ADDENDUM 4

SUBJECT: Texas A&M University Area Streets (Maria Ferrier Ave. to Mauermann Road) Phase 2 (2022 Bond), (WBS: 23-03921A), Scheduled to Close: November 3, 2026; Date of Issue: October 2, 2026

FROM: Jaime E. Contreras
Procurement Manager

DATE: October 30, 2026

THIS NOTICE SHALL SERVE AS ADDENDUM NO. 4 – TO THE ABOVE REFERENCED INVITATION FOR BID

This addendum is divided into sections for convenience only. All Respondents are responsible for reviewing the entire addendum. Compliance is required for any item included in this addendum, even if it appears only once. All interested parties and affected trades must review this addendum carefully and ensure full compliance in performing the related work. All documents in this addendum shall be attached to and incorporated into the Contract Documents.

Respondents and bidders shall be responsible for reading the entire addendum. All addenda issued for this solicitation shall be attached to and become part of the solicitation and resulting contract documents for this project. By submitting a response to a City solicitation, respondent/bidder is acknowledging the receipt of this addendum.

By virtue of this addendum, the specifications, requirements and amendments stated below become a permanent addition to the solicitation referenced above and any other supporting solicitation documents and postings.

THE ABOVE MENTIONED INVITATION FOR BID IS HEREBY AMENDED AS FOLLOWS:

CHANGES TO SOLICITATION

1. **Bid Opening:**
   a. Current: November 3, 2026
   b. Revised: November 6, 2026

REVISIONS TO CONSULTANT'S DOCUMENTS (SPECIFICATIONS, PLANS, BID FORM, ETC.)

Consultant's revisions will be issued as an attachment to this addendum.

1. Bid Form

a. N/A

2. Plans
   a. N/A

3. Specifications – Attached herein
   a. Governing Specifications
   b. Special Provision 526 Specification for Item 526
   c. Whiteway Foundation Detail (for CPS streetlight base)
   d. City of San Antonio Standard Specifications for Construction (June 2008)

SIGNED AND SEALED BY CONSULTANT (Engineer/Architect of Record). By signing and sealing this addendum, the Engineer/Architect of Record acknowledges that the sign/seal is only for changes/clarifications to the items associated with the Engineer's/Architect's work referenced in this addendum.



TBPE FIRM #0455

Jaime E. Contreras
Procurement Manager
Finance Department, Procurement Division

GOVERNING SPECIFICATIONS

All specifications applicable to this project are identified as follows:

2024 TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges with any revisions thereto where specified “TxDOT”.

Texas Department of Transportation – 2024

ITEM NO.	DESCRIPTION
450	RAILING
462	CONC BOX CULVERT & DRAINS
466	HEADWALLS AND WINGWALL
467	SAFETY END TREATMENT
496	REMOVING STRUCTURES
505	TRUCK MOUNTED ATTENUATOR (TMA) AND TRAILER ATTENUATOR (TA)
506	TEMPORARY EROSION, SEDIMENTATION, AND ENVIRONMENTAL CONTROLS
552	WIRE FENCE
662	WORK ZONE PAVEMENT MARKINGS

COSA Standard Specifications – 2008

ITEM NO.	DESCRIPTION
100	MOBILIZATION
101	PREPARING RIGHT-OF-WAY
102	OBLITERATING ABANDONED STREET
103	REMOVE CONCRETE
104	STREET EXCAVATION
105	CHANNEL EXCAVATION
106	BOX CULVERT EXCAVATION AND BACKFILL
107	EMBANKMENT
108	LIME TREATED SUBGRADE
209	CONCRETE PAVEMENT
210	ROLLING
300	CONCRETE
301	REINFORCING STEEL
303	WELDED WIRE FLAT SHEETS
306	STRUCTURE EXCAVATION
307	CONCRETE STRUCTURES
309	PRE-CAST REINFORCED CONCRETE BOX CULVERTS
400	EXCAVATION, TRENCHING, AND BACKFILLING
401	REINFORCED CONCRETE PIPE
403	STORM SEWER JUNCTION BOXES AND INLETS
407	CONCRETE ENCASEMENT, CRADLES, SADDLES, AND COLLARS
410	SUBGRADE FILLER
500	CONCRETE CURB, GUTTER AND CONCRETE CURN AND CUTTER
502	CONCRETE SIDEWALKS
505	CONCRETE RIP-RAP

507	CHAIN LINK WIRE FENCE
515	TOPSOIL
516	SODDING
520	HYDROMULCHING
526	FIELD OFFICE
530	BARRICADES, SIGNS AND TRAFFIC HANDLING
531	SIGNS
535	HOT APPLIED THERMOPLASTIC PAVEMENT MARKINGS
537	RAISED PAVEMENT MARKINGS
540	TEMPORARY EROSION, SEDIMENTATION AND WATER POLLUTION PREVENTION AND CONTROL
550	TRENCH EXCAVATION SAFETY PROTECTION
618	CONDUIT
636	ALUMINUM SIGNS

COSA Special Specifications

ITEM NO.	DESCRIPTION
801	TREE AND LANDSCAPE PROTECTION
5301	PORTABLE CHANGEABLE MESSAGE SIGN

COSA Special Provisions

ITEM NO.	DESCRIPTION
401	SPECIAL PROVISION TO REINFORCED CONCRETE PIPE (MAY 2009)
403	SPECIAL PROVISION TO STORM SEWER JUNCTION BOXES AND INLETS (MAY 2009)
502	SPECIAL PROVISION TO CONCRETE SIDEWALKS (MAY 2009)
505	SPECIAL PROVISION TO CONCRETE RIP-RAP (MAY 2009)
520	SPECIAL PROVISION TO HYDROMULCHING (MAY 2009)
526	SPECIAL PROVISION TO FIELD OFFICE (JUNE 2010)

Miscellaneous Special Specifications
ITEM NO. DESCRIPTION

N/A CONCRETE WASHOUT PIT

1.4.18 Concrete Washout Areas

The purpose of concrete washout areas is to prevent or reduce the discharge of pollutants to stormwater from concrete waste by conducting washout offsite, performing onsite washout in a designated area, and training employees and subcontractors.

The following steps will help reduce stormwater pollution from concrete wastes:

- Incorporate requirements for concrete waste management into material supplier and subcontractor agreements.
- Avoid mixing excess amounts of fresh concrete.
- Perform washout of concrete trucks in designated areas only.
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped onsite, except in designated areas.

For onsite washout:

- Locate washout area at least 50 feet from sensitive features, storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste.
- Wash out wastes into the temporary pit where the concrete can set, be broken up, and then disposed properly.

Below grade concrete washout facilities are typical. These consist of a lined excavation sufficiently large to hold expected volume of washout material. Above grade facilities are used if excavation is not practical. Temporary concrete washout facility (type above grade) should be constructed as shown on the details at the end of this section, with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations. Plastic lining material should be a minimum of 10 mil in polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

When temporary concrete washout facilities are no longer required for the work, the hardened concrete should be removed and disposed of. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and disposed of. Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities should be backfilled and repaired.

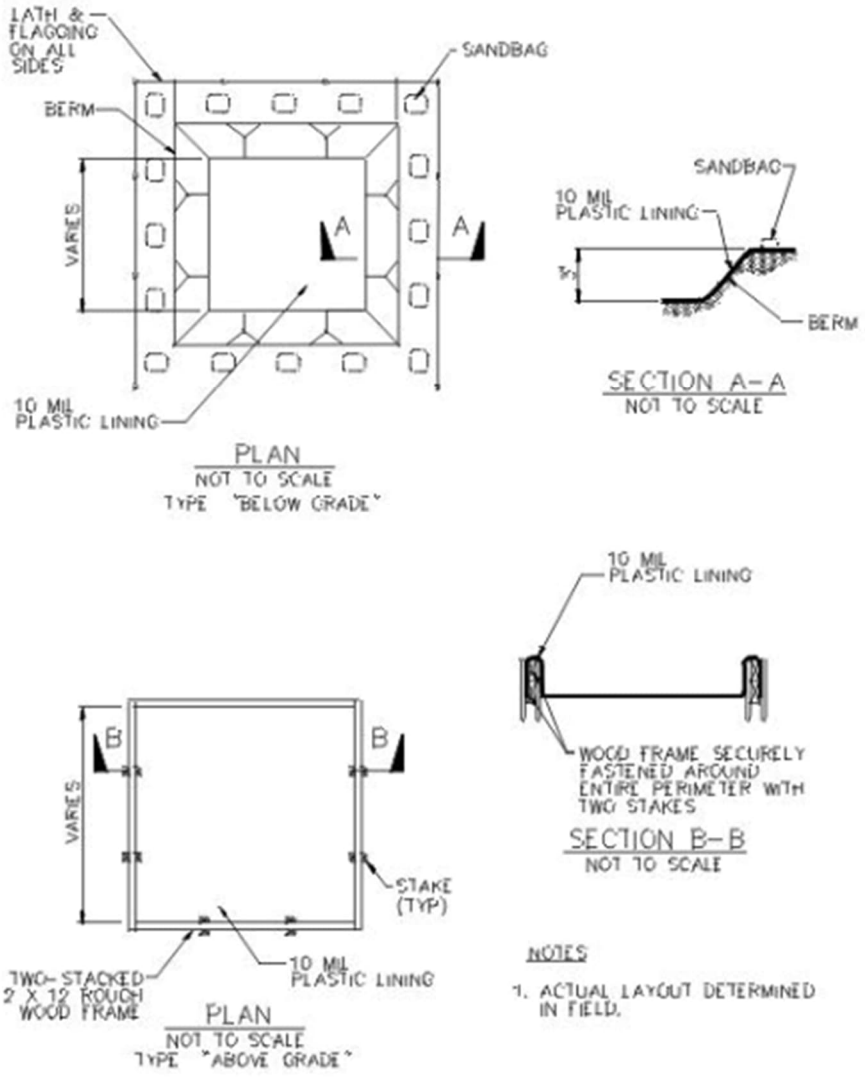


Figure 1-43 Schematics of Concrete Washout Areas

THE FOLLOWING ITEMS ARE SPECIAL PROVISIONS TO THE CITY OF SAN ANTONIO STANDARD SPECIFICATIONS FOR CONSTRUCTION DATED JUNE 2008

1. Item 526 Field Office……2 Pages

General

1. None

Standard Specifications

1. Delete Item 526 – Field Office *(dated June 2008)* in its entirety and replace with Item 526 – Field Office *(dated June 2010)* shown on the attached document.

ITEM

526 FIELD OFFICE

526.1. DESCRIPTION: *This item shall govern the erection or furnishing of a building to be used by the inspection force as a Field Office where the total contract amount (including Joint Bid Utilities) is one million dollars or greater.*

526.2. EQUIPMENT:

A. General. Furnish facilities after the receipt of the notice to proceed and before beginning physical work on the project. Provide field offices of the type specified near the worksite at a location acceptable to the Engineer. The Contractor may make use of permanent buildings or rental space meeting the requirements for field offices instead of portable buildings if approved. Maintain and clean the field office bi-weekly until the City accepts the project. Furnish other equipment as required.

B. Damage. Immediately repair or replace the facility if it is damaged in any manner. Payment for repair will be made at no cost to the City.

C. Right-Of-Way. When facilities are allowed in the right of way, remove buildings and other facilities and restore the right of way before project acceptance.

D. Parking and Fencing. Provide 6" compacted gravel parking area for the sole use of at least 2 City-owned vehicles. Situate the area near the field office at a location acceptable to the Engineer. Maintain the parking area until the project is completed and restore the area to a condition acceptable to the Engineer upon project completion. Enclose the field office and the parking area with a 6-ft. chain-link fence, a top-mounted 3-strand barbed wire, and a 12-ft. gate.

E. Field Office.

Provide field offices with roofs, floors, doors, and screened windows. The building shall be a minimum of 10 feet by 16 feet by 8 feet high with not less than three glass windows and one door. Ensure the floor has an impervious floor covering.

Ensure that the field office is weatherproof, piped for potable water, and electrically wired by certified personnel. Furnish and install adequate outlets, lighting, air conditioning, heating, and ventilation.

Provide a partitioned rest room furnished with rest room supplies, a lavatory and a flush toilet connected to a sewer or septic tank. A portable toilet may be used when approved by the Engineer.

Provide secured and controlled access to the field office through the use of security measures such as bars, alarms, or security fencing. Furnish steps to the building if deemed necessary by the Engineer.

Provide workbenches and tables at least 3 ft. wide and 6 ft. long, chairs, and filing cabinets in the quantity acceptable to the Engineer. Provide solar screens, blinds, or shades if deemed necessary by the Engineer.

Provide a telephone and service unless otherwise directed.

Provide all of the following in accordance with the requirements therein:

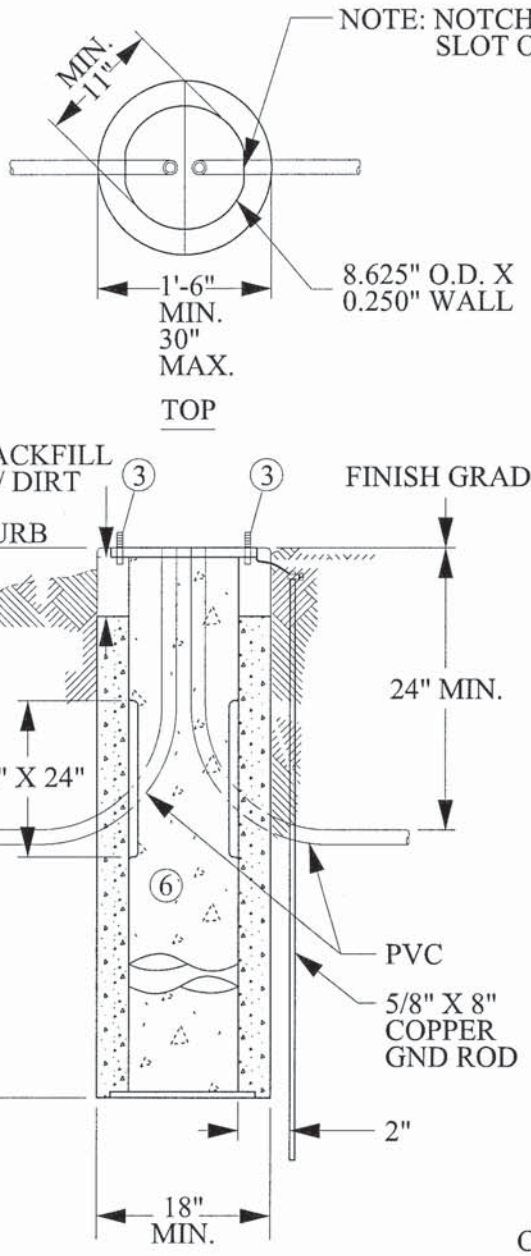
- computers (laptop or desktop) meeting the minimum requirements of Item 1000, "Web Portal" or as designated on the plans,
- printer scanner, and
- Internet service. The Internet service must be a provided on a line separate from required phone service.
- Digital camera with memory card 2GB or greater and appropriate software.

526.3. MEASUREMENT: No measurement will be made under this item.

526.4. PAYMENT: No payment will be made under this item. The Field Office and items listed above are not a pay item and shall remain the property of the contractor after completion of this project.

526.5. BID ITEM:

N/A



ELEV.

NOTES:

1. SET FOUNDATION AT LOCATION INDICATED ON CONSTRUCTION DRAWINGS.
2. FOUNDATION SHALL BE INSTALLED FLUSH W/CURB OR FINISH GRADE.
3. BOLT SHALL NOT EXCEED 4" IN LENGTH OF FINISH GRADE.
4. ANCHOR BOLT, WASHER, AND NUTS SUPPLIED W/ FOUNDATION SHOULD BE SECURED & RETAINED FOR SUBSEQUENT POLE INSTALLATION.
5. INSTALL GROUND ROD 3 INCHES BELOW BOTTOM SURFACE OF TOP PLATE.
6. FILL CENTER OF SHAFT W/ CONCRETE.
7. CONCRETE BACKFILL SHALL BE POURED 6 INCHES BELOW TOP PLATE.
8. PVC CONDUIT SHALL BE CUT OFF 3 1/2" INCHES PAST FINAL GRADE.
9. USE 1 INCH CARRIAGE BOLTS
10. A MINIMUM 7 DAY CONCRETE CURE REQUIRED PRIOR TO SETTING POLE ASSEMBLY.

MATERIAL NO.
1033433

CONCRETE BACKFILL REQUIREMENTS

	HOLE DIAMETER (IN)		
LENGTH OF STEEL ANCHOR FOUNDATION	18	20	24
	AMOUNT OF CONCRETE (CUBIC YARDS)		
5 (FT)	0.33	0.40	0.58
7 (FT)	0.46	0.57	0.81

CITY OF SAN ANTONIO

Standard Specifications for Construction



June 2008

INTRODUCTION

The specifications contained herein were adopted for use by the City of San Antonio on June 1, 2008.

For additional information on City of San Antonio specifications and updates go to:
http://www.sanantonio.gov/cims/standardspecifications.asp

For information on TxDOT Departmental Material Specifications (DMS), Manual of Testing Procedures, Material Inspection Guide and other TxDOT material information go to:
http://www.dot.state.tx.us

Outline of Specifications:

Each specification is outlined by Articles and Sections. The basic Articles required for a specification are:

XXX.1. Description.
XXX.2. Materials.
XXX.3. Equipment.
XXX.4. Construction or Work Methods.
XXX.5. Measurement.
XXX.6. Payment.
XXX.7. Bid Item

Here "XXX" represents the Item number. Some Articles are not used in every Item and additional Articles may be present in the Item. Measurement and Payment Articles may be combined when the work described is subsidiary to bid items of the Contract.

DEFINITION OF TERMS

Applicability. Wherever the following terms are used in these specifications or other Contract documents, the intent and meaning will be interpreted as shown below.

Abbreviations:

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
AI	Asphalt Institute
AISC	American Institute of Steel Construction
AMRL	AASHTO Materials Reference Laboratory
ANSI	American National Standards Institute
APWA	American Public Works Association
AREMA	American Railway Engineering and Maintenance-of-Way Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BMP	Best Management Practices
CFR	Code of Federal Regulations
CIMS	Capital Improvements Management Services Department of the City of San Antonio
CMP	Corrugated Metal Pipe
COE	U.S. Army Corps of Engineers
COSA	City of San Antonio
CRSI	Concrete Reinforcing Steel Institute
DMS	Departmental Material Specification
EPA	United States Environmental Protection Agency
FHWA	Federal Highway Administration, U.S. Department of Transportation
GSA	General Services Administration
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
LRFD	Load Resistance Factor Design
NCHRP	National Cooperative Highway Research Program
NEC	National Electrical Code (Published by NFPA)
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NESC	National Electrical Safety Code
NIST	National Institute of Standards and Technology
NRMCA	National Ready Mixed Concrete Association
OSHA	Occupational Safety & Health Administration, U.S. Department of Labor
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PSI	Pounds Per Square Inch
PPI	Plastics Pipe Institute

PS&E	Plans, Specifications, and Estimate
PW	Public Works Department of the City of San Antonio
RCP	Reinforced Concrete Pipe
RPLS	Registered Public Land Surveyor
RRC	Railroad Commission of Texas
SAE	Society of Automotive Engineers
SI	International System of Units
SSPC	The Society for Protective Coatings
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TDLR	Texas Department of Licensing and Regulation
TMUTCD	Texas Manual on Uniform Traffic Control Devices for Streets and Highways
UL	Underwriters Laboratory, Inc.
USC	United States Code
WRI	Wire Reinforcement Institute

Definitions:

1. **Actual Cost.** Contractor's actual cost to provide labor, material, equipment, and project overhead necessary for the work.
2. **Air Temperature.** The temperature measured in degrees Fahrenheit (°F) in the shade, not in the direct rays of the sun, and away from artificial heat.
3. **Arterial Highway.** A highway used primarily for through traffic and usually on a continuous route.
4. **Award.** The City's acceptance of a Contractor's bid for a proposed Contract that authorizes the City to enter into a Contract.
5. **Bidder.** An individual, partnership, limited liability company, corporation, or joint venture submitting a bid for a proposed Contract.
6. **Bridge.** A structure, including supports, erected over a depression or an obstruction (e.g., water, a highway, or a railway) having a roadway or track for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 ft. between faces of abutments, spring lines of arches, or extreme ends of the openings for multiple box culverts.
7. **Callout Work.** Contracts, or work items in Contracts, that require a Contractor's response on an as-needed basis.
8. **Certificate of Insurance.** A form approved by the City covering insurance requirements stated in the Contract.
9. **Change Order.** Written order to the Contractor detailing changes to the specified work, item quantities or any other modification to the Contract.
10. **City or City of San Antonio.** The governmental entities that comprise the City of San Antonio.
11. **Construction Bulletin C-8.** TxDOT Manual of procedures for driving and test loading piling.
12. **Construction Bulletin C-9.** TxDOT Manual of procedures for constructing and test loading drilled shafts.
13. **Consultant.** The licensed professional engineer or engineering firm, or the architect or architectural firm, registered in the State of Texas and under Contract to the City to perform professional services. The consultant may be the Engineer or architect of record or may provide services through and be subcontracted to the Engineer or architect of record.
14. **Contract.** The agreement between the City of San Antonio and the Contractor establishing the obligations of the parties for furnishing of materials and performance of the work prescribed in the Contract documents.
15. **Contract Documents.** Elements of the Contract including but not limited to the plans, specifications incorporated by reference, special provisions, special specifications, Contract bonds, change orders, and supplemental agreements.

16. **Contract Time.** The number of working days specified for completion of the work including authorized additional working days.
17. **Contractor.** The individual, partnership, limited liability company, corporation, or joint venture and all principals and representatives with which the Contract is made by the City.
18. **Control of Access.** The condition in which the right to access of owners or occupants of abutting land or other persons in connection with a street, roadway, or highway is fully or partially controlled by public authority.
19. **Cross-Sections.** Graphic representations of the original ground and the proposed facility, at right angles to the centerline or base line.
20. **Culvert.** Any buried structure providing an opening under a roadway for drainage or other purposes. Culverts may also be classified as bridges.
21. **Date of Written Authorization.** Date of the written work order authorizing the Contractor to begin work.
22. **Detour.** A temporary traffic route around a closed portion of a road.
23. **Department.** The Texas Department of Transportation (TxDOT).
24. **Departmental Material Specifications (DMS).** Reference specifications for various materials published by the TxDOT Construction Division.
25. **Direct Traffic Culvert.** Concrete box culvert whose top slab is used as the final riding surface or is to have an overlay or other riding surface treatment.
26. **Engineer.** The Capital Improvements Management Services (CIMS) Director of the City of San Antonio or the authorized representative of the CIMS Director. May also be the Public Works Director of the City of San Antonio or the authorized representative of the PW Director.
27. **Hazardous Materials or Waste.** Hazardous materials or waste include but are not limited to explosives, compressed gas, flammable liquids, flammable solids, combustible liquids, oxidizers, poisons, radioactive materials, corrosives, etiologic agents, and other material classified as hazardous by 40 CFR 261, or applicable state and federal regulations.
28. **Highway, Street, or Road.** General terms denoting a public way for purposes of vehicular travel, including the entire area within the right of way. Recommended usage in urban areas is highway or street; in rural areas, highway or road.
29. **Inspector.** The person assigned by the Engineer to inspect for compliance with the Contract any or all parts of the work and the materials used.
30. **Intersection.** The general area where 2 or more highways, streets, or roads join or cross, including the roadway and roadside facilities for traffic movements within it.
31. **Island.** An area within a roadway from which vehicular traffic is intended to be excluded, together with any area at the approach occupied by protective deflecting or warning devices.
32. **Licensed Professional Engineer.** A person who has been duly licensed by the Texas Board of Professional Engineers to engage in the practice of engineering in the State of Texas; also referred to as a Professional Engineer.
33. **Limits of Construction.** An area with established boundaries, identified within the highway right of way and easements, where the Contractor is permitted to perform the work.
34. **Local Street or Road.** A street or road primarily for access to residence, business, or other abutting property.
35. **Manual of Testing Procedures.** TxDOT Department manual outlining test methods and procedures maintained by the Materials and Pavements Section of the Construction Division.
36. **Median.** The portion of a divided highway separating the traffic lanes in opposite directions.
37. **Milestone Date.** The date that a specific portion of the work is to be completed, before the completion date for all work under the Contract.
38. **National Holiday.** January 1, the last Monday in May, July 4, the first Monday in September, the fourth Thursday in November, December 24, or December 25.

39. **Nonhazardous Recyclable Material (NRM).** A material recovered or diverted from the nonhazardous waste stream for the purposes of reuse or recycling in the manufacture of products that may otherwise be produced using raw or virgin materials.
40. **Notification.** Either written or oral instruction to the Contractor concerning the work. Voice mail is oral notification.
41. **Pavement.** That part of the roadway having a constructed surface for the use of vehicular traffic.
42. **Pavement Structure.** Combination of surface course and base course placed on a subgrade to support the traffic load and distribute it to the roadbed.

    A. **Surface Course.** Pavement structure layers designed to accommodate the traffic load. The top layer resists skidding, traffic abrasion, and the disintegrating effects of climate and is sometimes called the wearing course.

    B. **Base Course.** One or more layers of specified material thickness placed on a subgrade to support a surface course.

    C. **Subgrade.** The top surface of a roadbed upon which the pavement structure, shoulders, and curbs are constructed.

    D. **Subgrade Treatment**. Modifying or stabilizing material in the subgrade.
43. **Plans.** The drawings approved by the Engineer including true reproductions of the drawings that show the location, character, dimensions, and details of the work and are a part of the Contract.
44. **Prequalification.** The process for determining a Contractor's eligibility to bid work.
45. **Proposal.** The offer of the Bidder submitted on the prescribed form, including addenda issued, giving unit bid prices for performing the work described in the plans and specifications.
46. **Quality Assurance (QA).** Sampling, testing, inspection, and other activities conducted by the Engineer to determine payment and make acceptance decisions.
47. **Quality Control (QC).** Sampling, testing, and other process control activities conducted by the Contractor to monitor production and placement operations.
48. **Referee Tests.** Tests requested to resolve differences between Contractor and Engineer test results. The referee laboratory will be designated by the City of San Antonio.
49. **Right of Way.** A general term denoting land or property devoted to transportation purposes.
50. **Roadbed.** The graded portion of a highway prepared as foundation for the pavement structure and shoulders. On divided highways, the depressed median type and the raised median type highways are considered to have 2 roadbeds. Highways with a flush median are considered to have 1 roadbed.
51. **Roadside.** The areas between the outside edges of the shoulders and the right of way boundaries. Unpaved median areas between inside shoulders of divided highways and areas within interchanges are included.
52. **Roadway.** The portion of the highway (including shoulders) used by the traveling public.
53. **Sidewalk.** Portion of the right of way constructed exclusively for pedestrian use.
54. **Special Provisions.** Additions or revisions to these standard specifications or special specifications.
55. **Special Specifications.** Supplemental specifications applicable to the Contract not covered by these standard specifications.
56. **Specifications.** Directives or requirements issued or made pertaining to the method and manner of performing the work or to quantities and qualities of materials to be furnished under the Contract. References to TxDOT DMSs, ASTM or AASHTO specifications, or TxDOT bulletins and manuals, imply the latest standard or tentative standard in effect on the date of the proposal. The Engineer will consider incorporation of subsequent changes to these documents in the project Scope of Work.
57. **State.** The State of Texas.
58. **Station.** A unit of measurement consisting of 100 horizontal feet.
59. **Subcontract.** The agreement between the Contractor and subcontractor establishing the obligations of the parties for furnishing of materials and performance of the work prescribed in the Contract documents.
60. **Subcontractor.** An individual, partnership, limited liability company, corporation, or any combination thereof that the Contractor sublets, or proposes to sublet, any portion of a Contract,

excluding a material supplier, truck owner-operator, wholly owned subsidiary, or specialty-type businesses such as security companies and rental companies.

61. **Subsidiary.** Materials, labor, or other elements that because of their nature or quantity have not been identified as a separate item and are included within the items on which they necessarily depend.
62. **Substructure.** The part of the structure below the bridge seats or below the springing lines of arches. Parapets, back walls, and wing walls of abutments are considered as parts of the substructure.
63. **Superintendent.** The representative of the Contractor who is available at all times and able to receive instructions from the Engineer or authorized City representatives and to act for the Contractor.
64. **Superstructure.** The part of the structure above the bridge seats or above the springing lines of arches.
65. **Surplus Materials.** Any debris or material related to the Contract not incorporated into the work.
66. **Traffic Lane.** The strip of roadway intended to accommodate the forward movement of a single line of vehicles.
67. **Utility.** Privately, publicly, or cooperatively owned lines, facilities, and systems for producing, transmitting, or distributing communications, power, heat, gas, oil, water, waste, or storm water that are not connected with the highway drainage, signal systems, or other products that directly or indirectly serve the public; the utility company.
68. **Verification Tests.** Tests used to verify accuracy of QC and QA and mixture design testing.
69. **Wholly Owned Subsidiary.** A legal entity owned entirely by the Contractor or subcontractor.
70. **Work.** The furnishing of all labor, materials, equipment, and other incidentals necessary for the successful completion of the Contract.
71. **Work Order.** Written notice to the Contractor to begin the work. The work order may include the date on which work or time charges are to begin, the number of working days for specified work (for multiple work order Contracts), and plan sheets providing additional details specific to a location or to an item of work for non-site-specific work.
72. **Written Notice.** Written notice is considered to have been duly given if delivered in person to the individual or member to whom it is intended or if sent by regular, registered, or certified mail and delivered to the last known business address; sent by facsimile to the last known phone number; or sent by e-mail to the last known address. The date of the letter will serve as the beginning day of notice. Unclaimed mail or failure to provide current mailing address will not be considered a failure to provide written notice.

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BID ITEM SUMMARY I

DIVISION I - EARTHWORK

ITEM

100 MOBILIZATION

100.1. DESCRIPTION: *Establish and remove offices, plants, and facilities. Move personnel, equipment, and supplies to and from the project or the vicinity of the project site to begin work or complete work on Contract Items.*

100.2. MEASUREMENT: This Item will be measured by the lump sum as the work progresses.

100.3. PAYMENT: Partial payments of the lump sum bid for mobilization will be as follows. The adjusted Contract amount for construction Items as used below is defined as the total Contract amount less the lump sum for mobilization.

A. Payment will be made upon presentation of a paid invoice for the payment bond, performance bond, and required insurance. The combined payment for bonds and insurance will be no more than 10% of the mobilization lump sum or 1% of the total Contract amount, whichever is less.

B. Payment will be made upon verification of documented expenditures for plant and facility setup. The combined amount for all these facilities will be no more than 10% of the mobilization lump sum or 1% of the total Contract amount, whichever is less.

C. When 1% of the adjusted Contract amount for construction Items is earned, 50% of the mobilization lump sum bid or 5% of the total Contract amount, whichever is less, will be paid. Previous payments under this Item will be deducted from this amount.

D. When 5% of the adjusted Contract amount for construction Items is earned, 75% of the mobilization lump sum bid or 10% of the total Contract amount, whichever is less, will be paid. Previous payments under the Item will be deducted from this amount.

E. When 10% of the adjusted Contract amount for construction Items is earned, 90% of the mobilization lump sum bid or 10% of the total Contract amount, whichever is less, will be paid. Previous payments under this Item will be deducted from this amount.

F. Payment for the remainder of the lump sum bid for "Mobilization" will be made on the next estimate cycle after the initial retainage estimate or at final acceptance for projects without retainage.

100.4. BID ITEM:

Item 100.1 - Mobilization - lump sum

Item 100.2 - Insurance and Bond - lump sum

ITEM

101 PREPARING RIGHT-OF-WAY

101.1. DESCRIPTION: *Prepare the right of way and designated easements for construction operations by removing and disposing of all obstructions when removal of such obstructions is not specifically shown on the plans to be paid by other Items.*

101.2. MATERIALS:

A. Obstructions. Obstructions shall be considered to include, but not limited to, remains of houses not completely removed by others, foundations, floor slabs, concrete, brick, lumber, plaster, cisterns, septic tanks, basements, abandoned utility pipes or conduits, equipment or other foundations, fences, retaining walls, outhouses, shacks, and all other debris as well as buried concrete slabs, curbs, gutters, driveways, and sidewalks.

This item shall also include the removal of trees, stumps, bushes, shrubs, brush, roots, vegetation, logs, rubbish, paved parking areas, miscellaneous stone, brick, drainage structures, manholes, inlets, abandoned railroad tracks, scrap iron and all 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 to the new construction together with other objectionable materials not specifically provided for elsewhere by the plans and specifications.

B. Explosives. This item shall not govern for the demolition of buildings by the use of explosives. Such demolition work shall be governed by the use of a special specification controlling the work.

C. Fences. Unless shown otherwise on the plans, all fences along the right-of-way which are damaged or removed temporarily by the Contractor shall be replaced by the Contractor to an equal or better condition at no additional cost to the City.

D. Hazardous Materials. If the Contractor encounters hazardous substances, industrial waste, other environmental pollutants, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.

101.3. EQUIPMENT: Provide applicable equipment to conduct work as described in this specification or as specified on the plans.

101.4. CONSTRUCTION: Protect designated features on the right of way and prune trees and shrubs as directed. Do not park equipment, service equipment, store materials, or disturb the root area under the branches of trees designated for preservation. When shown on the plans, treat cuts on trees with an approved tree wound dressing within 20 min. of making a pruning cut or otherwise

causing damage to the tree. Follow all local and state regulations when burning. If burning of brush is approved, pile and burn at approved locations. When working in state or national forests or parks, coordinate work with state and federal authorities. Testing, removal, and disposal of hazardous materials will be in accordance with 101.2.D, "Hazardous Materials."

Clear areas shown on the plans of all obstructions, except those landscape features that are to be preserved. Such obstructions include but are not limited to those identified in 101.2.A, "Obstructions" and other items as specified on the plans. Remove vegetation and other landscape features not designated for preservation. Removal of live utility facilities is not included in this Item. Remove culverts, storm sewers, manholes, and inlets in proper sequence to maintain traffic and drainage.

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

- In areas receiving embankment, remove obstructions not designated for preservation to 2 ft. below natural ground.
- In areas to be excavated, remove obstructions to 2 ft. below the excavation level.
- In all other areas, remove obstructions to 1 ft. below natural ground.

When allowed by the plans or directed, cut trees and stumps off to ground level.

Holes remaining after removal of all obstructions, objectionable materials, vegetation, etc. shall be backfilled and tamped and the entire area bladed, to prevent ponding of water and to positive provide drainage. Backfill materials deemed unacceptable by the Engineer shall be removed and replaced at no additional cost to the City. In areas that are to be immediately excavated, backfilling and blading may be eliminated if approved by the Engineer. Areas to be used as borrow sites and material sources shall have all obstructions, objectionable materials, vegetation, etc., removed to the complete extent necessary to prevent such objectionable matter from becoming mixed with the material to be used in the construction.

Where a conduit is shown to be replaced, it shall be removed in its entirety and all connections to the existing conduit shall be extended to the new line. Where an existing conduit is to be cut and plugged, the line shall be cut back not less that 2 feet and a plug of concrete not less that 2 feet long shall be poured and held in the end of the pipe or the plug may be accomplished by using a precast stopper grouted into place.

Material to be removed will be designated as "salvageable" or "non-salvageable" on the plans prior to bidding by the Contractor. All "salvageable" material will remain the property of the City and will be stored at the site as directed by the Engineer. All "non-salvageable" materials and debris removed shall become the property of the Contractor and shall be removed from the site and shall be disposed of properly and in accordance with local, state, and federal requirements.

All asphaltic material shall be deposited of or recycled at a facility authorized to accept the asphalt for such purposes.

Dispose of wells in accordance with TxDOT Item 103, "Disposal of Wells."

101.5. MEASUREMENT: "Preparing Right-of-Way" for new construction will be measured by the lump sum.

101.6. PAYMENT: This item will be paid for at the contract lump sum price bid for "Preparing Right-of-Way," which price shall be full compensation for work herein specified, including the furnishing of all materials, equipment, tools, labor, and incidentals necessary to complete the work. The lump sum price will be pro-rated based on the number of phases in the project. A phase will be eligible for payment when street excavation is completed for that phase.

101.7. BID ITEM:

Item 101.1 - Preparing Right-of-Way - lump sum

ITEM

102 OBLITERATING ABANDONED STREET

102.1. DESCRIPTION: *This item shall govern obliterating sections of abandoned streets in accordance with these specifications and in conformity to the lines, grades, and details shown on the plans or as established by the Engineer.*

102.2. EQUIPMENT: Provide applicable equipment to conduct work as described in this specification or as specified on the plans.

102.3. CONSTRUCTION: Strip and windrow existing topsoil before shaping operations. Remove asphaltic pavement that is to be salvaged in accordance with Item 208, "Salvaging, Hauling & Stockpiling Reclaimable Asphaltic Pavement." Remove abandoned structures in accordance with Item 101, "Preparing Right-of-Way," unless otherwise shown on the plans.

