for any group of holes when assembled, 75 percent 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.

Miss-punched members shall not be corrected by welding without the approval of the OWNER.

7.10.11. DRILLED HOLES

Drilled holes shall be 3/16 in. (1.6 mm) 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 3/16 in. (1.6 mm) 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.

7.10.12. ASSEMBLING STEEL

Steel parts shall be assembled in the shop or in the field in accordance with the following:
(a) 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 the 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 3 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 distance set and the gears properly match-marked.

(b) 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 by the cantilever method, truss spans shall be 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 trailing 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 \(\frac{1}{2}\) 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 \(\frac{3}{4}\) of the holes so filled. Fitting-up bolts shall be of the same nominal diameter as the rivets, and cylindrical erection pins shall be \(\frac{1}{32}\) in. (8 mm) 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.

7.10.13. RIVETING

Shop and field riveting shall conform to the following provisions:

(a) 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.

(b) 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 over-heated 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 psi (7.26 kg/cm\(^2\)) at the hammer. Caulking or recupping shall not be permitted. In re-
moving 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.

7.10.14. BOLTED CONNECTIONS

When high-strength bolts are required or permitted, the bolts shall be in conformance with Item 2.11., “Metal for Structures” and with Item 7.11., “Structural Bolting.”

7.10.15. JOINTS AND CONNECTIONS

(a) Edge Planing. Sheared edges of plates more than \( \frac{3}{16} \) in. (15.9 mm) in thickness and carrying calculated stress shall be planed to a depth of \( \frac{1}{4} \) in. (6 mm).

(b) 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 \( \frac{1}{32} \) in. (.8 mm) tolerance in 12 in. (30 cm) and to within \( \frac{1}{16} \) in. (1.6 mm) 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 \( \frac{1}{8} \) in. (3.2 mm) tolerance in 12 in. (30 cm) and to within \( \frac{1}{16} \) in. (4.8 mm) 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.

(c) 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 \( \frac{1}{4} \) in. (6 mm).

(d) 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.

(e) 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 \( \frac{1}{8} \) in. (3.2 mm) below at any point.

(f) 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 filler under stiffener angles shall be sufficiently tight to exclude water after being painted.

(g) 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.

(h) 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 7 in. (17.5 cm) in diameter shall be forged and annealed.

In pins larger than 9 in. (22.5 cm) in diameter, the forging shall be permitted to cool to a temperature below the critical range cooling, and a hole not less than 2 in. (5 cm) 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 \( \frac{1}{32} \) in. (.8 mm). 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 \( \frac{1}{50} \) in. (.5 mm) for pins 5 in. (12.5 cm) or less in diameter, or \( \frac{1}{32} \) in. (.8 mm) for larger pins.

(i) Screw Threads. Screw threads shall make close fits in the nuts and shall be Unified Standard Series conforming to USASI B1.1-1960.
7.10.16. 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 sulfured-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 3 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 8 oz. (227 gm) 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 (726 kg/cm²) without extrusion or detrimental reduction in thickness.

7.10.17. 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.

7.10.18. 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 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 re-inspection 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 in. (1.6 mm) in greatest dimension; and provided further that the sum of the greatest dimension of all such defects in any square inch (6.3 cm²) of weld are does not exceed 3/8 in. (9.5 mm).

All welding shall be preformed 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 Designations 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 requirements 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-hydron electrodes shall be stored for holding in an approved low-hydrogen oven at a temperature of 300 to 400°F (149°C-204°C) 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 300 to 400°F (149°C-204°C) after re-baking.

Areas contiguous to welding operations shall be preheated to a minimum temperature of 300°F (149°C) when necessary to prevent distortion or weld cracking. Preheating to a temperature in excess of 400°F (204°C) 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 in. (1.6 mm).

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 erection 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.

7.10.19. SHOP PAINTING

The application of shop paint shall conform to the requirements of Item 2.9, "Paint and Protective Coating." Surfaces to be in contact after shop riveting is completed shall be cleaned but not painted.

7.10.20. 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. Matchmarks shall be made with paint in addition to the requirements of Item 7.10.26 and 2.9, "Paint and Protective Coating." Members weighing more than 3 tons (2722 kg) 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.

7.10.21. 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 false-work 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 \( \frac{1}{4} \) of the field holes for main connections shall be provided.

### 7.10.22. 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.

### 7.10.23. FALSE-WORK

The false-work 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 false-work to the OWNER for approval.

The false-work plans shall be complete in all details of members, connection equipment, etc. so that a structural check can be made of the false-work.

Approval of the CONTRACTOR'S plans shall not be considered as relieving the CONTRACTOR of any responsibility.

### 7.10.24. 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.

### 7.10.25. 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 operations. Any error in ship 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 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.

### 7.10.26. PAINT AND PAINTING

Unless otherwise provided, the application of field paints shall conform to the requirements of Item 2.9., “Paint and Protective Coatings.”

For railroad structures, which require that the steel be erected and assembled on false-work and moved into place as a unit, all field paint, except the final coat, shall be applied to the steel while on the false-work 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.

### 7.10.27. MEASUREMENT AND PAYMENT

No direct compensation shall be made for “steel structures.” Measurement and payment for quantities of 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.
ITEM 7.11. STRUCTURAL BOLTING

7.11.1. STRUCTURAL BOLTING
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.

7.11.2. MATERIAL
Bolts, nuts and washers shall conform to the requirements of Item 2.11.3., “Bolts.”

7.11.3. GENERAL
General requirements shall include the following:
(a) 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, sub-punched and reamed or drilled as required by Item 7.10., “Steel Structures.” Holes shall be of a nominal diameter not more than 1/16 in. (1.6 mm) in excess of the nominal bolt diameter. Field erection and fit-up of joints and splices shall conform to the requirements of Item 7.10., “Steel Structures.”
(b) 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.
(c) contact surfaces shall be free of oil, paint, lacquer or galvanizing.

The values in the following table allow for manufacturing tolerances; provide for the inclusion of either 1 or 2 flat circular washers; and the use of either a heavy or finished nut with adequate “strike-through” at the end of the bolt. For each required beveled washer, add an additional 1/8 in. (3.2 mm).

<table>
<thead>
<tr>
<th>Bolt Size (inches)</th>
<th>1/2</th>
<th>5/8</th>
<th>3/4</th>
<th>7/8</th>
<th>1</th>
<th>1 1/8</th>
<th>1 3/8</th>
<th>1 1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>To determine required bolt length add to grip * (inches)</td>
<td>13/16</td>
<td>1 1/16</td>
<td>1 3/16</td>
<td>1 5/16</td>
<td>1 9/16</td>
<td>1 12/16</td>
<td>1 13/16</td>
<td>2 1/16</td>
</tr>
</tbody>
</table>

* The total length of bolts shall be adjusted to the next 1/4 in. increment up to 5 inches in length and to the next 1/2 in. increment for lengths over 5 inches.

To determine the required length of interference-body bolts, the value shown in the table above, less 1/8 in. (3.2 mm), shall be added to the grip.

7.11.4. INSTALLATION
Installation shall include the following:
(a) 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 heavy semi-finished hexagon nuts when these are not the elements turned.
(b) All fasteners shall be tightened to give at least the required minimum bolt tension values shown in the following table on completion of the joint.
Item 7.11.4.

**The Turn-of-the-Nut Method.**

(1) The Turn-of-the-Nut Method.
(2) The Calibrated-Power Wrench Method.

**7.11.5. CONSTRUCTION**

(a) Pre-tightening. Prior to actual tightening of the bolts, the following procedures shall be followed:

(1) a minimum of 20 percent of the holes at a connection point shall be filled with erection pins to "fair-up" all holes.
(2) install bolts in all remaining holes.
(3) tighten a minimum of 20 percent 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.
(4) mark those bolts used for fit-up bolts.
(5) tighten all the remaining bolts the required amount, then remove the erection pins.
(6) fill the remaining holes with bolts and loosen all bolts used for fit-up.
(7) tighten the rest of the bolts by the required amount.

(b) Turn-of-the-Nut Method. This method indicates the following:

(1) 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.)
(2) tighten the nuts by the amount specified in the following table.

<table>
<thead>
<tr>
<th>Bolt Diameter (In Inches)</th>
<th>From Snug-tight Rotate Nut *&lt;br&gt;1/2 — 5/8</th>
<th>Turn for Grips</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>Up to 5 Inches</td>
<td></td>
</tr>
<tr>
<td>1/6</td>
<td>Up to 5 Inches</td>
<td></td>
</tr>
<tr>
<td>1/4</td>
<td>Up to 8 Inches</td>
<td></td>
</tr>
<tr>
<td>3/8</td>
<td>Up to 8 Inches</td>
<td></td>
</tr>
</tbody>
</table>

* Permissible tolerance: 1/4 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:

(3) follow steps (6) and (7) shown in Item 7.11.5.(a) preceding.
(4) tightening crew to mark finished work with identifying symbol.
(5) inspector mark accepted work.

(c) Calibrated-Power Wrench Method. When calibrated wrenches are used to provide the bolt tension specified in bolt tension specified in bolt tension table in Item 7.11.4., 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-fit.

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:

---

**BOLT TENSION**

<table>
<thead>
<tr>
<th>Bolt Size (inches)</th>
<th>1/2</th>
<th>5/8</th>
<th>3/8</th>
<th>1/4</th>
<th>3/8</th>
<th>1/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required Minimum Bolt Tensions <em>(lb.)</em></td>
<td>12,050</td>
<td>19,200</td>
<td>28,400</td>
<td>39,250</td>
<td>51,500</td>
<td>56,450</td>
</tr>
</tbody>
</table>

* Equal to the proof load of bolt given in ASTM Designation A 325.
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 Item 7.11.4.

In this tightened condition, the inspector's torque wrench shall be used to rotate the nut slowly in the tightening direction to move just the nut. The amount required to move the unit shall be used for the inspection torque (use the average of 3 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 percent 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 re-impacted with the calibrated power wrench.

When the calibrated 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 3 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 complete 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. This shall include:

1. tightens all bolts not used as fit-up bolts to the tension required by bolt tension table in Item 7.11.4.
2. following steps (6) and (7) shown in Item 7.11.5.(a).
3. following steps (4) and (5) shown in Item 7.11.5.(b).

Impact wrenches shall be of adequate capacity and sufficiently supplied with air to perform the required tightening in approximately 10 seconds.

### 7.11.6. 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 re-tightening bolts in case that tests indicate the required tension is not being obtained.

### 7.11.7. 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.

### ITEM 7.12. PRECAST CONCRETE UNITS

#### 7.12.1. DESCRIPTION

This item shall govern 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.
7.12.2. GENERAL
Cast-in-place and precast (formed) concrete units shall conform to the requirements of Item 7.6., "Concrete Structures," Item 2.2.6., "Steel Reinforcement," Item 7.4., "Concrete for Structures," and ASTM Designations 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 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.

7.12.3. 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 Item 7.4., "Concrete Structures," except that Class "C" concrete shall be required when a unit is used with monolithic 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 2 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 1 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 until 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 the Item 2.2.6., "Steel Reinforcement," 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 Engineer. Welding of steel reinforcement will not be permitted unless specifically shown on the plan details and shall conform to the requirements of Item 7.10.18, "Welding." The maximum variation in the position of the reinforcement shall be plus or minus 10 percent of the wall thickness or plus or minus 1/2 in., whichever is lesser. In no case, however, shall the cover over the reinforcement be less than shown on the plans.

7.12.4. FORMS, PRECAST MACHINE-MADE CONCRETE UNITS
Forms for precast machine-made concrete units shall be made of steel and shall comply with the requirements of Item 7.6., "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.
7.12.5. CASTING TOLERANCES
Allowable casting tolerances for concrete units shall not vary more than 1/16 in., 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.

7.12.6. 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 of the manufacturer.

7.12.7. 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.

7.12.8. 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 misshapen 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.

7.12.9. 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.

7.12.10. CONSTRUCTION METHODS
All excavation shall be in accordance with the requirements of Item 7.1., “Structural Excavation,” or Item 6.2., “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 Item 1.12.2., “Reinforced Concrete Culvert, Storm Drain, Pipe and Box Section,” or as specified in 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 2.11., “Metal for Structures.”

7.12.11. MEASUREMENT
Precast and cast-in-place units of each size and type, satisfactorily complete in accordance with the plans and specifications, will be measured by each concrete unit completed to the stage of construction required by the plans.
Excavations and backfill, unless otherwise noted on the plans, will be measured as required by Item 7.1., “Structural Excavation,” or Item 6.2., “Excavation Backfill,” as appropriate.
7.12.12. 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 of 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 Item 7.1, “Structural Excavation,” or Item 6.1, “Excavation and Backfill.”
PART III. CONSTRUCTION METHODS

DIVISION 8. MISCELLANEOUS CONSTRUCTION

Item 8.1. Barriers and Warning and/or Detour Signs
Item 8.2. Concrete Curb and Gutter
Item 8.3. Concrete Sidewalks and Driveway Approaches
Item 8.4. Concrete Medians
Item 8.5. Reinforced Concrete Headers
Item 8.6. Concrete Steps
Item 8.7. Retaining Walls
Item 8.8. Sawing
Item 8.9. Painting
Item 8.10. Electrical Conduit
Item 8.11. Metal Beam Guard Rail
Item 8.12. Railing
Item 8.13. Chain Link and Guard Fence
Item 8.14. Wire Fence
Item 8.15. Riprap
Item 8.16. Gabion Structure Assembly
Item 8.17. Solid Concrete Interlocking Paving Units
This page was intentionally left blank.
DIVISION 8. MISCELLANEOUS CONSTRUCTION

ITEM 8.1. BARRIERS AND WARNING AND/OR DETOUR SIGNS

8.1.1. DESCRIPTION
This item shall consist of the basic requirements which the CONTRACTOR must comply with in order to assure the safety of the public, the OWNER and the CONTRACTOR’S employees. The type and location of signs and barriers shall be provided as required in Item 1.24., “General Conditions.” Additional signs and/or barriers shall be erected if so directed by the OWNER in writing.

8.1.2. 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.

8.1.3. 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.

ITEM 8.2. CONCRETE CURB AND GUTTER

8.2.1. 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.

8.2.2. MATERIALS
All materials used in concrete herein specified shall conform to the requirements of the applicable sections of Item 5.8., “Portland Cement Concrete Pavement,” of these specifications and to additional requirements herein included.

8.2.3. CONSTRUCTION METHODS
(a) Excavation. Excavation shall be as provided in Item 3.3., “Unclassified Street Excavation,” and as shown on the plans.
(b) 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 of 20 diameters of the bar or 12 in. (30 cm), 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.
(c) 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 extend the full depth of concrete and be a minimum of 1 5/8 in. (41 mm) in thickness or equivalent when wooden forms are used, or be of a gauge that shall provide equivalent rigidity and strength when metal forms are used.

All forms showing a deviation of 1/8 in. (3.2 mm) in 10 ft. (3 m) from a straight line shall be rejected. For curves with a radius of less than 250 ft. (75 m), acceptable flexible metal forms or wood forms shall be used.
(d) 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 200 ft. (61 m) intervals and at intersection returns and other...
r rigid structures, or as otherwise specified by the OWNER. Tool joints shall also be placed at 5 ft. (1.5 m) 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 1/2 in. (12.5 mm) 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 the curb and gutter and sidewalk. Longitudinal dowels, across the expansion joints in the curb and gutter, shall be required. There shall be three No. 4 round, smooth bars for dowels at each expansion joint, spaced in accordance with standard reinforcement steel specifications. The dowel shall be a minimum of 24 in. (.6 m) 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 in. (25 mm) free expansion. Dowels shall be supported by an approved method to provide a true horizontal and longitudinal alignment.

In the event that 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 through the gutters (not curb) shall be sealed with hot-poured rubber sealer unless otherwise specified.

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.

(3) Concrete Placement. No concrete shall be placed when the air temperature is less than 35°F (1.6°C), 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 (7.2°C) for a period of at least 5 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 coarse 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.

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.

Where curb and gutter is not adjacent to new pavement, 2 in. (5 cm) of sand cushion shall be used. After the fine grading has been completed, a 2 in. (5 cm) layer of sand or suitable gravel cushion shall be evenly spread over the subgrade for curb and gutter, thoroughly wetted and tamped into place to the satisfaction of the OWNER. The forms shall be placed upon this sand or gravel base. A screed shall be used to shape the sand cushion to fit a plane parallel to the top of gutter. A curb and gutter machine may be used, if approved by the OWNER.

(f) Finishing. After the concrete has been struck off and while it is still plastic, the exposed surfaces may be plastered with 1/4 in. (6 mm) 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 ft. (3 m) straightedge, and the maximum distance from the straightedge to the concrete shall not ex-
ceed 1/4 in. (6 mm). All variations greater than 1/4 in. (6 mm) shall be immediately corrected. All honeycombed areas disclosed by removal of forms shall be immediately chipped out and patched with portland cement mortar.

(g) Curing. After finishing operations are completed, the concrete surface shall be sprayed with 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 sq. ft. per gallon (4.91 m² per L).

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.

8.2.4. MEASUREMENT AND PAYMENT

Curb and gutter shall be measured by their linear foot (m) in place complete. Laydown curb and gutter shall also be measured by the linear foot (m).

The work performed and materials furnished as prescribed in 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.

ITEM 8.3. CONCRETE SIDEWALKS AND DRIVEWAY APPROACHES

8.3.1. DESCRIPTION

This item shall govern the construction of barrier free access ramps, concrete sidewalks, driveways and approaches conforming to the lines, grades, locations and designs as indicated on the plans and specifications or as established by the OWNER.

8.3.2. MATERIALS

(a) General. All materials and requirements for concrete shall conform to the requirements of Item 8.2., "Concrete Curb and Gutter."

(b) Reinforcement. Driveway approaches and walk reinforcing, when required, shall be No. 6 gauge, 6 in. x 6 in. (15 cm x 15 cm) wire fabric or No. 3 bars on 24 in. (60 cm) centers. Sidewalk reinforcing (except in driveway approach) may be No. 10, 6 in. x 6 in. (15 cm x 15 cm).

8.3.3. CONSTRUCTION METHODS

(a) General. Concrete sidewalks shall have a minimum thickness of 4 in. (10 cm), except that sidewalks constructed in driveway approach sections shall have a minimum thickness equal to that of driveway approach or as called for by plans and specifications within the limits of the driveway approach. Standard slope for walks shall be 1/4 in. per ft. (20 mm per m) in the direction of the curb or street with a tolerance of 1/8 in. per ft. (10 mm per m). 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 in. (300 mm) 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 Item 8.8., "Sawing."

(b) 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.

(c) 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 90 percent of maximum density as determined by
Item 8.3.3.

MISCELLANEOUS CONSTRUCTION

ASTM D 698. Moisture content shall be within minus 2 to plus 4 of optimum. Any over excavation may be repaired with compacted sand or gravel thoroughly wetted in place to the satisfaction of the OWNER.

(d) 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.

(3) 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.

(f) 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 40 ft. (12 m) 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 1/2 in. (12.5 mm) in thickness. Edges of all construction and expansion joints and outer edges of all sidewalks shall be finished to approximately a 1/2 in. (12.5 mm) radius with a suitable finishing tool. Sidewalks shall be “flagged” 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.

(g) Curing. Sidewalks and driveways shall be cured in accordance with the requirements of Item 8.2., “Concrete Curb and Gutter.”

8.3.4. MEASUREMENT AND PAYMENT

Measurement for sidewalks complete and in place shall be by the sq. ft. (m²). Measurement for driveway approaches complete in place shall be by the sq. ft. (m²). Measurement of driveway approaches shall start at the back of the lay-down curb line 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.

ITEM 8.4. CONCRETE MEDIANS

8.4.1. DESCRIPTION

This item shall consist of concrete medians in accordance with these specifications and in conformance with the lines and grades established by the OWNER and details shown on the plans.

8.4.2. MATERIALS

Material requirements shall be the same as those for Item 8.3., “Concrete Sidewalks and Driveway Approaches.”

(a) General. Excavation and fine grading shall be done in conjunction with Item 3.3., “Unclassified Street Excavation,” and shall be subsidiary to the item.

(b) Sand Cushion. After the fine grading has been completed, a 1 in. (2.5 cm) layer of sand or suitable gravel cushion may be spread over the subgrade for the median, thoroughly wetted, and tamped into place to the satisfaction of the OWNER.

(c) Forms. Forms, where required, shall be of wood or metal, straight, free of warp and of a depth equal to the depth of the required section. They shall be securely staked to line and grade and maintained in a true position during the depositing of concrete.

(d) Finishing. The surface shall be finished with a float and lightly brushed to obtain a uniform finish. Tooled joints shall be placed longitudinally and transversely at intervals not to exceed 6 ft. (1.8 m) center to center, as shown on the plans, or as directed by the OWNER. Joints in the median shall coincide with joints in curb and gutter. Expansion joint material shall be placed between the median and the back of curb and around all obstructions protruding through the concrete median.
8.4.3. MEASUREMENT AND PAYMENT

Concrete median shall be measured by the square yard (m²) in place.

The work performed and materials furnished as prescribed by this item, measured as provided for in this item, shall be paid for at the contract unit price bid for "concrete median," which price shall be full compensation for constructing concrete median and for preparing the subgrade; furnishing and placing all materials, including sand cushion, reinforcement and expansion materials; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

ITEM 8.5. REINFORCED CONCRETE HEADERS

8.5.1. DESCRIPTION

This item shall govern the construction of reinforced concrete header to the size, shape and at the location shown on the plans.

8.5.2. MATERIALS

Material requirements shall be the same as those for Item 5.8., "Portland Cement Concrete Paving."

8.5.3. CONSTRUCTION METHODS

Concrete header shall be constructed at the location(s) shown on the plans and shall be constructed as shown on the plans.

8.5.4. MEASUREMENT AND PAYMENT

Concrete header shall be paid by the linear foot complete in place.

The work performed and materials furnished as prescribed by this item, measured as provided for in this item, shall be paid for at the contract unit price bid for concrete header. This payment shall be full compensation for necessary excavation, reinforcing steel, furnishing and placing concrete, and for all labor, tools, equipment and incidentals necessary to complete the work.

ITEM 8.6. CONCRETE STEPS

8.6.1. DESCRIPTION

This item shall govern the construction of reinforced concrete steps with or without buttress walls at the location(s) shown on the plans or as directed by the OWNER.

8.6.2. MATERIALS

Material requirements shall be the same as those for Item 5.8., "Portland Cement Concrete Paving."

8.6.3. CONSTRUCTION METHODS

(a) General. Concrete steps shall be constructed at the location(s) shown on the plans or as directed by the OWNER and as detailed on the plans.

(b) Finishing. Concrete steps may be finished by the use of mortar topping and shall be troweled and lightly brushed.

(c) Curing. Concrete steps shall be cured in accordance with the requirements of Item 8.2., "Concrete Curb and Gutter."

8.6.4. MEASUREMENT AND PAYMENT

Concrete steps shall be measured by the sq. ft. (m²) of tread complete in place. If buttress walls are included, they shall be measured by the sq. ft. (m²) of wall top.

Concrete steps and buttress walls shall be paid for at the contract unit price bid, which price shall be full compensation for all excavation sand cushion; furnishing and placing all materials, including reinforcement and expansion joint material; and for all labor, tools, equipment and incidentals necessary to complete the work.
**ITEM 8.7. RETAINING WALLS**

**8.7.1. DESCRIPTION**
This item shall govern the construction of concrete retaining walls of the size and shape detailed on the plans and at the location(s) shown on the plans. The requirements of Item 7.1, “Structural Excavation,” shall apply to the construction of retaining walls.

**8.7.2. MATERIALS**
(a) Concrete. Concrete shall be of the grade specified on the plans and shall conform to the requirements of Item 7.4, “Concrete for Structures.”
(b) Reinforcing Steel. Reinforcing steel shall be of the size and type shown on the plans and shall conform to the requirements of Item 7.2.3.(b), “Reinforcing Steel.”