Scarify and mix the abandoned roadbed with soil and blade to produce a smooth, uniform appearance. Fill, cut, and shape the designated sections of the abandoned road to blend into the surrounding terrain. Where fill is required to bring the section up to the established grade, utilize materials that meet the requirements of Item 107, "Embankment."

Eliminate ditches except where needed to facilitate drainage.

Cover disturbed areas with topsoil after shaping operations to facilitate establishment of vegetation.

When designated on the plans that the area shall be sodded, Item No. 516 "Sodding" shall apply.

102.4. MEASUREMENT: "Obliterating Abandoned Street" will be measured by the square yard of accepted work and no separate measurement of excavation, breaking down old structures, backfilling old structures or removing old curbing, sidewalks, driveways, etc. will be made. Any sodding required will be measured for under Item 516, "Sodding." Any fill required to bring the section to the established grade will be measured and paid for under Item 107, "Embankment."

102.5. PAYMENT: This item will be paid for at the contract price bid for "Obliterating Abandoned Street" which price shall be full compensation for all work herein specified, including all excavation and disposal of excavated material for scarifying, for breaking down structures and backfilling same, and for all labor, tools, equipment, and incidentals necessary to complete the work.

Sodding will be paid for under Item 516, "Sodding." Fill will be paid for under Item 107, "Embankment."

102.6. BID ITEM:

Item 102.1 - Obliterating Abandoned Street - per square yard

ITEM

103 REMOVE CONCRETE

103.1. DESCRIPTION: *This item shall govern the breaking up, removing, and satisfactorily disposing of existing concrete, as classified, at locations shown on the plans or as directed by the Engineer. Existing concrete not shown on the plans, located beneath the natural ground surface, not indicated by the Engineer or not obvious to the naked eye will not be covered under this item. Such materials will be removed as needed and paid for under Item 104 "Street Excavation," Item 105 "Channel Excavation," or Item 306 "Structural Excavation."*

103.2. CLASSIFICATION: Existing concrete to be removed under this item will be classified as follows:

A. Concrete Curb. "Concrete Curb" will include curb, curb and gutter, and low curb at driveways, and combinations thereof. The removal of monolithic concrete curb or dowelled concrete curb will be included in the concrete pavement measurement.

B. Concrete Traffic Barrier. "Concrete Traffic Barrier" will include permanent concrete barrier used for channeling or dividing traffic that is not considered salvageable.

C. Sidewalks and Driveways. "Sidewalks and Driveways" will include concrete sidewalks and driveways.

D. Miscellaneous Concrete. "Miscellaneous Concrete" will include all other items that are not noted above or covered by other items.

103.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

103.4. CONSTRUCTION:

A. General. The existing concrete shall be broken up, removed, and disposed of by the Contractor in accordance with federal, state, and local regulations.

B. Partial Removal of Concrete. When only a portion of the existing concrete is to be removed, care shall be exercised to avoid damage to that portion to remain in place. The existing concrete shall be cut to neat lines shown on the plans or as established by the Engineer, by sawing with an appropriate type circular concrete saw to a minimum depth of ½-inch. Any existing concrete which is damaged or destroyed beyond the neat lines so established shall be replaced at the Contractor's expense. Where reinforcement is encountered in the removed portions of the concrete, a minimum of 1-foot shall be cleaned of all old concrete and left in place to tie into the new concrete construction.

103.5. MEASUREMENT: Measurement for this item will be conducted as follows:

A. Concrete Curb. Concrete curb removed as prescribed above will be measured by the linear foot in its original position regardless of the thickness and reinforcing steel encountered.

B. Concrete Traffic Barrier. Concrete Traffic Barrier as prescribed above will be measured by the linear foot in its original position regardless of the type or size encountered.

C. Concrete Sidewalk and Driveway. Concrete sidewalks and driveways removed as prescribed above will be measured by the square foot in its original position regardless of the thickness of the concrete and reinforcing steel encountered.

D. Miscellaneous Concrete. Miscellaneous Concrete will be measured by the square foot in its original position regardless of the thickness of the concrete and reinforcing steel encountered.

103.6. PAYMENT: This item will be paid for at the contract unit price bid for "Remove Concrete Curb," "Remove Concrete Traffic Barrier," "Remove Concrete Sidewalks and Driveways," or "Remove Miscellaneous Concrete" which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the work.

103.7. BID ITEM:

Item 103.1 - Remove Concrete Curb - per linear foot

Item 103.2 - Remove Concrete Traffic Barrier - per linear foot

Item 103.3 - Remove Sidewalks and Driveways - per square foot

Item 103.4 - Remove Miscellaneous Concrete - per square foot

ITEM

104 STREET EXCAVATION

104.1. DESCRIPTION: *Excavate and properly dispose all excavated material, of whatever character, within the limits of the work and construct, compact, shape and finish earthwork on the entire length of the street, approaches, and/or sidewalk in accordance with specification requirements herein outlined and in conformity with the required lines, grades, and typical cross sections, shown on the plans or directed by the Engineer.*

104.2. MATERIALS: All excavation shall be unclassified and shall include all materials encountered regardless of their nature or the manner in which they are removed, except those covered by other pay items.

A. Hazardous Materials. If the Contractor encounters hazardous substances, industrial waste, other environmental pollutants, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.

B. Existing Structures/Obstructions. Removal of structures and other obstructions prior to excavation and finishing of all other earthwork described herein shall be completed and paid for in accordance with Item 101, "Preparing Right-of-Way" unless otherwise stated on the plans.

C. Existing Asphaltic Materials. All asphaltic material shall be disposed of or recycled at a facility authorized to accept the material for such purposes.

104.3. EQUIPMENT: Provide applicable equipment to conduct work as described in this specification or as specified on the plans.

104.4. CONSTRUCTION: The subgrade shall be shaped in conformity to the lines and grades established by the Engineer by removal of existing material or addition of approved material. Material removed in one area may be utilized in the addition of material to the subgrade in another area if approved by the Engineer. All material required for completion of the subgrade shall be subject to approval by the Engineer.

Unsuitable excavation or excavation in excess of that needed for construction shall be known as "Waste" and shall become the property of the Contractor and it shall become his sole responsibility to dispose of this material off the limits of the right-of-way. Proper disposal shall be in conformance with, but not limited to, the following provisions:

- Do not deposit excavated material within jurisdictional wetlands, and

- Obtain appropriate permits and apply provisions pertaining to soil erosion and stream pollution, when necessary, to meet federal and/or local regulations, rules, and procedures.

A. Rock Cuts. Excavate to finished subgrade elevation using equipment appropriate for the conditions encountered. Manipulate and compact subgrade in accordance with Section 104.4.C., "Compaction," unless excavation is to clean homogenous rock at finished subgrade elevation. If excavation extends below finished subgrade, use approved material compacted in accordance with Section C to replace undercut material at no additional cost. All unstable or otherwise objectionable material shall be removed from the subgrade and replaced with approved material in loose lifts not to exceed 12 inches in depth. Removal and replacement of unstable material will be paid by the Engineer.

B. Earth Cuts. All earth cuts shall be scarified to a uniform depth of at least 6-inches below the required finished subgrade elevation. All holes, ruts, and depressions shall be filled with approved material in loose lifts not to exceed 12 inches in depth. Compact the scarified subgrade in accordance with Section 104.4.C., "Compaction."

If the Engineer determines that the subgrade is unsuitable, the contractor shall remove the unsuitable material to the limits directed by the Engineer and replace it with suitable material. Removal and replacement of unsuitable material will be paid by the Engineer.

C. Compaction. Subgrade materials shall be compacted to the required density and moisture content as shown below, unless otherwise shown on the plans:

Subgrade Material	**Density**	**Moisture Content**
PI ≤ 20	≥ 95% of Max Dry Density	- 2% of Opt. or greater
PI > 20	≥ 95% of Max Dry Density	≥ Opt. Moisture

The maximum dry density and optimum moisture content shall be determined in accordance with TxDOT Test Method Tex-114-E. Tests for in place density shall be made in accordance with TxDOT Test Method Tex-115-E and within 24 hours after compacting operations are completed. If the material fails to meet the density specified, it shall be re-worked as necessary to obtain the density required.

For materials with a PI > 20, just prior to placing any base materials or stabilization, the top 3 inches of compacted subgrade shall be tested for density and moisture content. If tests show the density to be more than 2% below the specified minimum or the moisture content to be more than 3% above or below the optimum, the course shall be reworked as necessary to obtain the specified compaction and moisture content.

If the material used to replace undercuts or unsuitable material contains more than 30% oversize fraction (i.e. 30% or more retained on the ¾-inch sieve) or is gap-graded (many large particles with limited small particles), the maximum density determined by Tex-114-E may not be appropriate for field compaction. If this situation is encountered, the Engineer may elect to accept the material without density testing. With the approval of the Engineer, place layers in loose lifts not to exceed 12 inches. Before and during rolling operations, bring each layer to the moisture content directed. Compact each layer until there is no evidence of further consolidation. Maintain a level layer to aid in uniform compaction. If the required stability or finish is lost for any reason, recompact and refinish the subgrade at no additional expense to the City.

The contractor is also responsible for compaction of trenches installed as a part of this specification.

D. Tolerances. The surface of the subgrade shall be finished to the lines and grades as established. Any deviation in excess of ½-inch in cross section and in a length of 16-feet measured longitudinally shall be corrected by loosening, adding, or removing material, reshaping and compacting by sprinkling and rolling in accordance with Section 104.4.C., "Compaction." Sufficient subgrade shall be prepared in advance to insure satisfactory prosecution of the work.

E. Quality Control. After each layer of embankment or select material is complete, tests as necessary will be made by the Engineer. If the material fails to meet the density specified, the course shall be reworked, as necessary, to obtain the specified compaction.

Should the subgrade, due to any reason or cause, lose the required stability, density/moisture as described in Section 104.4.C., "Compaction" or finish before the pavement is placed, it shall be recompacted in accordance with Section C and refinished at the sole expense of the Contractor. Excessive loss of moisture in the subgrade shall be prevented by sprinkling, sealing or covering with a subsequent layer of asphaltic or other approved material.

104.5. MEASUREMENT: All accepted street excavation will be measured in its original position and the volume computed in cubic yards by the method of average end areas. Cross-sectional areas shall be computed to the established line of the subgrade, to a vertical line behind the curb, as indicated on the plans from the subgrade to the top of the proposed curb and then to the lines for parkway slopes as shown on the cross-sections of the plans.

Excavation and replacement of unsuitable materials below finish subgrade elevations will be measured by the cubic yard with the amount agreed upon by the Contractor and City prior to acceptance.

104.6. PAYMENT: This item will be paid for at the contract unit price bid for "Street Excavation," which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, labor, and incidentals necessary to complete the work.

Authorized removal and replacement of unsuitable material in excess of the bid quantity shall be paid for at the unit bid item price for street excavation.

104.7. BID ITEM:

Item 104.1 - Street Excavation - per cubic yard

ITEM

105 CHANNEL EXCAVATION

105.1. DESCRIPTION: *Excavate open channels within the limits shown on the plans, regardless of the type of material encountered, and dispose of any unused excavated materials. Construct, shape and finish all earthwork involved in conformance with the required lines, grades and cross sections, and in accordance with the plans and specification requirements.*

Note: This item does not apply to excavation required for box culvert conduits, cast-in-place or precast pipe storm sewers, or for pipe sanitary sewers as excavation for those types of construction are governed by the conditions set forth in other specification items. Excavation for other small drainage structures shall be governed and paid for under other appropriate items or under Item 306, "Structural Excavation", when indicated on the plans. Such excavation will be considered as that beyond the limits of the channel excavation as indicated on the plans.

105.2. MATERIALS: All excavation shall be unclassified and shall include all materials encountered regardless of their nature or the manner in which they are removed, except those covered by other pay items.

A. Hazardous Materials. If the Contractor encounters hazardous substances, industrial waste, other environmental pollutants, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.

B. Existing Structures/Obstructions. Removal of structures and other obstructions prior to excavation and finishing of all other earthwork described herein shall be completed and paid for in accordance with Item 101, "Preparing Right-of-Way" unless otherwise stated on the plans.

C. Existing Asphaltic Materials. All asphaltic material shall be disposed of or recycled at a facility authorized to accept the material for such purposes.

105.3. EQUIPMENT: Provide applicable equipment to conduct work as described in this specification or as specified on the plans.

105.4. CONSTRUCTION: All channel excavation shall be performed as shown on the plans, or specified herein if not denote on the plans, and shall conform to the established alignment, grades and cross sections. Suitable excavated materials shall be utilized, insofar as practicable, in constructing required embankments, or backfilling around drainage structures.

Unsuitable excavation or excavation in excess of that needed for construction shall be known as "Waste" and shall become the property of the Contractor and it shall become his sole responsibility to dispose of this material off the limits of the right-of-way. Proper disposal shall be in conformance with, but not limited to, the following provisions:

- Do not deposit excavated material within jurisdictional wetlands, and
- Obtain appropriate permits and apply provisions pertaining to soil erosion and stream pollution, when necessary, to meet federal and/or local regulations, rules, and procedures.

A. Temporary Construction Access. Any temporary construction access that crosses a channel will be constructed so as to allow a continuous flow at all times. The channel flow line will not be blocked or raised at any temporary construction access.

B. Channel Side Slope (Fill). When the plans indicate fill of a channel side slope, the fill material shall be placed in layers not to exceed 12 inches and shall be benched or notched into existing slopes. Each lift of fill shall be compacted to the required density and moisture content as shown below, unless otherwise shown on the plans:

Subgrade Material	Density	Moisture Content
PI ≤ 20	≥ 95% of Max Dry Density	- 2% of Opt. or greater
PI > 20	≥ 95% of Max Dry Density	≥ Opt. Moisture

The maximum dry density and optimum moisture content shall be determined in accordance with TxDOT Test Method Tex-114-E. Tests for in place density shall be made in accordance with TxDOT Test Method Tex-115-E and within 24 hours after compacting operations are completed. If the material fails to meet the density specified, it shall be re-worked as necessary to obtain the density required.

The fill material shall be free from roots, trash, silt and objectionable debris and shall be approved by the Engineer. The channel side slopes, in fill areas, shall be cut to the finished dimensions after completion of the fill process.

C. Lateral Ditches. At locations where lateral ditches enter the channel, the Contractor shall perform grading as may be required to maintain lateral ditch side slopes within the easement area. The cost of all grading shall be considered incidental to the unit price bid and no extra payment will be made.

D. Channel Completion. Prior to final acceptance by the Engineer, the Contractor shall remove all sediment from the bottom of the channel and dispose of this material off site. The cost of sediment removal and grading shall be incidental to the unit price bid, and no extra payment will be made. Revegetation is not required on channels primarily composed of rock.

105.5. MEASUREMENT: Accepted channel excavation for open channels will be measured in its original position and the volume computed in cubic yards by the method of average end areas in accordance with the lines, grades and cross sections shown on the plans.

105.6. PAYMENT: This item will be paid for at the contract unit price bid for "Channel Excavation," which price shall be full compensation for all work herein specified, including the furnishing of all materials, equipment, tools, labor, and incidentals necessary to complete the work as well as the proper disposal of unsuitable materials.

105.7. BID ITEM:

Item 105.1 - Channel Excavation - per cubic yard

ITEM

106 BOX CULVERT EXCAVATION AND BACKFILLING

106.1. DESCRIPTION: *Excavate and place storm drainage box culverts, whether cast-in-place or precast, within the limits shown on the plans, regardless of the type of material encountered. Remove and satisfactorily dispose all unused excavated materials. Construct, shape, backfill, and finish all earthwork in conformance with the required lines, grades and cross sections in accordance with the plans and specification requirements contained herein.*

Note: This item does not apply to excavation of open channels, or that required for pipe storm sewers or pipe sanitary sewers as excavation for those types of construction are governed by the conditions set forth in their respective specification requirements. Excavation for other small drainage structures shall be governed and paid for under other appropriate items or under Item 306, "Structural Excavation," when indicated on the plans. Such excavation will be considered as that beyond the limits of box culvert excavation as indicated on the plans. Where a box culvert is used as a bridge in open channel construction, excavation shall be governed by Item 105, "Channel Excavation" and as Item 306, "Structural Excavation" beyond the limits of the channel excavation.

106.2. MATERIALS: All box culvert excavation will be unclassified, and shall include all materials encountered regardless of their nature or the manner in which they are removed. Use materials that meet the requirements of the following Items, when indicated on the plans or required:

A. Flexible Base. Item 200, "Flexible Base."

B. Subgrade Filler. Item 410, "Subgrade Filler."

C. Cement Stabilized Sand. Item 412, "Cement Stabilized Sand."

D. Flowable Fill. Item 413, "Flowable Fill."

E. Filter Fabric. TxDOT DMS 6200, "Filter Fabric," Type1.

106.3. EQUIPMENT: Provide applicable equipment to conduct work as described in this specification or as specified on the plans.

106.4. CONSTRUCTION:

A. General. All box culvert excavation shall be performed as specified herein and shall conform to the established alignment, grades and cross sections or other limits indicated in the plans.

B. Safety. Provide slopes, benching, sheeting, bracing, pumping, and bailing as necessary to maintain the stability and safety of excavations. Excavation protection is governed by Item 550, "Trench Excavation Safety Protection," and Item 551, "Special Shoring."

C. Excavation. Suitable excavated materials shall be utilized, insofar as practicable, in backfilling around the box culvert, or other drainage structures or in constructing required embankments, if applicable. Unsuitable materials below footing grade shall be removed and replaced with gravel subgrade filler as defined in Item 410, "Subgrade Filler."

Excavated materials which are unsuitable for embankments or backfilling, or excavation in excess of that needed for construction shall become the property of the Contractor and it shall become his sole responsibility to properly dispose of this material outside the limits of the project. Proper disposal shall be in conformance with, but not limited to, the following provisions:

- Do not deposit excavated material within jurisdictional wetlands, and
- Obtain appropriate permits and apply provisions pertaining to soil erosion and stream pollution, when necessary, to meet federal, state, and/or local regulations, rules, and procedures.

1. **Hazardous Materials.** If the Contractor encounters hazardous substances, industrial waste, other environmental pollutants, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.

2. **Existing Structures/Obstructions.** Removal of structures and other obstructions prior to excavation and finishing of all other earthwork described herein shall be completed and paid for in accordance with Item 101, "Preparing Right-of-Way" unless otherwise stated on the plans.

3. **Existing Asphaltic Materials.** All asphaltic material shall be disposed of or recycled at a facility authorized to accept the material for such purposes.

4. **Excavation in Streets.** When structures are installed in streets, highways, or other paved areas, cut pavement and base in accordance with Item 230, "Base and Pavement Replacement." Restore pavement structure after completion of excavation and backfilling in accordance with Item 230, "Base and Pavement Replacement."

   Unless otherwise shown on the plans, maintain and control traffic in accordance with the approved traffic control plan or in conformance with the latest edition of the Texas MUTCD.

5. **Utilities.** Conduct work with minimum disturbance of existing utilities, and coordinate work in or near utilities with the utility owners. Inform utility owners sufficiently before work begins to allow them time to identify, locate, reroute, or make other adjustments to utility lines.

   Avoid cutting or damaging underground utility lines that are to remain in place. If damage occurs, promptly notify the utility company. If an active sanitary sewer line is damaged during excavation, provide temporary flumes across the excavation while open, and restore the lines when backfilling has progressed to the original bedding lines of the cut sewer.

6. **De-Watering.** Do not construct or place structures in the presence of water unless approved. Place precast units or poured structural concrete only on a dry, firm surface. Remove water by bailing, pumping, well-point installation, deep wells, underdrains, or other approved method.

   If structures are approved for placement in the presence of water, remove standing water in a manner that does not allow water movement through or alongside concrete being placed. Do not pump or bail while placing structural concrete or for a period of at least 36 hours thereafter unless from a suitable sump separated from the concrete work. Pump or bail during placement of seal concrete only to the extent necessary to maintain a static head of water within the cofferdam. Do not pump or bail to de-water inside a sealed cofferdam until the seal has aged at least 36 hours.

   If the bottom of an excavation cannot be de-watered to the point that the subgrade is free of mud or it is difficult to keep reinforcing steel clean, place a stabilizing material in the bottom of the excavation. Stabilizing material may be flexible base, controlled low strength material, flowable backfill, or other material approved by the Engineer. Stabilizing material placed for the convenience of the Contractor will be at the Contractor's expense.

D. Backfilling. Backfilling to the top of the box culvert (initial backfill) shall be completed by one of the four methods 1., 2., 3., or 4. below. Backfilling from the top of the culvert to the top of the trench (secondary backfill), or proposed subgrade elevation, shall be completed in accordance with Item 400, "Excavation, Trenching, and Backfilling." Backfill behind cast-in-place culvert walls shall not begin until the concrete has attained a compressive strength of 2,000 psi. Backfill on top of cast-in-place supporting slabs shall not begin until the concrete has attained a compressive strength of 3,000 psi. Avoid wedging action of backfill against structures. If necessary to prevent such action, step or serrate slopes bounding the excavation. Place backfill along both sides of culverts equally and in uniform layers.

1. **Suitable On-Site Excavated Material.** Material for backfill shall be placed in uniform layers not more than 12 inches in depth (loose measurement) and shall be compacted to the density specified herein. Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density, by means of a mechanical tamper.

   Each lift of fill shall be compacted to the required density and moisture content as shown below, unless otherwise shown on the plans:

Subgrade Material	**Density**	**Moisture Content**
PI ≤ 20	≥ 95% of Max Dry Density	- 2% of Opt. or greater
PI > 20	≥ 95% of Max Dry Density	≥ Opt. Moisture

The maximum dry density and optimum moisture content shall be determined in accordance with TxDOT Standard Laboratory Test Method Tex-114-E. Tests for in place density shall be made in accordance with TxDOT standard laboratory test method Tex-115-E and within 24 hours after compacting operations are completed. If the material fails to meet the density specified, it shall be re-worked as necessary to obtain the density required.

2. **Select Fill.** A clean gravel, or gravel approved by the Engineer, conforming to the requirements of article 410.3.B. "Gravel" of Item No.410, "Subgrade Filler" may be used for backfill material from the bottom of the trench to the top of the conduit or as otherwise shown on the plans. The gravel shall be placed in the trench in loose lifts not to exceed 12 inches in depth and lightly tamped to consolidate and seat the mass against conduit and earthen surfaces.

   A filter fabric shall be placed on the top and the sides of the gravel backfill (initial backfill) between the trench sides as well as the secondary backfill. The filter fabric shall conform to the requirements of Texas Department of Transportation Material Specification DMS-6200, Type1. Filter fabric shall be considered incidental to construction and no separate payment for filter fabric will be made.

   Where conditions permit and with approval of the Engineer, material conforming to Item 200, "Flexible Base" may be used from the top of the gravel filter bed to the top of the box culvert. This backfill material shall be placed in uniform layers not more than 12 inches in depth (loose measurement) and shall be compacted to the required density. Each layer of material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density by means of a mechanical tamper.

   Compaction of the Flexible Base shall be such that the density of each layer shall be not less than 95% of the maximum dry density as determined by TxDOT Standard Laboratory Test Method TEX-113-E, unless otherwise shown on the plans.

3. **Controlled Low Strength Material (CLSM).** CLSM shall be placed by direct discharge from a mixer truck or other approved method. A minimum of 30 psi at 3 days and maximum strength of 800 psi at 28 days is required. There is no separate pay item for Controlled Low Strength Material, unless shown on the plans as a separate pay item for culvert backfill.

4. **Flowable Backfill.** When shown on the plans, backfill the excavation with flowable backfill that conforms to Item 413, "Flowable Backfill" to the elevations shown on the plans. Prevent the structure from being displaced during the placement of the flowable backfill and prevent flowable backfill from entering culverts. There is no separate pay item for Flowable Backfill material, unless shown on the plans as a separate pay item for culvert backfill.

E. Quality Control. After each layer of embankment backfill or flexible base is complete, tests as necessary will be made by the Engineer. If the material fails to meet the density specified, the course shall be reworked, as necessary, to obtain the specified compaction.

Should the backfill, due to any reason or cause, lose the required stability, density/moisture, or finish before the next lift is placed, it shall be re-compacted and refinished at the sole

expense of the Contractor. Excessive loss of moisture in the backfill shall be prevented by sprinkling or other approved methods.

106.5. MEASUREMENT: Accepted box culvert excavation will be measured in its original position and the volume computed in cubic yards by the method of average end areas in accordance with the line, grade and limits shown on the plans. Backfill will not be measured for payment unless a specific line item titled "Box Culvert – Backfill," which identifies the type of backfill and quantity, is shown on the plans. Filter material will not be measured for payment. Excavation diagrams on the plans take precedence over the provisions of this Article.

Cutting and restoring pavement will be measured by the square yard as shown on the plans. Excavation below pavement or base will be measured as structural excavation of the pertinent type.

106.6. PAYMENT: This item shall be paid for at the contract unit price bid for "Box Culvert Excavation and Backfill." Replacement of unsuitable material with gravel subgrade will be paid for under Item 410, "Subgrade Filler." Cutting and restoring pavement will be paid for at the unit price bid for "Cutting and Restoring Pavement" under Item 511. Work completed to repair damage to base or pavement incurred outside the limits shown on the plans, or the limits authorized by the Engineer, will not be measured for payment.

Price bid shall be full compensation for all work herein specified, including excavating all material, backfilling, compacting, furnishing all materials, equipment, tools, labor, and incidentals necessary to complete the work.

106.7. BID ITEM:

Item 106.1 - Box Culvert Excavation and Backfill - per cubic yard

ITEM

107 EMBANKMENT

107.1. DESCRIPTION: *Furnish, place, and compact materials for construction of roadways, embankments, levees, dikes, or any designated section of the roadway where additional material is required.*

107.2. MATERIALS: Furnish approved material capable of forming a stable embankment from required excavation in the areas shown on the plans or from sources outside the right of way. Provide material meeting the requirements of Type B unless one or more of the following types is shown on the plans or directed by the Engineer:

A. Type A. Granular material that is free from vegetation or other objectionable material and meets the requirements of Table 1.

Table 1
Testing Requirements

Property	TxDOT Standard Laboratory Test Procedure	Specification Limit
Liquid limit	Tex-104-E	≤ 45
Plasticity index (PI)	Tex-106-E	≤ 15
Bar linear shrinkage	Tex-107-E	≥ 2

The Linear Shrinkage test only needs to be performed as indicated in TxDOT standard laboratory test procedure Tex-104-E.

B. Type B. Materials such as rock, loam, clay, or other approved materials.

C. Type C. Material meeting the specification requirements shown on the plans.

D. Type D. Material from required excavation areas shown on the plans.

Retaining wall backfill material must meet the requirements of the pertinent retaining wall Items.

107.3. EQUIPMENT: Provide applicable equipment to conduct work as described in this specification or as specified on the plans.

107.4. CONSTRUCTION: When offsite sources are used, the Contractor must comply with all Federal, State, County, City, and local laws, ordinances, and regulations pertaining to the work included in this item and demonstrate to the City that all applicable permits, contracts, or other legal documentation are in place prior to use of the offsite borrow source. To allow for required testing, notify the Engineer before opening a material source. Complete preparation of the right of way, in accordance with Item 101, "Preparing Right of Way," for areas to receive embankment.

Backfill tree-stump holes or other minor excavations with approved material and tamp. Restore the ground surface, including any material disked loose or washed out, to its original slope. Compact the ground surface by sprinkling in accordance with TxDOT Item 204, "Sprinkling" and by rolling using equipment complying with Item 210, "Rolling," when directed.

Scarify and loosen the unpaved surface areas, except rock, to a depth of at least 6-inches, unless otherwise shown on the plans. Bench slopes before placing material. Begin placement of material at the toe of slopes. Do not place trees, stumps, roots, vegetation, or other objectionable material in the embankment. Simultaneously recompact scarified material with the placed embankment material. Do not exceed the layer depth specified in Section 107.3.D, "Compaction Methods."

Construct embankments to the grade and sections shown on the plans. Construct the embankment in layers approximately parallel to the finished grade for the full width of the individual roadway cross sections, unless otherwise shown on the plans. Ensure that each section of the embankment conforms to the detailed sections or slopes. Maintain the finished section, density, and grade until the project is accepted.

A. Earth Embankments. Earth embankment is mainly composed of material other than rock. Construct embankments in successive layers, evenly distributing materials in lengths suited for sprinkling and rolling.

Obtain approval to incorporate rock and broken concrete produced by the construction project in the lower layers of the embankment. When the size of approved rock or broken concrete exceeds the layer thickness requirements in Section 107.3.D, "Compaction Methods," place the rock and concrete outside the limits of the completed roadbed. Cut and remove all exposed reinforcing steel from the broken concrete.

Move the material dumped in piles or windrows by blading or by similar methods and incorporate it into uniform layers. Featheredge or mix abutting layers of dissimilar material for at least 100-feet to ensure there are no abrupt changes in the material. Break down clods or lumps of material and mix embankment until a uniform material is attained.

Apply water free of industrial wastes and other objectionable matter to achieve the uniform moisture content specified for compaction.

When ordinary compaction is specified, roll and sprinkle each embankment layer in accordance with Section 107.3.D.1, "Ordinary Compaction." When density control is specified, compact the layer to the required density in accordance with Section 107.3.D.2, "Density Control." When rock and broken concrete are allowed in lower layers of earth embankments, proof-roll these layers as directed where density testing is not possible, in accordance with TxDOT Item 216, "Proof Rolling" to ensure proper compaction.

B. Rock Embankments. Rock embankment is mainly composed of rock. Construct rock embankments in successive layers for the full width of the roadway cross-section with a depth of 18-inches or less. Increase the layer depth for large rock sizes as approved. Do not exceed a depth of 2½ feet in any case. Fill voids created by the large stone matrix with smaller stones during the placement and filling operations.

Ensure the depth of the embankment layer is greater than the maximum dimension of any rock. Do not place rock greater than 2 feet in its maximum dimension, unless otherwise approved. Construct the final layer with graded material so that the density and uniformity is in accordance with Section 107.3.D, "Compaction Methods." Break up exposed oversized material as approved.

When ordinary compaction is specified, roll and sprinkle each embankment layer in accordance with Section 107.3.D.1, "Ordinary Compaction." When density control is specified, compact each layer to the required density in accordance with Section 107.3.D.2,

"Density Control." When directed, proof-roll each rock layer where density testing is not possible, in accordance with TxDOT Item 216, "Proof Rolling" to ensure proper compaction.

C. Embankments Adjacent to Culverts and Bridges. Compact embankments adjacent to culverts and bridges in accordance with Item 106, "Box Culvert Excavation and Backfilling."

D. Compaction Methods. Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least ½ the width of the roller. On super elevated curves, begin rolling at the lower side and progress toward the high side. Alternate roller trips to attain slightly different lengths. Compact embankments in accordance with one of the following methods as shown on the plans:

1. **Ordinary Compaction.** Use approved rolling equipment complying with Item 210, "Rolling," to compact each layer. The plans or the Engineer may require specific equipment. Do not allow the loose depth of any layer to exceed 12 inches, unless otherwise approved. Before and during rolling operations, bring each layer to the moisture content directed. Compact each layer until there is no evidence of further consolidation. Maintain a level layer to ensure uniform compaction. If the required stability or finish is lost for any reason, recompact and refinish the subgrade at no additional expense to the City.

2. **Density Control.** Compact each layer to the required density using equipment complying with Item 210, "Rolling." Determine the maximum lift thickness based on the ability of the compacting operation and equipment to meet the required density. Do not exceed layer thickness of 12 inches loose material, unless otherwise approved. Maintain a level layer to ensure uniform compaction.

   The Engineer will use TxDOT standard laboratory test procedure Tex-114-E to determine the maximum dry density (D_a) and optimum moisture content (W_{opt}). Meet the requirements for field density and moisture content in Table 2, unless otherwise shown on the plans.

Table 2
Field Density Control Requirements

Description	Density	Moisture Content
	Tex-115-E	
PI ≤ 15	≥ 98% D_a	
15 < PI ≤ 35	≥ 98% D_a and ≤ 102% D_a	≥ $W_{opt.}$
PI > 35	≥ 95% D_a and ≤ 100% D_a	≥ $W_{opt.}$

   Each layer is subject to testing by the Engineer for density and moisture content. During compaction, the moisture content of the soil should not exceed the value shown on the moisture-density curve, above optimum, required to achieve:

   - 98% dry density for soils with a PI greater than 15 but less than or equal to 35 or
   - 95% dry density for soils with PI greater than 35.

   When required, remove small areas of the layer to allow for density tests. Replace the removed material and recompact at no additional expense to the City. Proof-roll in accordance with TxDOT Item 216, "Proof Rolling," when shown on the plans or as directed. Correct soft spots as directed.

E. Maintenance of Moisture and Reworking. Maintain the density and moisture content once all requirements in Table 2 are met. For soils with a PI greater than 15, maintain the moisture content no lower than 4 percentage points below optimum. Rework the material to obtain the specified compaction when the material loses the required stability, density, moisture, or finish. Alter the compaction methods and procedures on subsequent work to obtain specified density as directed.

F. Acceptance Criteria.

1. Grade Tolerances.

a. Staged Construction. Grade to within 0.1-foot in the cross-section and 0.1-foot in 16-feet measured longitudinally.

b. Turnkey Construction. Grade to within ½-inch in the cross-section and ½-inch in 16-feet measured longitudinally.

2. Gradation Tolerances. When gradation requirements are shown on the plans, material is acceptable when not more than 1 of the 5 most recent gradation tests is outside the specified limits on any individual sieve by more than 5 percentage points.

3. Density Tolerances. Compaction work is acceptable when not more than 1 of the 5 most recent density tests is outside the specified density limits, and no test is outside the limits by more than 3 lb. per cubic foot.

4. Plasticity Tolerances. Material is acceptable when not more than 1 of the 5 most recent PI tests is outside the specified limit by no more than 2 points.

107.5. MEASUREMENT: Embankment will be measured by the cubic yard. Measurement will be further defined for payment as follows:

A. Final. The cubic yard will be measured in its final position using the average end area method. The volume is computed between the original ground surface or the surface upon which the embankment is to be constructed and the lines, grades, and slopes of the embankment. In areas of salvaged topsoil, payment for embankment will be made in accordance with TxDOT Item 160, "Topsoil." Shrinkage or swell factors will not be considered in determining the calculated quantities.

B. Original. The cubic yard will be measured in its original and natural position using the average end area method.

C. Vehicle. The cubic yard will be measured in vehicles at the point of delivery.

When measured by the cubic yard in its final position, this is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Change Order. Additional measurements or calculations will be made if adjustments of quantities are required.

Shrinkage or swell factors are the Contractor's responsibility. When shown on the plans, factors are for informational purposes only.

Measurement of retaining wall backfill in embankment areas is paid for as embankment, unless otherwise shown on plans. Limits of measurement for embankment in retaining wall areas are shown on the plans.

107.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Embankment (Final)," "Embankment (Original)," or "Embankment (Vehicle)," of the compaction method and type specified. This price is full compensation for furnishing embankment; hauling; placing, compacting, finishing, and reworking; disposal of waste material; and equipment, labor, tools, and incidentals.

When proof rolling is directed, it will be paid for in accordance with TxDOT Item 216, "Proof Rolling."

All sprinkling and rolling, except proof rolling, will not be paid for directly, but will be considered subsidiary to this Item, unless otherwise shown on the plans.

Where subgrade is constructed under this contract, correction of soft spots in the subgrade will be at the Contractor's expense. Where subgrade is not constructed under this contract, correction of soft spots in the subgrade will be paid in accordance through the Change Order process.

107.7. BID ITEM:

Item 107.1 - Embankment (Final) - per cubic yard

Item 107.2 - Embankment (Original) - per cubic yard

Item 107.3 - Embankment (Vehicle) - per cubic yard

ITEM

108 LIME TREATED SUBGRADE

108.1. DESCRIPTION: *Treat the subgrade by pulverizing, adding lime, mixing, and compacting to the required density. This item applies to both natural ground and embankment subgrade and shall be constructed as specified herein and in conformance with the typical sections, lines and grades as shown on the plans or as established by the Engineer.*

108.2. MATERIALS: Lime for this item shall conform to the requirements of TxDOT Item No. 260, "Lime Treatment – Road Mixed" of the Texas Department of Transportation Standard Specifications (Latest Edition). Acceptable forms of lime shall be:

- "Type A, Hydrated Lime,"
- "Type B, Commercial Lime Slurry," or
- "Type C, Quicklime."

The Contractor shall select, prior to construction, the grade to be used and shall notify the Engineer in writing before changing from one grade to another. Lime shall be placed in slurry form only, unless written permission is granted by the Engineer and a safety and containment plan is submitted to the Engineer by the Contractor seven days prior to use. In circumstances where it would be beneficial to utilize lime for "drying" subgrade materials to expedite construction, the Contractor may request approval from the Engineer to use pelletized lime.

Provide materials in conformance with the following Items and requirements:

A. Lime. TxDOT DMS-6350 "Lime and Lime Slurry."

B. Mix Design. The Engineer will determine the target lime content and optimum moisture content in accordance with TxDOT Tex -121-E.

108.3. EQUIPMENT: The machinery, tools and equipment necessary for proper prosecution of the work shall be on the project and approved by the Engineer prior to the beginning of construction operations. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

When lime is furnished in trucks, the weight of lime shall be determined on certified scales and delivered to the job site with exit ports sealed at the plant.