**8.7.3. CONSTRUCTION METHODS**
Concrete retaining walls shall be constructed in accordance with the details shown on the plans and in conformance with the requirements of Item 7.1, “Structural Excavation,” and Item 7.6, “Concrete Structures.”

**8.7.4. MEASUREMENT AND PAYMENT**
Concrete used in the construction of retaining walls shall be measured by the cubic yard (m³). Calculations shall be based upon plan dimensions and quantities.

- Structural excavation shall be measured in accordance with Item 7.1., “Structural Excavation.”
- Reinforcing steel shall be measured in accordance with Item 7.2.3.(b), “Reinforcing Steel.”

Payment for all work prescribed under this item shall be made at the unit prices bid for the various items delineated in this item above. This price shall be full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the work.

When pay items are not provided for structural excavation and/or reinforcing steel, these items shall be subsidiary to the pay item for concrete for retaining walls.

**ITEM 8.8. SAWING**

**8.8.1. 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).

**8.8.2. 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 \( \frac{1}{8} \) in. (3 mm) to \( \frac{1}{4} \) in. (6 mm) 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.

**8.8.3. CONSTRUCTION METHODS**
(a) General. Sawing shall be in accordance with the requirements of this item unless otherwise shown on the plans or in the special provisions.
(b) 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 \( 1 \frac{1}{2} \) in. (38 mm). Except for sidewalks, if a saw cut falls within 3 ft. (.9 m) 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 in. (.46 m) 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. (75 m) in either length or width unless otherwise approved by the owner.

(c) Sawcuts for Contraction Joints. Saw cuts for contraction joints shall be a minimum of 1/4 the depth of the pavement.

8.8.4 MEASUREMENT AND PAYMENT

Sawing shall not be measured for payment but shall be considered subsidiary to the items requiring sawing.

ITEM 8.9. PAINTING

8.9.1. DESCRIPTION

This item shall govern for the type, quality and 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 they 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.

8.9.2. MATERIALS

All materials used in the painting herein specified shall conform to the requirements of the applicable sections of Item 2.9. of these specifications and to additional requirements herein included.

8.9.3. CONSTRUCTION METHODS

(a) 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 for 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.

(b) 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 (4.4°C) nor when there is a likelihood of change in weather conditions within 2 hours after application which would result in air temperatures below 40°F (4.4°C) 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 the fresh paint.

(c) Number of Coats and Color. Except for surfaces hereinafter specified or otherwise provided for on the plans, all structural steel shall be painted with 1 shop coat of primer, 1 field coat primer and 2 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.

(d) 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 1/2 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 into tightly covered mixing pots at the end of the day and 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.

(e) Thinning. At temperatures above 70°F (21°C), 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 (21°C), 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.

(f) 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. (10 cm) in width; brushes should be springy and not flabby. Brushes shall not be permitted to become seedy from skins.

(g) 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 air stream in contact with the paint. Before thinning for spray application is permitted by the OWNER, he shall make sure that at least 50 psi (345 Pa) 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 in. (20 cm) 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. Over spray shall be held at 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.
(h) 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 8.9.3(a) 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 in. (5 cm) 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 in.) (0.09 mm) or 468 sq. ft. of surface per gallon (11.5 m² per L) of paint. The corresponding dry film thickness shall be 2.1 mils (0.0021 in.) (0.05 mm).

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.

(i) Field Cleaning and Spot Painting. When the erection work is complete, including straightening of bent metal, etc., the shop coated surface shall be restored to a serviceable condition acceptable to the OWNER by means of preparation of surface as outlined in Item 8.9.3(a) 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 8.9.3(h) shall be thoroughly removed, as directed for removal of grease and oil in Item 8.9.3(a), immediately prior to erection.

(j) 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 in.) (0.09 mm).

(k) Finish Coats. When the first field coat, including all touched-up marred places, has thoroughly hardened, the finishing field coats of finish paint may be applied. Cracks and cavities which have not been sealed in a watertight manner by the first field coat shall be filled with red lead paste, containing 92 to 94 percent red lead and 8 to 6 percent linseed oil. This shall be allowed to sufficiently surface dry before the second field coat is applied so as not to work up into finish paint. 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 in.) (0.04 mm) for each coat of paint applied.

(l) 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.
8.10.3. CONSTRUCTION METHODS

On the plans.

conduit.

8.10.2. MATERIAL

Prior

plans.

8.10.1. DESCRIPTION

This item

necessary to complete the work, all in with the plans and these specifications.

of paint, and for furnishing all labor, material, scaffolding, protection tools and incidentals necessary to complete the work, all in accordance with the plans and these specifications.

ITEM 8.10. ELECTRICAL CONDUIT

8.10.1. DESCRIPTION

This item shall govern the furnishing and installation of conduit of the size and at the locations as indicated on the plans.

8.10.2. MATERIAL

All conduit shall be described in the applicable Item 2.10., “Electrical Components,” of these specifications as shown on the plans.

8.10.3. CONSTRUCTION METHODS

Prior to the installation of conduit, the OWNER shall be notified so that a representative will 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 conduit 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 “Y” at least 3 in. (7.5 cm) high, cut into the face of curb, gutter or wall directly above the conduit.

All conduit shall be placed a minimum of 6 in. (15 cm) below the bottom of the pavement base, 10 in. (25 cm) for nonmetallic conduit, and in no case shall be of a greater depth than 30 in. (.75 m) measured from the top of curb. Installation under existing pavements may be accomplished by jacking, tunneling or drilling. Conduit shall extend 6 in. (15 cm) 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 in. (.45 m) to 30 in. (.75 m) 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 OWNER. 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 in. (20 cm.).

A No. 9 galvanized pull wire shall be placed in all conduit 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 7 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.

8.10.4. 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, all excavation, all gravel backfill, furnishing and installing all fittings, installing pull-boxes and for all labor, materials, tools, equipment and incidentals necessary to complete the work.

ITEM 8.11. METAL BEAM GUARDRAIL

8.11.1. 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.

8.11.2. MATERIALS

All materials furnished shall be as shown on the plans in accordance with the applicable Items of 2.11.7, "Metal Railings," of these specifications.

8.11.3. CONSTRUCTION METHODS

Unless the plans call for setting in concrete, the posts shall be backfilled by thoroughly tamping the material in 4 in. (10 cm) 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 jointed end to end by bolts and lapped in the direction of traffic in the lane adjoining the guard rail. 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 2 coats of finish paint. Steel posts and non-galvanized rail shall be painted with 1 prime coat of paint and 2 coats finish paint in accordance with Item 8.9, "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 2 coats of zinc dust-zinc oxide paint conforming to the requirement of Federal Specifications MIL-P-15145.

8.11.4. MEASUREMENT AND PAYMENT

The railing shall be measured by the linear foot (m) from end to end along the face of the railing including terminal sections. The price paid per linear foot (m) 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.

ITEM 8.12. RAILING

8.12.1. 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.
8.12.2. MATERIALS

All materials shall conform to the requirements of Item 2.11., "Metal For Structures." 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 free from grease, dirt and contact with dissimilar metals. Care shall be taken at all times to avoid scratching, marring, dents, 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.

8.12.3. CONSTRUCTION

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 Item 7.10., "Steel Structures," and to the requirements of this specification.

Shop drawings shall be prepared and forwarded for approval in accordance with the requirements of Item 7.10., "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 sulfur 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 Item 7.10., "Steel Structures." The material shall be 1/8 in. (3.2 mm) in thickness, unless otherwise specified. All welding shall conform with the recommendations of the American Welding Society. Welding of aluminum material 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 1 prime coat of red lead painting and two field coats of aluminum paint conforming to the requirements of Item 8.9., "Painting." Aluminum railings 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 on shop coat of red lead painting. 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 Item 8.9., "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 2 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 false-work for the span has been released. During the construction of railing, care shall be exercised to insure proper functioning of expansion joints, if any.

8.12.4. MEASUREMENT AND PAYMENT

Railing shall be measured as the number of linear feet (m) of satisfactorily completed railing. Payment shall be made at the contract price bid per linear foot (m) for “railing,” which price shall be full compensation for all pipe structural shapes, paint, labor, tools and equipment, and all incidentals necessary for completing the railing in conformity with the plans and these specifications.
ITEM 8.13. CHAIN LINK AND BARRIER FENCE

8.13.1. DESCRIPTION
This item shall consist of one line of chain link fabric supported on posts and constructed as prescribed by this specification at such places as shown on the plans or as designated by the OWNER. Guard fence shall be that fence installed as a guard or barrier in or on concrete structures such as retaining walls and headwalls. The fence overall height and the fabric height shall be as shown on the plans.

8.13.2. MATERIALS
All materials furnished shall be as shown on the plans in accordance with the applicable Item 2.8., “Chain Link and Barrier Fence,” of these specifications.

8.13.3. CONSTRUCTION METHODS
(a) General. The chain link fence shall be constructed in accordance with the details on the plans, and as specified herein, with new materials unless specified otherwise. All work shall be performed in a workmanlike manner satisfactory to the OWNER. Prior to the beginning of the work, or upon request of the CONTRACTOR, the OWNER shall locate the position of the work by establishing and marking the line and grade for the fences.
(b) Clearing Fence Line. The site of the fence shall be sufficiently cleared of obstructions, and surface irregularities shall be graded so that the fence shall conform to the general contour of the ground. The fence line shall be cleared to a minimum width of 2 ft (.6 m) on each side of the center line of the fence. This clearing shall consist of the removal of all stumps, brush, rocks, trees or other obstructions which shall interfere with proper construction of the fence. Stumps within the cleared area of the fence line shall be grubbed or excavated.

The bottom of the fence shall be placed a uniform distance above the ground and as specified on the plans. When shown on the plans, or as directed by the OWNER, the existing fences which coincide with or are in a position to interfere with the new fence location shall be removed by the CONTRACTOR as a part of the construction work, unless such removal is listed as a separate item in the bid schedule. All holes remaining after post and stump removal shall be refilled with suitable soil, gravel or other material acceptable to the OWNER and shall be compacted properly with tampers. The work shall include the handling and disposal of all material cleared, excavated or removed, regardless of the type, character, composition or condition of such material encountered.
(c) Installing Posts. All posts shall be spaced not more than 10 ft (3 m) apart and as shown on the plans. Terminal (end, corner, and pull) posts, gate posts and line posts shall be set in concrete bases of 2000 psi (14 kPa) concrete to the diameter and depth as shown on the plans. The concrete bases for the posts shall be of sufficient depth to provide a minimum of 2 in. (5 cm) of concrete below the bottom of the posts. The top of the concrete bases shall be slightly above the ground, trowel finished and sloped to drain away from the posts. Holes of full depth and size for the concrete bases for posts shall be dug to the size and depth as shown on the plans. All post settings shall be made carefully so that all posts shall be vertical, in true alignment and rigidly secured in position. On terminal (end, corner, and pull) posts and gate posts, the post tops and brace rail clamps around the posts shall be placed before setting the posts in the concrete bases or at such a time that heavy clamps can be installed without spreading them to accommodate the post.

In setting the gate posts, great care must be taken to make sure that gate posts are set the exact distance apart as shown on the plans. A line drawn across from the top of 1 gate post to the other must be level regardless of the grade of the ground line. If the ground is not level, the upgrade posts shall be set first to get the proper height for the downgrade gate post. The concrete for post setting shall be allowed to cure for 7 days. Stretcher bar bands and truss bands shall be spread and slipped on end, corner, pull, brace and gate posts as the next operation. Post tops are then inserted on all other posts. Pull posts shall be placed not over 500 ft. (150 m) apart in straight runs and at each vertical angle point, all as directed by the OWNER. Corner posts shall be placed at each horizontal angle point. Corner and pull posts shall have horizontal braces and truss rods as shown on the plans or as specified. Posts to be placed in concrete structures shall be placed in previously embedded oversize pipe sleeves and then packed with sulfur compound.