108.4. CONSTRUCTION:

A. General. The completed course shall be uniformly treated, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and shall have a smooth surface.

B. Preparation of Subgrade or Existing Base. Prior to treating existing material, it shall be shaped to conform to the typical sections, as shown on the plans.

Before pulverizing or scarifying an existing material, when directed by the Engineer, the Contractor shall proof roll the roadbed in accordance with TxDOT Item 216, "Proof Rolling."

Soft spots shall be corrected as directed by the Engineer. When the Contractor elects to use a cutting and pulverizing machine that will process the material to the plan depth, the Contractor will not be required to excavate to the secondary grade or windrow the material. This method will be permitted only if a machine is provided which will insure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a uniform surface over the entire width of the cut. The machine shall provide a visible indication of the depth of cut at all times.

In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade to the typical sections, lines and grades as shown on the plans or as established by the Engineer.

C. Pulverization. The existing pavement or base material shall be pulverized or scarified so that 100 % shall pass the 2-½ inch sieve.

D. Application. The percentage by weight or pounds per square yard of lime to be added will be as shown on the plans and may be varied by the Engineer if conditions warrant.

Lime shall be spread only on that area where the mixing operations can be completed during the same working day.

Unless otherwise approved by the Engineer, the lime operation shall not be started when the air temperature is below 40ºF and falling, but may be started when the air temperature is above 35ºF and rising. The temperature will be taken in the shade and away from artificial heat. Lime shall not be placed when weather conditions in the opinion of the Engineer are unsuitable.

The application and mixing of lime with the material shall be accomplished by the methods herein described as "Slurry Placing." "Dry Placing" is not allowed unless approved by the Engineer as described in Section 108.2, "Materials." Type A, Hydrated Lime shall be applied by "Slurry Placing" unless otherwise shown on the plans or approved by the Engineer. Type B Commercial Lime Slurry shall be applied by "Slurry Placing." Type C Quicklime shall be applied by "Slurry Placing" only. "Dry Placing" will not be allowed unless approved by the Engineer. When Type C Quicklime is used for dry placement, it shall be Grade "DS." When Type C Quicklime is used for slurry placement, it shall be either Grade "DS" or Grade "S." Grade "S" shall be used in slurry placement only.

CAUTION: Use of quicklime can be dangerous. Users should be informed of the recommended precautions in handling, storage and use of quicklime.

1. Slurry Placing. When Type A Hydrated Lime is specified and slurry placement is to be used, the Type A Hydrated Lime shall be mixed with water to form a slurry with a solids content approved by the Engineer.

Type B Commercial Lime Slurry shall be delivered to the project in slurry form at or above the minimum dry solids content approved by the Engineer. The distribution of lime at the rate(s) shown on the plans or approved by the Engineer shall be attained by successive passes over a measured section of roadway until the proper lime content has been secured.

When Type C Quicklime is applied as slurry, the amount of dry quicklime shall be 80 percent of the amount shown on the plans. The slurry shall contain at least the minimum

dry solids content approved by the Engineer. The residue from the slurrying procedure shall be spread uniformly over the length of the roadway currently being processed unless otherwise approved by the Engineer. This residue is primarily inert material with little stabilizing value, but may contain a small amount of quicklime particles that slake slowly. A concentration of these particles could cause the compacted stabilized material to swell during slaking.

Slurry shall be of such consistency that it can be applied uniformly without difficulty.

When the distributor truck is not equipped with an agitator, the Contractor shall have a standby pump available on the project for agitating the lime and water as required by the Engineer in case of undue delays in dispersing the slurry.

2. **Dry Placing.** Dry placing is not allowed unless approved by the Engineer as described in Section 108.2, "Materials." If allowed, the lime shall be distributed by an approved spreader at the rate shown on the plans or as directed by the Engineer. The lime shall be distributed at a uniform rate and in such a manner as to reduce the scattering of lime by the wind. The material shall be sprinkled as approved by the Inspector.

E. Mixing. The mixing procedure shall be the same for "Slurry Placing" or "Dry Placing" as herein described.

Begin Mixing within 6 hours of lime application. During the interval between application and mixing, hydrated lime that has been exposed to the open air for a period of six (6) hours or more or to excessive loss due to washing or blowing will not be accepted for payment.

1. **Initial Mixing.** The material and lime shall be thoroughly mixed. The material and lime shall be brought to the proper moisture content and left to mellow for 1 to 4 days. When pebble grade quicklime is used, allow the mixture to mellow for 2 to 4 days as approved by the Engineer.

   In addition to the above, when Type C Quicklime, Grade "DS," is approved for use by the Engineer under "Dry Placing," the material and lime shall be mixed as thoroughly as possible at the time of the lime application. Sufficient moisture shall be added during the mixing to hydrate the quicklime.

   During the mellowing period, the material shall be kept moist as directed by the Inspector.

   When shown on the plans or approved by the Engineer, the pulverization requirement may be waived when the material contains a substantial quantity of aggregate.

2. **Final Mixing.** After the required mellowing 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 the use of approved pulverization methods.

   Following mixing, a sample of the material at roadway moisture will be obtained for pulverization testing. All non-slaking aggregates retained on the ¾ inch sieve will be removed from the sample. The remainder of the material shall meet the following pulverization requirement when tested by TXDOT Test Method Tex-101-E, Part III:

Minimum passing 1 ¾" sieve	100
Minimum passing ¾" sieve	85
Minimum passing No. 4 sieve	60

F. Compaction. Prior to compaction, the material shall be aerated or sprinkled as necessary to provide the optimum moisture. Compaction of the mixture shall begin immediately after final mixing and in no case more than 24 hours after final mixing.

Compaction shall continue until the entire depth of the mixture is uniformly compacted. 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 sections, lines and grades as shown on the plans or as established by the Engineer.

1. **Ordinary Compaction.** Roll with approved compaction equipment, as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompacting.

2. **Density Control.** Each course shall be sprinkled as required and compacted to the extent necessary to provide not less than 95 percent of the optimum density. Unless otherwise shown on the plans, the Engineer will determine roadway density of completed sections in accordance with TxDOT Test Method Tex-115-E. The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.

When the material fails to meet the density requirements, or should the material lose the required stability, density or finish before the next course is placed, or the project is accepted, it shall be reworked as specified below.

G. Reworking a Section. When a section is reworked within 72 hours after completion of compaction, the Contractor shall rework the section to provide the required compaction. When a section is reworked more than 72 hours after completion of compaction, the Contractor shall add 25 percent of the specified rate of lime. Reworking shall include loosening, road mixing as approved by the Engineer, compacting, and finishing. When a section is reworked, a new optimum density will be determined from the reworked material in accordance with TXDOT Test Method Tex-121-E, part II and shall compact in-place to a minimum of 95% of this density.

H. Finishing. Immediately after completing compaction, clip, skin, or tight-blade the surface of the lime treated material with a maintainer or subgrade trimmer to a depth of approximately ¼-inch. Remove loosened material and dispose of it at an approved location. Roll the clipped surface immediately with a pneumatic-tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines and grades shown on the plans or as directed.

Finish grade of constructed subgrade in accordance with the following grade tolerances

1. **Staged Construction.** Grade to within 0.1-foot in the cross-section and 0.1-foot in 16-feet measured longitudinally.

2. **Turnkey Construction.** Grade to within ½-inch in the cross-section and ½-inch in 16-feet measured longitudinally.

Do not surface patch.

I. Curing. After the final layer or course of the lime treated material 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 with a pneumatic tire or other suitable roller. The completed section shall be moist cured or prevented from drying by addition of an asphalt material at the rate of 0.05 to 0.20 gallons per square yard. Curing shall continue for 2 to 5 days before further courses are added or traffic is permitted, unless otherwise approved by the Engineer.

However, the lime treated material may be covered by other courses, the day following finishing, when approved by the Engineer. When the plans provide for the treated material to be covered by other courses of material, the next course shall be applied within 14 calendar days after final compaction is completed, unless otherwise approved by the Engineer.

108.5. MEASUREMENT: When Lime is furnished in trucks, the weight of lime will be determined on certified scales, or the Contractor must provide a set of standard platform scales at a location approved by the Engineer. Scales must conform to the requirements of TxDOT Standard Specification Item 520, "Weighing and Measuring Equipment."

A. Hydrated Lime.

1. **Dry.** Lime will be measured by the ton (Dry Weight).

2. **Slurry.** Lime slurry will be measured by the ton (dry weight) of the hydrated lime used to prepare the slurry at the site.

3. **Commercial Lime Slurry.** Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.

B. Quicklime.

1. **Dry.** Lime will be measured by the ton (dry weight) of the quicklime.

2. **Slurry.** Lime slurry will be measured by the ton (dry weight) of the quicklime used to prepare the slurry multiplied by a conversion factor of 1.28 to give the quantity of equivalent hydrated lime, which will be the basis of the payment

108.6. PAYMENT: Work performed and materials furnished as prescribed by this item and measured as provided under "Measurement" will be paid for as follows:

"Lime" will be paid for at the unit price bid per ton of 2,000 pounds for "Lime" of the type specified, not to exceed 1% of the calculated quantity (based on delivered weight), which price shall be full compensation for furnishing all lime.

"Lime Treatment for Subgrade" will be paid for at the contract unit price bid per square yard, which price shall be full compensation for all correction of secondary subgrade, for loosening, mixing, pulverizing, spreading, drying, application of lime, water content of the slurry, shaping

and maintaining, for all sprinkling and rolling, for all manipulations required, for all hauling and freight involved, for all tools, equipment, labor and incidentals necessary to complete the work.

108.7. BID ITEM:

Item 108.1 - Lime Treated Subgrade - (___inches compacted depth) - per square yard

Item 108.2 - Lime - per ton

ITEM

109 CEMENT TREATED SUBGRADE

109.1. DESCRIPTION: *Treat natural subgrade or fill materials used to meet the top of subgrade profile, by the addition of portland cement and water. Pulverize, mix, and compact the mixed material to the required density, as herein specified and in conformance with the typical sections, lines, grades and thickness as shown on the plans.*

109.2. MATERIALS: Soil shall consist of approved material, free from vegetation or other objectionable matter, encountered in the roadbed section and other acceptable material used in the preparation of the roadbed in accordance with this specification. Notify the Engineer of the proposed material sources and of changes to material sources. The Engineer will verify that the specification requirements are met before the sources can be used. The Engineer may sample and test project materials at any time before compaction. Use TxDOT standard laboratory test procedure Tex-100-E for material definitions.

Cement shall be placed in slurry form only, unless written permission is granted by the Engineer and a safety and containment plan is submitted to the Engineer by the Contractor seven days prior to use.

A. Cement. Furnish hydraulic cement that meets the requirements of TxDOT's DMS 4600, "Hydraulic Cement," TxDOT's Hydraulic Cement Quality Monitoring Program (HCQMP), and ASTM C-150 Type I Portland Cement. Sources not on the HCQMP or other sources to be used in combination with an approved source will require approval before use.

B. Flexible Base. When treating entirely new base, furnish material that meets the requirements of Item 200, "Flexible Base," for the type and grade shown on the plans, before the addition of cement. When treating existing flexible base, with or without existing asphalt concrete pavement, the material shall conform to the requirements shown on the plans. Incorporate new base with the existing materials when shown on plans.

C. Water. Furnish water free of industrial waste and other objectionable material.

D. Asphalt. When permitted for curing purposes, furnish asphalt or emulsion that meets the requirements of Item 300, "Asphalts, Oils, and Emulsions," as shown on the plans or directed.

E. Mix Design. The Engineer will determine the target cement content and optimum moisture content to produce a treated mixture that meets the strength requirements shown on the plans. The mix will be designed in accordance with TxDOT standard laboratory test procedure Tex-120-E or will be based on prior experience with the project materials. The Contractor may propose a mix design developed in accordance with TxDOT standard laboratory test procedure Tex-120-E. The Engineer, at their discretion, will use TxDOT standard laboratory test procedure Tex-120-E to verify the Contractor's proposed mix design before acceptance. Reimburse the City for subsequent mix designs or partial designs necessitated by changes in the material or requests by the Contractor, when the City performs these services. When treating existing materials, limit the amount of asphalt concrete pavement to no more than 50% of the mix unless otherwise shown on the plans or directed.

109.3. EQUIPMENT: Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with TxDOT Item 216, "Proof Rolling," when required.

A. Cement Storage Facility. Store cement in closed, weatherproof containers.

B. Cement Slurry Equipment. Use slurry tanks equipped with agitation devices to slurry cement on the project or other approved location. The Engineer may approve other slurrying methods. Provide a pump for agitating the slurry when the distributor truck is not equipped with an agitator. Equip the distributor truck with an approved sampling device.

C. Pulverization Equipment. Provide pulverization equipment that:

1. cuts and pulverizes material uniformly to the proper depth with cutters that will plane to a uniform surface over the entire width of the cut,

2. provides a visible indication of the depth of cut at all times, and

3. uniformly mixes the materials.

109.4. CONSTRUCTION: Construct each layer uniformly, free of loose or segregated areas and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

A. Preparation of Subgrade for Treatment. Shape natural subgrade or fill material in accordance with applicable bid items to conform to the typical sections shown on the plans and as directed.

When shown on the plans or directed, proof roll the roadbed in accordance with TxDOT Item 216, "Proof Rolling," before pulverizing or scarifying material. Correct soft spots as directed.

B. Pulverization. Pulverize or scarify existing material after shaping so that 100% passes a 2½ inch sieve. If the material cannot be uniformly processed to the required depth in a single pass, excavate and windrow the material to expose a secondary grade to achieve processing to plan depth.

C. Application of Cement. Uniformly apply cement using slurry placement unless approved by the Engineer. Add cement at the percentage determined in Section 201.2.E, "Mix Design." Apply cement only on an area where mixing, compacting, and finishing can be completed during the same working day.

Start cement application only when the air temperature is at least 35°F and rising or is at least 40°F. The temperature will be taken in the shade and away from artificial heat. Suspend application when the Engineer determines that weather conditions are unsuitable.

1. Slurry Placement. Mix the required quantity of cement with water, as approved. Provide slurry free of objectionable materials and with a uniform consistency that can be easily applied. Agitate the slurry continuously. Apply slurry within 2 hours of adding water and when the roadway is at a moisture content drier than optimum. Distribute slurry uniformly by making successive passes over a measured section of the roadway until the specified cement content is reached.

2. **Dry Placement.** Dry placement shall not be allowed unless approved by the Engineer as described in Section 109.2, "Materials." If used, before applying cement, bring the prepared roadway to approximately optimum moisture content. When necessary, sprinkle in accordance with TxDOT Item 204, "Sprinkling." Distribute the required quantity of dry cement with approved equipment. Minimize dust and scattering of cement by wind. Do not apply cement when wind conditions, in the opinion of the Engineer, cause blowing cement to become dangerous to traffic or objectionable to adjacent property owners.

D. Mixing. The mixing procedure shall be the same for "Slurry Placing" or "Dry Placing" as herein described. Thoroughly mix the material and cement using approved equipment. Mix until a homogeneous mixture is obtained. If required, sprinkle the treated materials during the mixing operation to maintain optimum mixing moisture. Spread and shape the completed mixture in a uniform layer.

After mixing, the Engineer will sample the mixture at roadway moisture and test in accordance with TxDOT standard laboratory test procedure Tex-101-E, Part III, to determine compliance with the gradation requirements in Table 1.

Table 1
Gradation Requirements Minimum % Passing

Sieve Size	Subgrade
1-¾ in.	100
¾ in.	85
No. 4	60

E. Compaction. Compact the mixture in one lift using density control unless otherwise shown on the plans. Complete compaction within 2 hours after the application of cement.

Sprinkle or aerate the treated material in accordance with TxDOT Item 204, "Sprinkling," to adjust the moisture content during compaction so that it is within 2.5 percentage points of optimum as determined by TxDOT standard laboratory test procedure Tex-120-E. Determine the moisture content of the mixture at the beginning and during compaction in accordance with TxDOT standard laboratory test procedure Tex-103-E. Adjust operations as required.

Begin rolling longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least one-half the width of the roller unit. On superelevated curves, begin rolling at the low side and progress toward the high side. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph, as directed.

Remove areas that lose required stability, compaction, or finish. Replace with cement-treated mixture at the Contractor's expense.

1. **Ordinary Compaction.** Roll with approved compaction equipment, as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompacting.

2. **Density Control.** Compact to at least 95% of the maximum density determined in accordance with TxDOT standard laboratory test procedure Tex-120-E at a frequency of one test performed per 300 linear feet of paving for two lanes. The Engineer will determine roadway density in accordance with TxDOT standard laboratory test procedure Tex-115-E and, if shown on the plans, will verify strength in accordance with TxDOT

standard laboratory test procedure Tex-120-E. Remove material that does not meet density requirements. Remove areas that lose required stability, compaction, or finish. Replace with cement-treated mixture and compact and test in accordance with density control methods.

The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pounds per cubic foot below the specified density.

F. Finishing. Immediately after completing compaction, clip, skin, or tight-blade the surface of the cement treated material with a maintainer or subgrade trimmer to a depth of approximately ¼-inch. Remove loosened material and dispose of it at an approved location. Roll the clipped surface immediately with a pneumatic-tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines and grades shown on the plans or as directed.

Finish grade of constructed subgrade in accordance with the following grade tolerances:

1. **Staged Construction.** Grade to within 0.1 foot in the cross-section and 0.1 foot in 16-feet measured longitudinally.

2. **Turnkey Construction.** Grade to within ½ inch in the cross-section and ½ inch in 16-feet measured longitudinally.

Do not surface patch.

G. Curing. Cure for at least 3-days by sprinkling in accordance with TxDOT Item 204, "Sprinkling," or by applying an asphalt material at the rate of 0.05 to 0.20 gallons per square yard, as shown on the plans or directed. Maintain the moisture content during curing at no lower than 2.5 percentage points below optimum. Do not allow equipment on the finished course during curing except as required for sprinkling, unless otherwise approved. Continue curing until placing another course or opening the finished section to traffic.

109.5. MEASUREMENT:

A. Cement. Cement will be measured by the ton (dry weight). When cement is furnished in trucks, the weight of cement will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the Engineer. Scales must conform to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment."

When cement is furnished in bags, indicate the manufacturer's certified weight. Bags varying more than 5% from that weight may be rejected. The average weight of bags in any shipment, as determined by weighing 10 bags taken at random, must be at least the manufacturer's certified weight.

Cement slurry will be measured by the ton (dry weight) of the cement used to prepare the slurry at the job site or from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.

B. Cement Treatment. Cement treatment will be measured by the square yard of surface area. The dimensions for determining the surface areas are established by the widths shown on the plans and lengths measured at placement.

109.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid in accordance with Section 109.5.A, "Cement," or Section 109.5.B, "Cement Treatment."

Removal and disposal of existing asphalt concrete pavement will be paid for in accordance with pertinent Items or as agreed upon with the City through the Change Order process.

Sprinkling and rolling, except proof-rolling, will not be paid for directly but will be subsidiary to this Item, unless otherwise shown on the plans. When proof-rolling is shown on the plans or directed by the Engineer, it will be paid for in accordance with TxDOT Item 216, "Proof Rolling."

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade or existing base will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade will be in accordance with pertinent Items or as agreed upon with the City through the Change Order process.

Asphalt used solely for curing will not be paid for directly, but will be subsidiary to this Item. Asphalt placed for the purpose of curing and priming will be paid for under Item 202, "Prime Coat."

A. Cement. Cement will be paid for at the unit price bid for "Cement." This price is full compensation for materials, delivery, equipment, labor, tools, and incidentals.

B. Cement Treatment. Cement treatment will be paid for at the unit price bid for "Cement Treated Subgrade," for the depth specified. No additional payment will be made for thickness or width exceeding that shown on the plans. This price is full compensation for shaping existing material, loosening, mixing, pulverizing, providing cement, spreading, applying cement, compacting, finishing, curing, curing materials, blading, shaping and maintaining shape, replacing mixture, disposing of loosened materials, processing, hauling, preparing secondary subgrade, water, equipment, labor, tools, and incidentals.

109.7. BID ITEM:

Item 109.1 - Cement Treated Subgrade - (___inches compacted depth) - per square yard

Item 109.2 - Cement - per ton

DIVISION II - BASE & SURFACE COURSES

ITEM

200 FLEXIBLE BASE

200.1. DESCRIPTION: *Construct a base course for surfacing, pavement, or other base courses composed of crushed stone, and constructed as herein specified in one or more courses in conformance with the typical sections shown on the plans and to the lines and grades as established by the Engineer.*

200.2. MATERIALS: Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. The Engineer may sample and test project materials at any time before compaction throughout the duration of the project to assure specification compliance. Use the TxDOT standard laboratory test procedure Tex-100-E for material definitions.

A. Aggregate. Furnish aggregate of the type and grade shown on the plans and conforming to the requirements of Table 1. Each source must meet Table 1 requirements for liquid limit, plasticity index, and wet ball mill for the grade specified. Do not use additives such as but not limited to lime, cement, or fly ash to modify aggregates to meet the requirements of Table 1, unless shown on the plans.

Table 1
Aggregate Material Requirements

Property	Test Method[1]	Grade 1	Grade 2	Grade 3	Grade 4
Master gradation sieve size (% retained)	Tex-110-E				As shown on the plans
2-½ in.		–	0	0	
1-¾ in.		0	0–10	0–10	
⅞ in.		10–35	–	–	
⅜ in.		30–50	–	–	
No. 4		45–65	45–75	45–75	
No. 40		70–85	60–85	50–85	
Liquid limit, % max.[2]	Tex-104-E	35	40	40	As shown on the plans
Plasticity index, max.[2]	Tex-106-E	10	12	12	As shown on the plans
Plasticity index, min.[2]		As shown on the plans			
Wet ball mill, % max.[3]	Tex-116-E	40	45	–	As shown on the plans
Wet ball mill, % max. increase passing the No. 40 sieve[3]		20	20	–	

1. TxDOT standard laboratory test procedures
2. Determine plastic index in accordance with Tex-107-E (linear shrinkage) when liquid limit is unattainable as defined in Tex-104-E.
3. ASTM C131 (Grad. A), Los Angeles Abrasion, can be used in lieu of the wet ball mill procedure. The maximum abrasion allowed to the crushed stone is forty (40) when subjected to the Los Angeles Abrasion test.

1. Material Tolerances. The Engineer may accept material if no more than 1 of the 5 most recent gradation tests has an individual sieve outside the specified limits of the gradation.

When target grading is required by the plans, no single failing test may exceed the master grading by more than 5 percentage points on sieves No. 4 and larger or 3 percentage points on sieves smaller than No. 4 sieve.

The Engineer may accept material if no more than 1 of the 5 most recent plasticity index tests is outside the specified limit. No single failing test may exceed the allowable limit by more than 2 points.

2. **Material Types.** Do not use fillers or binders unless approved by the Engineer. Furnish the type specified on the plans in accordance with the following.

   a. **Type A.** Crushed stone produced and graded from oversize quarried aggregate that originates from a single, naturally occurring source. Do not use gravel or multiple sources.

   b. **Type B.** Crushed or uncrushed gravel. Blending of 2 or more sources is allowed. Use of this material must have written approval by the City Engineer prior to selection for bidding or construction.

   c. **Type C.** Crushed gravel with a minimum of 60% of the particles retained on a No. 4 sieve with 2 or more crushed faces as determined by TxDOT's standard laboratory test procedure Tex-460-A, Part I. Blending of 2 or more sources is allowed.

   d. **Type D.** Type A material or crushed concrete. Crushed concrete containing gravel will be considered Type D material. Crushed concrete must meet the requirements in Section 200.2.A.3.b, "Recycled Material (Including Crushed Concrete) Requirements," and be managed in a way to provide for uniform quality. The Engineer may require separate dedicated stockpiles in order to verify compliance.

   e. **Type E.** As shown on the plans.

3. **Recycled Material.** Recycled asphalt pavement (RAP) and other recycled materials may be used when shown on the plans. Request approval to blend 2 or more sources of recycled materials.

   a. **Limits on Percentage.** When RAP is allowed, do not exceed 20% RAP by weight unless otherwise shown on the plans. The percentage limitations for other recycled materials will be as shown on the plans.

   b. **Recycled Material (Including Crushed Concrete) Requirements.**

      (1) **Contractor Furnished Recycled Materials.** When the Contractor furnishes the recycled materials, including crushed concrete, the final product will be subject to the requirements of Table 1 for the grade specified. Certify compliance with TxDOT's DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials Guidelines," for Contractor furnished recycled materials. In addition, recycled materials must be free from reinforcing steel and other objectionable material and have at most 1.5% deleterious material when tested in accordance with TxDOT's standard laboratory test procedure Tex-413-A. For RAP, do not exceed a maximum percent loss from decantation of 5.0% when tested in accordance with TxDOT's standard laboratory test procedure Tex-406-A. Test RAP without removing the asphalt.

(2) City Furnished Required Recycled Materials. When the City furnishes and requires the use of recycled materials, unless otherwise shown on the plans:

- City required recycled material will not be subject to the requirements in Table 1,
- Contractor furnished materials are subject to the requirements in Table 1 and this Item,
- the final product, blended, will be subject to the requirements in Table 1, and
- for final product, unblended (100% City furnished required recycled material), the liquid limit, plasticity index, wet ball mill, classification, and compressive strength is waived.

Crush City-furnished RAP so that 100% passes the 2 inch sieve. The Contractor is responsible for uniformly blending to meet the percentage required.

(3) City Furnished and Allowed Recycled Materials. When the City furnishes and allows the use of recycled materials or allows the Contractor to furnish recycled materials, the final blended product is subject to the requirements of Table 1 and the plans.

c. Recycled Material Sources. City-owned recycled material is available to the Contractor only when shown on the plans. Return unused City-owned recycled materials to the City stockpile location designated by the Engineer unless otherwise shown on the plans.

The use of Contractor-owned recycled materials is allowed when shown on the plans. Contractor-owned surplus recycled materials remain the property of the Contractor. Remove Contractor-owned recycled materials from the project and dispose of them in accordance with federal, state, and local regulations before project acceptance. Do not intermingle Contractor-owned recycled material with City-owned recycled material unless approved by the Engineer.

B. Water. Furnish water free of industrial wastes and other objectionable matter.

C. Material Sources. Only commercial sources may be used unless otherwise allowed by the City and shown on the plans.

200.3. EQUIPMENT: Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with TxDOT Item 216, "Proof Rolling," when required.

200.4. CONSTRUCTION: Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

Stockpile base material temporarily at an approved location before delivery to the roadway. Build stockpiles in layers no greater than 2 feet thick. Stockpiles must have a total height between 10 and 16 feet unless otherwise shown on the plans. After construction and acceptance of the

stockpile, loading from the stockpile for delivery is allowed. Load by making successive vertical cuts through the entire depth of the stockpile.

Do not add or remove material from temporary stockpiles that require sampling and testing before delivery unless otherwise approved. Charges for additional sampling and testing required as a result of adding or removing material will be deducted from the Contractor's estimates.

Haul approved flexible base in clean trucks. Deliver the required quantity to each 100 foot station or designated stockpile site as shown on the plans. Prepare stockpile sites as directed. When delivery is to the 100 foot station, manipulate in accordance with the applicable Items.

A. Preparation of Subgrade or Existing Base. Remove or scarify existing asphalt concrete pavement in accordance with Item 104, "Street Excavation," when shown on the plans or as directed. Shape the subgrade or existing base to conform to the typical sections shown on the plans or as directed.

When new base is required to be mixed with existing base, deliver, place, and spread the new flexible base in the required amount per station. Manipulate and thoroughly mix the new base with existing material to provide a uniform mixture to the specified depth before shaping.

When shown on the plans or directed, proof roll the roadbed in accordance with TxDOT Item 216, "Proof Rolling," before pulverizing or scarifying. Correct soft spots as directed.

B. Placing. Spread and shape flexible base into a uniform layer with an approved spreader the same day as delivered unless otherwise approved. Construct layers to the thickness shown on the plans. Maximum lift thickness shall be 10 inches of loose material. Maintain the shape of the course. Control dust by sprinkling, as directed. Correct or replace segregated areas as directed, at no additional expense to the City.

Place successive base courses and finish courses using the same construction methods required for the first course.

C. Compaction. Compact in courses not to exceed 8 inches compacted depth using density control unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved. Bring each layer to the moisture content directed. When necessary, sprinkle the material in accordance with TxDOT Item 204, "Sprinkling."

Begin rolling longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least ½ the width of the roller unit. On superelevated curves, begin rolling at the low side and progress toward the high side. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph as directed.

Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish before the next course is placed or the project is accepted. Continue work until specification requirements are met. Perform the work at no additional expense to the City.

1. **Ordinary Compaction.** Roll with approved compaction equipment as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing approved material as required, reshaping, and recompacting.

2. **Density Control.** Compact to at least 95% of the maximum density determined by TxDOT's standard laboratory test procedure Tex-113-E unless otherwise shown on the plans. Determine the moisture content of the material at the beginning and during compaction in accordance with TxDOT's standard laboratory test procedure Tex-103-E.

   The Engineer will determine roadway density of completed sections in accordance with TxDOT's standard laboratory test procedure Tex-115-E. The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pounds per cubic foot below the specified density.

D. Finishing. After completing compaction, clip, skin, or tight-blade the surface with a maintainer or subgrade trimmer to a depth of approximately ¼ inch. Remove loosened material and dispose of it at an approved location. Seal the clipped surface immediately by rolling with a pneumatic tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades as shown on the plans or as directed.

In areas where surfacing is to be placed, correct grade deviations greater than ¼ inch in 16 feet measured longitudinally or greater than ¼ inch over the entire width of the cross-section. Correct by loosening, adding, or removing material. Reshape and recompact in accordance with Section 200.4.C, "Compaction."

E. Curing. Cure the finished section until the moisture content is at least 3 percentage points below and above optimum or as directed before applying the next successive course or prime coat.

200.5. MEASUREMENT: Flexible base will be measured by the square yard method per thickness shown in the proposal.

Measurement by the square yard is a plans quantity measurement. The quantity to be paid for is the quantity shown in the proposal unless modified by the Engineer. Additional measurements or calculations will be made if adjustments of quantities are required.

Measurement is further defined for payment by the square yard of surface area in the completed and accepted final position. The surface area of the base course is based on the width of flexible base as shown on the plans.

200.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the types of work shown below. No additional payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans for square yard measurement.

Sprinkling and rolling will not be paid for directly but will be subsidiary to this Item unless otherwise shown on the plans.

Where subgrade is constructed under this Contract (Subgrade Treatment), correction of soft spots in the subgrade will be at the Contractor's expense. Where subgrade is not constructed under this project, correction of soft spots in the subgrade will be paid in accordance with pertinent Items.

Payment will be made for the type and grade specified. For square yard measurement, a depth will be specified. This price is full compensation for furnishing materials, temporary stockpiling, assistance provided in stockpile sampling and operations to level stockpiles for measurement,

loading, hauling, delivery of materials, spreading, blading, mixing, shaping, placing, compacting, reworking, finishing, correcting locations where thickness is deficient, curing, furnishing scales and labor for weighing and measuring, and equipment, labor, tools, and incidentals.

200.7. BID ITEM:

Item 200.1 - per square yard per ___ inches compacted depth

ITEM

201 CEMENT TREATED BASE

201.1. DESCRIPTION: *Uniformly mix and compact portland cement, water, and base in the roadway in accordance with these specifications and shape to the lines, grades, and typical sections of the plans. Base materials may be entirely new flexible base, existing pavement materials, or a combination thereof.*

201.2. MATERIALS: Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. The Engineer will verify that the specification requirements are met before the sources can be used. The Engineer may sample and test project materials at any time before compaction. Use the TxDOT standard laboratory test procedure Tex-100-E for material definitions. Cement shall be placed by slurry method, unless written approval is granted by the Engineer and a safety and containment plan is submitted to the City by the Contractor seven days prior to use.

A. Cement. Furnish hydraulic cement that meets the requirements of TxDOT's DMS 4600, "Hydraulic Cement," TxDOT's Hydraulic Cement Quality Monitoring Program (HCQMP), and ASTM C-150 Type I Portland Cement. Sources not on the HCQMP or other sources to be used in combination with an approved source will require approval before use.

B. Flexible Base. When treating entirely new base, furnish material that meets the requirements of Item 200, "Flexible Base," for the type and grade shown on the plans, before the addition of cement. When treating existing flexible base, with or without existing asphalt concrete pavement, the material shall conform to the requirements shown on the plans. Incorporate new base with the existing materials when shown on plans.

C. Water. Furnish water free of industrial waste and other objectionable material.

D. Asphalt. When permitted for curing purposes, furnish asphalt or emulsion that meets the requirements of Item 300, "Asphalts, Oils, and Emulsions," as shown on the plans or directed.

E. Mix Design. The Engineer will determine the target cement content and optimum moisture content to produce a treated mixture that meets the strength requirements shown on the plans. The mix will be designed in accordance with TxDOT standard laboratory test procedure Tex-120-E or will be based on prior experience with the project materials. The Contractor may propose a mix design developed in accordance with TxDOT standard laboratory test procedure Tex-120-E. The Engineer, at their discretion, will use TxDOT standard laboratory test procedure Tex-120-E to verify the Contractor's proposed mix design before acceptance. Reimburse the City for subsequent mix designs or partial designs necessitated by changes in the material or requests by the Contractor, when the City performs these services. When treating existing materials, limit the amount of asphalt concrete pavement to no more than 50% of the mix unless otherwise shown on the plans or directed.

201.3. EQUIPMENT: Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with TxDOT Item 216, "Proof Rolling," when required.

A. Cement Storage Facility. Store cement in closed, weatherproof containers.

B. Cement Slurry Equipment. Use slurry tanks equipped with agitation devices to slurry cement on the project or other approved location. The Engineer may approve other slurrying methods. Provide a pump for agitating the slurry when the distributor truck is not equipped with an agitator. Equip the distributor truck with an approved sampling device.

C. Pulverization Equipment. Provide pulverization equipment that:

1. cuts and pulverizes material uniformly to the proper depth with cutters that will plane to a uniform surface over the entire width of the cut,

2. provides a visible indication of the depth of cut at all times, and

3. uniformly mixes the materials.

201.4. CONSTRUCTION: Construct each layer uniformly, free of loose or segregated areas and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

A. Preparation of Base for Treatment. Prior to treating new base materials, deliver, place, spread, and shape the new material in accordance with Item 200, "Flexible Base" to conform to the typical sections shown on the plans and as directed.

Prior to treating existing pavement, either remove or pulverize existing asphalt concrete pavement in accordance with pertinent Items and the plans or as directed. Shape the material in accordance with applicable bid items to conform to the typical sections shown on the plans and as directed.

When new base is required to be mixed with existing base, deliver, place, and spread the new material in the required amount per station. Manipulate and thoroughly mix the base with existing material to provide a uniform mixture to the specified depth before shaping. Shape the material in accordance with applicable bid items to conform to the typical sections shown on the plans and as directed.

When shown on the plans or directed, proof roll the roadbed in accordance with TxDOT Item 216, "Proof Rolling," before pulverizing or scarifying existing material. Correct soft spots as directed.

B. Pulverization. Pulverize or scarify existing material after shaping so that 100% passes a 2½ inch sieve. If the material cannot be uniformly processed to the required depth in a single pass, excavate and windrow the material to expose a secondary grade to achieve processing to plan depth.

C. Application of Cement. Uniformly apply cement using slurry placement unless otherwise approved by the Engineer. Add cement at the percentage determined in Section 201.2.E, "Mix Design." Apply cement only on an area where mixing, compacting, and finishing can be completed during the same working day.

Start cement application only when the air temperature is at least 35°F and rising or is at least 40°F. The temperature will be taken in the shade and away from artificial heat. Suspend application when the Engineer determines that weather conditions are unsuitable.

1. **Slurry Placement.** Mix the required quantity of cement with water, as approved. Provide slurry free of objectionable materials and with a uniform consistency that can be easily applied. Agitate the slurry continuously. Apply slurry within 2 hours of adding water and when the roadway is at a moisture content drier than optimum. Distribute slurry uniformly by making successive passes over a measured section of the roadway until the specified cement content is reached.

2. **Dry Placement.** Dry placement is not allowed unless approved by the Engineer as described in 201.2, "Materials." If used, before applying cement, bring the prepared roadway to approximately optimum moisture content. When necessary, sprinkle in accordance with TxDOT Item 204, "Sprinkling." Distribute the required quantity of dry cement with approved equipment. Minimize dust and scattering of cement by wind. Do not apply cement when wind conditions, in the opinion of the Engineer, cause blowing cement to become dangerous to traffic or objectionable to adjacent property owners.

D. Mixing. Thoroughly mix the material and cement using approved equipment. Mix until a homogeneous mixture is obtained. Sprinkle the treated materials during the mixing operation to maintain optimum mixing moisture. Spread and shape the completed mixture in a uniform layer.

After mixing, the Engineer will sample the mixture at roadway moisture and test in accordance with TxDOT standard laboratory test procedure Tex-101-E, Part III, to determine compliance with the gradation requirements in Table 1.

Table 1
Gradation Requirements

Sieve Size	Min. % Passing
1-¾ in.	100
¾ in.	85

E. Compaction. Compact the mixture in one lift using density control unless otherwise shown on the plans. Complete compaction within 2 hours after the application of cement.

Sprinkle or aerate the treated material in accordance with TxDOT Item 204, "Sprinkling," to adjust the moisture content during compaction so that it is within 2.0 percentage points of optimum as determined by TxDOT standard laboratory test procedure Tex-120-E. Determine the moisture content of the mixture at the beginning and during compaction in accordance with TxDOT standard laboratory test procedure Tex-103-E. Adjust operations as required.

Begin rolling longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least one-half the width of the roller unit. On superelevated curves, begin rolling at the low side and progress toward the high side. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph, as directed.

Remove areas that lose required stability, compaction, or finish. Replace with cement-treated mixture at the Contractor's expense.

1. **Ordinary Compaction.** Roll with approved compaction equipment, as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompacting.

2. **Density Control.** Compact to at least 98% of the maximum density determined in accordance with TxDOT standard laboratory test procedure Tex-120-E. The Engineer will determine roadway density in accordance with TxDOT standard laboratory test procedure Tex-115-E and, at their discretion, will verify strength in accordance with TxDOT standard laboratory test procedure Tex-120-E. Remove material that does not meet density requirements. Remove areas that lose required stability, compaction, or finish. Replace with cement-treated mixture and compact and test in accordance with density control methods.

The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pounds per cubic foot below the specified density.

F. Finishing. Immediately after completing compaction, clip, skin, or tight-blade the surface of the cement treated material with a maintainer or subgrade trimmer to a depth of approximately ¼-inch. Remove loosened material and dispose of it at an approved location. Roll the clipped surface immediately with a pneumatic-tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines and grades shown on the plans or as directed.

Finish grade of constructed base in accordance with the following grade tolerances:

1. **Staged Construction.** Grade to within 0.1 foot in the cross-section and 0.1 foot in 16-feet measured longitudinally.

2. **Turnkey Construction.** Grade to within ½ inch in the cross-section and ½ inch in 16-feet measured longitudinally.

Do not surface patch.

G. Curing. Cure for at least 3 days (24 hours each) by sprinkling in accordance with TxDOT Item 204, "Sprinkling," or by applying an asphalt material at the rate of 0.05 to 0.20 gallon per square yard, as shown on the plans or directed. Maintain the moisture content during curing at no lower than 2 percentage points below optimum. Do not allow equipment on the finished course during curing except as required for sprinkling, unless otherwise approved. Continue curing until placing another course or opening the finished section to traffic.

H. Maintenance. The Contractor shall be required to maintain at his own expense the entire cement treated base within the limits of his contract in good condition satisfactory to the Inspector 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 construction, which 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 a manner to insure restoration of a uniform surface of good quality cement treated base. Faulty work shall be replaced for the full depth of base. Any low area shall be remedied by replacing the material for the full depth of treatment, rather than adding a thin layer of base material to the completed work.

201.5. MEASUREMENT:

A. Cement. Cement will be measured by the ton (dry weight). When cement is furnished in trucks, the weight of cement will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the Engineer. Scales must conform to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment."

When cement is furnished in bags, indicate the manufacturer's certified weight. Bags varying more than 5% from that weight may be rejected. The average weight of bags in any shipment, as determined by weighing 10 bags taken at random, must be at least the manufacturer's certified weight.

Cement slurry will be measured by the ton (dry weight) of the cement used to prepare the slurry at the job site or from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.

B. Cement Treatment. Cement treatment will be measured by the square yard of surface area. The dimensions for determining the surface area is established by the widths shown on the plans and lengths measured at placement.

201.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid in accordance with Section 201.6.A, "Cement," or Section 201.6.B, "Cement Treatment."

Furnishing and delivering new base will be paid for in accordance with Item 200.6, "Flexible Base." Mixing, spreading, blading, shaping, compacting, and finishing of new or existing base material will be paid for under Section 201.6.B, "Cement Treatment." Removal and disposal of existing asphalt concrete pavement will be paid for in accordance with pertinent Items or as agreed upon with the City through the change order process.

Sprinkling and rolling, except proof-rolling, will not be paid for directly but will be subsidiary to this Item, unless otherwise shown on the plans. When proof-rolling is shown on the plans or directed by the Engineer, it will be paid for in accordance with TxDOT Item 216, "Proof Rolling."

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade or existing base will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade or existing base will be in accordance with pertinent Items or as agreed upon with the City through the change order process.

Asphalt used solely for curing will not be paid for directly, but will be subsidiary to this Item. Asphalt placed for the purpose of curing and priming will be paid for under Item 202, "Prime Coat."

A. Cement. Cement will be paid for at the unit price bid for "Cement." This price is full compensation for materials, delivery, equipment, labor, tools, and incidentals.

B. Cement Treatment. Cement treatment will be paid for at the unit price bid for "Cement Treatment (Existing Material)," "Cement Treatment (New Base)," or "Cement Treatment (Mixing Existing Material and New Base)," for the depth specified. No additional payment will be made for thickness or width exceeding that shown on the plans. This price is full

compensation for shaping existing material, loosening, mixing, pulverizing, providing cement, spreading, applying cement, compacting, finishing, curing, curing materials, blading, shaping and maintaining shape, replacing mixture, disposing of loosened materials, processing, hauling, preparing secondary subgrade, water, equipment, labor, tools, and incidentals.

201.7. BID ITEM:

Item 201.1 - Cement Treatment (Existing Material) __-inches compacted depth - per square yard

Item 201.2 - Cement Treatment (New Base) __-inches compacted depth - per square yard

Item 201.3 - Cement Treatment (Mixing Existing Material and New Base) __-inches compacted depth - per square yard

Item 201.4 - Cement - per ton

ITEM

202 PRIME COAT

202.1. DESCRIPTION: *This item shall govern for the application of asphaltic material on the completed base course and/or other areas in accordance with this specification and as directed by the Engineer. Apply blotter material as required.*

202.2. MATERIALS: Provide materials in accordance with the following requirements:

A. Bituminous. Unless the type and grade are shown on the plans, utilize an MC-30 or AE-P asphalt cement in accordance with Item 300, "Asphalts, Oils, and Emulsions" of the Standard Specifications of the Texas Department of Transportation for prime coat. Where Emulsified Asphalts are used, the amount of emulsified asphalt as a percentage by volume of the total mixture shall be within the limits shown on the plans, or shall be of a percentage as directed by the Engineer.

B. Blotter. Unless otherwise shown on the plans or approved, use either base course sweepings obtained from cleaning the base or sand as blotter materials.

202.3. EQUIPMENT: Provide applicable equipment in accordance with this specification or as specified on the plans.

A. Distributor. Furnish a distributor that will apply the asphalt material uniformly at the specified rate or as directed.

1. Transverse Variance Rate. When a transverse variance rate is shown on the plans, confirm that the nozzles outside the wheel paths will output a predetermined percentage more of asphalt material by volume than the nozzles over the wheel paths.

2. Calibration.

a. Transverse Distribution. Furnish a distributor test report, no more than 1 year old, documenting that the variation in output for individual nozzles of the same size does not exceed 10% when tested at the greatest shot width in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part III.

Include the following documentation on the test report:

- the serial number of the distributor,
- a method that identifies the actual nozzle set used in the test, and
- the fan width of the nozzle set at a 12 inch bar height.

When a transverse variance rate is required, perform the test using the type and grade of asphalt material to be used on the project. The Engineer may verify the transverse rate and distribution at any time. If verification does not meet the requirements, correct deficiencies and furnish a new test report.

B. Tank Volume. Furnish a volumetric calibration and strap stick for the distributor tank in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part I.

Calibrate the distributor within the previous 3 years of the date first used on the project. The Engineer may verify calibration accuracy in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part II.

C. Computerized Distributor. When paying for asphalt material by weight, the Engineer may allow use of the computerized distributor display to verify application rates. Verify application rate accuracy at a frequency acceptable to the Engineer.

D. Broom. Furnish rotary, self-propelled brooms.

E. Rollers. Rollers provided shall meet the requirements for their type as shown in Item 210, "Rollers."

F. Asphalt Storage and Handling Equipment. When the plans or the Engineer allows storage tanks, furnish a thermometer in each tank to indicate the asphalt temperature continuously.

Keep equipment clean and free of leaks. Keep asphalt material free of contamination.

G. Digital Measuring Instrument. Furnish a vehicle with a calibrated digital-measuring instrument accurate to ±6 ft. per mile.

202.4. CONSTRUCTION:

A. General. Apply the mixture when the air temperature is 60ºF and above, or above 50ºF and rising. Measure the air temperature in the shade away from artificial heat. The Engineer will determine when weather conditions are suitable for application.

Do not permit traffic, hauling, or placement of subsequent courses over freshly constructed prime coats. Maintain the primed surface until placement of subsequent courses or acceptance of the work.

B. Surface Preparation. Prepare the surface by sweeping or other approved methods. When directed, before applying bituminous material, lightly sprinkle the surface with water to control dust and ensure absorption.

C. Application.

1. Bituminous. The Engineer will select the application temperature within the limits recommended in Item 300, "Asphalts, Oils, and Emulsions." Apply material within 15ºF of the selected temperature.

Unless otherwise shown on the plans, prime coat shall be applied at a rate not to exceed 0.20 gallon per square yard of surface. The prime coat shall be applied evenly and smoothly, under a pressure necessary for proper distribution.

When emulsified asphalts are used as prime coat, agitate the water and emulsified asphalt to produce a uniform blend. Evenly distribute, at the rate specified, to locations shown on the plans or as directed. Regulate the percentage of emulsified asphalt in the mixture and distribute successive applications to achieve the specified rate, if necessary.

During the application of prime coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutters or structures. When directed, roll the freshly applied prime coat with a pneumatic-tire roller to ensure penetration.

2. **Blotter.** Spread blotter material before allowing traffic to use a primed surface. When "Prime Coat and Blotter" is shown on the plans as a bid item, apply blotter material to primed surface at the rate shown in the plans or as directed. When "Prime Coat" is shown on the plans as a bid item, apply blotter to spot locations or as directed to accommodate traffic movement through the work area. Remove blotter material before placing the surface. Dispose of blotter material according to applicable state and federal requirements.

202.5. MEASUREMENT: The asphaltic material for prime coat will be measured at the point of delivery on the project in gallons at the applied temperature. The quantity to be paid for shall be the number of gallons of asphaltic material used, as directed, in the accepted prime coat to the pay limits as shown on the plans. When emulsions are used, only that percentage of emulsified asphalt as a percentage by volume of the total mixture shall be paid for by the gallon of asphaltic material used in the accepted prime coat. Water used will not be measured for payment.

202.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Prime Coat" or "Prime Coat and Blotter" of the type and grade of bituminous material specified. This price is full compensation for cleaning and sprinkling the area to be primed; materials, including blotter material; and rolling, equipment, labor, tools, and incidentals.

202.7. BID ITEM:

Item 202.1 - Prime Coat - per gallon

Item 202.2 - Prime Coat and Blotter - per gallon

ITEM

203 TACK COAT

203.1. DESCRIPTION: *Apply asphaltic material on the completed base course after the prime coat has sufficiently cured, existing pavement, bituminous surface, or in the case of a bridge, on the prepared floor slab in accordance with these specifications and/or as directed by the Engineer.*

203.2. MATERIALS: The asphaltic material used for Tack Coat shall meet the requirements for "Asphalt Cement", "Cut-Back Asphalt" or "Emulsified Asphalt" in Item No. 300, "Asphalts, Oils and Emulsions" of the Texas Department of Transportation Standard Specifications. The asphaltic material used for Tack Coat shall be the type or grade shown in the referring specification, or on the plans, or as directed/approved by the Engineer.

203.3. EQUIPMENT: Provide equipment that conforms to the requirements of Item 202, "Prime Coat," Part 3, "Equipment."

203.4. CONSTRUCTION: Before the tack coat is applied, the surface shall be cleaned thoroughly with a vacuum sweeper to the satisfaction of the Engineer. The asphaltic material shall be applied on the clean surface by an approved type of self-propelled pressure distributor evenly and smoothly under a pressure necessary for proper distribution.

The tack coat shall be applied at the rate specified by the referring specification or on the plans. Unless otherwise stated or allowed by the Engineer the application rate shall not exceed 0.10 gallon per square yard of surface.

Where the pavement mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Engineer. All contact surfaces of curbs and structures and all joints shall be painted with a thin uniform coat of the asphaltic material used for tack coat. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutters or structures.

203.5. MEASUREMENT: The asphaltic material for tack coat will be measured at point of delivery on the project in gallons at the applied temperature. The quantity to be paid for shall be the number of gallons of asphaltic material used, as directed, in the accepted tack coat. Water used with Emulsions will not be measured for payment.

203.6. PAYMENT: The work performed and materials furnished as prescribed by this item will be paid for at the contract unit price bid per gallon for "Tack Coat" which price shall be full compensation for cleaning the surface, for furnishing, heating, hauling and distributing the tack coat as specified; for all freight involved; and for all manipulations, labor, tools, equipment, and incidentals necessary to complete the work.

203.7. BID ITEM:

Item 203.1 - Tack Coat - per gallon

ITEM

204 SURFACE TREATMENTS

204.1. DESCRIPTION: *Construct a surface treatment composed of a single or double application of asphalt material, each covered with aggregate, constructed on existing pavements or on the prepared base course or surface in accordance with these specifications. This item shall also govern for the furnishing and placing of aggregates. Quantities for the different types of surfaces and materials will be shown on the plans.*

204.2. MATERIALS: All materials shall be of the type and grade as shown on the plans and shall conform to the pertinent material requirements of the following:

A. Asphaltic Cement. TxDOT Item 300, "Asphalts, Oils, and Emulsions."

B. Aggregates. TxDOT Item 302, "Aggregates for Surface Treatments."

204.3. EQUIPMENT: Provide applicable equipment in accordance with this specification or as specified on the plans.

A. Distributor. Furnish a distributor that will apply the asphalt material uniformly at the specified rate or as directed.

1. Transverse Variance Rate. When a transverse variance rate is shown on the plans, ensure that the nozzles outside the wheel paths will output a predetermined percentage more of asphalt material by volume than the nozzles over the wheel paths.

2. Calibration.

a. Transverse Distribution. Furnish a distributor test report, no more than 1 year old, documenting that the variation in output for individual nozzles of the same size does not exceed 10% when tested at the greatest shot width in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part III.

Include the following documentation on the test report:

- the serial number of the distributor,
- a method that identifies the actual nozzle set used in the test, and
- the fan width of the nozzle set at a 12-inch bar height.

When a transverse variance rate is required, perform the test using the type and grade of asphalt material to be used on the project. The Engineer may verify the transverse rate and distribution at any time. If verification does not meet the requirements, correct deficiencies and furnish a new test report.

b. Tank Volume. Furnish a volumetric calibration and strap stick for the distributor tank in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part I.

Calibrate the distributor within the previous 3 years of the date first used on the project. The Engineer may verify calibration accuracy in accordance with Tex-922-K, "Calibrating Asphalt Distribution Equipment," Part II.

3. **Computerized Distributor.** When paying for asphalt material by weight, the Engineer may allow use of the computerized distributor display to verify application rates. Verify application rate accuracy at a frequency acceptable to the Engineer.

B. Aggregate Spreader. Use a continuous-feed, self-propelled spreader to apply aggregate uniformly at the specified rate or as directed.

C. Broom. Furnish rotary, self-propelled brooms.

D. Aggregate Haul Trucks. Unless otherwise authorized, use trucks of uniform capacity to deliver the aggregate. Provide documentation showing measurements and calculation in cubic yards. Clearly mark the calibrated level. Truck size may be limited when shown on the plans.

E. Rollers. Unless otherwise shown on the plans, rollers provided shall meet the requirements for "Pneumatic Tire" as shown in Item 210, "Rollers."

F. Asphalt Storage and Handling Equipment. When the plans or the Engineer allows storage tanks, furnish a thermometer in each tank to indicate the asphalt temperature continuously.

Keep equipment clean and free of leaks. Keep asphalt material free of contamination.

G. Digital Measuring Instrument. Furnish a vehicle with a calibrated digital-measuring instrument accurate to ±6 feet per mile.

204.4. CONSTRUCTION:

A. General. Asphalt and aggregate rates shown on the plans are for estimating purposes only. The Engineer will adjust the rates for the existing conditions.

B. Weather. Do not place surface treatments when, in the Engineer's opinion, general weather conditions are unsuitable.

Meet the requirements for air and surface temperature shown below.

1. **Standard Temperature Limitations.** Apply surface treatment when air temperature is above 50°F and rising. Do not apply surface treatment when air temperature is 60°F and falling. In all cases, do not apply surface treatment when surface temperature is below 60°F.

2. **Polymer-Modified Asphalt Cement Temperature Limitations.** When using materials described in TxDOT Item 300, Section 2.B, "Polymer Modified Asphalt Cement," apply surface treatment when air temperature is above 70°F rising. Do not apply surface treatment when air temperature is 80°F and falling. In all cases, do not apply surface treatment when surface temperature is below 70°F.

3. **Asphalt Material Designed for Winter Use.** When winter asphalt application is allowed, the Engineer will approve the air and surface temperature for asphalt material application. Apply surface treatment at air and surface temperatures as directed.

C. Surface Preparation. Remove existing raised pavement markers. Repair any damage incurred by removal as directed. Remove dirt, dust, or other harmful material before sealing. When shown on the plans, remove vegetation and blade pavement edges.

Building paper shall be placed over all manholes, valve boxes, grates, etc., so as to protect the surfaces from asphaltic materials. Asphaltic materials shall not be placed, lapped, or splashed onto adjacent structures.

D. Rock Land and Shot.

1. Definitions.

a. A "rock land" is the area covered at the aggregate rate directed with 1 truckload of aggregate.

b. A "shot" is the area covered by 1 distributor load of asphalt material.

2. Setting Lengths. Calculate the lengths of both rock land and shot. Adjust shot length to be an even multiple of the rock land. Verify that the distributor has enough asphalt material to complete the entire shot length. Mark shot length before applying asphalt. When directed, mark length of each rock land to verify the aggregate rate.

E. Asphalt Placement.

1. General. The maximum shot width is the width of the current transverse distribution test required under Section 204.3.A.2.a, "Transverse Distribution," or the width of the aggregate spreader box, whichever is less. Adjust the shot width so operations do not encroach on traffic or interfere with the traffic control plan, as directed. Use paper or other approved material at the beginning and end of each shot to construct a straight transverse joint and to prevent overlapping of the asphalt. Unless otherwise approved, match longitudinal joints with the lane lines. The Engineer may require a string line if necessary to keep joints straight with no overlapping. Use sufficient pressure to flare the nozzles fully.

In those areas where the asphalt distributor is not accessible, hand spraying may be permitted as directed by the Engineer.

Select an application temperature, as approved, in accordance with Item 300, "Asphalts, Oils, and Emulsions." Uniformly apply the asphalt material at the rate shown on the plans or as directed by the Engineer, within 15°F of the approved temperature, and not above the maximum allowable temperature.

2. Limitations. Do not apply asphalt to the roadway until:

- traffic control methods and devices are in place as shown on the plans or as directed,
- the loaded aggregate spreader is in position and ready to begin,
- haul trucks are loaded with enough aggregate to cover the shot area, and
- haul trucks are in place behind the spreader box.

3. **Non-Uniform Applications.** Stop application if it is not uniform due to streaking, ridging, puddling, or flowing off the roadway surface. Verify equipment condition, operating procedures, application temperature, and material properties. Determine and correct the cause of non-uniform application. If the cause is high or low emulsion viscosity, replace emulsion with material that corrects the problem.

4. **Test Strips.** The Engineer may stop asphalt application and require construction of test strips at the Contractor's expense if any of the following occurs:

   - non-uniformity of application continues after corrective action;
   - on 3 consecutive shots, application rate differs by more than 0.03 gallons per square yard from the rate directed; or
   - any shot differs by more than 0.05 gallons per square yard from the rate directed.

   The Engineer will approve the test strip location. The Engineer may require additional test strips until surface treatment application meets specification requirements.

F. Aggregate Placement. As soon as possible, apply aggregate uniformly at the rate directed without causing the rock to roll over.

G. Rolling. Start rolling operation on each shot as soon as aggregate is applied. Use sufficient rollers to cover the entire mat width in 1 pass, i.e., 1 direction. Roll in a staggered pattern. Unless otherwise shown on the plans, make a minimum of:

- 5 passes or
- 3 passes when the asphalt material is an emulsion.

If rollers are unable to keep up with the spreader box, stop application until rollers have caught up, or furnish additional rollers. Keep roller tires asphalt-free.

H. Patching. Before rolling, repair spots where coverage is incomplete. Repair can be made by hand spotting or other approved method. When necessary, apply additional asphalt material to embed aggregate.

I. Brooming. After rolling, sweep as soon as aggregate has sufficiently bonded to remove excess.

After rolling of the finished surface is completed, all parkways, private property, and driveways adjacent to the work shall be cleared of any surplus aggregate by the Contractor by sweeping.

Until the work has been accepted, additional sweeping shall be required as often as necessary so that loose aggregate does not present a hazard to traffic.

J. Final Acceptance. Maintain surface treatment until the Engineer accepts the work. Repair any surface failures.

K. Two-Course Surface Treatments. It is the intent of this specification that the application of asphalt and aggregate for multiple courses be applied within the same day, or immediately thereafter, and prior to opening the roadway to traffic.

The asphaltic material for each course of the surface treatment shall be applied and covered with aggregate in the same manner specified for the first application. Each surface shall then be broomed or raked as required by the Engineer and thoroughly rolled as specified for the first course. Asphaltic material and aggregate for each course shall be applied at the rates directed by the Engineer or as shown on the plans.

The Contractor shall be responsible for the maintenance of each course until covered by the succeeding courses or until the work is accepted by the Engineer. All holes or failures in the 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 material will not adhere to or be picked up by the wheels of vehicles.

204.5. MEASUREMENT: "Surface Treatment" will be measured by the completed and accepted square yard.

204.6. PAYMENT: The work performed as prescribed by this item will be paid for at the contract unit bid price per square yard for "Surface Treatment," which price shall be full compensation for furnishing and placing all materials, sweeping, rolling, manipulations, labor, tools, equipment, and incidentals necessary to complete the work.

204.7. BID ITEM:

Item 204.1 - One Course Surface Treatment - per square yard

Item 204.2 - Two Course Surface Treatment - per square yard

ITEM

205 HOT MIX ASPHALTIC CONCRETE PAVEMENT

205.1. DESCRIPTION: *Construct a leveling-up course, a surface course or any combination of these courses as shown on the plans, each to be composed of a compacted mixture of mineral aggregate and asphaltic material. The pavement shall be constructed on the newly constructed subgrade or base course, existing pavement, bituminous surface or in the case of bridges, on the prepared floor slab, as herein specified and in accordance with the details shown on the plans.*

205.2. MATERIALS: Materials used in Hot Mix Asphaltic Concrete Pavement shall meet the requirements as set forth herein. If shown on the plans, materials may also meet the requirements as described in Item 340, "Dense-Graded Hot-Mix Asphalt (Method)" or Item 341, "Dense-Graded Hot-Mix Asphalt (QC/QA)" of the Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.

Unless otherwise shown on the plans, provide aggregates that meet the aggregate quality requirements of TxDOT's Bituminous Rated Source Quality Catalog (BRSQC). Unapproved sources may be used if accepted by the Engineer and approved prior to use.

Furnish aggregates from sources that conform to the requirements shown in Table 1 herein, and as specified in this Section, unless otherwise shown on the plans. Provide aggregate stockpiles that meet the definition in this Section for either a coarse aggregate or fine aggregate. When reclaimed asphalt pavement (RAP) is used, provide RAP stockpiles in accordance with this Section. Aggregate from RAP is not required to meet Table 1 requirements unless otherwise shown on the plans.

Document all test results on a mixture design report and submit to the Engineer for approval. The Engineer may perform tests on independent or split samples to verify Contractor mix design results. Stockpile aggregates for each source and type separately. Determine aggregate gradations for mixture design and production testing based on the washed sieve analysis given in TxDOT standard laboratory test procedure Tex-200-F, Part II. Do not add material to an approved stockpile from other sources, unless otherwise approved by the Engineer.

Unless otherwise shown on the plans, reclaimed asphalt pavement (RAP) may be used in asphalt pavement maintenance or rehabilitation applications and shall be limited to a maximum of 20% RAP for surface or wearing courses and 30% RAP for courses below the surface or wearing course. Higher percentages of RAP may be used if requested in writing and approved by the Engineer prior to use.

A. Coarse Aggregate. Coarse aggregate stockpiles must have no more than 20% passing the #8 sieve. Provide aggregates with a surface aggregate classification (SAC) as shown below:

Street Classification	Minimum Surface Aggregate Classification
Primary and Secondary Arterials	A
Collector and Local Type B Streets	B
Local Type A Street With Bus Traffic	B
Local Type A Street Without Bus Traffic	C

SAC requirements apply only to aggregates used on the surface of travel lanes, unless otherwise shown on the plans. Blending aggregates to meet SAC criteria is allowable. Class B aggregate meeting all other requirements in Table 1 may be blended with a Class A aggregate in order to meet requirements for Class A materials. When blending Class A and B aggregates to meet a Class A requirement, ensure that at least 50% by weight of the material retained on the No. 4 sieve comes from the Class A aggregate source. Blend by volume if the bulk specific gravities of the Class A and B aggregates differ by more than 0.300. When blending, do not use Class C or D aggregates. For blending purposes, coarse aggregate from RAP will be considered as Class B aggregate.

B. Reclaimed Asphalt Pavement (RAP). RAP is defined as a salvaged, pulverized, broken or crushed asphalt pavement. The RAP to be used in the mix shall be crushed or broken to the extent that 100% will pass the two inch sieve.

The stockpiled RAP shall not be contaminated by dirt or other objectionable materials. Unless otherwise shown on the plans, stockpiled, crushed RAP shall have a decantation of 5% or less and a plasticity index of eight (8) or less, when tested in accordance with TxDOT standard laboratory test procedures Tex-406-A, Part I, and Tex-106-E, respectively. This requirement applies to stockpiles from which the asphalt has not been removed by extraction. When RAP is used, determine asphalt content and gradation for mixture design purposes.

C. Fine Aggregate. Fine aggregates may consist of manufactured sands, screenings and field sands. Supply fine aggregates that are free from organic impurities. Field sands and other uncrushed aggregates shall be limited to 15% of the total aggregate.

If 10% or more of the fine aggregate stockpile is retained on the No. 4 sieve, test the stockpile and verify that it meets the requirements in Table 1 for coarse aggregate angularity (TxDOT standard laboratory test procedure Tex-460-A) and flat and elongated particles (TxDOT standard laboratory test procedure Tex-280-F).

D. Asphalt Binder. Unless shown on the plans, provide the type and grade of performance-graded asphalt binder in accordance with TxDOT Item 300.2.J. "Performance-Graded Binders" and as specified below:

<table>
<tr><th rowspan="2">Street Classification</th><th colspan="3">Minimum PG Asphalt Cement Grade</th></tr>
<tr><th>Surface Courses</th><th>Binder & Level Up Courses</th><th>Base Courses</th></tr>
<tr><td>Primary and Secondary Arterials</td><td>PG 76-22</td><td rowspan="2">PG 70-22</td><td rowspan="4">PG 64-22</td></tr>
<tr><td>Collector and Local Type B Streets</td><td rowspan="2">PG 70-22</td></tr>
<tr><td>Local Type A Street With Bus Traffic</td><td rowspan="2">PG 64-22</td></tr>
<tr><td>Local Type A Street Without Bus Traffic</td><td>PG 64-22</td></tr>
</table>

E. Mineral Filler. Mineral filler consists of finely divided mineral matter such as agricultural lime, crusher fines, hydrated lime, cement, or fly ash. Mineral filler is allowed unless otherwise shown on the plans. Do not use more than 2% hydrated lime or cement, unless otherwise shown on the plans. The plans may require or disallow specific mineral fillers. When used, provide mineral filler that:

- is sufficiently dry, free-flowing, and free from clumps and foreign matter;

- does not exceed 3% linear shrinkage when tested in accordance with Tex-107-E; and
- meets the gradation requirements of Table 3 herein.

F. Baghouse Fines. Fines collected by the baghouse or other dust collecting equipment may be reintroduced into the mixing drum.

G. Tack Coat. Unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder and in accordance with Item 203, "Tack Coat." Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

H. Additives. When shown on the plans, use the type and rate of additive specified. Other additives that facilitate mixing or improve the quality of the mixture may be allowed when approved. If lime or a liquid antistripping agent is used, add in accordance with TxDOT Item 301, "Asphalt Antistripping Agents." Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream, unless the plant has a baghouse or dust collection system that reintroduces the lime back into the drum.

Table 1
Aggregate Quality Requirements

Property	TxDOT Standard Laboratory Test Procedure	Surface Courses	Binder, Level Up, & Base Courses
Coarse Aggregate			
Deleterious Material, %, max	Tex-217-F, Part I	1.0	1.5
Decantation, %, max	Tex-217-F, Part II	1.5	1.5
Micro-Deval Abrasion, %, max	Tex-461-A	Screening Only	Screening Only
Los Angeles Abrasion, %, max	Tex-410-A	35	40
Magnesium Sulfate Soundness, 5 cycles, %, max	Tex-411-A	25	30
Coarse Aggregate Angularity, 2 crushed faces, %, min	Tex-460-A, Part I	95[1]	85[1]
Flat and Elongated Particles @ 5:1, %, max	Tex-280-F	10	10
Fine Aggregate			
Linear Shrinkage, %, max	Tex-107-E	3	3
Combined Aggregate[2]			
Sand Equivalent, %, min	Tex-203-F	45	45

Note 1: Applies to Gravel Only
Note 2: Aggregate without mineral filler, RAP, or additives combined as used in the job-mixed formula (JMF)

Table 2
Gradation Requirements for Fine Aggregates

Sieve Size, in	% Passing by Weight or Volume
3/8	100
#8	70 – 100
#200	0 – 30

Table 3
Gradation Requirements for Mineral Filler

Sieve Size, in	% Passing by Weight or Volume
#8	100
#200	55 – 100

205.3. EQUIPMENT: All equipment for the handling of all materials, mixing, placing and compacting of the mixture shall be maintained in good repair and operating condition and subject to the approval of the Engineer. Any equipment found to be defective and potentially having a negative effect on the quality of the paving mixture or ride quality will not be allowed.

A. Spreading and Finishing Machine. The spreading and finishing machine shall be approved by the Engineer and shall meet the requirements indicated below.

1. Screed Unit. The spreading and finishing machine shall be equipped with a heated compacting screed. It shall produce a finished surface meeting the requirements of the typical cross sections and the surface test.

Extensions added to the screed shall be provided with the same compacting action and heating capability as the main screed unit, except for use on variable depth tapered areas and/or as approved by the Engineer.

The spreading and finishing machine shall be equipped with an approved automatic dual longitudinal screed control system and automatic transverse screed control system. The longitudinal controls shall be capable of operating from any longitudinal grade reference including a stringline, ski, mobile stringline, or matching shoe.

The Contractor shall furnish all equipment required for grade reference. It shall be maintained in good operating condition by personnel trained in the use of this type of equipment.

The grade reference used by the Contractor may be of any type approved by the Engineer. The contractor shall set the grade reference to have sufficient support so that the maximum deflection shall not exceed 1/16 inch between supports.

2. Tractor Unit. The tractor unit shall be equipped with a hydraulic hitch sufficient in design and capacity to maintain contact between the rear wheels of the hauling equipment and the pusher rollers of the finishing machine while the mixture is being unloaded.

No portion of the weight of hauling equipment, other than the connection, shall be supported by the asphalt paver. No vibrations or other motions of the loading equipment, which could have a detrimental effect on the riding quality of the completed pavement, shall be transmitted to the paver.

The use of any vehicle which requires dumping directly into the finishing machine and which the finishing machine cannot push or propel to obtain the desired lines and grades without resorting to hand finishing will not be allowed.

B. Material Transfer Equipment. Equipment to transfer mixture from the hauling units or the roadbed to the spreading and finishing machine will be allowed unless otherwise shown on the plans. A specific type of material transfer equipment shall be required when shown on the plans.

C. Motor Grader. The motor grader, when used, shall meet the requirements as shown in Item 220, “Blading.”

D. Rollers. Rollers provided shall meet the requirements for their type as shown in Item 210, “Rolling.”

205.4. CONSTRUCTION: It shall be the responsibility of the Contractor to design, produce, transport, place and compact the specified paving mixture in accordance with the requirements herein. The Engineer will perform verification testing as needed. Provide quality control (QC) testing as needed to meet the requirements of this Item. Provide a certified Level I-A specialist at the plant during production hours. Provide a certified Level I-B specialist to conduct placement tests.

A. Quality Control Plan (QCP). Unless otherwise shown on the plans, develop and follow a QCP. Obtain approval from the Engineer for changes to the QCP made during the project. The Engineer may suspend operations if the Contractor fails to comply with the QCP.

Submit a written QCP to the Engineer and receive the Engineer's approval of the QCP before beginning production. Include the following items in the QCP.

1. Project Personnel. Provide:

a. a list of individuals that will conduct tests as well their associated certifications (i.e. Level IA, IB, and II certifications), including when certifications will expire for each individual; and

b. a list of individuals responsible for QC with authority to take corrective action and the contact information for each individual listed.

2. Material Delivery and Storage. Provide:

a. the sequence of material processing, delivery, and minimum quantities to assure continuous plant operations;

b. aggregate stockpiling procedures to avoid contamination and segregation;

c. frequency, type, and timing of aggregate stockpile testing to assure conformance of material requirements before mixture production; and

d. procedure for monitoring the quality and variability of asphalt binder.

3. Production. Detail:

a. loader operation procedures to avoid contamination in cold bins;

b. procedures for calibrating and controlling cold feeds;

c. procedures to eliminate debris or oversized material;

d. procedures for adding and verifying rates of each applicable mixture component (e.g., aggregate, asphalt binder, RAP, lime, liquid antistrip);

e. procedures for reporting job control and acceptance test results; and

f. procedures to avoid segregation and drain-down in the silo.

4. Loading and Transporting. Provide:

a. the type and application method for release agents; and

b. truck loading procedures to avoid segregation.

5. Placement and Compaction. Provide:

a. the proposed agenda for mandatory pre-paving meeting including date and location;

b. the type and application method for release agents in the paver and on rollers, shovels, lutes, and other utensils;

c. procedures for the transfer of mixture into the paver while avoiding segregation and preventing material spillage;

d. the process to balance production, delivery, paving, and compaction to achieve continuous placement operations;

e. the paver operations (e.g., operation of wings, height of mixture in auger chamber) to avoid physical and thermal segregation and other surface irregularities; and

f. procedures to construct quality longitudinal and transverse joints.

B. Mixture Design. Use a Level II specialist certified by a TxDOT-approved hot-mix asphalt certification program to develop the mixture design. Have the Level II specialist sign the design documents. Unless otherwise shown on the plans, use the typical weight design example given in TxDOT standard laboratory test procedure Tex-204-F, Part I or Part III, to design a mixture meeting the requirements listed in Tables 1 through 5. At the request of the Engineer, furnish representative samples of all materials used in the mixture design for verification. If the design cannot be verified by the Engineer, furnish another mixture design.

The Contractor may submit a new mixture design at anytime during the project. The Engineer will approve all mixture designs before the Contractor can begin production.

Provide the Engineer with a mixture design report that includes the following items:

- the combined aggregate gradation, source, specific gravity, and percent of each material used;
- results of all applicable tests;
- the mixing and molding temperatures;
- all applicable correlation and correction factors;
- the signature of the Level II person or persons who performed the design;
- the date the mixture design was performed; and
- a unique identification number for the mixture design.

The Hamburg Wheel Test is not required, unless otherwise shown on the plans. When required through plan note, the minimum number of passes shown in Table 6 shall be met, unless otherwise approved by the Engineer. The contractor will be responsible for submitting the results of the Hamburg Wheel test to the Engineer with the other mixture design data. Use an approved laboratory to perform the Hamburg Wheel test. The TxDOT Construction

Division maintains a list of approved laboratories that may be referenced. Hamburg Wheel Testing will not be performed or required for any Type "F" mixtures.