(d) Installing Fabric. The fabric shall be placed on the outward facing side of the posts and shall be installed so that the top edge projects over the top rail of the fence. The fabric shall be stretched taut and securely fastened to the
post, the top rail and the bottom tension wire. The tension wire shall be installed parallel to the line of the fabric. The bottom of the fabric shall extend to within 2 in. (5 cm) of the natural ground or paved surface. However, over irregular ground, this distance may vary between 1 in. (2.5 cm) and 6 in. (15 cm) for a distance not to exceed 8 ft. (2.4 m). High points of ground shall be excavated to clear the bottom of the fabric; depressions shall be filled and compacted to within 2 in. (5 cm) of the bottom fabric; both shall be considered as incidental work. For guard fence, the fabric shall extend to within 6 in. (15 cm) above the concrete surface for structures.

The fabric shall be fastened to end, corner, slope and gate posts with 3/16 in. (4.7 mm) x 3/8 in. (19 mm) high carbon steel tension bars and not less than No. 12 gauge x 1 in. (2.5 cm) steel tension bar bands spaced at 16 in. (40 cm) intervals; and to line posts, top rail and tension wire with tie wires or metal bands. Tie wires or metal bands shall be placed on line posts at intervals of approximately 16 in. (40 cm) and top rail and tension wire at intervals of approximately 24 in. (60 cm).

(e) Installing Gates. The widths of any gates to be installed shall be indicated on the plans or in the special provisions.

Gates with fabric 7 ft (2.1 m) or more in height shall have a horizontal stiffener. Vertical stiffeners shall be installed at a maximum of 8 ft. (2.4 m) centers. A 3/8 in. (9.4 mm) adjustable tension rod shall be installed on all gates over 4 ft. (1.2 m) in width. The corners of gate frames shall be fastened together and reinforced with a fitting designed for the purpose or by welding. All welds shall be ground smooth.

Chain link fence fabric shall be attached to the gate frame by the use of tension bars and tie wires as specified and by suitable tension connectors spaced at approximately 16 in. (40 cm) intervals. The swing gates shall be hung by at least 2 steel or malleable iron hinges, so designed as to securely clamp to the gate post and permit the gate to be swung back 180° from the closed position. Gates shall be provided with a combination steel or malleable iron catch and locking attachment of approved design. Stops to hold gates open and a center rest with catch shall be provided where required.

(f) Existing Fence Connections. Wherever the new fence joins an existing fence, either at a corner or at the intersection of straight fence lines, a corner post with a brace post shall be set at the junction and braced the same as for corner posts. If the connection is made at other than the corner of the new fence, the last span of the old fence shall contain a brace span.

(g) Repair of Damaged Coating. On all galvanized parts where zinc coating has been omitted, chipped off or removed, the steel or iron left exposed shall be repaired. Damaged zinc coating shall be repaired by thoroughly wire brushing the damaged area and removing all loose, cracked or weld burned zinc coating. The cleaned area shall be painted with 2 coats of zinc oxide zinc dust paint conforming to the requirements of federal Specification TT-P-641 b. or approved equal. The paint shall be furnished by the CONTRACTOR at his expense.

8.13.4. MEASUREMENT AND PAYMENT

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 (m) 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; and 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; all preparation, hauling, and erection; and for all labor tools, equipment and incidentals necessary for a complete in-place gate installation.
ITEM 8.14. WIRE FENCE

8.14.1. CONSTRUCTION METHODS

"Wire fence" shall consist of constructing fence supported on metal or wood posts in accordance with the details and at the locations shown on the plans. The fence shall consist of a combination of woven fence fabric and barbed wire as specified on the plans. Barbed wire shall be used only where not prohibited by ordinance.

8.14.2. MATERIALS

All materials furnished shall be as shown on the plans in accordance with the applicable Item of 2.8.2., "Wire Fence," of these specifications.

8.14.3. CONSTRUCTION METHODS

Fence posts shall be spaced at intervals as shown on the plans and set to a minimum depth of 2 ft (.6 m) for wood posts and 2 1/2 ft (.75 m) for metal posts. Posts shall be set in a vertical position. Corner and pull posts shall be braced in 2 directions. End and gate posts shall be braced in one direction. Where alignment changes 30° or more, a corner post shall be installed. At alignment angles varying from 15° to less than 30°, the angle post shall be braced to adjacent line posts by diagonal tension wires. Where steel posts are specified, a pull post assembly shall be installed at approximately 500 ft. (150 m) intervals; where wooden posts are specified, the spacing of pull-post assemblies shall be approximately 1,000 ft. (300 m). Metal line posts may be driven in place, provided such driving does not damage the posts. Metal corner, end, pull post and braces shall be set in portland cement concrete footings crowned at the top to shed water. All posts shall be placed the minimum depth below ground. Posts shall be set plumb and firm to the line shown on the plans. Backfill shall be thoroughly tamped in 4 in. (10 cm) layers. The timber post braces shall be notched.

The corner, end angle post assembly shall be installed before stretching the wire between the posts. At all grade depressions where stress tends to pull the posts out of the ground, the fencing shall be snubbed or guyed at the critical point by means of a double No. 9 gauge galvanized wire connected to each horizontal line of barbed wire or to the top and bottom wire or wire mesh fabric and to a deadman weighing not less than 100 lb. (45.4 kg), buried in the ground. The fencing shall be stretched before being snubbed and guyed. Existing cross fences shall be connected to the new fences and corner posts with braces which shall be placed at junctions with existing fences. The barbed wire and wire fabric shall be drawn taut and fastened to posts with galvanized ties or staples.

8.14.4. MEASUREMENT AND PAYMENT

Fencing shall be measured by the linear foot (m) of wire fence, measured at the bottom of the fabric along the centerline of the fence from center to center of end posts, excluding gates. Gates shall be measured per each gate, complete in place.

The work performed and material furnished as prescribed by this item, measured as provided in this item, shall be paid for at the unit price bid for "wire fence," which price shall each be full compensation for furnishing and installing all fencing materials (except gates); for all preparation, hauling and installing of same; and for all labor, tools, equipment and incidentals necessary to complete the work, including excavation, backfilling and disposal of surplus material.

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; all preparation, hauling and erection; and for all labor, tools, equipment and incidentals necessary for a complete in place gate installation.

ITEM 8.15. RIPRAP

8.15.1. 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, for erosion control at the ends of pipes and structures, and at other designated locations.

8.15.2. MATERIALS
Materials used in the performance of the work herein specified shall conform to the requirements of Division 2, "Materials," of these specifications as shown on the plans.

8.15.3. 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.

(a) 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 differenced 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.

(b) Grouted Riprap, Type A and Type B. The stones shall be placed in the same manner as specified in (a) preceding 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 3 days after grouting. Grouted riprap Type B shall have a concrete toe wall as specified for dry riprap Type B.

(c) 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 the 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 and 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 the 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.

(d) 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 Item 7.7., "Concrete for Structure." Reinforcement shall be properly supported throughout placement of concrete.
(e) Pneumatically Placed Concrete (Gunite) Riprap Type I and Type II. Pneumatically placed 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. Pneumatically placed concrete shall conform to the requirements of Item 7.9, "Pneumatically Placed Concrete." Reinforcement shall conform to the details on the plans and with Item 2.2.6, "Steel Reinforcement." Reinforcement shall be supported properly throughout placement of concrete. All subgrade surfaces shall be moist when concrete is placed. The surface shall be given a wood float finish or gun finish as directed by the OWNER. The strength and design of pneumatically placed concrete riprap shall be specified on the plans as either Type I or Type II in accordance with the Item 7.9, "Pneumatically Placed Concrete."

The riprap shall be cured with membrane-curing compound in accordance with Item 7.6, "Concrete Structures," immediately following the finishing operation.

8.15.4. MEASUREMENT AND PAYMENT
Riprap shall be measured for payment either in square yards (m²) of the specified minimum thickness or in cubic yards (m³), 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.

ITEM 8.16. GABION STRUCTURE ASSEMBLY

8.16.1 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. Material specifications shall be in accordance with Item 2.24., "Gabion Structures."

8.16.2. GABION BASKET ASSEMBLY
(a) Twisted wire mesh 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 selvage 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 ft. 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 in. to 5 in. apart, pulling the basket pieces tightly together. Secure the end of the wire by again looping and twisting.

(b) Welded wire mesh gabion baskets are assembled by unfolding baskets on a hard surface and connecting front, back, side, and diaphragm panels together by threading the preformed spiral binder through the mesh openings along the edge and those of the adjoining panel. Spiral binders shall be secured at both ends. Welded wire mesh gabion baskets may also be assembled and interconnected to form a continuous structural unit using 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) every 6 inches, pulling the panels tightly together to produce a joint that is as strong as the mesh. Secure the end of the wire by again looping and twisting.

8.16.3. GABION BASKET PLACEMENT
Gabion baskets shall be placed in position empty and shall be bound together, each to its neighbor, along all contacting edges in order to form a continuous connecting structural unit. Binding 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.

Twisted wire mesh 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.

**8.16.4. 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 hand work 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 in. layers in order to install a looped inner tie wire in each cell connecting to front and back faces every 12 in. of vertical height in any unsupported face. Individual cells may not be filled more than 1 ft. above any adjacent cell unless looped inner tie wires run in both directions.

**8.16.5. GABION BASKET CLOSURE**

(a) Twisted wire mesh. Each twisted wire mesh gabion basket shall be filled to its maximum, which is approximately 1 1/2" 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.

(b) Welded wire mesh. Each welded wire mesh gabion basket shall be filled to its maximum height, even with the top and sides and leveled with a minimum amount of voids. The lids shall be closed such that the edges of the lid panel is within 1 inch of the top edge of the side front and back panels. The lid shall be connected to these panels using the preformed spiral binder or lacing wire as specified in Item 8.16.2. Where welded mesh gabions are placed side by side, the side panel of one may be used as a common side and shall be connected in the manner prescribed in Item 8.16.2.

**8.16.6. MEASUREMENT AND PAYMENT**

Gabions shall be measured for payment either in square yards (m²) of the specified minimum thickness or in cubic yards (m³), 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.

**ITEM 8.17. SOLID CONCRETE INTERLOCKING PAVING UNITS**

**8.17.1. DESCRIPTION**

This item shall govern the construction of concrete pavements and medians utilizing interlocking paving units according to lines, grades, locations, and designs as indicated on the plans and specifications, or as established by the Engineer.

**8.17.2. GENERAL**

Concrete Interlocking Paving Units are to be used on a site specific basis only. The Engineer shall specify the special material and construction requirements for each location. Each site specific application requires proper engineering design for the anticipated traffic volumes and vehicle loads.

**8.17.3. MATERIALS**

(a) Concrete Pavers. ASTM Designation C 936 provides standards for the interlocking paving unit construction.

JANUARY 1998
(b) Subgrade. The Engineer shall specify the site specific requirements for each use. Subgrades for pavements may consist of a reinforced concrete base, flexible base or stabilized subgrade. Construction methods shall generally follow Division 4 Subbase and Base Course requirements. Subgrades for medians shall be site specific and according to design parameters of the Engineer.

(c) Material Course. The bedding course shall be a well graded, clean, washed material meeting the following graduation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 50</td>
<td>≥10 but ≤35</td>
</tr>
<tr>
<td>No. 200</td>
<td>≤3</td>
</tr>
</tbody>
</table>

Use concrete sand, limestone screening or similar materials. Do not use mason sand. The material shall be of uniform moisture content when spread and shall be protected against rain when stockpiled on site prior to spreading.

The filler course shall be a well graded, clean, washed sand with at least 50% finer than a No. 50 sieve.

(d) Curbs and Gutters. Adaptation of curbs and gutters for concrete pavement units shall meet the intent of Item 8.2., “Concrete Curb and Gutter,” with variations as approved by the Engineer. Edge restraining is a critical design component.

8.17.4. CONSTRUCTION METHODS

Construction methods for each type unit shall be provided by the manufacturer and approved by the Engineer based on the site specific use.

8.17.5. MEASUREMENT AND PAYMENT

Concrete paving units shall be measured by the square yard of completed and accepted pavement. Payment shall include all labor, equipment, materials, tools, and incidentals necessary to complete the work.
This page was intentionally left blank.
Model Forms
APPENDIX A

Model Forms
APPENDIX A. MODEL FORMS

APPENDIX A.1. CONTRACTOR'S AFFIDAVIT OF FINAL PAYMENT

APPENDIX A.2. CERTIFICATE OF INSURANCE

APPENDIX A.3. STANDARD CONSTRUCTION CONTRACT

APPENDIX A.4. PERFORMANCE BOND

APPENDIX A.5. PAYMENT BOND

APPENDIX A.6. CHANGE ORDER
CONTRACTOR'S AFFIDAVIT OF FINAL PAYMENT

THE STATE OF TEXAS  )
COUNTY OF ________  )

KNOW ALL MEN BY THESE PRESENTS:

BEFORE ME, the undersigned authority, on this day personally appeared ______________________ (“Affidant”), who, after being by me duly sworn, deposes, and says that he is ______________________ (corporation, partnership, trade name) of _______________ County, State of Texas (the “Contractor”), which said Contractor was awarded the contract dated the ____ day of ________, 19___, for the construction of __________________________ at ______________________ (the “Work”), for a total consideration of ________ Dollars to be paid to the said Contractor (the “Contract”), and that Affidant has full power of authority to make this affidavit.

That ______________________ (the “Owner”) has approved the final estimate on said Work, and that the said Contractor has fully satisfied and paid any and all claims that may be covered by Chapter 53 of the Texas Property Code and Article 5160 of the Revised Civil Statutes of the State of Texas, or any other applicable statutes or charter provisions, and that all just bills for labor and materials have been paid and discharged by said Contractor insofar as they pertain to the work in question.

That in addition to any funds which may have been previously paid by the Owner, the Contractor hereby accepts the amount of ______________________ Dollars as FULL AND FINAL PAYMENT under the aforementioned Contract, and hereby waives and releases any right Affidant and/or the Contractor may have to pursue claims of any nature against the Owner arising out of or in any manner connected with the performance of the Work and/or the Contract, including but not limited to claims of third parties that supplied material and/or labor for the Work for or through the Contractor (“Subcontractors”), as well as claims for delay, additional compensation or for recovery of liquidated damages which may have been withheld by the Owner. The Contractor shall defend, hold harmless and indemnify the Owner from any such claims of such Subcontractors. The Contractor further releases the Owner from any claim or liability arising from any act or neglect of the Owner related to or connected with the Contract. This affidavit is given pursuant to the final payment provisions of the Contract, and shall not be deemed to alter or modify the terms and provisions of said Contract.

____________________________
By __________________________
(Affidant)

____________________________
(Printed Name)

SUBSCRIBED AND SWORN TO BEFORE ME, this the _________ day of ________, A.D. 19______

____________________________
By __________________________
(Notary Public in and for the State of Texas)

[Notary Seal]

____________________________
(Printed Name of Notary)

My commission expires ______________________

JANUARY 1998
CERTIFICATE OF INSURANCE

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND, OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.

COMPANIES AFFORDING COVERAGE

<table>
<thead>
<tr>
<th>CODE</th>
<th>SUB-CODE</th>
<th>COMPANY LETTER A</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSURED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMPANY LETTER B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMPANY LETTER C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COMPANY LETTER D</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COVERAGE

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED, NOTWITHSTANDING ANY REQUIREMENT, TERM, OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS, AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

<table>
<thead>
<tr>
<th>Type of Insurance</th>
<th>Policy Number</th>
<th>Effective Date (MM/DD/YY)</th>
<th>Expiration Date (MM/DD/YY)</th>
<th>All Limits in Thousands</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Liability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Claims Made Occur.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner’s &amp; Contractor's Prot.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automobile Liability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Auto</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Owned Autos</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scheduled Autos</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hired Autos</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Owned Autos</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garage Liability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excess Liability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Than Umbrella Form</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workers Compensation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>And Employers Liability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

General Aggregate: $ _
Products-Comp/Ops Aggregate: $ _
Personal & Advertising Injury: $ _
Each Occurrence: $ _
Fire Damage (Any one fire): $ _
Medical Expense (Any one person): $ _
Combined Single Limit: $ _
Bodily Injury (Per person): $ _
Bodily Injury (per accident): $ _
Property Damage: $ _

Each Occurrence: $ _
Aggregate: $ _
Statutory: $(_) (Each Accident)
$(_) (Disease – Policy Limit)
$(_) (Disease – Each Employee)

Description of Operations/Locations/Vehicles/Restrictions/Special Items

CERTIFIED HOLDER

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING COMPANY WILL ENDEAVOR TO MAIL ____ DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT, BUT FAILURE TO MAIL SUCH NOTICE SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE COMPANY, ITS AGENTS, OR REPRESENTATIVES.

AUTHORIZED REPRESENTATIVE

356 JANUARY 1998
STANDARD CONSTRUCTION CONTRACT

STATE OF TEXAS

COUNTY OF ____________

KNOW ALL MEN BY THESE PRESENTS:

THIS CONTRACT is made and entered into on this the __________________ day of _____________, 19_______, by and between the ____________________________________________, (hereinafter referred to as "Owner") and ____________________________________________, (hereinafter referred to as "Contractor"). In consideration of the mutual covenants hereinafter set forth, the Owner and Contractor agree as follows:

Article I. Work

The Contractor shall perform all of the work as specified in the Contract Documents. The work is generally described as follows:

_______________________________________

Plans and Specifications prepared by:

All extra work shall be performed as specified or indicated in the Contract Documents; and, at the Contractor's own cost and expense, the Contractor shall furnish all the materials, supplies, machinery, equipment, tools, superintendence, labor, insurance, and other accessories and services as may be necessary in order to complete the construction, as described above and in accordance with the Contract Documents unless otherwise agreed to by the Owner.

Article II. Contract Documents

The Contract Documents may only be altered, amended or modified as provided in the General Conditions. The Contract Documents consist of: this written agreement setting forth the work to be performed; advertisement, if any; instructions to bidders, if any; proposal; addendum; specifications, including the general, special, and technical conditions, provisions, plans, or working drawings; any supplemental changes or agreements pertaining to the work or materials therefor; bonds; the Standard Specifications for Public Works Construction published by the North Central Texas Council of Governments, as amended; and, any additional documents incorporated by reference. These form the Contract Documents and all are as fully a part of the Contract as if attached to this agreement or repeated herein.

Article III. Contract Time

The Contractor shall perform and complete all the items of work listed and referred to in the Contract Documents within _____________ calendar days.

Article IV. Contract Price

The Owner shall pay the Contractor for completion of the work in accordance with the Contract Documents using current funds. Such payments shall be subject to the General and Special Conditions to the Contract, as contained in the Contract Documents.

Article V. Miscellaneous Provisions

The terms used in this Contract shall have the same meaning as designated in the General Provisions of the Standard Specifications for Public Works Construction, North Central Texas Council of Governments, as amended. The Contract Documents, which constitute the entire agreement between the Owner and Contractor, are listed in Article II. No assignment by either party hereto of any rights under or interests in the Contract Documents will be binding on the other party hereto without the written consent of the party sought to be bound. The Owner and Contractor each binds itself, its partners, successors, assigns, and legal representatives hereto to the covenants, agreements, and obligations contained in the Contract Documents.

IN WITNESS WHEREOF, the Owner and Contractor have executed this Contract in duplicate and on the date aforementioned. All portions of the Contract Documents have been signed or identified by the Owner and Contractor.

CONTRACTOR

By: ____________________________
Title: ____________________________

ATTEST:

Printed Name: ____________________________

OWNER:

By: ____________________________
Title: ____________________________

ATTEST:

Printed Name: ____________________________

JANUARY 1998
PERFORMANCE BOND

STATE OF TEXAS

COUNTY OF __________________________

KNOW ALL MEN BY THESE PRESENTS:

THAT _______________________________ of the City of ________________, County of ________________, State of ________________, (hereinafter referred to as "Principal"), and _______________________________ (hereinafter referred to as "Surety"), authorized under the laws of the State of Texas to act as Surety on bonds for principals, are held and firmly bound unto _______________________________ (hereinafter referred to as "Owner") in the penal sum of $________________________ (not less than 100% of the approximate total amount of the contract as evidenced in the proposal) for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors, and assigns, jointly and severally, by these presents:

WHEREAS, the Principal has entered into a certain written contract with the Owner, dated the _______ day of _________________________, 19______, to which said contract is hereby referred to and made a part hereof and as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, the condition of this obligation is such, that if the said Principal fully and faithfully executes the work and performance of the contract in accordance with the plans, specifications, and contract documents, including any extensions thereof, and according to the true intent and meaning of said contract and the plans and specifications hereto annexed, then this obligation shall be void; otherwise, to remain in full force and effect.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the provisions of Article 5160 for Public Work, as amended, and Article 53.201 of the Property Code, and all liabilities on this bond shall be determined in accordance with the provisions of said articles to the same extent as if they were fully copied at length herein.

Surety, for value received, stipulates and agrees that the bond shall automatically be increased by the amount of any change order or supplemental agreement which increases the contract price with or without notice to the Surety and that no change, extension of time, alteration, or addition to the terms of the contract, or to the work performed thereunder, or to the plans, specifications, or drawings accompanying the same shall in any way affect its obligation on this bond, and it does hereby waive notice of any such change, extension of time, alteration, or addition to the terms of the contract or to the work to be performed thereunder.

Surety agrees that the bond provides for the repairs and/or replacement of all defects due to faulty materials and workmanship that appear within a period of one (1) year from the date of completion and acceptance of the improvement by the Owner.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument on this the ____________ day of _________________________, 19______.  

PRINCIPAL

Title: ________________________________
Company: ____________________________
Address: ______________________________

SURETY

Title: ________________________________
Company: ____________________________
Address: ______________________________

358 JANUARY 1998
PAYMENT BOND

STATE OF TEXAS

COUNTY OF __________

THAT ______________________, County of __________, State of __________ (hereinafter referred to as "Principal"), and ______________________, County of __________, State of __________ (hereinafter referred to as "Surety"), authorized under the laws of the State of Texas to act as Surety on bonds for principals, are held and firmly bound unto ______________________ (hereinafter referred to as "Owner") in the penal sum of $______________ (not less than 100% of the approximate total amount of the contract as evidenced in the proposal) for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors, and assigns, jointly and severally, by these presents:

WHEREAS, the Principal has entered into a certain written contract with the Owner, dated the __________ day of __________, 19_________, to which said contract is hereby referred to and made a part hereof and as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, the condition of this obligation is such, that the bond guarantees the full and proper protection of all claimants supplying labor and material in the prosecution of the work provided for in said contract and for the use of each claimant, and that conversely should the Principal faithfully perform said contract and in all respects duly and faithfully observe and perform all and singular the covenants, conditions, and agreements in and by said contract agreed to by the Principal, and according to the true intent and meaning of said contract and the claims and specifications hereto annexed, then this obligation shall be void; otherwise, to remain in full force and effect.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the provisions of Article 5160 of the Revised Civil Statutes of Texas, as amended, and Article 53.201 of the Property Code, and all liabilities on this bond shall be determined in accordance with the provisions of said articles to the same extent as if they were fully copied at length herein.

Surety, for value received, stipulates and agrees that the bond shall automatically be increased by the amount of any change order or supplemental agreement which increases the contract price with or without notice to the Surety and that no change, extension of time, alteration, or addition to the terms of the contract, or to the work performed thereunder, or the plans, specifications, or drawings accompanying the same shall in any way affect its obligation on this bond, and it does hereby waive notice of any such change, extension of time, alteration, or addition to the terms of the contract or to the work to be performed thereunder.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument on this the __________ day of __________, 19_________.