Table 4
Master Gradation Bands (% Passing by Weight or Volume) and Volumetric Properties

Sieve Size	A Coarse Base	B Fine Base	C Coarse Surface	D Fine Surface	F Fine Mixture
1-½"	98.0–100.0	–	–	–	–
1"	78.0–94.0	98.0–100.0	–	–	–
¾"	64.0–85.0	84.0–98.0	95.0–100.0	–	–
½"	50.0–70.0	–	–	98.0–100.0	–
⅜"	–	60.0–80.0	70.0–85.0	85.0–100.0	98.0–100.0
#4	30.0–50.0	40.0–60.0	43.0–63.0	50.0–70.0	70.0-90.0
#8	22.0–36.0	29.0–43.0	32.0–44.0	35.0–46.0	35.0–50.0
#30	8.0–23.0	13.0–28.0	14.0–28.0	15.0–29.0	12.0–27.0
#50	3.0–19.0	6.0–20.0	7.0–21.0	7.0–20.0	6.0–19.0
#200	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0	2.0–7.0
Design Voids in the Mineral Aggregate (VMA), % minimum					
	12.0	13.0	14.0	15.0	16.0
Plant-Produced Voids in the Mineral Aggregate (VMA), % minimum					
	11.0	12.0	13.0	14.0	15.0

Table 5
Laboratory Mixture Design Properties

Property	TxDOT Standard Laboratory Test Procedure	Required	
Target laboratory-molded density, %	Tex-207-F	96.5	Base, Binder, and Level Up Courses
		Surface or Wearing Courses	
		96.5	Primary and Secondary Arterials
		97.0	Collectors, Local Type B Streets, and Local Type A Street With Bus Traffic
		97.5	Local Type A Street Without Bus Traffic
Boil test[1]	Tex-530-C	–	

1. Used to establish baseline for comparison to production results. May be waived when approved.

Table 6
Hamburg Wheel Test Requirements[1]

High-Temperature Binder Grade	Minimum # of Passes[2] @ 0.5" Rut Depth, Tested @ 122°F
PG 64 or lower	5,000
PG 70	10,000
PG 76 or higher	20,000

1. Tested in accordance with Tex-242-F.
2. May be decreased if shown on the plans.

C. Job-Mix Formula. The laboratory mixture design shall be submitted to the Engineer for approval prior to production and placement. The submittal shall provide the laboratory

designed mixture target properties and data that demonstrate the contractor's ability to produce the mixture within the tolerances specified in Table 7 herein either through a trial batch or by submittal of previous production data from a City or TxDOT project.

Once approved, the contractor may begin production and placement of the approved JMF. Results from Lot 1 of the JMF may be used to modify the optimum mixture properties as long as the tested properties are within the tolerances specified in Table 7 herein. Further adjustments to the JMF may be allowed by the Engineer during production and placement, if warranted. JMF adjustment requests must be made in writing to the Engineer and the mixture must conform to the master gradation limits for the mixture type and be within the operational limits of Table 7 noted above for the initial JMF approved by the Engineer.

Table 7
Operational Tolerances

Description	Test Method	Allowable Difference from Current JMF Target
Individual % Retained for #8 Sieve or Larger	Tex-200-F or Tex-236-F	±5.0[1]
Individual % Retained for Sieves Smaller than #8 and Larger than #200		±3.0[1]
% Passing the #200 Sieve		±2.0[1]
Asphalt Content, %	Tex-236-F	±0.3[2]
Laboratory-Molded Density, %	Tex-207-F	±1.0
VMA, % minimum		Note 3

Note 1: When within these tolerances, mixture production gradations may fall outside the master grading limits; however, the % passing the #200 sieve will be considered out of tolerance when outside the master grading limits.
Note 2: Tolerance between Laboratory Mix and Plant Trial Batch may exceed ±0.3.
Note 3: Test and verify that Table 4 requirements are met.

D. Production. Do not heat the asphalt binder above the temperatures specified in TxDOT Item 300, "Asphalts, Oils, and Emulsions," or outside the manufacturer's recommended values. Do not store an asphaltic mixture for a period long enough to affect the quality of the mixture, nor in any case longer than 12 hr.

Notify the Engineer of the target discharge temperature and produce the mixture within 25°F of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 350°F. The Engineer will not pay for, or allow placement of, any mixture produced at more than 350°F. Control the mixing time and temperature so that moisture is removed from the mixture before discharging from the plant. If requested, determine the moisture content by oven-drying in accordance with TxDOT standard laboratory test procedure Tex-212-F, Part II, and verify that the mixture contains no more than 0.2% of moisture by weight. Obtain the sample immediately after discharging the mixture into the truck, and perform the test promptly.

Perform a new trial batch when the plant or plant location is changed. The Engineer may suspend production for noncompliance with this Item. Take corrective action and obtain approval to proceed after any production suspension for noncompliance.

E. Tack Coat. The surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Inspector. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. Unless otherwise shown on the plans, tack

coat shall be applied with an approved sprayer at a rate directed by the Engineer between 0.04 and 0.10 gallon residual asphalt per square yard of surface.

F. Transporting Asphaltic Concrete. The asphaltic mixture shall be hauled to the work site in vehicles previously cleaned of all foreign material and with beds that do not discharge or lose materials during the haul. Trucks that do not meet the satisfaction of the Engineer or Inspector will not be allowed to deliver materials to City projects. The dispatching of the vehicles shall be arranged so that all material is delivered, placed, and rolled during daylight hours unless otherwise shown on the plans. In cool weather, or for long hauls, covering and insulating of the truck bodies may be required. If necessary, to prevent the mixture from adhering to the inside of the truck body, the inside of the truck may be given a light coating of release agent satisfactory to the Engineer.

G. Placement.

1. **Weather Conditions.** Place mixture, when placed with a spreading and finishing machine, or the tack coat when the roadway surface temperature is 60°F or higher unless otherwise approved. Measure the roadway surface temperature with a handheld infrared thermometer. Place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer.

   The asphaltic mixture, when placed with a motor grader, shall not be placed when the surface temperature is below 65°F and is falling, but may be placed when the surface temperature is above 55°F and is rising. The maximum depth of asphalt mixture placed with a motor grader will not exceed 5 inches of compacted material.

   Mat thicknesses of 1-½ inches and less shall not be placed when the temperature of the surface on which the mat is to be placed is below 60°F.

   It is further provided that the tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions, temperature and moisture condition of the base are suitable.

2. **Placement Temperature.** If, after being discharged from the mixer and prior to placing, the temperature of the asphaltic mixture falls below 200°F, all or any part of the load may be rejected and payment will not be made for the rejected material.

3. **Placement Operations.** Placement and laydown operations shall be in conformance with this section and Section 205.4.H. - "Quality Control and Acceptance."

   Prepare the surface by removing raised pavement markers and objectionable material such as moisture, dirt, sand, leaves, and other loose impediments from the surface before placing mixture. Remove vegetation from pavement edges.

   The asphaltic mixture shall be dumped and spread on the approved prepared surface with the spreading and finishing machine. Place the mixture to meet the typical section requirements and produce a smooth, finished surface with a uniform appearance and texture. In addition, the placing of the asphaltic mixture shall be completed without tearing, shoving, gouging or segregating the mixture and without producing streaks in the mat.

Unloading into the finishing machine shall be controlled so that bouncing or jarring the spreading and finishing machine shall not occur and the required lines and grades shall be obtained without resorting to hand finishing.

When approved by the Engineer, level-up courses may be spread with a motor grader.

Construction joints of successive courses of asphaltic material shall be offset at least 6 inches. Construction joints on surface courses shall coincide with lane lines, or as directed by the Engineer.

The spreading and finishing machine shall be operated at a uniform forward speed consistent with the plant production rate, hauling capability, and roller train capacity to result in a continuous operation. The speed shall be slow enough that stopping between trucks is not ordinarily required. If, in the opinion of the Inspector, sporadic delivery of material is adversely affecting the mat, the Inspector may require paving operations to cease until acceptable methods are provided to minimize starting and stopping of the paver.

The hopper flow gates of the spreading and finishing machine shall be adjusted to provide an adequate and consistent flow of material. These shall result in enough material being delivered to the augers so that they are operating approximately 85 percent of the time or more. The augers shall provide means to supply adequate flow of material to the center of the paver. Augers shall supply an adequate flow of material for the full width of the mat, as approved by the Engineer. Augers should be kept approximately one-half to three-quarters full of mixture at all times during the paving operation.

When the asphaltic mixture is placed in a narrow strip along the edge of an existing pavement, or used to level up small areas of an existing pavement, or placed in small irregular areas where the use of a finishing machine is not practical, the finishing machine may be eliminated when authorized by the Engineer.

Adjacent to flush curbs, gutters and structures, the surface shall be finished uniformly high so that when compacted, it will be slightly above the edge of the curb or structure.

If a pattern of surface irregularities or segregation is detected, the Contractor shall make an investigation into the causes and immediately take the necessary action. With the approval of the Inspector, placement may continue for no more than one full production day from the time the Contractor is first notified and while corrective actions are being taken. If the problem still exists after that time, paving shall cease until the Contractor further investigates the causes and the Engineer approves further corrective action to be taken.

Place mixture within the compacted lift thickness shown in Table 8, unless otherwise shown on the plans or allowed.

Use the guidelines in Table 9 to establish the temperature of mixture delivered to the paver.

Table 8
Compacted Lift Thickness and Required Core Height

Mixture Type	Compacted Lift Thickness		Minimum Untrimmed Core Height (in.) Eligible for Testing
	Minimum (in.)	Maximum (in.)	
A	3.00	6.00	2.00
B	2.50	5.00	1.75
C	2.00	4.00	1.50
D	1.50	3.00	1.25
F	1.25	2.50	1.25

Table 9
Suggested Minimum Mixture Placement Temperature

High-Temperature Binder Grade	Minimum Placement Temperature (Before Entering Paver)
PG 64 or lower	260°F
PG 70	270°F
PG 76	280°F
PG 82 or higher	290°F

4. **Compaction.** The pavement shall be compacted thoroughly and uniformly with the necessary rollers to obtain the compaction and cross section of the finished paving mixture meeting the requirements of the plans and specifications.

   The edges of the pavement along curbs, headers and similar structures, and all places not accessible to the roller, or in such positions as will not allow thorough compaction with the rollers, shall be thoroughly compacted with lightly oiled tamps.

   Rolling with a trench roller will be required on widened areas, in trenches and other limited areas where satisfactory compaction cannot be obtained with the approved rollers.

   a. **In-Place Compaction Control.** Use density control unless ordinary compaction control is specified on the plans. Use the control strip method given in Tex-207-F, Part IV, to establish the rolling pattern for density controlled areas.

      Where specific density or air void requirements are waived, furnish and operate compaction equipment as approved.

      Do not use pneumatic-tire rollers if excessive pickup of fines by roller tires occurs. Unless otherwise directed, use only water or an approved release agent on rollers, tamps, and other compaction equipment. Keep diesel, gasoline, oil, grease, and other foreign matter off the mixture.

      When rolling with the three-wheel, tandem or vibratory rollers, it is recommended that rolling start by first rolling the joint with the adjacent pavement and then continue by rolling longitudinally at the sides and proceed toward the center of the pavement, overlapping on successive trips by at least 1 foot. Alternate trips of the roller should be slightly different in length. On super-elevated curves, rolling should begin at the low side and progress toward the high side.

      When rolling with vibratory steel-wheel rollers, equipment operation shall be in accordance with Item 210, “Rolling”, and the manufacturer's recommendations, unless otherwise directed by the Engineer. Vibratory rollers shall not be left vibrating

while not rolling or when changing directions. In addition, vibratory rollers shall not be allowed in the vibrating mode on mats with a plan depth of less than 1-½ inches, unless approved by the Engineer.

The motion of the rollers shall be slow enough to avoid other than usual initial displacement of the mixture. If any displacement occurs, it shall be corrected to the satisfaction of the Inspector. Ensure pavement is fully compacted before allowing rollers to stand on the pavement.

(1) Ordinary Compaction Control. One three-wheel roller, one pneumatic-tire roller, and one tandem roller shall be furnished for each compaction operation except as provided below or approved by the Engineer. The use of a tandem roller may be waived by the Engineer when the surface is already adequately smooth and further steel-wheel rolling is shown to be ineffective. With approval of the Engineer, the Contractor may substitute a vibratory roller for the three-wheel roller and/or the tandem roller. Use of at least one pneumatic-tire roller is required unless approved by the Engineer. Additional or heavier rollers shall be furnished if required by the Engineer.

Rolling patterns shall be established by the Contractor to achieve the maximum compaction. The selected rolling pattern shall be followed unless changes in the mixture or placement conditions occur which affect compaction. When changes in the mixture or placement conditions occur, a new rolling pattern shall be established.

(2) Density Compaction Control. Place and compact asphaltic concrete materials in accordance with the method specified in Section 205.4.H, "Quality Control and Acceptance."

5. Compaction Cessation Temperature. Regardless of the method required for in-place compaction control, all rolling for compaction shall be completed before the mixture temperature drops below 175°F.

6. Opening to Traffic. Allow the compacted pavement to cool to 160°F or lower before opening to traffic unless otherwise directed. When directed, sprinkle the finished mat with water or limewater to expedite opening the roadway to traffic.

If the surface ravels, flushes, ruts or deteriorates in any manner prior to final acceptance of the work, it will be the Contractor's responsibility to correct this condition at their expense, to the satisfaction of the Inspector and in conformance with the requirements of this specification.

H. Quality Control and Acceptance. Control and acceptance of hot mixed asphaltic concrete pavement shall be followed as specified herein or as directed on the plans. The contractor shall conduct production and placement operations in accordance with the method specified. All testing will be conducted in accordance with the testing methods shown in Table 10.

Table 10
Acceptable Production and Placement Testing Methods

Description	Test Method
Gradation including % passing the #200 sieve	Tex-200-F or Tex-236-F
Laboratory-molded density	Tex-207-F
VMA	
Laboratory-molded bulk specific gravity	
In-Place air voids	
Segregation (density profile)	Tex-207-F, Part V
Longitudinal joint density	Tex-207-F, Part VII
Moisture content	Tex-212-F, Part II
Theoretical maximum specific (Rice) gravity	Tex-227-F
Asphalt content	Tex-236-F
Hamburg Wheel test	Tex-242-F
Thermal profile	Tex-244-F
Asphalt binder sampling and testing[1]	Tex-500-C
Boil test[1]	Tex-530-C

1. The Engineer may waive the sampling and testing requirements at their discretion.

1. **Production Sampling and Testing.** For a given project, sample asphaltic concrete materials at the production facility every 500 tons for each mixture type supplied or as directed by the Engineer. Unless otherwise shown on the plans, a production facility that supplies the same mixture to multiple City projects on the same day will not be required to sample and test at the required frequency for every project. A single test report may be used on two or more projects to represent the quality of the mixture for that day's production.

   During production, do not exceed the operational tolerances in Table 7. Stop production if testing indicates tolerances are exceeded on:

   - 3 consecutive tests on any individual sieve,
   - 4 consecutive tests on any of the sieves, or
   - 2 consecutive tests on asphalt content.

   Suspend production and shipment of mixture if the asphalt content deviates from the current JMF by more than 0.5% for any test.

   Begin production only when test results or other information indicate, to the satisfaction of the Engineer, that the next mixture produced will be within Table 7 tolerances.

   The Contractor shall perform a Hamburg Wheel test at the direction of the Engineer at any time during production, including when the boil test indicates a change in quality from the materials submitted for the initial JMF. If the production sample fails the Hamburg Wheel test criteria in Table 6, suspend production until further Hamburg Wheel tests meet the specified values. The Engineer may require up to the entire sublot of any mixture failing the Hamburg Wheel test to be removed and replaced at the Contractor's expense.

   If the Hamburg Wheel test results in a "remove and replace" condition, the Contractor may request that the Engineer confirm the results by retesting the failing material. An Independent laboratory retained by the Engineer will perform the Hamburg Wheel tests

and determine the final disposition of the material in question based on the initial test results.

2. Placement Sampling and Testing.

a. In-Place Density. For every 500 tons of compacted asphaltic material or as directed by the Engineer, test the in place density. The in place density shall be in the range of 92.0% to 97.0% of the maximum density. Do not increase the asphalt content of the mixture to increase pavement density.

Unless otherwise shown on the plans, obtain 2 roadway specimens at each location selected by the Engineer for in-place density determination. Unless otherwise determined, the Engineer will witness the coring operation and measurement of the core thickness. Unless otherwise approved, obtain the cores within 1 working day after placement is completed. Obtain two 6 inch diameter cores side-by-side from within 1 foot of the location provided by the Engineer. For Type C, D and F mixtures, 4 inch diameter cores are allowed. Mark the cores for identification.

Visually inspect each core and verify that the current paving layer is bonded to the underlying layer. If an adequate bond does not exist between the current and underlying layer, take corrective action to insure that an adequate bond will be achieved during subsequent placement operations.

Immediately after obtaining the cores, dry the core holes and tack the sides and bottom. Fill the hole with the same type of mixture and properly compact the mixture. Repair core holes with other methods when approved.

If the core heights exceed the minimum untrimmed values listed in Table 8, trim the cores within 1 working day following placement operations unless otherwise approved. If the core height before trimming is less than the minimum untrimmed value shown in Table 8, decide whether or not to include the pair of cores in the density determination for that sublot. If the cores are to be included in density determination, trim the cores. If the cores will not be included in density determination, store untrimmed cores for the Engineer.

The Engineer will measure density in accordance with Tex-207-F and Tex-227-F. Before drying to a constant weight, cores may be predried using a vacuum device, or by other methods approved by the Engineer, to remove excess moisture. The Engineer will use the average density of the 2 cores to calculate the in-place density at the selected location.

If the in-place density in the compacted mixture is below 92% or greater than 97%, change the production and placement operations to bring the in-place density within requirements. The Engineer may suspend production until the in-place density is brought to the required level, and may require a test section as described below, before proceeding.

At the onset of production, or after production and placement operations have been altered to bring the in-place density into conformance, construct a test section of 1 lane-width and at most 0.2 miles in length to demonstrate that compaction to between 92.0% and 97.0% in-place density can be obtained. Continue this procedure until a test section with the correct density can be produced. The Engineer will allow only 2

test sections per day. When a test section producing satisfactory in-place air void content is placed, resume full production.

(1) Shoulders and Ramps. Shoulders and ramps are subject to in-place density testing, unless otherwise shown on the plans.

(2) Miscellaneous Areas. Miscellaneous areas include areas that are not generally subject to primary traffic, such as driveways, mailbox turnouts, crossovers, gores, spot level-up areas, and other similar areas. Miscellaneous areas also include level-ups and thin overlays if the layer thickness designated on the plans is less than the compacted lift thickness shown in Table 8.

Miscellaneous areas will not be included in the in place density testing. Compact areas that are not subject to in-place air void determination in accordance with ordinary compaction control.

b. Segregation (Density Profile). If shown on the plans, test for segregation using density profiles in accordance with Tex-207-F, Part V. Provide the Engineer with the results of the density profiles as they are completed. Areas defined as "Miscellaneous Areas," are not subject to density profile testing.

If density profiles are required by the plans, perform a density profile every time the screed stops, on areas that are identified by either the Contractor or the Engineer as having thermal segregation, and on any visibly segregated areas. If the screed does not stop, and there are no visibly segregated areas or areas that are identified as having thermal segregation, perform a minimum of 1 profile per 500 tons of compacted material or as directed by the Engineer.

Reduce the test frequency to a minimum of 1 profile per 2,000 tons of compacted material, or as directed by the Engineer, if 4 consecutive profiles are within established tolerances. Continue testing at this frequency unless a profile fails, at which point resume testing at a minimum frequency of 1 per 500 tons or as directed by the Engineer. The Engineer may further reduce the testing frequency based on a consistent pattern of satisfactory results.

Unless otherwise shown on the plans, the density profile is considered failing if it exceeds the tolerances in Table 11. No production or placement bonus will be paid for any sublot that contains a failing density profile. The Engineer may make as many independent density profile verifications as deemed necessary. The Engineer's density profile results will be used when available.

Investigate density profile failures and take corrective actions during production and placement to eliminate the segregation. Suspend production if 2 consecutive density profiles fail, unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

Table 11
Segregation (Density Profile) Acceptance Criteria

Mixture Type	Maximum Allowable Density Range (Highest to Lowest)	Maximum Allowable Density Range (Average to Lowest)
Type A & Type B	8.0 pcf	5.0 pcf
Type C, Type D, & Type F	6.0 pcf	3.0 pcf

c. Longitudinal Joint Density.

(1) Informational Tests. While establishing the rolling pattern, perform joint density evaluations and verify that the joint density is no more than 3.0 pounds per cubic foot below the density taken at or near the center of the mat. Adjust the rolling pattern if needed to achieve the desired joint density. Perform additional joint density evaluations at least once per sublot unless otherwise directed.

(2) Record Tests. If shown on the plans, for each 500 tons of compacted material or as directed by the Engineer, perform a joint density evaluation at each pavement edge that is or will become a longitudinal joint. Determine the joint density in accordance with Tex-207-F, Part VII. Record the joint density information and submit results to the Engineer. The evaluation is considered failing if the joint density is more than 3.0 pounds per cubic foot below the density taken at the core random sample location and the correlated joint density is less than 90.0%. The Engineer may make independent joint density verifications at the random sample locations. The Engineer's joint density test results will be used when available.

Investigate joint density failures and take corrective actions during production and placement to improve the joint density. Suspend production if 2 consecutive evaluations fail unless otherwise approved. Resume production after the Engineer approves changes to production or placement methods.

d. Recovered Asphalt DSR. The Engineer may take production samples or cores from suspect areas of the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet the requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Engineer. The aging ratio is the dynamic shear rheometer (DSR) value of the extracted binder divided by the DSR value of the original unaged binder (including RAP binder). DSR values are obtained according to AASHTO T 315 at the specified high temperature performance grade of the asphalt. The binder from RAP will be included proportionally as part of the original unaged binder. The Engineer may require removal and replacement of the defective material at the Contractor's expense. The asphalt binder will be recovered for testing from production samples or cores using Tex-211-F.

e. Irregularities. Immediately take corrective action if surface irregularities, including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, color, texture, roller marks, tears, gouges, streaks, or uncoated aggregate particles, are detected.

The Engineer may allow placement to continue for at most 1 day of production while taking appropriate action. If the problem still exists after that day, suspend paving until the problem is corrected to the satisfaction of the Engineer.

At the expense of the Contractor and to the satisfaction of the Engineer, remove and replace any mixture that does not bond to the existing pavement or that has other surface irregularities identified above.

3. **Individual Loads of Hot Mix.** The Engineer can reject individual truckloads of hot mix. When a load of hot mix is rejected for reasons other than temperature, the Contractor may request that the rejected load be tested. Make this request within 4 hr. of rejection. The Engineer will sample and test the mixture. If test results are within the operational tolerances shown in Table 7, payment will be made for the load. If test results are not within operational tolerances, no payment will be made for the load and the Engineer may require removal.

4. **Ride Quality.** When required by the plans, measure ride quality in accordance with TxDOT Standard Specification Item 585, "Ride Quality for Pavement Surfaces." Surface Test Type A or B as well as Pay Schedule 1, 2, or 3 shall also be indicated on the plans.

205.5. MEASUREMENT: Hot Mix Asphaltic Concrete Pavement shall be measured by square yard, complete in place, for the thickness specified on the plans. Limits of payment will be from face of curb to face of curb. Pavement area shall not exceed the limits shown on the plans without written authorization.

205.6. PAYMENT: The work performed and materials furnished, as described by this item and measured as provided herein, shall be paid for at the contract unit bid price per square yard specified on the plans of "Hot Mix Asphaltic Concrete Pavement," which price shall be full compensation for furnishing and placing all materials, and for all labor, tools, equipment, and incidentals necessary to complete the work. The prime coat and tack coat, when required, shall be paid under the provisions of Item Nos. 202 and 203, respectively.

Trial batches will not be paid for unless they are incorporated into pavement work approved by the Engineer.

Pay adjustment for ride quality, when required on the plans, will be determined in accordance with TxDOT Standard Specification Item 585, "Ride Quality for Pavement Surfaces."

205.7. BID ITEM:

Item 205.1 - Hot Mix Asphaltic Pavement Type A - per square yard __inches pavement thickness

Item 205.2 - Hot Mix Asphaltic Pavement Type B - per square yard __inches pavement thickness

Item 205.3 - Hot Mix Asphaltic Pavement Type C - per square yard __inches pavement thickness

Item 205.4 - Hot Mix Asphaltic Pavement Type D - per square yard __inches pavement thickness

Item 205.5 - Hot Mix Asphaltic Pavement Type F - per square yard __inches pavement thickness

ITEM

206 ASPHALT TREATED BASE

206.1. DESCRIPTION: *Construct a base or foundation course composed of a compacted mixture of aggregate and asphalt binder mixed hot in a mixing plant.*

206.2. MATERIALS: Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. When a source change occurs, the Engineer will verify that the specification requirements are met and may require a new laboratory mixture design. Use TxDOT standard laboratory test procedure Tex-100-E for material definitions.

A. Aggregate. Furnish natural aggregates or crushed concrete unless otherwise shown on the plans. When shown on the plans, other recycled materials, including reclaimed asphalt concrete pavement (RAP), are allowed up to the maximum percentage shown on the plans. Stockpile aggregates for each source and type separately. Do not add material to an approved stockpile unless approved by the Engineer.

Furnish aggregates that conform to the requirements shown in Table 1 and specified in this Section unless otherwise shown on the plans. Each source must meet the requirements of Table 1. The Engineer may allow testing of the proposed combined aggregates, rather than each source, to meet Table 1 requirements.

Table 1
Aggregate Quality Requirements

Property	Test Method[1]	Specification Requirement
Wet ball mill, % max	Tex-116-E	50
Max increase, % passing #40		20
Los Angeles abrasion[2], % max	Tex-410-A	50
Liquid limit, max	Tex-104-E	40
Plasticity index, max	Tex-106-E	10
Sand equivalent, % min	Tex-203-F	40
Decantation[3], % max	Tex-406-A	5.0
Crushed faces, % min	Tex-460-A	60

1. TxDOT standard laboratory test procedure.
2. Use only when shown on the plans, instead of wet ball mill test.
3. Required only for RAP stockpiles and recycled aggregates when more than 30% RAP is allowed.

B. Recycled Materials. The use of recycled materials is allowed only when shown on the plans. Crushed concrete, RAP (except for City furnished RAP), and other recycled materials must meet the requirements of this Article. Request approval to blend 2 or more sources of recycled materials.

1. Limits on Percentage. When RAP is allowed by the plans, use no more than 30% unless otherwise shown on the plans. The percentage limitations for other recycled materials will be as shown on the plans.

2. Recycled Material (Including Crushed Concrete) Requirements.

a. Contractor Furnished Recycled Materials. When the Contractor furnishes the recycled materials, including crushed concrete, the final product will be subject to the requirements of this Article and Table 2 for the grade specified. Certify compliance with TxDOT's DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials Guidelines," for Contractor-furnished recycled materials. In addition, recycled materials must be free from reinforcing steel and other objectionable material and have at most 1.5% deleterious material when tested in accordance with TxDOT standard laboratory test procedure Tex-413-A. The unblended recycled materials (crushed concrete and RAP) must not exceed the decantation shown in Table 1. Test RAP without removing the asphalt. Do not use RAP that is contaminated by dirt or other objectionable material. Crushed concrete must be managed in a way to provide for uniform quality. The Engineer may require separate dedicated stockpiles in order to verify compliance.

When more than 30% Contractor-owned recycled materials is allowed and used, the individual materials are subject to the requirements of Table 1.

b. City Furnished Required Recycled Materials. When the City furnishes and requires the use of recycled materials, unless otherwise shown on the plans:

- City required recycled material will not be subject to the requirements in Table 1,
- Contractor furnished materials are subject to the requirements in Table 1 and this Item, and
- the final product, blended or unblended, will be subject to the requirements in Table 2.

Crush City-furnished RAP so that 100% passes the 2 inch sieve. The Contractor is responsible for uniformly blending to meet the percentage required.

c. City Furnished and Allowed Recycled Materials. When the City furnishes and allows the use of recycled materials or allows the Contractor to furnish recycled materials, the final blended product is subject to the requirements of this Article, Table 2, and the plans.

3. Recycled Material Sources. City-owned recycled material is available to the Contractor only when shown on the plans. The location, approximate asphalt content, and approximate gradation will be shown on the plans for City-owned RAP sources in a stockpile condition prior to Contract Execution. Assume that required City-owned RAP meets Table 1 requirements. Return unused City-owned recycled materials to the City stockpile location designated by the Engineer unless otherwise shown on the plans.

The use of Contractor-owned recycled materials is allowed when shown on the plans. Contractor-owned surplus recycled materials remain the property of the Contractor. Remove Contractor-owned recycled materials from the project and dispose of it in accordance with federal, state, and local regulations before project acceptance. Do not intermingle Contractor-owned recycled material with City-owned recycled material unless approved by the Engineer.

C. Asphalt Material. Furnish the type and grade of asphalt binder specified on the plans. Provide asphalt binder that meets requirements of TxDOT Item 300, "Asphalts, Oils and

Emulsions." When more than 30% RAP is allowed and used, ensure that the new binder and recovered binder from the RAP, when blended proportionally, meet the PG binder designation shown on the plans.

D. Tack Coat. Unless otherwise shown on the plans or approved, furnish CSS 1H, SS 1H, or a PG binder with a minimum high temperature grade of PG 58 for tack coat binder and in accordance with Item 203 "Tack Coat" and TxDOT Item 300, "Asphalts, Oils, and Emulsions."

Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use. If required, verify that emulsified asphalt proposed for use meets the minimum residual asphalt percentage specified in TxDOT Item 300, "Asphalts, Oils, and Emulsions."

E. Additives. When shown on the plans, use the type and rate of additive specified. Other additives that facilitate mixing or improve the quality of the mix may be allowed when approved.

If lime or a liquid anti-stripping agent is used, add in accordance with TxDOT Item 301, "Asphalt Anti-stripping Agents." Do not add lime directly into the mixing drum of any plant where lime is removed through the exhaust stream unless the plant has a baghouse or dust collection system that reintroduces the fines back into the drum.

206.3. EQUIPMENT: Provide machinery, tools, and equipment in accordance with TxDOT Item 320, "Equipment for Production, Hauling, and Placement of Hot-Mixed Asphalt Materials."

206.4. CONSTRUCTION: Produce, haul, place, and compact the specified mixture in accordance with the requirements of this Item.

A. Mixture Design. Using TxDOT standard laboratory test procedure Tex-126-E and the materials proposed for the project, the Engineer will determine the target asphalt content required to produce a mixture meeting the requirements in Table 2 for the grade shown on the plans. The gradation of the combined aggregates will be determined in accordance with TxDOT standard laboratory test procedure Tex-200-F, Part I. The Engineer may accept a design from the Contractor that is performed in accordance with TxDOT standard laboratory test procedure Tex-126-E. Reimburse the City for subsequent mixture designs or partial designs necessitated by changes in the material or requests by the Contractor.

The mixture must contain between 4.0% and 9.0% asphalt when designed in accordance with TxDOT standard laboratory test procedure Tex-126-E. The Engineer will evaluate the mixture for moisture susceptibility in accordance with TxDOT standard laboratory test procedure Tex-530-C unless otherwise shown on the plans. A maximum of 10% stripping is allowed unless otherwise shown on the plans. The test sample will be retained and used to establish a baseline for comparison to production results. The Engineer may waive this test if a similar design using the same materials has proven satisfactory.

Produce a trial batch using the proposed project materials and equipment in a large enough quantity to ensure that the mixture is representative of the mixture design. The City will verify the strength requirement in Table 2 is met. The Engineer may waive trial mixtures if similar designs have proven satisfactory.

Table 2
Mix Requirements

Master Gradation Bands Tex-200-F, Part I[1], % Passing by Weight				
Sieve Size	**Grade 1**	**Grade 2**	**Grade 3**	**Grade 4**
1-¾"		100	100	As shown on the plans
1-½"	100	90–100		
1"	90–100			
⅜"	45–70			
#4	30–55	25–55		
#40	15–30	15–40	15–40	
Strength Requirements				
Slow strength, psi, min.[2]	50	40	30	30[3]

1. TxDOT standard laboratory test procedure.
2. TxDOT standard laboratory test procedure Tex-126-E, at optimum asphalt content.
3. Unless a higher minimum strength is shown on the plans.

B. Production Operations. Produce a new trial batch when the plant or plant location is changed. Take corrective action and receive approval to proceed after any production suspension for non-compliance to the specification.

1. **Storage and Heating of Materials.** Do not heat the asphalt binder above the temperature specified in TxDOT Item 300, "Asphalts, Oils and Emulsions," or outside the manufacturer's recommended values. On a daily basis, provide the Engineer with the records of asphalt binder and hot mix asphalt discharge temperatures in accordance with TxDOT Item 320, "Equipment for Hot Mix Asphalt Materials." Unless otherwise approved, do not store hot mix for more than 12 hours or for a time period less than 12 hours that affects the quality of the mixture.

2. **Mixing and Discharge of Materials.** Notify the Engineer of the target discharge temperature and produce the mixture within 25ºF of the target. When ordinary compaction is used, the Engineer will select a target discharge temperature between 225ºF and 350ºF. Produce the mixture within 25ºF of the target. Monitor the temperature of the material in the truck before shipping to ensure that it does not exceed 350ºF. The City will not pay for or allow placement of any mixture produced at more than 350ºF.

   Control the mixing time and temperature so that substantially all moisture is removed from the mixture before discharging from the plant. The Engineer may perform TxDOT standard laboratory test procedure Tex-212-F, Part II, to verify that the mixture contains no more than 0.2% moisture by weight. The sample will be taken immediately after the mixture is discharged into the truck and tested promptly.

C. Hauling Operations. Before use, clean all truck beds to ensure that the mixture will not become contaminated. When a release agent is necessary, use a release agent on the approved list maintained by the TxDOT Construction Division to coat the truck bed.

D. Placement Operations. Prepare the surface by removing objectionable material such as moisture, dirt, sand, leaves and other loose impediments before placing the mixture. Coordinate mixture delivery and paver speed to ensure a continuous placement operation. Suspend placement operations when, in the opinion of the Engineer, a continuous paving operation is not maintained. Place the mixture to produce a smooth, finished surface with a

uniform appearance and texture that meet typical section requirements. Offset longitudinal joints of successive courses of treated base by at least 6 inches. Place the mix adjacent to gutters and structures so that the pavement will drain properly.

1. **Weather Conditions.** Tack coat and mixture may be placed only when the roadway surface temperature is 50ºF or higher unless otherwise approved. Measure the roadway surface temperature with a handheld infrared thermometer. Place tack coat or mixtures only when the Engineer determines that general weather conditions and moisture conditions of the roadway surface are suitable. The Engineer may waive placement temperature requirements.

2. **Tack Coat.** Clean the surface before placing the tack coat. Unless otherwise approved, apply tack coat uniformly at a rate between 0.04 and 0.10 gallon of residual asphalt per square yard of surface area. Apply a thin uniform tack coat to all contact surfaces of curbs, structures, and joints. Prevent splattering of tack coat when placed adjacent to curbs, gutters, and structures. Roll the tack coat with a pneumatic tire roller unless otherwise directed. The Engineer may use TxDOT standard laboratory test procedure Tex-243-F to verify that the tack coat has adequate adhesive properties. The Engineer may suspend paving operations until there is adequate adhesion. The Engineer may waive the requirement to place tack coat.

3. **Lay Down Operations.** Dump and spread the asphalt mixture on the approved prepared surface with a spreading and finishing machine. Place the material without tearing, shoving, gouging, or segregating the mixture.

   Do not jar or bounce the finishing machine when loading it. Obtain the required lines and grades without hand finishing. The Engineer may authorize hand finishing when the mixture is:

   - placed in a narrow strip along the edge of existing pavement,
   - used to level small areas, or
   - placed in small irregular areas where the use of a finishing machine is not practical.

   Leveling courses and other areas may be spread with a motor grader when shown on the plans or approved.

   When hot mix is placed in windrows, operate windrow pick-up equipment so that substantially all the mixture deposited on the roadbed is picked up and loaded into the spreading and finishing machine.

   Adjust the hopper flow gates of the spreading and finishing machine to provide an adequate and consistent flow of material. Operate the augers at least 85% of the time. Keep the augers one-half to three-quarters full of mixture. Maintain an adequate flow of material to the center of the paver for the full width of the mat.

   Immediately take appropriate corrective action if surface irregularities including but not limited to segregation, rutting, raveling, flushing, fat spots, mat slippage, color, texture, roller marks, tears, gouges, or streaks are detected. Continue placement for no more than 1 day of production while appropriate action is taken. If no appropriate corrective action

is taken or if the problem still exists after 1 day, suspend paving until the Engineer approves further production.

E. Compaction. Uniformly compact the pavement to the density requirements of this Item. Use the procedure described in TxDOT standard laboratory test procedure Tex-207-F, Part IV, to establish the rolling pattern. Do not use pneumatic tire rollers if excessive pickup of fines by roller tires occurs.

When using three-wheel, tandem, or vibratory rollers, first roll the joint with the adjacent pavement. Continue rolling longitudinally at the sides, proceeding toward the center of the pavement, and overlap successive trips by at least one foot unless otherwise directed. Make alternate trips of the roller slightly different in length. Begin rolling of super-elevated curves at the low side and proceed toward the high side, unless otherwise directed.

When operating vibratory rollers:

- do not operate in vibrating mode when stationary;
- do not operate in vibrating mode when changing directions;
- do not operate in vibrating mode on mats with a plan depth of less than 1-½ in.;
- do not allow the roller to stand on pavement that has not been fully compacted;
- do not operate when in contact with the compacted, finished pavement structure layer;
- in case of over-vibration resulting in disruption of the compacted material, rework and recompact or replace the damaged material at the Contractor's expense;
- roll at a speed producing at least 10 blows per foot unless otherwise directed;
- keep the drums moist with water without using excess water; and
- do not drop diesel, gasoline, oil, grease, or other foreign matter on the pavement.