PRINCIPAL

Title:_____________________
Company:_________________
Address:_________________

SURETY

Title:_____________________
Company:_________________
Address:_________________
CHANGE ORDER

Project: ________________________________

Date of Issuance: ____________________________

OWNER: ____________________________________

ADDRESS: ---------------------------------------------

CONTRACTOR: ____________________________________________

ENGINEER: ____________________________________________

CONTRACT FOR: ____________________________________________

ENGINEER'S PROJECT NO. ________________________________

You are directed to make the following changes in the Contract Documents:

DESCRIPTION: ____________________________________________

PURPOSE OF CHANGE ORDER: ________________________________

ATTACHMENTS:

<table>
<thead>
<tr>
<th>CHANGE IN CONTRACT PRICE</th>
<th>CHANGE IN CONTRACT TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Contract Price</td>
<td>Original Contract Time</td>
</tr>
<tr>
<td>$ _______________________</td>
<td>(Days or Date Range)</td>
</tr>
<tr>
<td>Net price change from previous Change Order(s) No. _______ to No. _______</td>
<td>Net change from previous Change Orders:</td>
</tr>
<tr>
<td>$ _______________________</td>
<td>(Days)</td>
</tr>
<tr>
<td>Contract Price prior to this Change Order:</td>
<td>Contract Time prior to this Change Order:</td>
</tr>
<tr>
<td>$ _______________________</td>
<td>(Days or Date Range)</td>
</tr>
<tr>
<td>Net Increase (Decrease) of this Change Order:</td>
<td>Net Increase (Decrease) of this Change Order:</td>
</tr>
<tr>
<td>$ _______________________</td>
<td>(Days)</td>
</tr>
<tr>
<td>Contract Price with all approved Change Orders:</td>
<td>Contract Time with all approved Change Orders:</td>
</tr>
<tr>
<td>$ _______________________</td>
<td>(Days or Date Range)</td>
</tr>
</tbody>
</table>

RECOMMENDED: ____________________________
(Engineer)

APPROVED: ____________________________
(Owner)

APPROVED: ____________________________
(Contractor)

360
JANUARY 1998
CHANGE ORDER INSTRUCTIONS:

A. **General Information.** This document was developed to provide a uniform format for handling contract changes that affect Contract Price or Contract Time. Changes that have been initiated by a Work Directive Change must be incorporated into a subsequent Change Order if they affect Price or Time.

Changes that affect Contract Price or Contract Time should be promptly covered by a Change Order. The practice of accumulating change order times to reduce the administrative burden may lead to unnecessary disputes.

For supplemental instructions and minor changes not involving a change in the Contract Price or Contract Time, a Field Order may be used.

B. **Completing the Change Order Form.** Engineer initiates the form, including a description of the changes involved and attachments based upon documents and proposals submitted by CONTRACTOR, or requests from OWNER or both.

Once Engineer has completed and signed the form, all copies should be sent to CONTRACTOR for approval. After approval by CONTRACTOR, all copies should be sent to owner for approval. Engineer should make distribution of executed copies after approval by OWNER.

If a change only applies to price or to time, cross out the part of the tabulation that does not apply.
This page was intentionally left blank.
INDEX

Treated Soils.................................................. 4.7, 4.9.
Tests ........................................................... 2.2.4.
Volume and Weight of Bag ................................ 2.1.
Water ............................................................ 2.2.4.
Water Measuring Devices ................................. 2.2.4.
Water-Reducing Admixtures ............................. 2.2.2.
Weighing Equipment ........................................ 2.2.1.
CHAIN LINK AND BARRIER FENCES ................. 2.8.1.
Barbed Wire .................................................. 2.8.1, 2.8.2.
Heavy Duty Chain Link Fence .......................... 2.8.1.
Metal Posts ................................................... 2.8.2.
Posts .............................................................. 2.8.1.
Rails, Gates, Braces and Fittings ...................... 2.8.1, 2.8.2.
Wire Fencing .................................................. 2.8.2.
Wood Posts ..................................................... 2.8.2.
CHANGE ORDER, Definition .......................... 1.00.
CHANNEL EXCAVATION, UNCLASSIFIED ......... 3.5.
CHEMICAL, ADMIXTURES ............................... 2.2.2.
CHLORINATED PARAFFIN ............................... 2.9.1.
CHLORINATED RUBBER .................................. 2.9.1.
CLAIMS AGAINST OWNER ............................... 1.48.
CLAIMS FOR ADDITIONAL PAYMENT ............... 1.39.
CLAY DRAIN TILE .......................................... 2.3.2.
CLEARING AND GRABBING ............................ 3.2.
COFFERDAMS ............................................... 7.1.2.
COMPENSATION ............................................ 1.04.2.
COMPLETION TIME, Definition ....................... 1.00.
COMPOST ..................................................... 2.1.5.
CONCRETE AGGREGATES ................................ 2.1.1.
AASHTO Designation T89 ............................... 2.1.4.
AASHTO Designation T90 ............................... 2.1.4.
AASHTO Designation T180 ............................. 2.1.4.
ASTM Designation C 131 ................................ 2.1.1.
ASTM Designation C 535 ................................ 2.1.1.
ASTM Test Designations ................................ 2.1.1.
Coarse .......................................................... 2.1.1.
Deleterious Substances ................................ 2.1, 2.1.1.
Dry Riprap ..................................................... 2.1.6.
Field Sand Material ...................................... 2.1.5.
Field Stone ................................................... 2.1.6.
Fine ............................................................. 2.1.1.
Fineness Modulus ......................................... 2.1.1.
For Hot-Mix Asphaltic Concrete (HMAC) .......... 2.1.2.
For Portland Cement Concrete ....................... 2.1.1.
General Requirements for HMAC Aggregates .... 2.1.2.
Gradation ................................................. 2.1.1, 2.1.3, 2.1.4, 2.1.5.
Grouted Riprap ............................................ 2.1.6.
Lightweight .................................................. 2.1.1.
Measuring ..................................................... 2.1.1.
Metal Posts, Fences .................................... 2.8.2.
Mineral Filler ............................................... 2.1.1.
Mortar Riprap ............................................... 2.1.6.
Non-Pumping Subbase ................................... 2.1.4.
Pit-Run ...................................................... 2.1.1.
Quarry Stone ............................................... 2.1.6.
Rejection .................................................... 2.1.1, 2.1.3, 2.1.4, 2.1.5, 2.1.6.
Re-Mix .......................................................... 2.1.1.
Riprap ........................................................... 2.1.6.
Scales for .................................................... 2.1.1.
Stone Masonry .............................................. 2.1.6.
Stone Riprap ................................................ 2.1.6.
Storage ......................................................... 2.1.1.
Test for Staining Materials (ASTM C 641) ....... 2.1.1.
Tests ......................................................... 2.1.1, 2.1.3, 2.1.4, 2.1.5.
Trench Backfill, Type "A" ................................ 2.1.5.
Trench Backfill, Types "B", and "C" ................. 2.1.5.
Weighing .................................................... 2.1.1, 2.1.2.
CONCRETE BEDDING,STORM SEWERS .......... 2.1.7.
CONCRETE CEMENT, CLASSES OF ............... 2.2.1.
CONCRETE CURB AND GUTTER ..................... 2.1.
CONCRETE DRAIN TILE ............................... 2.3.2.
CONCRETE FOR STRUCTURES ....................... 2.2.4.
Vaults ......................................................... 7.4.7.
Waterstops .................................................. 7.4.8.
CONCRETE (GUNITE) .................................... 7.9.
CONCRETE MEDIANS ..................................... 8.4.
CONCRETE PILES ......................................... 2.7.3.
CONCRETE SIDEWALKS AND ......................... 8.6.
DRIVEWAY APPROACHES .............................. 8.3.
CONCRETE STEPS ........................................ 8.6.
CONDUCTORS, MULTIPLE-CIRCUIT ................. 2.10.2.
CONDUIT ..................................................... 2.1.
Flexible ...................................................... 2.10.2.
Plastic ....................................................... 2.10.2.
Rigid Steel .................................................. 2.10.2.
CONTINUOUS MIXING PLANT, ......................... 2.4.13.
BITUMINOUS MATERIALS ............................... 2.4.13.
CONTRACT .................................................. 1.44.
Award of .................................................... 1.13.
Definition ................................................... 1.00.
Drawings and Specifications ......................... 1.20.1.
Execution of ............................................... 1.17.
Priority of Documents ................................... 1.19.
CONTRACT DRAWINGS, Definition .................. 1.00.
CONTRACT DRAWINGS AND CONTRACT DOCUMENTS,
Definition ................................................... 1.00.
CONTRACT DRAWINGS AND CONTRACT PRICE,
Definition ................................................... 1.00.
CONTRACT SPECIFICATIONS, Definition .......... 1.00.
CONTRACT TIME, Definition .......................... 1.00.
CONTRACT WORK, Definition ......................... 1.00.
CONTRACTOR, Definition ................................ 1.00.
CONTRACTOR'S WARRANTIES ........................ 1.00.
AND UNDERSTANDING .................................... 1.21.
CONVENIENCE OF OWNER ............................. 1.57.
COPPER BEARING STRUCTURAL STEEL ............ 2.11.1.
COOPER WIRE ............................................. 2.10.2.
COTTON MATS ............................................. 2.2.11.
CRACKED FUEL OILS ................................... 2.4.7.
CRUDE OILS ............................................... 2.4.7.
CRUSHED STONE EMBEDMENT ......................... 2.1.8.
CURB AND GUTTER, CONCRETE ..................... 8.2.
CURING CONCRETE ....................................... 5.8.2.
CURING MATERIALS ...................................... 2.2.11.
Asphalt for Curing Concrete Base .................. 2.2.11.
Cotton Mats ............................................... 2.2.11.
Membrane Curing Compound ......................... 2.2.11.
Polyethylene Film ....................................... 2.2.11.
Waterproof Paper ........................................ 2.2.11.
CUT-BACK ASPHALT ...................................... 2.4.1, 2.4.5.

-D-

efault,CONTRACTOR IN ................................... 1.44.
DEFINITIONS .............................................. 1.00.
DELAYS; EXTENSION OF TIME;
LIQUIDATED DAMAGES ................................. 1.36.

364	JANUARY 1998
INDEX

Extra Work.................................................. 1.37.3.
Liquidated Damages................................. 1.36.1.
Quantities.................................................. 1.37.1.
DETOUR SIGNS........................................... 8.1.
DISPUTED WORK........................................ 1.39.
DOCUMENTS............................................... 1.19.
DOWEL BARS.............................................. 2.2.5.
Dowel Caps................................................ 2.2.5.
DRAIN TILE.
Clay......................................................... 2.3.2.
Concrete.................................................... 2.3.2.
DRAWINGS, Definition.............................. 1.00.
DRAWINGS AND SPECIFICATIONS
  Contract.................................................. 1.20.1.
  Supplemental.......................................... 1.20.2.
DRILLED HOLES.......................................... 7.10.11.
DRILLED SHAFT FOUNDATIONS..................... 7.2.
DRIVEWAY APPROACHES............................... 8.3.
DRIVING PILING.......................................... 7.3.
DRUM MIXING PLANT, BITUMINOUS MATERIALS.. 2.4.13.

ELASTOMERIC MATERIALS......................... 2.2.12.
ELECTRICAL COMPONENTS....................... 2.10.
  Copper Wire.......................................... 2.10.2.
  Electroliers.......................................... 2.10.2.
  Flexible Conduit.................................... 2.10.2.
  Indoor Cable Tray................................... 2.10.2.
  Luminaires............................................ 2.10.2.
  Multiple-Circuit Conductors.................... 2.10.2.
  Plastic Conduit...................................... 2.10.2.
  Rigid Steel Conduit............................... 2.10.2.
  Underground Trench Duct....................... 2.10.2.
ELECTRICAL CONDUIT.............................. 8.10.
ELECTROLIERS.......................................... 2.10.2.
EMBANKMENT............................................ 3.7.
EMULSIFIED ASPHALT........................... 2.4.1, 2.4.8.
EMULSIFIED ASPHALT PAVING TREATMENT............ 5.4.
ENGINEER, Definition............................ 1.00.
Authority.............................................. 1.41.
EQUAL EMPLOYMENT OPPORTUNITY................. 1.56.
EROSION CONTROL..................................... 3.12.
ESTOPPEL................................................ 1.43.
EXECUTION OF CONTRACT............................ 1.17.
EXPOSED SURFACES FINISHING.................... 7.6.10.
EXTRA WORK............................................ 1.37.3.
EXTRA WORK, Definition......................... 1.00.

FALSEWORK............................................ 7.6.6.
FENCE................................................... 8.13.
FERTILIZER.............................................. 2.15.2, 3.11.
FIBROUS REINFORCEMENT........................... 2.2.13.
FIBERGLASS SEWER PIPE............................ 2.12.23.
FIELD SAND MATERIAL............................... 2.1.5.
FIELD STONE............................................ 2.1.6.
FINAL INSPECTION..................................... 1.42.2, 1.51.3.
FINISHING CONCRETE................................. 7.6.10.
FIRE HYDRANTS.
  Breakable Type...................................... 2.14.4.
  O-Ring................................................ 2.14.10.

FITTINGS, see WATERWORKS
FLAGMEN.................................................. 1.24.
FLEXIBLE BASE (CRUSHED STONE)................... 4.5.
FLEXIBLE CONDUIT.................................... 2.10.2.
FLEXIBLE METAL GUARD RAILINGS.................. 2.11.7.
FLUX OIL............................................... 2.4.9.
FLY ASH.................................................. 2.2.2.
FORGINGS............................................... 2.11.4.
FORMS................................................... 5.8.3, 7.6.7.
  Portland Cement Concrete Pavement............. 5.8.3.
  Concrete Structures............................... 7.6.7.
  Precast Machine-Made Concrete Units.......... 7.12.4.
FOUNDATION.......................................... 5.3.
FUEL OILS, CRACKED................................. 2.4.7.

GABION STRUCTURES................................. 2.24.
GABION STRUCTURE ASSEMBLY...................... 8.16.
GALVANIZING.......................................... 2.9.2.
GATES, FENCES......................................... 2.8.1, 2.8.2.
GEOTEXTILES........................................... 2.23.
GOVERNING LAW....................................... 1.59.
GRAVEL BASE COURSE.................................. 4.4.
GRAVEL GROUT.......................................... 6.4.3.
GRAVEL SURFACE........................................ 5.2.
GUARD RAILINGS, FLEXIBLE METAL................. 2.11.7.

HEADERS................................................. 8.5.
HIGH-STRENGTH BOLTS............................. 2.11.3.
HIGH-STRENGTH LOW-ALLOY STEEL................... 2.11.1.
HOLIDAY TEST......................................... 2.9.4.
HOT-MIX ASPHALT CONCRETE
  PAVEMENT............................................ 5.7.
  Pavement Thickness Test.......................... 5.7.
  Tack Coat............................................ 5.7.
HYDRANTS, see FIRE HYDRANTS
HYDRO MULCH MATERIALS............................ 2.15.3.
HYDRO MULCHING....................................... 3.10.7.

INDEMNIFICATION..................................... 1.22.2.
INDOOR CABLE TRAY................................. 2.10.2.
INSPECTION; TESTS................................. 1.42.
  Defective Work...................................... 1.42.1.
  Final Inspection..................................... 1.42.2.
  Samples; Tests of Materials..................... 1.42.3.
INSPECTOR, Definition............................. 1.00.
INSTALLATION OF UNDERGROUND CONDUIT,
  see UNDERGROUND CONDUIT INSTALLATION
INSURANCE.............................................. 1.26.
  Workers' Compensation........................... 1.26.
IRON CASTINGS........................................ 2.11.5.
## INDEX

### -L-

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIME PRODUCTS</td>
<td></td>
</tr>
<tr>
<td>JACKING, BORING, OR TUNNELING</td>
<td>6.4</td>
</tr>
<tr>
<td>JOINT FILLER</td>
<td>2.2.9</td>
</tr>
<tr>
<td>Asphalt Boards for</td>
<td>2.2.9</td>
</tr>
<tr>
<td>JOINT SEALANT</td>
<td>2.2.10</td>
</tr>
<tr>
<td>JOINT SEALING</td>
<td>2.2.10</td>
</tr>
<tr>
<td>Thermoplastic</td>
<td></td>
</tr>
<tr>
<td>JOINTS</td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>5.8.2</td>
</tr>
<tr>
<td>Contraction</td>
<td>5.8.2</td>
</tr>
<tr>
<td>Expansion</td>
<td>5.8.2</td>
</tr>
<tr>
<td>LIGHTWEIGHT CONCRETE FOR STRUCTURES</td>
<td>7.5</td>
</tr>
<tr>
<td>Curing Concrete</td>
<td>7.6.11</td>
</tr>
<tr>
<td>Falsework</td>
<td>7.6.6</td>
</tr>
<tr>
<td>Finishing</td>
<td>7.6.10</td>
</tr>
<tr>
<td>Finishing Exposed Surfaces</td>
<td>7.6.14</td>
</tr>
<tr>
<td>Removal of Forms and Falsework</td>
<td>7.6.12</td>
</tr>
<tr>
<td>LIME PRODUCTS</td>
<td></td>
</tr>
<tr>
<td>Hydrated Lime (Dry)</td>
<td>2.5.2</td>
</tr>
<tr>
<td>Hydrated Lime Slurry</td>
<td>2.5.3</td>
</tr>
<tr>
<td>Lime</td>
<td>2.5.1</td>
</tr>
<tr>
<td>Quicklime (Mason’s Lime)</td>
<td>2.5.4</td>
</tr>
<tr>
<td>Rejection</td>
<td>2.5.5</td>
</tr>
<tr>
<td>Residue</td>
<td>2.5.3</td>
</tr>
<tr>
<td>LIME TREATED SOILS</td>
<td>4.6</td>
</tr>
<tr>
<td>LIMESTONE, CRUSHED</td>
<td>4.5</td>
</tr>
<tr>
<td>LIMITING TRENCH WIDTH</td>
<td>6.2.12</td>
</tr>
<tr>
<td>LINSEED OIL</td>
<td></td>
</tr>
<tr>
<td>Modified</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Polymerized</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Raw</td>
<td>2.9.1</td>
</tr>
<tr>
<td>LIQUIDATED DAMAGES</td>
<td>1.36,1.36.1</td>
</tr>
<tr>
<td>Extra Work</td>
<td>1.57.3</td>
</tr>
<tr>
<td>Quantities</td>
<td>1.57.1</td>
</tr>
<tr>
<td>LONG OIL ALKYD</td>
<td>2.9.1</td>
</tr>
<tr>
<td>LUMBER AND TIMBER</td>
<td>2.6.1</td>
</tr>
<tr>
<td>LUMINAIRES</td>
<td>2.10.2</td>
</tr>
<tr>
<td>MATERIAL, PAYMENT FOR</td>
<td>1.25</td>
</tr>
<tr>
<td>MATERIAL MAN OR SUPPLIER, Definition</td>
<td>1.00</td>
</tr>
<tr>
<td>MECHANICAL VIBRATORY EQUIPMENT</td>
<td>5.8.3</td>
</tr>
<tr>
<td>MEDIAN, CONCRETE</td>
<td>8.4</td>
</tr>
<tr>
<td>MEMBRANE CURING COMPOUND</td>
<td>2.2.11</td>
</tr>
<tr>
<td>METAL BEAM GUARDRAIL</td>
<td>8.11</td>
</tr>
<tr>
<td>METAL FOR STRUCTURES</td>
<td>2.11</td>
</tr>
<tr>
<td>Aluminum Railings</td>
<td>2.11.7</td>
</tr>
<tr>
<td>Anchor Bolts</td>
<td>2.11.3</td>
</tr>
<tr>
<td>Bolts</td>
<td>2.11.3</td>
</tr>
<tr>
<td>Bronze Castings</td>
<td>2.11.6</td>
</tr>
<tr>
<td>Carbon Steel</td>
<td>2.11.1</td>
</tr>
<tr>
<td>Castings</td>
<td>2.11.5</td>
</tr>
<tr>
<td>Copper Bearing Structural Steel</td>
<td>2.11.1</td>
</tr>
<tr>
<td>Flexible Metal Guard Railings</td>
<td>2.11.7</td>
</tr>
<tr>
<td>Forgings</td>
<td>2.11.4</td>
</tr>
<tr>
<td>Galvanized Steel Railings</td>
<td>2.11.7</td>
</tr>
<tr>
<td>High-Strength Bolts</td>
<td>2.11.3</td>
</tr>
<tr>
<td>High-Strength Low-Alloy Steel</td>
<td>2.11.1</td>
</tr>
<tr>
<td>Iron Castings</td>
<td>2.11.5</td>
</tr>
<tr>
<td>Metal Railings</td>
<td>2.11.7</td>
</tr>
<tr>
<td>Painted Steel Railings</td>
<td>2.11.7</td>
</tr>
<tr>
<td>Rivets</td>
<td>2.11.2</td>
</tr>
<tr>
<td>Sheet Copper</td>
<td>2.11.6</td>
</tr>
<tr>
<td>Steel Castings</td>
<td>2.11.5</td>
</tr>
<tr>
<td>Steel Railings</td>
<td>2.11.7</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>2.11.1</td>
</tr>
<tr>
<td>Structural Plate</td>
<td>2.12.17</td>
</tr>
<tr>
<td>Tunnel Lining Plate</td>
<td>2.12.19</td>
</tr>
<tr>
<td>Unfinished Bolts</td>
<td>2.11.3</td>
</tr>
<tr>
<td>Wrought Iron</td>
<td>2.11.8</td>
</tr>
<tr>
<td>METAL RAILINGS</td>
<td>2.11.7</td>
</tr>
<tr>
<td>METAL SHELL PILES</td>
<td>2.7.3</td>
</tr>
<tr>
<td>MINERAL AGGREGATES</td>
<td>2.4.13</td>
</tr>
<tr>
<td>MINERAL FILLER, CEMENT</td>
<td>2.2.3</td>
</tr>
<tr>
<td>Concrete Aggregates</td>
<td>2.1.1</td>
</tr>
<tr>
<td>MONOLITHIC CURB</td>
<td>5.8.2</td>
</tr>
<tr>
<td>MONTHLY ESTIMATE</td>
<td>1.51</td>
</tr>
<tr>
<td>MORTAR RIPRAP</td>
<td>2.1.6</td>
</tr>
<tr>
<td>MULTIPLE-CIRCUIT CONDUCTORS</td>
<td>2.10.2</td>
</tr>
</tbody>
</table>

### -N-

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW BILLET STEEL</td>
<td>2.2.6</td>
</tr>
<tr>
<td>NOTICE, Definition</td>
<td>1.00</td>
</tr>
<tr>
<td>NOTICE TO PROCEED</td>
<td>1.16</td>
</tr>
</tbody>
</table>

### -O-

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>OIL ASPHALT</td>
<td>2.4.1,2.4.2</td>
</tr>
<tr>
<td>OPPORTUNITY</td>
<td>1.56</td>
</tr>
<tr>
<td>OWNER, Definition</td>
<td>1.00</td>
</tr>
<tr>
<td>OWNER’S REPRESENTATIVE, Definition</td>
<td>1.00</td>
</tr>
<tr>
<td>OWNER’S RIGHT TO SUSPEND WORK</td>
<td>1.44</td>
</tr>
</tbody>
</table>