Where specific air void requirements are waived, furnish and operate compaction equipment as approved. Use lightly oiled tamps to thoroughly compact the edges of the pavement along curbs, headers, and similar structures and in locations that will not permit thorough compaction with rollers. The Engineer may require rolling with a trench roller on widened areas, in trenches, and in other limited areas.

In-place compaction control is required for all mixtures. Complete all rolling for compaction before the mixture temperature drops below 175ºF. Unless otherwise shown on the plans, use density control.

1. **Density Control.** Determine the number and type of rollers needed to obtain the required density. Operate the rollers in accordance with the requirements of this specification and as approved.

   Place and compact material to the minimum density of 95 to 100 percent as determined by TxDOT standard laboratory test procedure Tex-126-E or as shown on the plans. The Engineer will determine laboratory-molded density in accordance with TxDOT standard

laboratory test procedure Tex-126-E from material sampled at the plant. Actual in-place density will be determined in accordance with TxDOT standard laboratory test procedure Tex-126-E unless otherwise directed. Unless otherwise shown on the plans, obtain required roadway specimens as directed. The Engineer will measure air voids in accordance with TxDOT standard laboratory test procedure Tex-207-F. When a satisfactory correlation to results obtained in accordance with TxDOT standard laboratory test procedure Tex-126-E is shown, other methods of determining in-place compaction may be used.

If in-place density is more than 1.0 percentage point below minimum density, cease production immediately. If in-place density is between 0.1 and 1.0 percentage points below minimum density, investigate the causes and make the necessary corrections. If minimum density is not obtained within one full day of operation, cease production.

Resume production after placing a test section of one lane width and a maximum 0.2 miles long that demonstrates that minimum density can be obtained. Repeat this procedure until producing a test section that meets minimum density requirements. Place no more than 2 test sections per day. Increasing the asphalt content of the mixture to increase in-place density is allowed by approval only.

2. **Ordinary Compaction.** When ordinary compaction is required by the plans, furnish one three-wheel roller, one pneumatic tire roller, and one tandem roller, as directed, for each compaction operation. The Engineer may waive the use of the tandem roller when the surface is adequately smooth and further steel wheel rolling is shown to be ineffective. The Engineer may allow a vibratory roller to be substituted for the three-wheel roller, the tandem roller, or both. Use at least one pneumatic tire roller. Pneumatic tire rollers will provide a minimum of 80 psi ground contact pressure when used for compaction and a minimum of 55 psi ground contact pressure when used for kneading and sealing the surface. Provide additional rollers as directed.

   Establish rolling patterns in accordance with TxDOT standard laboratory test procedure Tex-207-F, Part IV, unless otherwise directed. Follow the selected rolling pattern unless changes in mixture or placement conditions that affect compaction occur. When changes occur, establish a new rolling pattern.

F. Sampling and Testing.

1. **Production Sampling.**

   a. **Mixture Sampling.** The Engineer will obtain mixture samples in accordance with TxDOT standard laboratory test procedure Tex-222-F at a minimum frequency of one test every 2,000 tons produced and placed or each days production and placement quantity if less.

2. **Production Testing.** The Engineer will perform production tests.

   a. **Operational Tolerances.** The Engineer will determine compliance with operational tolerances. The gradation of the aggregate must be within the master grading limits for the specified grade except that a tolerance of 2 percentage points is allowed on the sieve size for each mixture grade that shows 100% passing in Table 2.

Ensure that the asphalt content does not vary by more than 0.5 percentage points from the design target.

b. Individual Loads of Asphalt-Treated Base. The Engineer retains the right to reject individual truckloads of asphalt-treated base when it is evident that the material quality is unacceptable. When a load is rejected for reasons other than temperature, the Contractor may request that the rejected load be tested. Make this request within 4 hours of rejection. If City test results are within the operational tolerances listed in Section 292.4.F.2.a, "Operational Tolerances," payment will be made for the load. If City test results are not within operational tolerances, no payment will be made for the load.

3. Placement Sampling and Testing. Obtain two 6 inch diameter cores side by side at locations selected by the Engineer for every 2,000 tons produced and placed or each days production and placement quantity if is less. Provide the Engineer an opportunity to witness the coring operation and measure the core thickness. Mark the cores for identification. Immediately after obtaining the cores, dry the core holes and tack the sides and bottom. Fill the hole with the same type of mixture and properly compact the mixture. Other methods of repairing the core holes are allowed when approved.

Trim the cores, if necessary, and deliver them to the Engineer within 1 working day following placement operations unless otherwise approved.

a. In-Place Air Voids. The Engineer will measure in-place air voids in accordance with TxDOT standard laboratory test procedures Tex-207-F and Tex-227-F to verify that in-place density requirements of Section 206.4.E.1, "Density Control," are met.

b. Irregularities. Remove and replace, at the expense of the Contractor and to the satisfaction of the Engineer, any mixture that does not bond to the existing pavement or has other surface irregularities identified by the Engineer. Correct grade deviations greater than ¼ inch in 16 feet measured longitudinally or greater than ¼ inch over the entire width of the cross-section, as shown on the plans.

c. Production Binder Properties. The Engineer may take cores or other production samples at random from the project to determine recovered asphalt properties. Asphalt binders with an aging ratio greater than 3.5 do not meet requirements for recovered asphalt properties and may be deemed defective when tested and evaluated by the Engineer. The aging ratio, as determined in accordance with laboratory test procedure AASHTO T-315, is the DSR value of the extracted binder divided by the DSR value of the original unaged binder. The binder from RAP will be included proportionally as part of the original unaged binder. The Engineer may require the defective material be removed and replaced at the Contractor's expense. The asphalt binder will be recovered for testing from cores in accordance with TxDOT standard laboratory test procedure Tex-211-F.

G. Surface Finish. Use Surface Test Type A in accordance with TxDOT Standard Specification Item 585, "Ride Quality for Pavement Surfaces," unless otherwise shown on the plans.

H. Opening to Traffic. Open the completed course to traffic when permitted or directed. If the surface ravels, flushes, ruts, or deteriorates in any manner before final acceptance, correct it at the Contractor's expense and to the satisfaction of the Engineer.

206.5. MEASUREMENT: This Item will be measured by the square yard of in-place composite hot mix at the thickness stated in the proposal. The composite hot mix is defined as the asphalt, aggregate, RAP, and additives noted on the plans and approved by the Engineer.

206.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Asphalt Treated Base" of the grade and binder type specified. This price is full compensation for furnishing and disposing of materials, producing trial batches, loading, hauling, placing, compacting, sampling, testing, replacing defective material, furnishing scales and labor for weighing and measuring, and equipment, labor, tools, and incidentals. City-owned RAP from sources designated on the plans shown to be available will be provided to the Contractor at no cost.

206.7. BID ITEM:

Item 206.1 - Asphalt Treated Base - per square yard ___inches compacted depth

ITEM

207 SINGLE COURSE BITUMINOUS SLURRY SEAL

207.1. DESCRIPTION: *The work covered by this specification includes the design, testing, construction and quality control required for the proper application of slurry seal surface.*

207.2. APLLICABLE SPECIFICATIONS AND TEST METHODS:

A. Agencies.

AASHTO: American Association of State Highways and Transportation Officials
ASTM: American Society for Testing and Materials
ISSA: International Slurry Surfacing Association

B. Aggregate and Mineral Filler.

AASHTO	ASTM	Title
T2	D75	Sampling Mineral Aggregates
T27	C136	Sieve Analysis of Aggregates
T11	C117	Materials Finer than No. 200 in Mineral Aggregates
T176	D2419	Sand Equivalent Value of Soils and Fine Aggregate
T84	C128	Specific Gravity and Absorption of Fine Aggregate
T19	C29	Unit Weight of Aggregate
T96	C131	Resistance to Abrasion of Small-Size Coarse Aggregate by Use of the Los Angeles Machine
T37	D546	Sieve Analysis of Mineral Filler
T104	C88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
N/A	D242	Mineral Filler for Bituminous Paving Mixtures
T127	C183	Sampling Hydraulic Cement

C. Emulsified Asphalt.

AASHTO	ASTM	Title
T40	D140	Sampling Bituminous Materials
T59	D244	Testing Emulsified Asphalt
M140	D977	Specification for Emulsified Asphalt
M280	D2397	Mixing, Setting and Water Resistance Test To Identify A Quick-Set Emulsified Asphalt

D. Residue From Emulsion.

AASHTO	ASTM	Title
T59	D244	Residue by Evaporation
T49	C2397	Penetration 3.5 oz (100 gm) at 5 Seconds 77ºF (25ºC)

E. Slurry Seal System.

ASTM	ISSA	Title
N/A	TB 101	Guide for Sampling Slurry Mix for Extraction Test
N/A	TB 106	Measurement of Slurry Seal Consistency
N/A	TB 109	Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded-Wheel Tester
N/A	TB 111	Outline Guide Design Procedure for Slurry Seal
N/A	TB 112	Method of Estimate Slurry Seal Spread Rates and To Measure Pavement Macrotexture
N/A	TB 114	Wet Stripping Test for Cured Slurry Seal Mixes
N/A	TB 115	Determination of Slurry Seal Compatibility
N/A	TB 39	Method of Classified Emulsified Asphalt, Aggregate Mixtures by Modified Cohesion Test Measurement of Set and Cure Characteristics
D3910	N/A	Design, Testing, and Construction of Slurry Seal
D2172	N/A	Quantitative Extraction of Bitumen for Bituminous Paving Mixtures

207.3. MATERIALS: Provide materials in conformance with the following Items and requirements:

A. General. The slurry seal shall consist of a mixture of an approved emulsified asphalt, mineral aggregate, mineral filler, water and specified additives, proportioned, mixed and uniformly spread over a properly prepared surface. The completed slurry seal shall leave a homogenous mat, adhere firmly to the prepared surface and have a skid resistant surface texture.

B. Asphalt Emulsion. The emulsion shall be SS-1H or CRS-2H in conformance with TxDOT Item 300, Section 2.D. "Emulsified Asphalt" with a 4% Latex additive milled into the emulsion by the emulsion manufacturer. All shipments of latex modified emulsion shall be accompanied by a shipping ticket and a certificate of compliance which shall be provided to the Engineer.

AASHTO	ASTM	Title	Specification Criteria
Test on Emulsion			
T59	D244	Residue After Distillation	60% Minimum
Test on Emulsion Residue			
T49	C2397	Penetration at 77ºF (25ºC)	40 – 90

C. Mineral Aggregate. Provide a crushed aggregate from a single source meeting the requirements of Table 1 and Table 2. Unless otherwise shown on the plans, furnish aggregate with a minimum "B" Surface Aggregate Classification (SAC) as defined in TxDOT's Bituminous Rated Source Quality Catalog (BRSQC). Include the amount of mineral filler added to the mix in determining the total minus No. 200 aggregate fraction.

Table 1
Aggregate Gradation Requirements
Tex-200-F, Part II (Washed)
Cumulative % Retained

Sieve Size	Type I	Type II	Type III
½"	0	0	0
⅜"	0	0	0 – 1
#4	0	0 – 10	6 – 14
#8	0 – 10	10 – 35	35 – 55
#16	10 – 35	30 – 55	54 – 75
#30	35 – 60	50 – 70	65 – 85
#50	58 – 75	70 – 82	75 – 90
#100	70 – 85	79 – 90	82 – 93
#200	80 – 90	85 – 95	85 – 95

Table 2
Aggregate Quality Requirements

Property	TxDOT Standard Laboratory Test Method	Requirement
Magnesium sulfate soundness, %, max.[1]	Tex-411-A	30
Sand equivalent value, %, min.	Tex-203-F	70
Los Angeles abrasion, %, max	Tex-410-A	30

1. Use design gradation for the soundness test.

D. Mineral Filler. Provide mineral filler that is free of lumps and foreign matter consisting of non-air-entrained cement meeting the requirements of DMS-4600, "Hydraulic Cement," or hydrated lime meeting the requirements of DMS-6350, "Lime and Lime Slurry." The type and amount of mineral filler needed shall be determined by a laboratory mix design and will be considered as part of the aggregate gradation. An increase or decrease of less than one percent (1%) may be permitted when the micro-surfacing is being placed if it is found to be necessary for better consistency or set times.

E. Water. Provide water that is potable and free of harmful soluble salts.

F. Other Additives. Use approved additives as recommended by the emulsion manufacturer in the emulsion mix or in any of the component materials when necessary to adjust mix time in the field.

G. F. Job-Mix Formula (JMF). Provide a mix design conforming to the proportions shown in Table 3 and meeting the requirements shown in Table 4. The mix design is subject to verification using laboratory produced mixes or trial batch mix before approval.

Provide emulsion and aggregate that are compatible so that the mixing process will completely and uniformly coat the aggregate. Design the mix so that the mixture will have sufficient working life to allow for proper placement at the predicted ambient temperature and humidity.

Table 3
JMF Proportions

Material	Proportion
Residual Asphalt	Type I - 10.0 to 16.0% by wt. of dry aggregate Type II & III – 6.0 to 9.0% by wt. of dry aggregate
Mineral Filler (Hydraulic Cement or Hydrated Lime)	0.5 to 3.0% by wt. of dry aggregate
Field Control Additive	As required to provide control of break and cure
Water	As required to provide proper consistency

Table 4
JMF Requirements

Property	TxDOT Standard Laboratory Test Method	Requirement
Wet track abrasion, g/sq. ft., max. wear value	Tex-240-F, Part IV	75
Gradation (aggregate and mineral filler)	Tex-200-F, Part II (Washed)	Table 1
Mix time, controlled to 120 sec.	Tex-240-F, Part I	Pass

H. Rate of Application. The slurry seal mixture shall be of the proper consistency at all times, so as to provide the application rate required by the surface condition. Suggested application rates are based upon the weight of dry aggregate in the mixture. Application rates are affected by the unit weight of the aggregate.

Unless a specific aggregate type and application rate are shown in the plans, the following recommended aggregate types and average single application rates are suggested for the various street classifications and situations:

Aggregate Type	Suggested Placement Locations	Suggested Application Rate
Type I	Local Type A w/o Bus Traffic	8 - 12 lb/yd^2
Type II	Local Type A and B Streets	10 - 20 lb/yd^2
Type III	Collectors and Arterials Wheel Ruts	15 - 30 lb/yd^2 See Section 239.4.K., “Ruts”

207.4. EQUIPMENT: All methods employed in performing the work and all equipment, tools, and machinery used for handling the material and executing any part of the work shall be subject to the approval of the Engineer before the work is started, and whenever found unsatisfactory they shall be changed and improved as required. All equipment, tools, machinery and containers used must be kept clean and maintained in a satisfactory condition.

A. Mixing Equipment. Furnish a self-propelled slurry seal mixing machine with:

- self-loading devices to promote continuous laying operations;
- sufficient storage capacity for mixture materials;
- individual volume or weight controls that will proportion each material to be added to the mix;
- continuous flow mixing with a revolving multi-blade mixer capable of discharging the mixture on a continuous flow basis;
- opposite side driving stations;

- full hydrostatic control of the forward and reverse speed during operation;
- a water pressure system and nozzle-type spray bar immediately ahead of the spreader box and capable of spraying the roadway for the width of the spreader box;
- a mechanical-type spreader box equipped with paddles or other devices capable of agitating and spreading the materials throughout the box;
- a spreader box with devices capable of providing lateral movement or side shift abilities; and
- a spreader box with a front seal and adjustable rear strike-off. Provide an adjustable secondary rear strike-off, if required.

Calibrate and properly mark each control device that proportions the individual materials. Equip the aggregate feed with a revolution counter or similar device capable of determining the quantity of aggregate used at all times. Provide a positive-displacement-type emulsion pump with a revolution counter or similar device capable of determining the quantity of emulsion used at all times. Provide an approved mineral filler feeding system capable of uniformly and accurately metering the required material.

B. Scales. Scales used for weighing aggregates and emulsion must meet all requirements of TxDOT Item 520, "Weighing and Measuring Equipment." The weighing equipment for aggregates may be either a suspended hopper or a belt scale.

C. Asphalt Storage and Handling Equipment. When storage tanks are used, furnish a thermometer in each tank to indicate the asphalt temperature continuously. Keep equipment clean and free of leaks. Keep asphalt materials free from contamination.

D. Cleaning Equipment. Power brooms and blowers, air compressors, vacuum sweepers, water flushing equipment, and hand brooms shall be suitable for cleaning the pavement surface and cracks therein.

E. Auxiliary Equipment. Hand squeegees, shovels and other equipment shall be provided as necessary to perform the work.

207.5. CONSTRUCTION:

A. General. Produce, transport, and place slurry seal as specified in this Item or on the plans. The slurry mixture shall be of the desired consistency as it leaves the mixer and no additional elements shall be added. No lumping, balling, or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate will be permitted.

If the coarse aggregate settles to the bottom of the mix, the slurry will be removed from the pavement. Care shall be taken not to overload the spreader box, which shall be towed at a slow and uniform rate not to exceed 5 miles per hour. The action of the squeegee in the spreader box shall permit free flow of the slurry into all surface voids and cracks. A sufficient amount of slurry seal shall be fed to the box to keep a full supply against the full width of the squeegee. The mixture shall not be permitted to overflow the front sides of the spreader box. Adjacent lanes shall be lapped at the edges a minimum dimension which will provide complete sealing at the overlap.

The fresh mix shall be protected by barricades and markers to permit drying. In areas where the spreader box cannot be used, the slurry shall be applied by means of hand squeegees. Any joints or cracks that are not filled by the slurry mixture shall be corrected by use of hand squeegees. Upon completion of the work, the slurry seal shall have no holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement. The finished surface shall present a uniform and skid resistant appearance satisfactory to the Engineer. All wasted and unused material and all debris shall be removed from the site prior to final acceptance. Ensure that the finished surface has a uniform texture and the slurry seal mat is fully adhered to the underlying pavement.

B. Temporary Material Storage.

1. **Aggregate Storage.** Stockpile materials in a manner that will prevent segregation or contamination. Remix stockpiles with suitable equipment when necessary to eliminate segregation. Use a scalping screen while transferring aggregates to the mixing machine to remove oversize material.

2. **Mineral Filler Storage.** Store the mineral filler in a manner that will keep it dry and free from contamination.

3. **Asphalt Material Storage.** Keep asphalt materials free from contamination.

C. Weather Limitations. Place the material when the atmospheric temperature is at least 50°F and rising and the surface temperature is at least 50°F. Cease placement when the atmospheric temperature is below 60°F and falling, when weather is foggy or rainy, or when rain is imminent as determined by the Engineer. Cease placement 24 hr. before forecasted temperatures below 32°F.

No slurry shall be applied under the following conditions:

1. While puddles of water remain on the pavement surface to be sealed.

2. When the weather is foggy.

3. If there is a chance of rain before it can be cured properly.

Slurries that cure by evaporation should not be laid during periods of abnormally high humidity.

Any uncured slurry that is washed away from the roadway by rain or other water sources into yards, driveways, sidewalks, parkways, etc., shall be removed and cleaned by the Contractor at his expense. Open or underground drainage systems shall be removed and cleaned as directed by the Engineer at the Contractor's expense.

D. Surface Preparation. The Engineer shall approve the surface preparation prior to surfacing. No dry aggregate either spilled from the lay-down machine or existing on the road, will be permitted.

1. **Surface Cleaning.** Thoroughly clean the surface of all vegetation, loose aggregate, and soil. Remove existing raised pavement markers. When existing surface conditions require, provide a water spray immediately ahead of the spreader box. Apply water at a rate that will dampen the entire surface without any free-flowing water ahead of the

spreader box. If water is used, cracks shall be allowed to dry thoroughly before applying slurry seal.

2. **Protection.** Manholes, valve boxes, drop inlets and other service entrances shall be protected from the slurry seal by a suitable method. The Contractor shall cover all raised pavement markers in a manner to protect and insure the integrity of the markers prior to placing the slurry seal and shall remove such covers after the completion of micro-surfacing so that the markers will remain fully functional. Any markers damaged by the Contractor's operations shall be repaired or replaced at no cost to the City.

3. **Tack Coat.** The Engineer may require a tack coat if the surface to be covered is extremely dry and raveled, or is concrete or brick. If required by the Engineer, the tack coat should consist of one part emulsified asphalt/three parts water. The emulsified asphalt should be the same as used in the mix. The distributor shall be capable of applying the dilution evenly at a rate of 0.05 to 0.10 gal/yd^2. The tack coat shall be allowed to cure before application of the slurry seal.

4. **Crack Pre-Treatment.** If shown on the plans, pre-treat the cracks in the surface with an acceptable crack sealer prior to the application of the micro-surfacing.

E. Material Transfer. Minimize construction joints by providing continuous loading of material while placing slurry seal. Ensure that oversized material has been removed prior to transferring the aggregates to the mixing machine.

F. Placing. Spread the mixture uniformly to the lines and grades shown on the plans or as directed by means of a mechanical type spreader box. Shift the spreader box when necessary to maintain proper alignment. Clean the spreader box as necessary to minimize clumps. Set and maintain the spreader box skids to prevent chatter in the finished mat. Prevent loss of material from the spreader box by maintaining contact between the front seal and the road surface. Adjust the rear seal to provide the desired spread. Adjust the secondary strike-off, if present, to provide the desired surface texture.

G. Curing. Protect the finished mat from traffic until the mix cures and will not be damaged by traffic. Adjust mixture properties according to humidity conditions and ambient air temperatures to allow uniformly moving traffic on completed travel lanes within 1 hr. after placement with no damage to the surface. Protect other locations subject to sharp turning or stopping and starting traffic for longer periods when necessary.

H. Production Testing. Provide access to the mixing unit discharge stream for sampling purposes. Produce a slurry seal mixture that will meet the tolerances specified in Table 5. Remove and replace or use other approved means to address material that does not meet these requirements, at no additional cost.

Table 5
Production Tests

Property	TxDOT Standard Laboratory Test Method	Requirement
Asphalt content, % by wt.	Tex-236-F1 or asphalt meter readings	Design target ±0.5% and within limits of Table 1
Gradation, % retained	Tex-200-F, Part II (washed)[1]	#8 sieve and larger: ±5 from design gradation. #16 sieve and smaller: ±3 from design gradation.[2]

1. Dried to constant wt. at 230°F ±10°F.
2. Material passing #200 sieve including the mineral filler must conform to the limitations of the master gradation shown in Table 1.

I. Workmanship. Remove and replace slurry material exhibiting evidence of poor workmanship at no additional cost.

1. Finished Surface. Provide a finished surface that has a uniform texture free from excessive scratch marks, tears, or other surface irregularities. Marks, tears, or irregularities are considered excessive if:

- more than 1 is at least ¼ inch wide and at least 10 feet long in any 100 feet of machine pull,
- more than 3 are at least ½ inch wide and more than 6 inches long in any 100 feet of machine pull, or
- any are 1 inch wide or wider and more than 4 inches in length.

2. Construction Joints. Place longitudinal joints on lane lines unless otherwise directed. Provide longitudinal and transverse joints that are uniform and neat in appearance. Provide construction joints that have limited buildup and that have no gaps between applications. Joints with buildup will be considered acceptable if:

- no more than ½ inch vertical space exists between the pavement surface and a 4 foot straightedge placed perpendicular to the longitudinal joint and
- no more than ¼ inch vertical space exists between the pavement surface and a 4 foot straightedge placed perpendicular to the transverse joint.

3. Edges. Provide an edge along the roadway centerline, lane lines, shoulder, edge of pavement, or curb line that is uniform and neat in appearance. The edge is considered acceptable when:

- it varies no more than ±3 inches from a 100 foot straight line on a tangent section and
- it varies no more than ±3 inches from a 100 foot arc on a curved section.

J. Miscellaneous Areas. Use a single-batch-type lay-down machine or other approved method to place materials on ramps or other short sections. Lightly dampen the surface before placing the mix. Provide 100% coverage that is uniform in appearance and comparable to that produced by the spreader box.

207.6. MEASUREMENT: Slurry seal will be measured by the ton or square yard of the composite single course bituminous slurry seal as shown in the plans. The composite slurry seal mixture is defined as the asphalt emulsion, aggregate, and mineral filler.

A. Aggregate. The quantity of aggregate used in the accepted portion of work will be measured by net ticket weight of each individual load of aggregate based on dry weight of aggregate. Weigh the aggregate at the project stockpile site unless otherwise approved. Use either a suspended hopper scale or a belt scale meeting the requirements of TxDOT Item 520, "Weighing and Measuring Equipment." The calculated weight of mineral filler based on the accepted portion of work will be used for measurement and included in the total aggregate weight.

B. Asphalt Emulsion With Latex Additive. The quantity of asphalt emulsion with latex in the accepted portion of work will be measured by the ton of material based on the accepted load tickets issued from the manufacturer. At the completion of the project, any unused emulsion will be weighed back and deducted from the accepted asphalt emulsion quantity delivered.

207.7. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per ton or square yard for "Slurry Seal." This price is full compensation for preparing the existing surface (including removing existing raised pavement markers); furnishing, hauling, preparing, and placing materials; and equipment, labor, tools, and incidentals.

207.8. BID ITEM:

Item 207.1 - Single Course Bituminous Slurry Seal - per square yard

Item 207.2 - Single Course Bituminous Slurry Seal - per ton

ITEM

208 SALVAGING, HAULING & STOCKPILING RECLAIMABLE ASPHALTIC PAVEMENT

208.1. DESCRIPTION: *Salvage, by milling existing asphalt concrete pavement or asphalt-stabilized base, haul, and stockpile existing asphalt material.*

208.2. EQUIPMENT: The Engineer may require demonstration of the equipment's capabilities.

A. Milling (Planing) Machine. Use milling (planning) machines that:

1. have a minimum 6 foot cutting width except for work areas less than 6 feet wide;

2. are self-propelled with sufficient power, traction, and stability to maintain an accurate depth of cut and slope;

3. can cut in 1 continuous operation:

a. 4 inches of asphalt concrete pavement,

b. 1 inch of concrete pavement,

c. or a combination of 2 inches of asphalt concrete pavement and ½ inch of concrete pavement;

4. use dual longitudinal controls capable of operating on both sides automatically from any longitudinal grade reference, which includes string line, ski, mobile string line, or matching shoe;

5. use transverse controls with an automatic system to control cross slope at a given rate;

6. use integral loading and reclaiming devices to allow cutting, removal, and discharge of the material into a truck in one operation; and

7. include devices to control dust created by the cutting action.

B. Manual System. Use a manual system that can achieve a uniform depth of cut, flush to all inlets, valve covers, manholes, and other appurtenances within the paved area. Use of a manual system is allowed for areas restricted to self-propelled access and for detail pavement removal.

C. Sweeper. Unless otherwise approved, use a street sweeper to remove cuttings and debris from the planed or textured pavement. Equip the sweeper with a water tank, dust control spray assembly, both a pick-up and a gutter broom, and a debris hopper.

208.3. CONSTRUCTION: Remove dirt, raised pavement markings, and other debris, as directed. Unless otherwise shown on the plans, ensure that 95% of the reclaimed material passes a 2 inch sieve. Do not contaminate asphalt material during its removal, transportation, or storage. Repair pavement to remain that is damaged by the removal operations. Work performed under this item shall be prosecuted in such a manner as to cause minimum inconvenience to traffic or to the owners of adjacent property.

A. Grade Reference. When required, place grade reference points at maximum intervals of 50 feet. Use the control points to set the grade reference. Support the grade reference so the maximum deflection does not exceed 1/16 inch between supports.

B. Milling (Planing). Vary the speed of the machine to leave a grid or other pattern type with discontinuous longitudinal reach. Remove the pavement surface for the length, depth, and width shown on the typical section and to the established line and grades. Remove pavement to vertical lines adjacent to curbs, gutters, inlets, manholes, or other obstructions. Do not damage appurtenances or underlying pavement.

Provide a milled (planed) surface that has a uniform textured appearance and riding surface. Surface should be free from gouges, continuous longitudinal grooves, ridges, oil film, and other imperfections of workmanship. Leave a uniform surface of concrete pavement free of asphalt materials when removing an asphalt concrete pavement overlay.

When an overlay on the milled (planed) pavement is not required, provide a minimum texture depth of not less than 0.05 inch. Stop milling (planing) operations when surface texture depth is not sufficient.

When located within 4 inches of steep curbs, water valves, draw grates, bridge joints, etc., asphaltic concrete that cannot be removed by the milling (planing) machine shall be removed by a manual system conforming to 208.2.B. "Manual System" or other methods acceptable to the Engineer.

When milling (planing) over a bridge deck, the milling depth shall not exceed 3/16 inch into the original deck surface of the bridge. Do not damage armor joints, sealed expansion joints, and other appurtenances.

Provide a pavement surface that, after milling (planing), has a smooth riding quality and is true to the established line, grade, and cross section. Provide a pavement surface that does not vary more than ⅛ inch in 10 feet. Evaluate this criterion with a 10 foot straightedge placed parallel to the centerline of the roadway. Deviations will be measured from the top of the texture. Correct any point in the surface not meeting this requirement.

Sweep pavement and gutter. The pavement and curb surfaces shall be cleaned of all debris and left in a neat and presentable condition.

C. Edge Treatments. At the end of the day and for areas under traffic, slope vertical or near vertical longitudinal faces in the pavement surface in accordance with the requirements in the plans. Taper transverse faces to provide an acceptable ride.

D. Salvaged Materials. The loose material resulting from the operation shall become the property of the contractor. If the material is designated to remain the property of the City, it shall be as stockpiled by the Contractor at locations as shown on the plans. Prepare the stockpile site by removing vegetation and trash and by providing proper drainage. Keep salvaged paving material free from contamination during its removal, transportation, and storage. Place different types or quality of salvaged asphalt paving material into separate stockpiles. Silt fencing around stockpile areas shall be provided in accordance with Item 542, "Temporary Sediment Control Fence."

The plans or the Engineer may allow or require the use of salvaged material for other Items in the Contract.

Dispose of unsalvageable material in accordance with applicable federal, state, and local regulations.

208.4. MEASUREMENT: Measurement under this bid item shall include removal of asphaltic concrete pavement by the cubic yard (loose vehicle measurement) of material, or by the square yard in its original position at a depth as shown on the plans.

208.5. PAYMENT: The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per cubic yard for "Salvaging, Hauling and Stockpiling Reclaimable Asphaltic Pavement" or at the Unit price bid per square yard for "Salvaging, Hauling and Stockpiling Reclaimable Asphaltic Pavement" of the depth specified. This price shall be full compensation for cleaning and removing existing pavement; for any necessary stockpile area preparation; for loading, crushing or breaking, hauling and stockpiling of the material; and for furnishing all materials, labor, tools, equipment, supplies and all incidentals necessary to satisfactorily complete the work.

When plans call for the installation of silt fencing protection around stockpile areas, the fencing will be measured and paid for under Item No. 542.

208.6. BID ITEM:

Item 208.1 - Salvaging, Hauling, and Stockpiling Reclaimable Asphaltic Pavement (___inches depth) - per square yard

Item 208.2 - Salvaging, Hauling, and Stockpiling Reclaimable Asphaltic Pavement - per cubic yard (loose vehicle measurement)

ITEM

209 CONCRETE PAVEMENT

209.1. DESCRIPTION: *Construct hydraulic cement concrete pavement with or without curbs on the concrete pavement.*

209.2. MATERIALS:

A. Hydraulic Cement Concrete. Provide hydraulic cement concrete in accordance with Item 300, "Concrete," except that strength over-design is not required. Provide Class P concrete designed to meet a minimum average compressive strength of 3,500 psi at 7-days or a minimum average compressive strength of 4,400 psi at 28-days. Test in accordance with TxDOT standard laboratory test procedure Tex-448-A or Tex-418-A.

When shown on the plans or allowed, provide Class HES concrete for very early opening of small pavement areas or leave-outs to traffic. Design Class HES to meet the requirements of Class P and a minimum average compressive strength of 2,600 psi in 24-hours, unless other early strength and time requirements are shown on the plans or allowed. No strength over-design is required. Type III cement is allowed for Class HES concrete.

Use Class A or P concrete for curbs that are placed separately from the pavement. Provide concrete that is workable and cohesive, possesses satisfactory finishing qualities, and conforms to the mix design and mix design slump.

B. Reinforcing Steel. Unless shown on the plans, provide Grade 60 deformed steel for bar reinforcement in accordance with Item 301, "Reinforcing Steel." Provide approved positioning and supporting devices (baskets and chairs) capable of securing and holding the reinforcing steel in proper position before and during paving in accordance with 209.B.3, "Positioning and Support Devices for Reinforcement and Joint Assemblies." Provide corrosion protection when shown on the plans.

1. **Dowels.** Provide smooth, straight dowels of the size shown on the plans, free of burrs, and conforming to the requirements of Item 301, "Reinforcing Steel." Coat dowels with a thin film of grease or other approved de-bonding material. Provide dowel caps on the lubricated end of each dowel bar used in an expansion joint. Provide dowel caps filled with a soft compressible material with enough range of movement to allow complete closure of the expansion joint.

2. **Tie Bars.** Provide straight deformed steel tie bars. Provide either multiple-piece tie bars or single-piece tie bars as shown on the plans. Provide multiple-piece tie bars composed of 2 pieces of deformed reinforcing steel with a coupling capable of developing a minimum tensile strength of 125% of the design yield strength of the deformed steel when tensile-tested in the assembled configuration. Provide a minimum length of 33 diameters of the deformed steel in each piece. Use multiple-piece tie bars from the list of "Prequalified Multiple Piece Tie Bar Producers" maintained by the TxDOT Construction Division, or submit samples for testing in accordance with TxDOT standard laboratory test procedure Tex-711-I. A laboratory test report from an independent laboratory that has conducted Tex-711-I on the unapproved multiple piece tie bar may also be submitted to the Engineer for consideration.

C. Positioning and Support Devices for Reinforcement and Joint Assemblies. These devices shall be of sufficient structural quality to prevent movement of the dowels or steel reinforcement during concrete placement and finishing. Devices shall be of a type approved by the Engineer.

Positioning and supporting devices (chairs) for steel reinforcement bars shall be either plastic or metal and of sufficient number to maintain the position of the bars within the allowable tolerances.

Metal positioning and supporting devices for expansion and contraction joint assemblies (such as welded wire bar chairs, bar stakes, etc.) where used shall be as shown on the plans or may be similar devices of equivalent or greater strength, approved by the Engineer. The support devices shall secure the joint assembly and dowels within the allowable tolerances while providing no restraint against joint movement. Dowels used in joint assemblies shall be secured in parallel position by a transverse metal brace of the type and design shown on the plans, or may be secured by other devices approved by the Engineer. The devices shall provide positive mechanical connection between the brace and each unit (other than by wire tie) and prevent transverse movement of each load transmission device.

D. Curing Materials. Provide Type 2 membrane curing compound conforming to TxDOT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants." Provide SS-1 emulsified asphalt conforming to TxDOT Item 300, "Asphalts, Oils, and Emulsions," for concrete pavement to be overlayed with asphalt concrete under this Contract unless otherwise shown on the plans or approved. Provide materials for other methods of curing conforming to the requirements of Item 307, "Concrete Structures."

E. Epoxy. Provide Type III epoxy in accordance with TxDOT DMS-6100, "Epoxies and Adhesives," for installing all drilled-in reinforcing steel.

F. Evaporation Retardant. Provide evaporation retardant conforming to TxDOT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

G. Joint Sealants and Fillers. Provide Class 5 or Class 8 joint-sealant materials and fillers unless otherwise shown on the plans or approved and other sealant materials of the size, shape, and type shown on the plans in accordance with TxDOT DMS-6310, "Joint Sealants and Fillers."

209.3. EQUIPMENT: Furnish and maintain all equipment in good working condition. Use measuring, mixing, and delivery equipment conforming to the requirements of Item 300, "Concrete." Obtain approval for other equipment used.

A. Placing, Consolidating, and Finishing Equipment. Provide approved self-propelled paving equipment that uniformly distributes the concrete with minimal segregation and provides a smooth machine-finished consolidated concrete pavement conforming to plan line and grade. Provide an approved automatic grade control system on slip-forming equipment. Provide approved mechanically operated finishing floats capable of producing a uniformly smooth pavement surface. Provide equipment capable of providing a fine, light water fog mist.

Provide mechanically operated vibratory equipment capable of adequately consolidating the concrete. Provide immersion vibrators on the paving equipment at sufficiently close intervals to provide uniform vibration and consolidation of the concrete over the entire width and depth of the pavement and in accordance with the manufacturer's recommendations. Provide

immersion vibrator units that operate at a frequency in air of at least 8,000 cycles per minute. Provide enough hand-operated immersion vibrators for timely and proper consolidation of the concrete along forms, at joints and in areas not covered by other vibratory equipment. Surface vibrators may be used to supplement equipment-mounted immersion vibrators. Provide tachometers to verify the proper operation of all vibrators.

For small or irregular areas or when approved, the paving equipment described in this Section is not required.

B. Forming Equipment.

1. **Pavement Forms.** Provide metal side forms of sufficient cross-section, strength, and rigidity to support the paving equipment and resist the impact and vibration of the operation without visible springing or settlement. Use forms that are free from detrimental kinks, bends, or warps that could affect ride quality or alignment. Provide flexible or curved metal or wood forms for curves of 100 foot radius or less.

2. **Curb Forms.** Provide curb forms for separately placed curbs that are not slipformed that conform to the requirements of Item 500, "Concrete Curb, Gutter, and Concrete Curb and Gutter."

C. Reinforcing Steel Inserting Equipment. Provide inserting equipment that accurately inserts and positions reinforcing steel in the plastic concrete parallel to the profile grade and horizontal alignment in accordance to plan details.

D. Texturing Equipment.

1. **Carpet Drag.** Provide a carpet drag mounted on a work bridge or a moveable support system. Provide a single piece of carpet of sufficient transverse length to span the full width of the pavement being placed and adjustable so that a sufficient longitudinal length of carpet is in contact with the concrete being placed to produce the desired texture. Obtain approval to vary the length and width of the carpet to accommodate specific applications. Use an artificial grass-type carpet having a molded polyethylene pile face with a blade length of ⅝ to 1 inch, a minimum weight of 70 oz. per square yard, and a strong, durable, rot-resistant backing material bonded to the facing.

2. **Tining Equipment.** Provide a self-propelled transverse metal tine device equipped with 4 to 6 inch steel tines and with cross-section approximately 1/32 inch thick by 1/12 inch wide, spaced at 1 inch, center-to-center. Hand-operated tining equipment that produces an equivalent texture may be used only on small or irregularly shaped areas or, when permitted, in emergencies due to equipment breakdown.

E. Curing Equipment. Provide a self-propelled machine for applying membrane curing compound using mechanically pressurized spraying equipment with atomizing nozzles. Provide equipment and controls that maintain the required uniform rate of application over the entire paving area. Provide curing equipment that is independent of all other equipment when required to meet the requirements of Article 209.4.I, "Curing." Hand-operated pressurized spraying equipment with atomizing nozzles may be used on small or irregular areas or when permitted.

F. Sawing Equipment. Provide power-driven concrete saws to saw the joints shown on the plans. Provide standby power-driven concrete saws during concrete sawing operations. Provide adequate illumination for nighttime sawing.

G. Grinding Equipment. When required, provide self propelled powered grinding equipment that is specifically designed to smooth and texture concrete pavement using circular diamond blades. Provide equipment with automatic grade control capable of grinding at least a 3 foot width longitudinally in each pass without damaging the concrete.

H. Testing Equipment. Provide testing equipment regardless of job-control testing responsibilities in accordance with Item 300, "Concrete," unless otherwise shown in the plans or specified.

I. Coring Equipment. When required, provide coring equipment capable of extracting cores in accordance with the requirements of TxDOT standard laboratory test procedure Tex-424-A.

J. Miscellaneous Equipment. Furnish both 10 foot and 15 foot steel or magnesium long-handled standard straightedges. Furnish enough work bridges, long enough to span the pavement, for finishing and inspection operations. Furnish date stencils to impress pavement placement dates into the fresh concrete, with numerals approximately 2 inches high by 1 inch wide by ¼ inch deep.

209.4. CONSTRUCTION: Obtain approval for adjustments to plan grade-line to maintain thickness over minor subgrade or base high spots while maintaining clearances and drainage. Maintain subgrade or base in a smooth, clean, compacted condition in conformity with the required section and established grade until the pavement concrete is placed. Keep subgrade or base damp with water sufficiently in advance of placing pavement concrete. Adequately light the active work areas for all nighttime operations. Provide and maintain tools and materials to perform testing.

A. Paving and Quality Control Plan. Unless otherwise shown on the plans, submit a paving and quality control plan for approval before beginning pavement construction operations. Include details of all operations in the concrete paving process, including longitudinal construction joint layout, sequencing, curing, lighting, early opening, leave-outs, sawing, inspection, testing, construction methods, other details and description of all equipment. List certified personnel performing the testing. Submit revisions to the paving and quality control plan for approval.

B. Job-Control Testing. Unless otherwise shown on the plans, perform all fresh and hardened concrete job-control testing at the specified frequency. Provide job-control testing personnel meeting the requirements of Item 300, "Concrete." Provide and maintain testing equipment, including strength testing equipment at a location acceptable to the Engineer. Use of a commercial laboratory is acceptable. Maintain all testing equipment calibrated in accordance with pertinent test methods. Make strength-testing equipment available to the Engineer for verification testing.

Provide the Engineer the opportunity to witness all tests. The Engineer may require a retest if not given the opportunity to witness. Furnish a copy of all test results to the Engineer daily. Check the first few concrete loads for slump, air, and temperature on start-up production days to check for concrete conformance and consistency. Sample and prepare strength test specimens (2 specimens per test) on the first day of production and for each 3,000 square yards or fraction thereof of concrete pavement thereafter. Prepare at least 1 set of strength-test specimens for each production day. Perform slump, air, and temperature tests each time

strength specimens are made. Monitor concrete temperature to ensure that concrete is consistently within the temperature requirements. The Engineer will direct random job-control sampling and testing. Immediately investigate and take corrective action as approved if any Contractor test result, including tests performed for verification purposes, does not meet specification requirements.

When job-control testing by the Contractor is waived by the plans, the Engineer will perform the testing; however, this does not waive the Contractor's responsibility for providing materials and work in accordance with this Item.

1. **Job-Control Strength.** Unless otherwise shown on the plans or permitted by the Engineer, use 7-day job-control concrete strength testing in accordance with TxDOT standard laboratory test procedure Tex-418-A.

   For 7-day job-control by compressive strength, use a compressive strength of 3,200 psi or a lower job-control strength value proven to meet a 28-day compressive strength of 4,400 psi as correlated in accordance with TxDOT standard laboratory test procedure Tex-427-A.

   Job control of concrete strength may be correlated to an age other than 7-days in accordance with TxDOT standard laboratory test procedure Tex-427-A when approved. Job-control strength of Class HES concrete is based on the required strength and time.

   When a job-control concrete strength test value is more than 10% below the required job-control strength or when 3 consecutive job-control strength values fall below the required job-control strength, investigate the strength test procedures, the quality of materials, the concrete production operations, and other possible problem areas to determine the cause. Take necessary action to correct the problem, including redesign of the concrete mix if needed. The Engineer may suspend concrete paving if the Contractor is unable to identify, document, and correct the cause of low strength test values in a timely manner. If any job-control strength is more than 15% below the required job-control strength, the Engineer may evaluate the structural adequacy of the pavements. When directed, remove and replace pavements found to be structurally inadequate at no additional cost.

2. **Split-Sample Verification Testing.** When indicated on the plans, perform split-sample verification testing with the Engineer on random samples taken and split by the Engineer at a rate of at least 1 for every 10 job-control samples. The Engineer will evaluate the results of split-sample verification testing. Immediately investigate and take corrective action as approved when results of split-sample verification testing differ more than the allowable differences shown in Table 1, or when the average of 10 job-control strength results and the Engineer's split-sample strength result differ by more than 10%.

Table 1
Verification Testing Limits

Test Method[1]	Allowable Differences
Temperature, Tex-422-A	2°F
Slump, Tex-415-A	1 inch
Air content, Tex-414-A or Tex-416-A	1%
Compressive strength, Tex-418-A	10%

[1] TxDOT standard laboratory test procedures

C. Reinforcing Steel and Joint Assemblies. Accurately place and secure in position all reinforcing steel as shown on the plans and in accordance with the requirements herein. Place dowels at mid-depth of the pavement slab, parallel to the surface. Place dowels for transverse contraction joints parallel to the pavement edge. Tolerances for location and alignment of dowels will be shown on the plans. Stagger the longitudinal reinforcement splices to avoid having more than ⅓ of the splices within a 2 foot longitudinal length of each lane of the pavement. Use multiple-piece tie bars or drill and epoxy grout tie bars at longitudinal construction joints. Verify that tie bars that are drilled and epoxied into concrete at longitudinal construction joints develop a pullout resistance equal to a minimum of ¾ of the yield strength of the steel after 7-days. Test 15 bars using ASTM E-488, except that alternate approved equipment may be used. All 15 tested bars must meet the required pullout strength. If any of the test results do not meet the required minimum pullout strength, perform corrective measures to provide equivalent pullout resistance. Repair damage from testing. Acceptable corrective measures include but are not limited to installation of additional or longer tie bars.

1. **Manual Placement.** Secure reinforcing bars at alternate intersections with wire ties or locking support chairs. Tie all splices with wire.

2. **Mechanical Placement.** If mechanical placement of reinforcement results in steel misalignment or improper location, poor concrete consolidation, or other inadequacies, complete the work using manual methods.

D. Joints. Install joints as shown on the plans. Joint sealants are not required on concrete pavement that is to be overlaid with asphaltic materials. Clean and seal joints in accordance with TxDOT Item 438, "Cleaning and Sealing Joints and Cracks (Rigid Pavement and Bridge Decks)." Repair excessive spalling of the joint saw groove using an approved method before installing the sealant. Seal all joints before opening the pavement to all traffic. When placing of concrete is stopped, install a rigid transverse bulkhead, accurately notched for the reinforcing steel and shaped accurately to the cross-section of the pavement.

1. **Placing Reinforcement at Joints.** Where the plans require an assembly of parts at pavement joints, complete and place the assembly at the required location and elevation with all parts rigidly secured in the required position. Accurately notch joint materials for the reinforcing steel.

2. **Transverse Construction Joints.**

   a. **Jointed Concrete Pavement.** When the placing of concrete is intentionally stopped, install and rigidly secure a complete joint assembly and bulkhead in the planned transverse contraction joint location. When the placing of concrete is unintentionally

stopped, install a transverse construction joint either at a planned transverse contraction joint location or mid-slab between planned transverse contraction joints. For mid-slab construction joints, install tie bars of the size and spacing used in the longitudinal joints.

b. Curb Joints. Provide joints in the curb of the same type and location as the adjacent pavement. Use expansion joint material of the same thickness, type, and quality required for the pavement and of the section shown for the curb. Extend expansion joints through the curb. Construct curb joints at all transverse pavement joints. For non-monolithic curbs, place reinforcing steel into the plastic concrete pavement as shown on the plans unless otherwise approved. Form or saw the weakened plane joint across the full width of concrete pavement and through the monolithic curbs. Construct curb joints in accordance with Item 500, "Concrete Curb, Gutter, and Curb and Gutter."

E. Placing and Removing Forms. Use clean and oiled forms. Secure forms on a base or firm subgrade that is accurately graded and that provides stable support without deflection and movement by form riding equipment. Pin every form at least at the middle and near each end. Tightly join and key form sections together to prevent relative displacement.

Set side forms far enough in advance of concrete placement to permit inspection. Check conformity of the grade, alignment, and stability of forms immediately before placing concrete, and make all necessary corrections. Use a straightedge or other approved method to test the top of forms to ensure that the ride quality requirements for the completed pavement will be met. Stop paving operations if forms settle or deflect more than ⅛ inch under finishing operations. Reset forms to line and grade, and refinish the concrete surface to correct grade.

Avoid damage to the edge of the pavement when removing forms. Repair damage resulting from form removal and honeycombed areas with a mortar mix within 24 hours after form removal unless otherwise approved. Clean joint face and repair honeycombed or damaged areas within 24 hours after a bulkhead for a transverse construction joint has been removed unless otherwise approved. When forms are removed before 72 hours after concrete placement, promptly apply membrane curing compound to the edge of the concrete pavement.

Forms that are not the same depth as the pavement but are within 2 inches of that depth are permitted if the subbase is trenched or the full width and length of the form base is supported with a firm material to produce the required pavement thickness. Promptly repair the form trench after use. Use flexible or curved wood or metal forms for curves of 100 foot radius or less.

F. Concrete Delivery. Clean delivery equipment as necessary to prevent accumulation of old concrete before loading fresh concrete. Use agitated delivery equipment for concrete designed to have a slump of more than 5 inches. Segregated concrete is subject to rejection. Place agitated concrete within 60 minutes after batching. Place non-agitated concrete within 45 minutes after batching. In hot weather or under conditions causing quick setting of the concrete, times may be reduced by the Engineer. Time limitations may be extended if the Contractor can demonstrate that the concrete can be properly placed, consolidated, and finished without the use of additional water.

G. Concrete Placement. Do not allow the pavement edge to deviate from the established paving line by more than ½ inch at any point. Place the concrete as near as possible to its final location, and minimize segregation and re-handling. Where hand spreading is necessary, distribute concrete using shovels. Do not use rakes or vibrators to distribute concrete.

1. **Pavement.** Consolidate all concrete by approved mechanical vibrators operated on the front of the paving equipment. Use immersion-type vibrators that simultaneously consolidate the full width of the placement when machine finishing. Keep vibrators from dislodging reinforcement. Use hand-operated vibrators to consolidate concrete in areas not accessible to the machine-mounted vibrators. Do not operate machine-mounted vibrators while the paving equipment is stationary. Vibrator operations are subject to review.

2. **Date Imprinting.** Imprint dates in the fresh concrete indicating the date of the concrete placement. Make impressions approximately 1 foot from the outside longitudinal construction joint or edge of pavement and approximately 1 foot from the transverse construction joint at the beginning of the placement day. Orient the impressions to be read from the outside shoulder in the direction of final traffic. Impress date in DD MM YY format. Imprinting of the Contractor name or logo in similar size characters to the date is allowed.

3. **Curbs.** Where curbs are placed separately, conform to the requirements of Item 500, "Concrete Curb, Gutter, and Curb and Gutter."

4. **Temperature Restrictions.** Place concrete that is between 40°F and 95°F when measured in accordance with TxDOT standard laboratory test procedure Tex-422-A at the time of discharge, except that concrete may be used if it was already in transit when the temperature was found to exceed the allowable maximum. Take immediate corrective action or cease concrete production when the concrete temperature exceeds 95°F.

   Do not place concrete when the ambient temperature in the shade is below 40°F and falling unless approved. Concrete may be placed when the ambient temperature in the shade is above 35°F and rising or above 40°F. When temperatures warrant protection against freezing, protect the pavement with an approved insulating material capable of protecting the concrete for the specified curing period. Submit for approval proposed measures to protect the concrete from anticipated freezing weather for the first 72-hours after placement. Repair or replace all concrete damaged by freezing.

H. Spreading and Finishing. Unless otherwise shown on the plans, finish all concrete pavements with approved self-propelled equipment. Use power-driven spreaders, power-driven vibrators, power-driven strike-off, and screed, or approved alternate equipment. Use the transverse finishing equipment to compact and strike off the concrete to the required section and grade without surface voids. Use float equipment for final finishing. Use concrete with a consistency that allows completion of all finishing operations without addition of water to the surface. Use the minimal amount of water fog mist necessary to maintain a moist surface. Reduce fogging if float or straightedge operations result in excess slurry.

1. **Finished Surface.** Perform sufficient checks with long-handled 10 foot and 15 foot straightedges on the plastic concrete to ensure that the final surface is within the tolerances specified in Surface Test A in TxDOT standard test procedure Item 585, "Ride Quality for Pavement Surfaces." Check with the straightedge parallel to the centerline.

2. **Maintenance of Surface Moisture.** Prevent surface drying of the pavement before application of the curing system by means that may include water fogging, the use of wind screens and the use of evaporation retardants. Apply evaporation retardant at the rate recommended by the manufacturer. Reapply the evaporation retardant as needed to maintain the concrete surface in a moist condition until curing system is applied. Do not use evaporation retardant as a finishing aid. Failure to take acceptable precautions to prevent surface drying of the pavement will be cause for shut down of pavement operations.

3. **Surface Texturing.** Complete final texturing before the concrete has attained its initial set. Drag the carpet longitudinally along the pavement surface with the carpet contact surface area adjusted to provide a satisfactory coarsely textured surface. Prevent the carpet from getting plugged with grout. Do not perform carpet dragging operations while there is excessive bleed water.

   A metal-tine texture finish is required for all areas with a posted speed limit in excess of 45 mph. A metal-tine texture finish is required unless otherwise shown on the plans for areas with a posted speed limit less than 45 mph. Immediately following the carpet drag, apply a single coat of evaporation retardant at a rate recommended by the manufacturer. Provide the metal-tine finish immediately after the concrete surface has set enough for consistent tining. Operate the metal-tine device to obtain grooves spaced at 1 inch, approximately 3/16 inch deep, with a minimum depth of ⅛ inch, and approximately 1/12 inch wide. Do not overlap a previously tined area. Use manual methods to achieve similar results on ramps and other irregular sections of pavements. Repair damage to the edge of the slab and joints immediately after texturing. Do not tine pavement that will be overlaid or that is scheduled for blanket diamond grinding or shot blasting.

   When carpet drag is the only surface texture required by the plans, ensure that adequate and consistent micro-texture is achieved by applying sufficient weight to the carpet and keeping the carpet from getting plugged with grout, as directed by the Engineer. Target a carpet drag texture of .04 inch, as measured by Tex-436-A Correct any location with a texture less than .03 inch by diamond grinding or shot blasting. The Engineer will determine the test locations at points located transversely to the direction of traffic in the outside wheel path.

4. **Small or Irregular Placements.** Where machine placements and finishing of concrete pavement are not practical, use hand equipment and procedures that produce a consolidated and finished pavement section to the line and grade.

5. **Emergency Procedures.** Use hand-operated equipment for applying texture, evaporation retardant, and cure in the event of equipment breakdown.

I. Curing. Keep the concrete pavement surface from drying as described in Section 209.4.H.2, "Maintenance of Surface Moisture," until the curing material has been applied. Maintain and promptly repair damage to curing materials on exposed surfaces of concrete pavement continuously for at least 3 curing days. A curing day is defined as a 24 hour period when either the temperature taken in the shade away from artificial heat is above 50°F for at least 19 hours or when the surface temperature of the concrete is maintained above 40°F for 24 hours. Curing begins when the concrete curing system has been applied. Stop concrete paving if curing compound is not being applied promptly and maintained adequately. Other methods of curing in accordance with Item 307, "Concrete Structures," may be used when specified or approved.

1. **Membrane Curing.** Spray the concrete surface uniformly with 2 coats of membrane curing compound at an individual application rate of not more than 180 square feet per gallon. Do not allow the concrete surface to dry before applying the curing compound. Use a towel or absorptive fabric to remove any standing pools of bleed water that may be present on the surface before applying the curing compound. Apply the first coat within 10 min. after completing texturing operations. Apply the second coat within 30 minutes after completing texturing operations.

   Before and during application, maintain curing compounds in a uniformly agitated condition, free of settlement. Do not thin or dilute the curing compound.

   Where the coating shows discontinuities or other defects or if rain falls on the newly coated surface before the film has dried enough to resist damage, apply additional compound at the same rate of coverage to correct the damage. Ensure that the curing compound coats the sides of the tining grooves.

2. **Asphalt Curing.** When an asphaltic concrete overlay is required, apply a uniform coating of asphalt curing at a rate of 90 to 180 square feet per gallon as required. Apply curing immediately after texturing and just after the free moisture (sheen) has disappeared. Obtain approval to add water to the emulsion to improve spray distribution. Maintain the asphalt application rate when using diluted emulsions. Maintain the emulsion in a mixed condition during application.

3. **Curing Class HES Concrete.** For all Class HES concrete pavement, provide membrane curing in accordance with Section 209.4.I.1, "Membrane Curing," followed promptly by water curing until opening strength is achieved but not less than 24 hours.

J. Sawing Joints. Saw joints to the depth shown on the plans as soon as sawing can be accomplished without damage to the pavement regardless of time of day or weather conditions. Some minor raveling of the saw cut is acceptable. Use a chalk line, string line, sawing template, or other approved method to provide a true joint alignment. Provide enough saws to match the paving production rate to ensure sawing completion at the earliest possible time to avoid uncontrolled cracking. Reduce paving production if necessary to ensure timely sawing of joints. Promptly restore membrane cure damaged within the first 72 hours of curing.

K. Protection of Pavement and Opening to Traffic. Testing for early opening is the responsibility of the Contractor regardless of job-control testing responsibilities unless otherwise shown in the plans or directed. Testing result interpretation for opening to traffic is subject to the approval of the Engineer.

1. **Protection of Pavement.** Erect and maintain barricades and other standard and approved devices that will exclude all vehicles and equipment from the newly placed pavement for the periods specified. Before opening to traffic, protect the pavement from damage due to crossings using approved methods. Where a detour is not readily available or economically feasible, an occasional crossing of the roadway with overweight equipment may be permitted for relocating equipment only but not for hauling material. When an occasional crossing of overweight equipment is permitted, temporary matting or other approved methods may be required.

Maintain an adequate supply of sheeting or other material to cover and protect fresh concrete surface from weather damage. Apply as needed to protect the pavement surface from weather.

2. **Opening Pavement to All Traffic.** Pavement that is 7 days old may be opened to all traffic. Before opening to traffic, clean pavement, place stable material against the pavement edges, seal joints, and perform all other traffic safety related work.

3. **Opening Pavement to Construction Equipment.** Unless otherwise shown on the plans, concrete pavement may be opened early to concrete paving equipment and related delivery equipment after the concrete is at least 48 hours old and opening strength has been demonstrated in accordance with Section 209.4.K.4, "Early Opening to All Traffic," before curing is complete. Keep delivery equipment at least 2-feet from the edge of the concrete pavement. Keep tracks of the paving equipment at least 1 foot from the pavement edge. Protect textured surfaces from the paving equipment. Restore damaged membrane curing as soon as possible. Repair pavement damaged by paving or delivery equipment before opening to all traffic.

4. **Early Opening to All Traffic.** Concrete pavement may be opened after curing is complete and the concrete has attained a compressive strength of 2,800 psi, except that pavement using Class HES concrete may be opened after 24 hours if the specified strength is achieved.

   a. **Strength Testing.** Test concrete specimens cured under the same conditions as the portion of the pavement involved.

   b. **Maturity Method.** Unless otherwise shown on the plans, the maturity method, TxDOT standard laboratory test procedure Tex-426-A, may be used to estimate concrete strength for early opening pavement to traffic. Install at least 2 maturity thermocouples for each day's placement in areas where the maturity method will be used for early opening. Thermocouples, when used, will be installed near the day's final placement for areas being evaluated for early opening. Use test specimens to verify the strength–maturity relationship in accordance with TxDOT standard laboratory test procedure Tex-426-A, starting with the first day's placement corresponding to the early opening pavement section.

      After the first day, verify the strength–maturity relationship at least every 10 days of production. Establish a new strength–maturity relationship when the strength specimens deviate more than 10% from the maturity-estimated strengths. Suspend use of the maturity method for opening pavements to traffic when the strength–maturity relationship deviates by more than 10% until a new strength–maturity relationship is established.

      When the maturity method is used intermittently or for only specific areas, the frequency of verification will be as determined by the Engineer.

5. **Emergency Opening to Traffic.** Under emergency conditions, when the pavement is at least 72 hours old, open the pavement to traffic when directed in writing. Remove all obstructing materials, place stable material against the pavement edges, and perform other work involved in providing for the safety of traffic as required for emergency opening.

L. Pavement Thickness. Unless otherwise shown on the plans, the Engineer will perform 1 thickness test consisting of 1 reading at approximately the center of each lane every 500 feet or fraction thereof. The Engineer will check the thickness in accordance with TxDOT standard laboratory test procedure Tex-423-A unless other methods are shown on the plans. Core where directed in accordance with TxDOT standard laboratory test procedure Tex-424-A to verify deficiencies of more than 0.2 inch from plan thickness and to determine the limits of deficiencies of more than 0.75 inch from plan thickness. Fill core holes using a concrete mixture and method approved by the Engineer.

1. **Thickness Deficiencies Greater than 0.2-inch.** When any depth test measured in accordance with TxDOT standard laboratory test procedure Tex-423-A is deficient by more than 0.2 inch from the plan thickness, take one 4-inch diameter core at that location to verify the measurement.

   If the core is deficient by more than 0.2 inch but not by more than 0.75 inch from the plan thickness, take 2 additional cores from the unit (as defined in Section 209.4.L.3, "Pavement Units for Payment Adjustment") at intervals of at least 150 feet and at locations selected by the Engineer, and determine the thickness of the unit for payment purposes by averaging the length of the 3 cores. In calculations of the average thickness of this unit of pavement, measurements in excess of the specified thickness by more than 0.2 inch will be considered as the specified thickness plus 0.2 inch.

2. **Thickness Deficiencies Greater than 0.75-inch.** If a core is deficient by more than 0.75 inch, take additional cores at 10 foot intervals in each direction parallel to the centerline to determine the boundary of the deficient area. The Engineer will evaluate any area of pavement found deficient in thickness by more than 0.75 inch but not more than 1 inch. As directed, remove and replace the deficient areas without additional compensation or retain deficient areas without compensation. Remove and replace any area of pavement found deficient in thickness by more than 1 inch without additional compensation.

3. **Pavement Units for Payment Adjustment.** Limits for applying a payment adjustment for deficient pavement thickness from 0.2 inch to not more than 0.75 inch are 500-feet of pavement in each lane. Lane width will be as shown on typical sections and pavement design standards.

   For greater than 0.75 inch deficient thickness, the limits for applying zero payment or requiring removal will be defined by coring or equivalent nondestructive means as determined by the Engineer. The remaining portion of the unit determined to be less than 0.75 inch deficient will be subject to the payment adjustment based on the average core thickness at each end of the 10 foot interval investigation as determined by the Engineer.

   Shoulders will be measured for thickness unless otherwise shown on the plans. Shoulders 6 feet wide or wider will be considered as lanes. Shoulders less than 6 feet wide will be considered part of the adjacent lane.

   Limits for applying payment adjustment for deficient pavement thickness for ramps, widenings, acceleration and deceleration lanes, and other miscellaneous areas are 500 feet in length. Areas less than 500 feet in length will be individually evaluated for payment adjustment based on the plan area.

M. Ride Quality. When required by the plans, measure ride quality in accordance with TxDOT Item 585, "Ride Quality for Pavement Surfaces." Surface Test Type A or B as well as Pay Schedule 1, 2, or 3 shall also be indicated on the plans.

209.5. MEASUREMENT: This Item will be measured as follows:

A. Concrete Pavement. Concrete pavement will be measured by the square yard of surface area in place. The surface area includes the portion of the pavement slab extending beneath the curb.

B. Curb. Curb on concrete pavement will be measured by the foot in place.

209.6. PAYMENT: Payment includes full compensation for materials, equipment, labor, tools, and incidentals.

A. Concrete Pavement. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the adjusted unit price bid for "Concrete Pavement" of the type and depth specified as adjusted in accordance with Sections 209.6.B, "Deficient Thickness Adjustment" and 209.4.M, "Ride Quality."

B. Deficient Thickness Adjustment. Where the average thickness of pavement is deficient in thickness by more than 0.2 inch but not more than 0.75 inch, payment will be made using the adjustment factor as specified in Table 2 applied to the bid price for the deficient area for each unit as defined under Section 209.4.L.3, "Pavement Units for Payment Adjustment."

Table 2
Deficient Thickness Price Adjustment Factor (1 in = 25.4 mm)

Deficiency in Thickness Determined by Cores (in.)	Proportional Part of Contract Price Allowed (adjustment factor)
Not deficient	1.00
Over 0.00 through 0.20	1.00
Over 0.20 through 0.30	0.80
Over 0.30 through 0.40	0.72
Over 0.40 through 0.50	0.68
Over 0.50 through 0.75	0.57

C. Curb. Work performed and furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Curb" of the type specified.

209.7. BID ITEM:

Item 209.1 - Concrete Pavement - per square yard at __inches of depth

ITEM

210 ROLLING

210.1. DESCRIPTION: *Compact embankment, subgrade, base, surface treatments, broken concrete pavement, or asphalt pavement using rollers. Break up asphalt mats, pit run material, or base materials.*

210.2. EQUIPMENT: The Contractor may use any type of roller to meet the production rates and quality requirements of the Contract unless otherwise shown on the plans or directed. When specific types of equipment are required, use equipment that meets the requirements of this Article. The Engineer may allow the use of rollers that operate in one direction only when turning does not affect the quality of work or encroach on traffic.

Table 1
Roller Requirements[1]

Roller Type	Materials to be Compacted	Load (tons)	Contact Pressure	Roller Speed (mph)
Steel wheel	Embankment, subgrade, base, asphalt concrete	≥ 10	≥ 325 lb. per linear inch of wheel width	2–3
Tamping	Embankment, subgrade, base	–	125–550 psi per tamping foot	2–3
Heavy tamping	Embankment, subgrade, base	–	≤ 550 psi per tamping foot	2–3
Vibratory	Embankment, subgrade, base, asphalt concrete	Type A < 6 Type B > 6 Type C as shown on plans	Per equipment specification and as approved	As approved
Light pneumatic	Embankment, subgrade, base, surface treatment	4.5–9.0	≥ 45 psi	2–6
	Asphalt Concrete			4–12
Medium pneumatic	Same as light pneumatic	12–25	≥ 80 psi, as directed	Same as light pneumatic
Heavy pneumatic	Embankment, subgrade, base, previously broken concrete pavement, other pavements	≥ 25	≤ 150 psi	2–6
Grid	Embankment, base, breaking up existing asphalt mats or base	5–13	–	2–3

1. Unless otherwise specified in the Contract.
1 ton = 0.9 megagrams; 1 psi = 6.9 kPa, 1 lb = 0.45 kg, 1 in = 25.4 mm , 1 mph = 1 kph

A. Static Steel Wheel Rollers. Furnish single, double, or triple steel wheel, self-propelled power rollers weighing at least 10 tons capable of operating in a forward and backward

motion. Confirm all wheels are flat. When static steel wheel rollers are required, vibratory rollers in the static mode may be used.

For single steel wheel rollers, pneumatic rear wheels are allowed for embankment, subgrade, and base. For triple steel wheel rollers, provide rear wheels with a minimum diameter of 48 inches, a minimum width of 20 inches, and a minimum compression of 325 pounds per inch of wheel width.

B. Tamping Rollers. Furnish self-propelled rollers with at least 1 self-cleaning metal tamping drum capable of operating in a forward or backward motion with a minimum effective rolling width of 5 feet. For rollers with more than 1 drum, mount drums in a frame so that each drum moves independently of the other. Operate rollers in static or vibratory mode.

1. **Tamping Roller (Minimum Requirement).** For all tamping rollers except for heavy tamping rollers, provide tamping feet that exert a static load of 125 to 550 psi and extend outward at least 3 inches from the surface of the drum.

2. **Heavy Tamping Roller.** Provide tamping rollers that have:

   - 2 metal tamping drums, rolls, or shells, each with a 60 inch minimum diameter and a 5 foot minimum width, or

   - 1 rear and 2 forward drums, each with a 60 inch minimum diameter. Arrange drums so that the rear drum compacts the space between the 2 forward drums and the minimum overall rolling width is 10 feet.

   Equip drums with tamping feet that:

   - extend outward at least 7 inches from the drum surface,

   - have an area of 7 to 21 square inches,

   - are self-cleaning,

   - exert a static load of at least 550 psi, and

   - are spaced at 1 tamping foot per 0.65 to 0.70 square feet of drum area.

C. Vibratory Rollers. Furnish self-propelled rollers with at least 1 drum equipped to vibrate. Select and maintain amplitude and frequency settings per manufacturer's specifications to deliver maximum compaction without material displacement or shoving, as approved. Furnish the equipment manufacturer's specifications concerning settings and controls for amplitude and frequency. Operate rollers at speeds that will produce at least 10 blows per foot unless otherwise shown on the plans or approved. Pneumatic rear wheels are allowed for embankment, subgrade, and base. Equip each vibrating drum with:

- separate frequency and amplitude controls,

- controls to manually start and stop vibration, and

- a mechanism to continuously clean the face of the drum.

For asphalt-stabilized base and asphalt concrete pavement, furnish a roller that also has the ability to:

- automatically reverse the direction of the rotating eccentric weight,
- stop vibration before the motion of the roller stops, and
- thoroughly moisten the drum with water or approved asphalt release agent.

1. **Drum (Type A).** Furnish a roller with a static weight less than 6 tons and a vibratory drum.
2. **Drum (Type B).** Furnish a roller with a minimum static weight of 6 tons and a vibratory drum.
3. **Drum (Type C).** Furnish a roller as shown on plans.

D. Pneumatic Tire Rollers. Pneumatic tire rollers consist of rubber tire wheels on axles mounted in a frame with either a loading platform or body suitable for ballast loading. Arrange the rear tires to cover the gaps between adjacent tires of the forward group. Furnish rollers capable of forward and backward motion. Compact asphalt pavements and surface treatments with a roller equipped with smooth-tread tires. Compact without damaging the surface. When necessary, moisten the wheels with water or an approved asphalt release agent.

Select and maintain the operating load and tire air pressure within the range of the manufacturer's charts or tabulations to attain maximum compaction throughout the lift, as approved. Furnish the manufacturer's chart or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the particular tires furnished. Maintain individual tire inflation pressures within 5 psi of each other. Provide uniform compression under all tires.

1. **Light Pneumatic Tire.** Furnish a unit:

- with at least 9 pneumatic tires,
- with an effective rolling width of approximately 5 feet,
- capable of providing a total uniform load of 4.5 to 9 tons, and
- with tires capable of maintaining a minimum ground contact pressure of 45 psi.

2. **Medium Pneumatic Tire.** Furnish a unit:

- with at least 7 pneumatic tires,
- with an effective rolling width of approximately 7 feet,
- capable of providing a total uniform load of 12 to 25 tons, and
- with tires capable of maintaining a minimum ground contact pressure of 80 psi or 90 psi as directed.

3. **Heavy Pneumatic Tire.** Furnish a unit:

- with at least 4 pneumatic-tired wheels mounted on axles carrying at most 2 wheels,
- with wheels arranged to carry approximately equal loads on uneven surfaces,
- with a width between 8 and 10 feet that can turn 180° in the crown width,
- capable of providing a total uniform load of at least 25 tons,
- with tires capable of maintaining a maximum ground contact pressure of 150 psi, and
- with liquid-filled tires inflated to such a level that liquid will flow from the valve stem when the stem is in the uppermost position.

E. Grid Rollers. Furnish rollers that have 2 cylindrical cages with a minimum diameter of 66-inches and a minimum width of 32 inches. Mount cages in a rigid frame with weight boxes. Use a cage surface of cast or welded steel fabric grid with bars 1-½ inches wide, spaced on 5 inch centers in each direction, that undulate approximately 1-inch between the high and low points.

Furnish rollers capable of providing a total load of 5 to 13 tons and capable of being operated in a forward or backward motion

F. Alternate Equipment. Instead of the specified equipment, the Contractor may, as approved, operate other compaction equipment that produces equivalent results. Discontinue the use of the alternate equipment and furnish the specified equipment if the desired results are not achieved.

210.2. CONSTRUCTION: Perform this work in accordance with the applicable Items using equipment and roller speeds specified in Table 1. Use only rubber-tired equipment to push or pull compaction equipment on base courses. Use equipment that does not damage material being rolled.

210.3. MEASUREMENT: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured directly but will be subsidiary to pertinent Items.

210.4. PAYMENT: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly but will be subsidiary to pertinent Items.

210.5. BID ITEM:

N/A

ITEM

220 BLADING

220.1. DESCRIPTION: *Blade portions of the project limits as shown on the plans or as directed by the Engineer.*

220.2. EQUIPMENT: All equipment shall be approved by the Engineer prior to use and shall be able to efficiently produce the desired results. When work is measured and paid by the number of hours of blading, use a dual or four-wheel drive power maintainer equipped with pneumatic tires, a blade of at least 12 feet in length, and a wheelbase of not less than 16 feet. If the maintainer is not equipped with a scarifier attachment, provide a scarifier.

220.3. CONSTRUCTION: Blade all areas to the section, line and grade shown on the plans. Use a scarifier when necessary to loosen materials prior to blading. Use hand methods or other means around structures, trees, and other obstructions if doing the work with a blade is impractical. Do not drag, push, or scrape material along or across completed pavement.

220.4. MEASUREMENT: Unless otherwise shown on the plans as subsidiary to other pertinent items, this item will be measured by the 100-foot station, along the base line of each roadbed or by the number of hours of blading, including scarifying, performed. Roadbed is defined as the graded portion of a roadway prepared as foundation for the pavement structure and shoulders. On divided roadways, the depressed median type and the raised median type roadways are considered to have 2 roadbeds. Roadways with a flush median are considered to have 1 roadbed.

220.5. PAYMENT: Unless otherwise shown on the plans as subsidiary to other items, the work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Blading." This price is full compensation for furnishing and operating equipment and for labor, materials, tools, and incidentals.

Work done by hand labor methods adjacent to structures, trees, and other obstructions is not paid for directly, but will be considered subsidiary to this Item. Work performed under this Item will not include work specified for payment under other Items.