### -P-

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAINT AND PROTECTIVE COATINGS</td>
<td>2.9</td>
</tr>
<tr>
<td>Abrasion, Test for Resistance to</td>
<td>2.9.4</td>
</tr>
<tr>
<td>Additives</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Adhesion to the Pipe</td>
<td>2.9.4</td>
</tr>
<tr>
<td>Alkyd Resin Solution</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Aluminizing</td>
<td>2.9.3</td>
</tr>
<tr>
<td>Index Item</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>ASTM Designation D 2240</td>
<td>2.9.4</td>
</tr>
<tr>
<td>Chemical Resistance Test</td>
<td>2.9.4</td>
</tr>
<tr>
<td>Chlorinated Paraffin</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Chlorinated Rubber</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Coatings and Liners for Sanitary Sewers</td>
<td>2.9.4</td>
</tr>
<tr>
<td>Fire, Test for Resistance to</td>
<td>2.9.4</td>
</tr>
<tr>
<td>Galvanizing</td>
<td>2.9.2</td>
</tr>
<tr>
<td>Holiday Test</td>
<td>2.9.4</td>
</tr>
<tr>
<td>Long Oil Alkyd</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Modified Linseed Oil</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Oils</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Paint</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Pigments</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Polyethylene Wrap</td>
<td>2.9.5</td>
</tr>
<tr>
<td>Polymerized Linseed Oil</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Polyurethane Resin</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Rapid Dry Paint</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Raw Linseed Oil</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Ready-Mixed Paint</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Reflective Material</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Rejection</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Repair of Coating</td>
<td>2.9.3</td>
</tr>
<tr>
<td>Resins</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Solid Petroleum Resin Copolymer</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Surface Active Oil</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Temperature Changes, Test for Resistance to</td>
<td>2.9.4</td>
</tr>
<tr>
<td>Testing</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Thermoplastic Paint</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Thinners</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Traffic Paint</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Vinyl-Toluene/Acrylic Copolymer</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Zinc Coating, Repair of</td>
<td>2.9.2</td>
</tr>
<tr>
<td>PAINT</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Rapid Dry</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Ready-Mixed</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Thermoplastic</td>
<td>2.9.1</td>
</tr>
<tr>
<td>Traffic</td>
<td>2.9.1</td>
</tr>
<tr>
<td>PAINTING</td>
<td>8.9.</td>
</tr>
<tr>
<td>PARKWAYS</td>
<td>3.4.</td>
</tr>
<tr>
<td>PARTIAL PAYMENTS</td>
<td>1.51.</td>
</tr>
<tr>
<td>PATENTS</td>
<td>1.50.</td>
</tr>
<tr>
<td>PAVEMENT, see also PORTLAND CEMENT, CONCRETE PAVEMENT and BITUMINOUS MATERIALS</td>
<td></td>
</tr>
<tr>
<td>PAVEMENT ASPHALT, OILS AND EMULSIONS</td>
<td>5.1.</td>
</tr>
<tr>
<td>PAVEMENT LEAVEOUTS</td>
<td>5.8.5.</td>
</tr>
<tr>
<td>PAVEMENT STRENGTH TEST</td>
<td>5.8.6.</td>
</tr>
<tr>
<td>PAVEMENT TESTING</td>
<td>5.8.6.</td>
</tr>
<tr>
<td>PAVEMENT THICKNESS TEST</td>
<td>5.7.2.</td>
</tr>
<tr>
<td>PAVING MIXTURES, BITUMINOUS MATERIALS</td>
<td>2.4.13</td>
</tr>
<tr>
<td>PAVEMENT BOND</td>
<td>1.21.1</td>
</tr>
<tr>
<td>PAYMENT BOND, Definition</td>
<td>1.00.</td>
</tr>
<tr>
<td>PAYMENT FOR EXTRA WORK</td>
<td>1.38.</td>
</tr>
<tr>
<td>PAYMENT FOR LABOR AND MATERIAL</td>
<td>1.25.</td>
</tr>
<tr>
<td>PERFORMANCE BOND</td>
<td>1.21.1</td>
</tr>
<tr>
<td>PERFORMANCE BOND, Definition</td>
<td>1.00.</td>
</tr>
<tr>
<td>PERFORMANCE OF THE WORK</td>
<td>1.22.1</td>
</tr>
<tr>
<td>PIGMENTS, PAINT</td>
<td>2.9.1.</td>
</tr>
<tr>
<td>PILING, DRIVING</td>
<td>7.3.</td>
</tr>
<tr>
<td>PILING MATERIALS</td>
<td>2.7.</td>
</tr>
<tr>
<td>Concrete Piles</td>
<td>2.7.3.</td>
</tr>
<tr>
<td>Metal Shell Piles</td>
<td>2.7.3.</td>
</tr>
<tr>
<td>Precast Piles</td>
<td>2.7.3.</td>
</tr>
<tr>
<td>Prestressed Concrete Piles</td>
<td>2.7.3.</td>
</tr>
<tr>
<td>Steel Piles</td>
<td>2.7.2.</td>
</tr>
<tr>
<td>Timber Piles</td>
<td>2.7.1.</td>
</tr>
<tr>
<td>PIPE, see UNDERGROUND CONDUIT AND RELATED MATERIALS</td>
<td></td>
</tr>
<tr>
<td>PIPE BEDDING MATERIAL FOR STORM SEWERS</td>
<td>2.1.7.</td>
</tr>
<tr>
<td>Concrete Bedding</td>
<td>2.1.7.</td>
</tr>
<tr>
<td>Concrete Cradle Bedding</td>
<td>2.1.7.</td>
</tr>
<tr>
<td>Concrete Cushion Bedding</td>
<td>2.1.7.</td>
</tr>
<tr>
<td>Deleterious Substances</td>
<td>2.1.7.</td>
</tr>
<tr>
<td>Earth Bedding</td>
<td>2.1.7.</td>
</tr>
<tr>
<td>Gradation</td>
<td>2.1.7.</td>
</tr>
<tr>
<td>Rejection</td>
<td>2.1.7.</td>
</tr>
<tr>
<td>Rock Bedding/Foundation</td>
<td>2.1.7.</td>
</tr>
<tr>
<td>Rock Foundation</td>
<td>2.1.7.</td>
</tr>
<tr>
<td>Rock or Other Incompressible Foundation</td>
<td>2.1.7.</td>
</tr>
<tr>
<td>PIPE BEDDING MATERIAL FOR WATER AND SANITARY SEWER MAINS</td>
<td>2.1.8.</td>
</tr>
<tr>
<td>Crushed Stone Embedment</td>
<td>2.1.8.</td>
</tr>
<tr>
<td>Granular Material</td>
<td>2.1.8.</td>
</tr>
<tr>
<td>Natural Gravel</td>
<td>2.1.8.</td>
</tr>
<tr>
<td>Rock for Foundation</td>
<td>2.1.8.</td>
</tr>
<tr>
<td>Sand</td>
<td>2.1.8.</td>
</tr>
<tr>
<td>Select Material</td>
<td>2.1.8.</td>
</tr>
<tr>
<td>Tests</td>
<td>2.1.8.</td>
</tr>
<tr>
<td>PLAN, Definition</td>
<td>1.00.</td>
</tr>
<tr>
<td>PLANS, Definition</td>
<td>1.00.</td>
</tr>
<tr>
<td>PLACING CONCRETE</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>PLACING REINFORCING STEEL</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>PLASTIC CONDUIT</td>
<td>2.10.2</td>
</tr>
<tr>
<td>PLYWOOD</td>
<td>2.2.2.</td>
</tr>
<tr>
<td>PNEUMATICALLY PLACED CONCRETE (GUNITE)</td>
<td>2.7.9.</td>
</tr>
<tr>
<td>POLYEThYLENE FILM</td>
<td>2.2.11.</td>
</tr>
<tr>
<td>POLYEThYLENE WRAP</td>
<td>2.9.5.</td>
</tr>
<tr>
<td>POLYMERIZED LINSEED OIL</td>
<td>2.9.1.</td>
</tr>
<tr>
<td>POLYURETHANE RESIN</td>
<td>2.9.1.</td>
</tr>
<tr>
<td>PORTLAND CEMENT CONCRETE PAVEMENT</td>
<td>5.8.</td>
</tr>
<tr>
<td>Alley Paving</td>
<td>5.8.4.</td>
</tr>
<tr>
<td>Construction Joints</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Contraction Joints</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Curing Concrete</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Expansion Joints</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Finishing Concrete</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Forms</td>
<td>5.8.2, 5.8.3</td>
</tr>
<tr>
<td>Mechanical Vibrator Equipment</td>
<td>5.8.3.</td>
</tr>
<tr>
<td>Monolithic Curb</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Opening Pavement to Traffic</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Pavement Leaveouts</td>
<td>5.8.5.</td>
</tr>
<tr>
<td>Pavement Strength Test</td>
<td>5.8.6.</td>
</tr>
<tr>
<td>Pavement Testing</td>
<td>5.8.6.</td>
</tr>
<tr>
<td>Pavement Thickness Test</td>
<td>5.8.6.</td>
</tr>
<tr>
<td>Placing Concrete</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Placing Reinforcing Steel</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Slip Form Construction</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Superimposed Curb</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Transit Mixing</td>
<td>5.8.2.</td>
</tr>
<tr>
<td>Transverse Finishing Machine</td>
<td>5.8.3.</td>
</tr>
<tr>
<td>Vibrating Screed</td>
<td>5.8.3.</td>
</tr>
<tr>
<td>PORTLAND CEMENT MODIFICATION OF SUBGRADE SOILS</td>
<td>4.9.</td>
</tr>
<tr>
<td>PORTLAND CEMENT TREATMENT</td>
<td>4.7.</td>
</tr>
<tr>
<td>PRECAST CONCRETE CONDUIT, see UNDERGROUND CONDUIT AND RELATED MATERIALS</td>
<td></td>
</tr>
<tr>
<td>PRECAST REINFORCED CONCRETE UNITS</td>
<td>7.12.</td>
</tr>
<tr>
<td>PRECAST REINFORCED MANHOLE SECTIONS</td>
<td>2.19.</td>
</tr>
<tr>
<td>PRECAST PILES</td>
<td>2.7.3.</td>
</tr>
</tbody>
</table>

JANUARY 1998
INDEX

Cast Iron .............................................................. 2.13.1.
Ends ....................................................................... 2.13.4.
Gate ....................................................................... 2.13.1.
Gates and Rings ...................................................... 2.13.1.
Gearing ..................................................................... 2.13.1.
Gear Cases .................................................................. 2.13.1.
Hand Wheels and Operating Nuts ......................... 2.13.1.
Horizontal .............................................................. 2.13.1., 2.13.4.
Installation in Vertical Pipeline ................................. 2.13.1.
Operators ................................................................... 2.13.4.
Rejection .................................................................. 2.13.1., 2.13.3., 2.13.4.
Stems and Nuts ........................................................ 2.13.1.
Stuffing Boxes ......................................................... 2.13.1.
Tapping ..................................................................... 2.13.1.
Tapping Sleeves ....................................................... 2.13.1.
Tests .......................................................................... 2.13.3., 2.13.4.
Wedge Device .......................................................... 2.13.1.
VAULTS ...................................................................... 7.4.7.
VENUE ...................................................................... 1.59.
VIBRATING SCREED ............................................... 5.8.3.
VINYL-TOLUENE/ACRYLIC COPOLYMER ............... 2.9.1.

-W-

WAIVER ...................................................................... 1.43.
WARRANTIES, Contractor's ..................................... 1.21.
WATER CONDUIT INSTALLATION, see UNDERGROUND CONDUIT INSTALLATION
WATERPROOF PAPER ............................................... 2.2.11.
WATERSTOPS ........................................................... 7.4.8.
WATERWORKS, BRASS STOPs, COCKS AND FITTINGS FOR .................................................................... 2.16.
WEIGHT BATCHING PLANT .............................................. 2.4.13.
WELDING .................................................................... 7.10.16.
WIRE, COPPER ........................................................ 2.10.2.
WOOD POSTS, FENCES ............................................... 2.8.2.
WOOD PRODUCTS ...................................................... 2.6.
Lumber and Timber .................................................. 2.6.1.
Plywood ................................................................. 2.6.2.
Wood Preservatives .................................................. 2.6.1.
WORK
Disputed .................................................................... 1.39.
Performance of ......................................................... 1.22.1.
Protection of ............................................................ 1.24.
WORKERS' COMPENSATION ....................................... 1.26.
WORKING AREA; COORDINATION; CLEANUP .......... 1.32.
Construction Stakes .................................................... 1.32.1.
Railway Crossings ..................................................... 1.32.2.
WORKING DAY, Definition ....................................... 1.00.
WORKING TIME, Definition ................................. 1.00.
WROUGHT IRON ........................................................ 2.11.8.
For Structures ......................................................... 2.11.8.

-Z-

ZINC COATING, REPAIR OF ..................................... 2.9.2.