220.6. BID ITEM:

N/A

ITEM

230 BASE AND PAVEMENT REPLACEMENT

230.1. DESCRIPTION: *Repair localized sections of flexible pavement and full depth repair of concrete pavement including subgrade, base, and surfacing as shown on the plans due to distress from traffic loading, environment, or other causes. Cutting and replacing existing pavements for utility trench construction (cuts up to 6 feet in width) is specified in Item 511, "Cutting and Replacing Pavements (Trench Repair)."*

230.2. MATERIALS: Furnish materials in accordance with the requirements herein unless otherwise shown on the plans. Provide materials of the type and grade as shown on the plans and in accordance with the pertinent Items listed below:

A. Embankment. Item 107, "Embankment."

B. Lime Treated Subgrade. Item 108, "Lime Treated Subgrade."

C. Cement Treated Subgrade. Item 109, "Cement Treated Subgrade."

D. Flexible Base. Item 200, "Flexible Base."

E. Cement Treated Base. Item 201, "Cement Treated Base."

F. Asphalt Treated Base. Item 206, "Asphalt Treated Base."

G. Prime Coat. Item 202, "Prime Coat."

H. Surface Treatments. Item 204, "Surface Treatments."

I. Hot Mix Asphaltic Concrete Pavement. Item 205, "Hot Mixed Asphaltic Concrete Pavement."

J. Concrete Pavement. Item 209, "Concrete Pavements."

K. Concrete. Item 300, "Concrete."

L. Reinforcing Steel. Item 301, "Reinforcing Steel."

M. Epoxy. TxDOT DMS 6100, "Epoxies and Adhesives."

230.3. EQUIPMENT: Furnish equipment in accordance with the pertinent Items. Use of a motor grader will be permitted for asphalt concrete pavement unless otherwise shown on the plans.

230.4. CONSTRUCTION: Repair using one or more of the following operations as shown on the plans. Cut neat vertical faces around the perimeter of the work area when removing pavement structure layers. Removed materials are the property of the Contractor unless otherwise shown on the plans. Dispose of removed material in accordance with federal, state, and local regulations. Provide a smooth line and grade conforming to the adjacent pavement.

A. Removing Pavement Structure. All concrete and asphaltic concrete pavements shall be cut with a concrete saw or other approved equally capable equipment. If necessary, remove

adjacent soil and vegetation to prevent contamination of the repair area, and place it in a windrow. Do not damage adjacent pavement structure during repair operations.

1. **Existing Flexible Pavement.** The depth of the cut shall be such that upon removal of asphaltic concrete, the sides of the cut will be straight and square. Where existing base materials are to remain, pavements shall be removed to their full depth up to the top of the base material. Care shall be taken not to damage the existing base. If subgrade work is required, remove flexible pavement structure layers from work area.

2. **Existing Concrete Pavement.** Remove areas identified by the Engineer. Make repair areas rectangular, at least 6 feet long and at least ½ a full lane in width unless otherwise shown on the plans. Saw-cut and remove existing asphalt concrete overlay over the repair area and at least 6 inches outside each end of the repair area. Saw-cut full depth through the concrete around the perimeter of the repair area before removal. Do not spall or fracture concrete adjacent to the repair area. Schedule work so that concrete placement follows full-depth saw cutting by no more than 7 days unless otherwise shown on the plans or approved.

   Remove or repair loose or damaged base material, and replace or repair it with approved base material to the original top of base grade. Place a polyethylene sheet at least 4 mils thick as a bond breaker at the interface of the base and new pavement. Allow concrete used as base material to attain sufficient strength to prevent displacement when placing pavement concrete.

B. Preparing Subgrade. Fill holes, ruts, and depressions with approved material. If required, thoroughly wet, reshape, and compact the subgrade as directed.

Where subgrade has failed, remove unstable subgrade material to the depth directed and replace with an approved material.

C. Mixing and Placing Base Material. Place, spread, and compact material in accordance with the applicable Item to the required or directed depth. For flexible pavement repair, when bituminous material is to remain in the pavement structure, pulverize to a maximum dimension of 2-½ inches and uniformly mix with existing base to the depth shown on the plans.

1. **Flexible Base.** Use existing base and add new flexible base as required in accordance with Item 200, "Flexible Base," and details shown on the plans to achieve required section.

2. **Cement-Treated Base.** Use existing base, add flexible base, and stabilize with a minimum cement content of 4% by weight of the total mixture. Construct in accordance with details shown on the plans and Item 201, "Cement Treated Base," to achieve required section.

3. **Asphalt-Treated Base.** Place asphalt-treated base in accordance with details shown on the plans and Item 206, "Asphalt Treated Base," or Item 205, "Hot Mix Asphaltic Concrete Pavement," to achieve required section.

4. **Concrete Base.** Unless otherwise shown on the plans or permitted, furnish pavement concrete for replacement base material when required. The Engineer may waive quality control tests for base material.

D. Curing Base. Cure in accordance with the appropriate Item unless otherwise directed or approved by the Engineer. Maintain completed base sections until surfacing.

E. Surfacing. Apply surfacing with materials as shown on the plans to the completed base section.

1. **Prime Coat.** Protect the compacted, finished, and cured flexible or cement-treated base mixtures with a prime coat of the type and grade shown on the plans. Apply the prime coat at the rate shown on the plans.

2. **Surface Treatments.** Apply surface treatment with the type and grade of asphalt and aggregate as shown on the plans in accordance with Item 204, "Surface Treatments."

3. **Asphalt Concrete Pavement.** Apply tack coat of the type and grade and at the rate shown on the plans unless otherwise directed. Construct in accordance with Item 205, "Hot Mix Asphaltic Concrete Pavement," to achieve required section.

4. **Portland Cement Concrete Pavement.** Use only drilling operations that do not damage the surrounding operations when drilling holes for replacement steel. Place new deformed reinforcing steel bars of the same size and spacing as the bars removed or as shown on the plans. Lap all reinforcing steel splices in accordance with Item 301, "Reinforcing Steel." Place dowel bars and tiebars as shown on the plans. Epoxy-grout all tiebars for at least a 12 inch embedment into existing concrete. Completely fill the tiebar hole with Type III, Class A or Class C epoxy before inserting the tiebar into the hole.

   Provide grout retention disks for all tiebar holes. Provide and place approved supports to firmly hold the new reinforcing steel, tiebars, and dowel bars in place. Demonstrate, through simulated job conditions, that the bond strength of the epoxy-grouted tiebars meets a pullout strength of at least ¾ of the yield strength of the tiebar when tested in accordance with ASTM E 488 within 18 hr. after grouting. Increase embedment depth and retest when necessary to meet testing requirements. Perform tiebar testing before starting repair work.

   If the time frame designated for opening to traffic is less than 72 hours after concrete placement, provide Class HES concrete designed to attain a minimum average flexural strength of 255 psi or a minimum average compressive strength of 1,800 psi within the designated time frame. Otherwise provide Class P concrete conforming to Item 209, "Concrete Pavement." Type III cement is permitted for Class HES concrete. Mix, place, cure, and test concrete to the requirements of Item 209, "Concrete Pavement," and Item 300, "Concrete," unless otherwise shown on the plans. Broom-finish the concrete surface unless otherwise shown on the plans.

   Match the grade and alignment of existing concrete pavement. After concrete strength requirements have been met, replace any asphalt overlay and shoulder material removed with new asphalt concrete material in accordance with Item 205, "Hot Mixed Asphaltic Concrete Pavement."

   For repair areas to be opened to traffic before 72 hours, use curing mats to maintain a minimum concrete surface temperature of 70°F when air temperature is less than 70°F. Cure repaired area for at least 72 hours or until overlaid with asphalt concrete, if required, or until the area is opened to traffic. Saw and seal contraction joints in the repair area in

accordance with Item 209, "Concrete Pavement." Remove repair area debris from the right of way each day.

F. Finishing. Regrade and compact disturbed topsoil. Clean roadway surface after repair operations.

230.5. MEASUREMENT:

A. Flexible Pavement. This Item will be measured by the square yard. In areas where material is excavated, as directed, to depths greater than those specified on the plans, measurement will be made by dividing the actual depth of such area by the plan depth and then multiplying this figure by the area in square yards of work performed. Calculations for each repaired area will be rounded up to the nearest 1/10 square yard. At each repair location, the minimum area for payment purposes will be 1 square yard.

B. Concrete Pavement. This Item will be measured by the square yard of concrete surface area repaired. No measurement will be made for areas damaged because of Contractor negligence.

230.6. PAYMENT:

A. Flexible Pavement. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Flexible Pavement Structure Repair" of the specified depth. This price is full compensation for scarifying, removing, hauling, spreading, disposing of, and stockpiling existing pavement structure; removing objectionable or unstable material; furnishing and placing materials; maintaining completed section before surfacing; applying tack or prime coat; hauling, sprinkling, spreading, and compacting; and equipment, labor, tools, and incidentals.

B. Concrete Pavement. The work performed and the materials furnished in accordance with this Item and measured as specified under "Measurement" will be paid for at the unit price bid for "Concrete Full-Depth Repair" of the type and depth specified. This price is full compensation for removal, stockpiling, and disposal of waste material and for equipment, materials, labor, tools, and incidentals. Asphalt concrete, base material, and curbing will not be paid for directly but will be considered subsidiary to this Item.

230.7. BID ITEM:

Item 230.1 - Flexible Pavement Structure Repair - __inches compacted depth - per square yard

Item 230.2 - Concrete Pavement Full-Depth Repair - __inches compacted depth - per square yard

ITEM

234 GEOGRID FOR BASE OR EMBANKMENT REINFORCEMENT

234.1. DESCRIPTION: *Furnish and place geogrid base reinforcement in accordance with the lines and grades shown on the plans or as directed by the Engineer.*

234.2. MATERIALS: Provide geogrid in conformance with the Items and requirements stated herein.

A. Geogrid Reinforcement. Texas Department of Transportation Materials Specification DMS 6240, "Geogrid for Base/Embankment Reinforcement," of the type as shown on the plans. The sampling, testing and rejection criteria of that specification shall govern.

B. Unapproved Materials. Material substitutions for geogrids not conforming to the physical requirements of TxDOT DMS 6240 must be submitted with an alternative design proposal to the Engineer for consideration. Alternate design proposals must be accompanied by the test data from an approved laboratory showing all design and index properties in accordance with the test properties shown in TxDOT DMS 6240. If approved, the Engineer will provide written authorization. Allow a minimum of 14 days for the approval process.

234.3. CONSTRUCTION:

A. Subgrade soil shall be prepared in accordance with Specifications Item 104, "Street Excavation" and Item 107, "Embankment," prior to placement of geogrid reinforcement.

B. Geogrid reinforcement shall be rolled out parallel to the road direction at the proper elevation and alignment as shown on the construction drawings.

C. Geogrid sections shall be overlapped a minimum of one 1 foot in both directions. Placement of geogrid around corners will require cutting of geogrid product and diagonal overlapping. Unless otherwise directed by the Engineer, plastic ties shall be used at overlaps. The transverse spacing of the ties shall be 4 to 5 feet and the longitudinal tie spacing shall be 10 to 20 feet, unless otherwise approved by the Engineer.

D. The geogrid shall be pinned at the beginning of the backfilling section, but shall be left free to stretch or relieve tension throughout the remainder of the work area.

E. Contractor shall take steps to ensure that geogrid sections do not separate at overlaps during construction.

F. Base material shall be placed and compacted in accordance with Specification Item 200, "Flexible Base." This material shall be back dumped from trucks riding on top of the reinforced base material and bladed on to the grid ahead.

G. If approved by the Engineer, geogrid may be placed directly under hot-mixed asphaltic concrete base in accordance with Specification Item 205, "Hot-Mixed Asphalt Concrete Pavement." The lift thickness of base material placed directly on the geogrid shall not be greater than 6 inches compacted. This material shall be back dumped from trucks riding on top of the reinforced base material and bladed on to the grid ahead.

H. Tracked construction equipment shall not operate directly upon the geogrid. A minimum base thickness of 6 inches is required prior to operation of trucked vehicles over the geogrid.

I. Rubber tired equipment may pass over the geogrid at slow speeds, less than 5 miles per hour if the subgrade material is capable of supporting the loads without excessive rutting or causing damage to the grid. Equipment operators shall avoid sudden braking or sharp turning.

J. If ruts are created in the base material due to construction traffic, they shall be filled with additional base material rather than blading adjacent material into the rut.

K. Sections of geogrid, which are damaged by construction activity, shall be repaired or replaced at the Contractor's expense. All repaired sections shall contain a minimum 3 foot overlap in all directions.

234.4. MEASUREMENT: Accepted work as prescribed by this item will be measured by the square yard of base reinforcement complete in place in accordance with the plans with no allowance made for width of overlaps required.

234.5. PAYMENT: The work performed as prescribed by this item will be paid for at the contract unit price bid per square yard, measured as prescribed above, for "Base Reinforcement" which price shall be full compensation for furnishing all labor, materials, equipment and other items necessary and incidental to completion of work.

234.6. BID ITEM:

Item 234.1 - Base Reinforcement - per square yard

ITEM

236 FULL DEPTH RECLAMATION

236.1. DESCRIPTION: *Mix and compact emulsion, additives, water, and base with or without asphalt concrete pavement, in the roadway.*

236.2. MATERIALS: Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. The Engineer will verify that the specification requirements are met before the sources can be used. The Engineer may sample and test project materials at any time before compaction. Use TxDOT standard laboratory test procedure Tex-100-E for material definitions.

A. Emulsion. Provide an asphalt-emulsion that meets the requirements of Table 2.

B. Flexible Base ("Add Rock"). Furnish base material that meets the requirements of Item 200, "Flexible Base," for the type and grade shown on the plans, before the addition of emulsion.

C. Additive. Determine the amount and type of additive, if any, during the mix design. When an additive is required, the total amount in the mix will not exceed 1.0 % by weight of material.

1. **Lime.** When lime is required, furnish lime that meets the requirements for TxDOT's DMS 6350, "Lime and Lime Slurry," and DMS-6330, "Lime Sources Prequalification of Hydrated Lime and Quicklime." Use hydrated lime or commercial lime slurry, as shown on the plans. Dry placement shall not be used unless written approval is granted by the Engineer.

2. **Cement.** When cement is required, furnish hydraulic cement that meets the requirements of TxDOT's DMS-4600, "Hydraulic Cement," and their Hydraulic Cement Quality Monitoring Program (HCQMP). Sources not on the HCQMP will require testing and approval before use.

D. Mix Design. Submit a mix design to the Engineer for approval, before the start of the project. Include the optimum moisture content, maximum dry density, percent additive, percent "add rock", percent existing material, percent moisture content at which to add emulsion, and optimum percent asphalt emulsion required to meet the mixture requirements in Table 1. Prepare specimens for all tests in accordance with TxDOT standard laboratory test procedure Tex-241-F. Perform additional mix designs based on existing material variability, as directed by the Engineer. Any cost associated with taking samples from the existing base, traffic control during sampling procedures, equipment used for sampling, patching the existing pavement, and providing the mix design shall be included with the unit prices for item 236, "Full Depth Reclamation."

E. Water. Furnish water free of industrial waste and other objectionable material.

Table 1
Laboratory Mixture Design Properties[1]

Property	Procedure[2]	Criteria
Superpave gyratory compaction, gyrations	Tex-241-F[3]	30
Min. indirect tensile strength (ITS), minimum psi	Tex-226-F[4]	50
Resilient modulus, minimum	AASHTO T 307	300,000

1. It is recommended to sample at least 3-feet by 3-feet pits the entire existing pavement depth (being careful not to excavate into the subgrade) or an adequate volume for the mix design. Sample the existing pavement at an 800-foot interval and not less than 2 per roadway. Based on roadway variability, more than one design may be required.
2. TxDOT standard laboratory test procedure, unless otherwise noted.
3. Equipment requirements are 1.25° angle, 87 psi.
4. Indirect tensile strength specimens will be cured 72 hours at 104°F before testing.

Table 2
Emulsified Asphalt Properties

Test	Method	Min	Max
Residue from distillation, %	ASTM D 244[1]	63	-
Oil distillate by distillation, %	ASTM D 244[1]	-	0.5
Sieve Test, %	ASTM D 244[1]	-	0.1
Penetration[2], 77°F, dmm	ASTM D 5	-25%	+25%

1. Modified ASTM D244 procedure – distillation temperature of 350 °F with a 20 minute hold. The ASTM D244 vacuum distillation procedure may be substituted once the maximum oil distillate is satisfied.
2. To be determined from the mix design prior to emulsion manufacture for project. Penetration range will be reported on the submitted mix design.

236.3. EQUIPMENT: Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with TxDOT Item 216, "Proof Rolling," when required.

Provide a self-propelled mixer capable of fully mixing the existing road to the depth required, incorporate the asphalt emulsion and water, and mix the materials to produce a homogeneous material. Provide a mixer with a minimum power of 400 HP. Provide a machine capable of mixing not less than 8 feet wide and up to 12 inches deep in each pass. The mixer must contain a system for adding asphalt emulsion with a full width spray bar consisting of a positive displacement pump interlocked to the machine speed so that the amount of emulsion being added is automatically adjusted with changes in machine speed. The emulsion injection system will be capable of incorporating up to 7 gallons per square yard of emulsion. Provide individual valves on the emulsion injection system spray bar that are capable of being turned off as necessary to minimize emulsion overlap on subsequent passes.

236.4. CONSTRUCTION: Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans, or as directed.

A. Preshaping. Shape the existing material in accordance with applicable bid items to conform to typical sections shown on the plans and as directed before the addition of asphalt-emulsion. Incorporate water and add rock during this operation, if needed. Compact the material to support equipment and/or traffic, and to provide depth control during mixing.

B. Mixing. Moisture content before addition of the emulsion and additive (if required by the mix design) shall be within 1 percent from the mix design recommendation and as measured in Section 236.5, "Quality Control;" aerate if too wet and add water if too dry. Add emulsion

and additives, if required, at the percentage(s) determined in Section 236.2.D, "Mix Design." Monitor the required depth of mixing regularly.

Complete the entire operation of mixing the existing road, incorporating add rock, additive, water, and asphalt emulsion in one pass. Ensure that each adjacent pass of the mixer overlaps the previous pass by a minimum of 6 inches. Use multiple passes if the quality control requirements specified in Section 236.5, "Quality Control" are not met. If an additional pass of the mixer significantly improves dispersion of the emulsion, use this additional pass for the entire project.

After mixing, the Engineer will sample the mixture at roadway moisture and test in accordance with TxDOT standard laboratory test procedure Tex-101-E, Part III, to determine compliance with the following gradation requirements:

Sieve Size	Percent Passing
1-3/4 in.	97-100
3/4 in.	85

C. Application of Additive. Uniformly apply additive in advance of the mixer. Minimize dust and scattering of additives by wind. Do not apply additives when wind conditions, in the opinion of the Engineer, cause blowing additive to become dangerous to traffic or objectionable to adjacent property owners.

1. Lime. Uniformly apply lime using slurry placement as shown on the plans, or as directed. Dry placement of lime is not allowed unless otherwise approved by the Engineer. Add lime at the percentage determined in the mix design. Apply lime only on an area where mixing can be completed during the same working day.

Start lime application only when the air temperature is at least 35°F and rising or is at least 40°F. The temperature will be taken in the shade and away from artificial heat. Suspend application when the Engineer determines that weather conditions are unsuitable.

a. Slurry Placement. Provide slurry free of objectionable materials, at or above the approved minimum dry solids content, and with a uniform consistency that will allow ease of handling and uniform application. Deliver commercial lime slurry to the jobsite or prepare lime slurry at the jobsite or other approved location by using hydrated lime as specified.

Distribute slurry uniformly by making successive passes over a measured section of roadway until the specified lime content is reached.

b. Dry Placement. Dry placement is not allowed unless approved by the Engineer. If used, when necessary, sprinkle in accordance with TxDOT Item 204, "Sprinkling." Distribute the required quantity of hydrated lime with approved equipment. Only hydrated lime may be distributed by bag. Do not use a motor grader to spread hydrated lime.

2. Cement. Uniformly apply cement using slurry placement unless otherwise shown on the plans or approved by the Engineer. Add cement at the percentage determined in the mix design. Apply cement only on an area where mixing, compacting, and finishing can be

completed during the same working day. Distribute the required quantity of dry cement with approved equipment.

3. **Emulsion.** Uniformly apply emulsion as specified in Section 236.4.B, "Mixing." Add emulsion at the percentage determined in Section 236.2.D, "Mix Design." Apply emulsion only on an area where mixing and compaction can be completed during the same working day.

   Suspend emulsion application if the weather forecast calls for freezing temperatures within 7 days after incorporation of the emulsion. Suspend application when the Engineer determines that weather conditions are unsuitable.

D. Compaction. Compact the mixture using density control, unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved.

Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least one-half the width of the roller unit. On superelevated curves, begin rolling at the low side and progress toward the high side. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph, as directed.

Perform initial compaction using a heavy tamping roller applying high amplitude and low frequency. Maintain the heavy tamping roller within 500 feet of the mixer at all times. Continue rolling until the heavy tamping roller "walks out" of the material. Walking out for the heavy tamping roller is defined as light being evident between all of the pads at the material–heavy tamping roller drum interface.

After the completion of heavy tamping rolling, remove remaining tamping marks. Cut no deeper than the depth of the tamping marks. Achieve desired slope and shape to the lines and grades shown in the plans. Perform final surface shaping on the same day as the asphalt emulsion is incorporated.

Use a vibratory roller and pneumatic roller to compact the bladed material. Do not finish-roll in vibratory mode. If necessary, use a light spray of water to aid in final compaction density and appearance.

Rework material that fails to meet or that loses required moisture, density, stability, or finish within 24 hours of completion of compaction. Add additional emulsion and additives at 100% of the percentages determined during mix design. Reworking includes loosening, adding material or removing unacceptable material if necessary, mixing as directed, compacting, and finishing. Continue work until specification requirements are met. Perform the work at no additional expense to the City.

When an area fails to meet or loses required moisture, density, stability, or finish more than 24-hours after completion of compaction and before the next course is placed or the project is accepted, remove the unacceptable material and replace with new material that meets the mix design requirements. Compact and finish until specification requirements are met. Perform the work at no additional expense to the City.

1. **Ordinary Compaction.** Roll with approved compaction equipment, as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompacting.

2. **Density Control.** The Engineer will determine roadway density of completed sections in accordance with TxDOT standard laboratory test procedure Tex-115-E. The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.

   Compact the bottom course to at least 97% of the maximum density determined in accordance with TxDOT standard laboratory test procedure Tex-113-E, unless otherwise shown on the plans. Compact subsequent courses treated under this Item to at least 97% of the maximum density determined in accordance with TxDOT standard laboratory test procedure Tex-113-E, unless otherwise shown on the plans.

E. Curing. Cure the finished section until the moisture content is at least 2 percentage points below optimum, or as directed before applying the next successive course or prime coat. Do not allow equipment or traffic on the finished course during curing, unless otherwise approved. The Engineer may allow traffic on the finished course during curing if proof rolling indicates adequate stability. Proof roll in accordance with TxDOT Item 216, "Proof Rolling." If deformation occurs, do not allow traffic to return to the finished section until the mixed material is firm enough to accommodate traffic without deformation. Apply seals or additional courses within 14 calendar days of final compaction.

When the plans show no specific detour, the Contractor will provide one-way traffic control until proof rolling permits the return of normal traffic to the compacted material.

236.5. Quality Control. The Contractor is responsible for quality control (QC) of the process and the completed base. The Engineer will provide sampling frequencies.

A. Asphalt Emulsion. A representative from the asphalt emulsion supplier will check the mixing and curing properties at the beginning of the project, and will make recommendations for design changes to the Engineer.

B. Moisture Content. Use TxDOT standard laboratory test procedure Tex-103-E to check moisture content before addition of emulsion. Check the moisture content on the same day emulsion is applied. If rain has occurred after testing and before emulsion addition, recheck the moisture content. Adjust by moisture addition (water truck) or aeration if the average moisture content is not within 1% of the mix design recommendation. Recheck the moisture content if manipulation has occurred.

C. Emulsion Content. Apply the amount of asphalt emulsion recommended in the mix design. The Engineer must approve changes in asphalt emulsion content or supplier. Check the percentage of emulsion added using meter readings or truck weigh tickets, the quantity of material reclaimed (depth, width, and length) and estimated in-place density determined by TxDOT standard laboratory test procedure Tex-113-E (mix design or field check) or nuclear density gauge. Determine emulsion content on the first day of processing during the first emulsion transport. Adjust equipment calibration if necessary. Check emulsion content again if adjustments are made. Determine subsequent emulsion content as directed by the Engineer, but not less than once per day.

D. Density. Obtain samples to the full depth of reclamation before rolling and store in a sealed container for no longer than 2 hours. Compact in accordance with TxDOT standard laboratory test procedure Tex-113-E and adjust mixing and compaction operations to achieve maximum dry density established in the mix design.

236.6. MEASUREMENT:

A. Emulsion. Emulsion will be measured by the gallon.

B. Additive.

1. Lime. When lime is furnished in trucks, the weight of lime will be determined on certified scales, or the Contractor mush provide a set of standard platform truck scales at a location approved by the Engineer. Scales must conform to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment."

When lime is furnished in bags, each bag must indicate the manufacturer's certified weight. Bags varying more than 5% from that weight may be rejected. The average weight of bags in any shipment as determined by weighing 10 bags taken at random must be at least the manufacturer's certified weight.

a. Hydrated Lime.

(1) Dry. Lime will be measured by the ton (dry weight).

(2) Slurry. Lime will be measured by the ton (dry weight) of the hydrated lime used to prepare the lime slurry at the jobsite.

b. Commercial Lime Slurry. Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.

2. Cement. Cement will be measured by the ton (dry weight). When cement is furnished in trucks, the weight of cement will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the Engineer. Scales must conform to the requirements of TxDOT Item 520, "Weighing and Measuring Equipment.

When cement is furnished in bags, indicate the manufacturer's certified weight. Bags varying more than 5% from that weight may be rejected. The average weight of bags in ay shipment, as determined by weighing 10 bags taken at random, must be at least the manufacturer's certified weight.

3. Emulsion Treatment. Emulsion treatment will be measured by the square yard of surface area. The dimensions for determining the surface area are established by the widths shown on the plans and lengths measured at placement.

236.7. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid in accordance with Section 236.7.A, "Emulsion," Section 236.7.B, "Lime," Section 236.7.C, "Cement," and Section 236.7.D, "Emulsion Treatment."

Furnishing and delivering new base will be paid for in accordance with Item 200.6.B, "Flexible Base (Roadway Delivery)." Mixing, spreading, blading, shaping, compacting, and finishing new or existing base material will be paid for under Section 236.7.B, "Emulsion Treatment." Removal and disposal of existing asphalt concrete pavement will be paid for in accordance with pertinent Items.

Additives and emulsion used for reworking a section will not be paid for directly but will be subsidiary to this Item.

Sprinkling and rolling, except proof rolling, will not be paid for directly but will be subsidiary to this Item unless otherwise shown on the plans. When proof rolling is shown on the plans or directed by the Engineer, it will be paid for in accordance with TxDOT Item 216, "Proof Rolling."

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade or existing base will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade or existing base will be in accordance with pertinent Items or through the Change Order process.

A. Emulsion. Emulsion will be paid for at the unit price bid for "Emulsion." This price is full compensation for materials, delivery, equipment, labor, tools, and incidentals.

B. Lime. Lime will be paid for at the unit price bid for "Lime" of the specified type (Hydrated (Dry), Hydrated (Slurry), or Commercial Lime Slurry). This price is full compensation for furnishing lime.

C. Cement. Cement will be paid for at the unit price bid for "Cement." This price is full compensation for furnishing cement.

D. Emulsion Treatment. Emulsion treatment will be paid for at the unit price bid for "Emulsion Treatment (Existing Base)," or "Emulsion Treatment (Mixing Existing Material and New Base)," for the depth specified. No payment will be made for thickness or width exceeding that shown on the plans. This price is full compensation for shaping existing material, loosening, mixing, pulverizing, spreading, applying additives and emulsion, compacting, finishing, curing, curing materials, blading, shaping and maintaining shape, replacing mixture, disposing of loosened materials, processing, hauling, preparing secondary subgrade, water, equipment, labor, tools, and incidentals.

236.8. BID ITEM:

Item 236.1 - Emulsion per gallon

Item 236.2 - Emulsion Treatment (Existing Base) (__ inches compacted depth) per square yard

Item 236.3 - Emulsion Treatment (Mixing Existing Material and New Base) (__ inches compacted depth) per square yard

ITEM

237 POTHOLE REPAIR

237.1. DESCRIPTION: *Repair potholes, spalled areas, depressions, and raveled or damaged pavement edges in roadway surfaces.*

237.2. MATERIALS: The Contractor shall furnish all materials unless otherwise shown on the plans or approved by the Engineer. The Contractor shall use materials that meet the requirements of the items shown below unless otherwise approved by the Engineer. The specific grade and/or type of material should be appropriate for the repair required and the environmental conditions at the time of the repair.

A. Tacking Material. Item 203, "Tack Coat."

B. Hot Mix Asphaltic Concrete. Item 205, "Hot-Mix Asphaltic Concrete Pavement."

C. Asphaltic Concrete Patch Material. TxDOT DMS-9202, "Asphaltic Concrete Patching Material (Stockpile Storage)."

D. Rapid Curing Asphaltic Concrete Patch Material. TxDOT DMS-9203, "Asphaltic Concrete Patching Material (Containerized)."

237.3. EQUIPMENT: Provide machinery, tools, and equipment necessary for proper execution of the work and as described in the pertinent specification items.

237.4. CONSTRUCTION: Repair pothole by setting up work area for safety, marking area to be repaired, cutting and squaring-off the repair area, excavation when necessary, cleaning and removal of debris by use of broom and compressed air, compaction of subgrade, use of tacking material in repair area, supply of paving material, spreading and compaction of repair area, edge sealing, and cleanup. Traffic control during all pothole repairs shall be in accordance with the appropriate requirements of the latest edition of the Texas Manual on Unified Traffic Control Devices (TMUTCD).

Work requests will be made on a callout basis.

The Contractor shall begin physical repair within 48 hours of notification. When the request is made on the weekend, physical repair shall commence no later than the following Monday. When an emergency request is made, physical repair shall commence within 24 hours including weekends.

A. Traffic Control. Shall include but not limited to traffic control devices and other barriers, cones and flag people in each direction of traffic flow, as in accordance with the latest edition of the Texas Manual on Unified Traffic Control Devices (TMUTCD). The Contractor is required to develop and implement an appropriate traffic control plan that conforms to the requirements of the TMUTCD for the specific situation where the pothole repair(s) will occur.

B. Mark Patch Boundaries. Washable paint shall be used to mark the perimeter of the repair.

C. Cut Boundaries. Cut and square the sides of the repair area by saw cutting, jack hammer or by other approved methods. Limits shall extend to sound pavement.

D. Excavation. Excavate to a minimum of 4 inches in depth. Over-excavation may be required if stable base material is not encountered at 4 inches. Over-excavate 2 inches into stable base material. If stable base is not encountered and the excavation reaches the top of subgrade, work should cease under this item and the repair should be conducted using Item 230, "Base and Pavement Replacement."

E. Clean and Repair Foundation. Remove loose and foreign material, clean and dry the repair area by use of broom and compressed air. Unless the repair is being conducted as an emergency repair, the repair area must not have excessive moisture in the base and no standing water in the bottom of the repair area.

F. Measure Repair. Length, width and depth of the repair shall be measured in tenths of a foot.

G. Apply Tack Coat. Repair area floor and all side walls shall be tacked with an approved asphalt material in accordance with Item 203, "Tack Coat." All contact surfaces shall be painted with a thin uniform coat of the asphaltic material used for tack coat. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutters or structures.

H. Place Asphaltic Material. Place asphaltic material as indicated on the plans or which conforms to the materials and requirements identified in 237.2, "Materials." Other materials may be utilized if approved by the Engineer. The repair material shall be placed in horizontal lifts no more than 3 inches in depth and compacted.

I. Compaction. The Contractor shall finish to grade and compact to conform to the roadway surface. The surface shall be compacted with mechanical tampers, or rollers as directed and approved. Compaction of the surface shall achieve full consolidation. The compaction equipment shall provide a high-frequency, low-amplitude and 3,500 – 5,000 pounds centrifugal compaction force.

J. Site Clean-up. The Contractor shall repair pavement edges to the line and grade of original pavement, clean roadway surface after repair operations, and dispose of materials removed as directed or approved by the Engineer.

K. Reporting. The contractor shall provide the Engineer with a report of the work performed to include the following elements, at a minimum:

1. Detailed location of repair;

2. Date and time of repair;

3. Operator's name(s).

4. Length, width and depth of the repair measured in tenths of a foot;

5. estimated quantity of asphaltic concrete or patching material used measured in tons to two decimal points;

237.5. MEASUREMENT: Emergency mobilization will be measured by each emergency work request. Pothole repair will be measured by the square yard of surface area. For contracts with callout work but without emergency mobilization, the minimum quantity per callout respectively will be 5 square yards, unless otherwise noted on the plans or directed by the Engineer.

The surface area of repairs will be measured by the square yard to two decimal points.

237.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pothole Repair." This price shall be full compensation for removal, sawing, and disposal of debris and excess material; surface preparation; application of tack coat; furnishing and compaction of asphaltic concrete or patching materials; and for all labor, tools, equipment and incidentals necessary to complete the work. Unit price shall also include traffic control setup and removal. The price bid for emergency mobilization is full compensation for beginning work within 3 hours of notification. Emergency mobilization will be paid for in addition to pothole repair.

237.7. BID ITEM:

Item 237.1 - Pothole Repair - per square yard

Item 237.2 - Emergency Mobilization - per each

ITEM

238 RUBBERIZED EMULSION AGGREGATE SLURRY WITH POLYMER (REAS)

238.1. DESCRIPTION: *This Item shall govern for the installation of a mixture of rubberized polymer modified emulsion asphalt (RPME) consisting of proportioned and mixed ground tire rubber and polymer, mineral aggregate, and water properly proportioned, mixed, and spread on an asphalt prepared underlying course or existing wearing course in accordance with these specifications and shall conform to the dimensions shown on the plans or as directed by the Engineer. The slurry, when cured, shall bare a homogeneous appearance, fill all cracks, and adhere firmly to the adjacent surface, and have a skid resistance texture.*

Methods, materials, or any specific reference included in this specification shall conform to the following specifications:

- AASHTO M 17
- ASTM C 88
- ASTM C 117
- ASTM C 131
- ASTM C 136
- ASTM D 242
- ASTM D 2419

238.2. MATERIALS:

A. Aggregate. The aggregate shall consist of sound and durable manufactured sand, slag, crusher fines, crushed stone, or a combination thereof. The aggregate shall be clean and free from vegetable matter, dirt, and other deleterious substances. The aggregate shall have a sand equivalent of not less than 45 percent when tested in accordance with ASTM D 2419. The aggregate shall show a loss of not more than 35 percent when tested in accordance with ASTM C 131. The sodium sulfate soundness loss shall not exceed 12 percent, or the magnesium soundness loss shall not exceed 20 percent after 5 cycles when tested in accordance with ASTM C 88. Aggregate shall be 100 percent crushed. The combined aggregate shall conform to the gradation shown in Table 1 when tested in accordance with ASTM C 136 and ASTM C 117.

The job mix formula (mix design) shall be run using aggregate within the gradation band shown in Table 1. Once the mix design has been submitted and approved, the aggregate used on the project shall not vary by more than the tolerances shown in Table 2. At no time shall the aggregate used go out of the gradation bands in Table 1.

The aggregate will be accepted at the job location or stockpile. The stockpile will be accepted based on five gradation tests samples in accordance with ASTM D 75. If the average of the five tests is within the gradation tolerances, then the materials will be accepted. If the tests show the materials to be out of tolerance, the Contractor will be given the choice either to remove the material or blend other aggregates with the stockpile material to bring it into specification. Materials used in blending shall meet the quality tests before blending and shall be blended in a manner to produce a consistent gradation. This may require a new mix design.

Table 1
Aggregate Gradation Requirements
% by Weight Passing Sieve

Sieve Size	Type II
⅜"	100
#4	90 - 100
#8	65 - 90
#16	45 - 70
#30	30 - 50
#50	18 - 30
#100	10 - 21
#200	5 - 15
Residual RPME[1] content by percent dry weight of aggregate	14 - 17

[1]RPME – Rubberized polymer modified emulsion

Screening shall be required at the project stockpile site if there are any problems created by having oversize materials in the mix.

Precautions shall be taken to prevent segregation of the aggregate in storing and handling. The stockpile shall be kept in areas that drain readily.

B. Aggregate Tolerance. Once the mix design has been accepted, the aggregate gradation used on the project may vary from the aggregate gradation used in the mix design on each sieve by the percentages shown in Table 2. If the project aggregate fails to remain within this tolerance, the Engineer at the expense of the Contractor will require a new mix design.

Table 2
Aggregate Gradation Tolerances
% by Weight Passing Sieve

Sieve Size	Type II
⅜"	± 5%
#4	± 5%
#8	± 5%
#16	± 5%
#30	± 5%
#50	± 4%
#100	± 3%
#200	± 2%
Residual RPME[1] content by percent dry weight of aggregate	± 1%

[1]RPME – Rubberized polymer modified emulsion

C. Mineral Filler. If mineral filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D 242 and shall be used in the amounts required by the mix design. The mineral filler shall be considered as part of the aggregate.

D. Rubberized Polymer Modified Emulsion (RPME). The RPME shall be a slow-set or a quick-set type of emulsion as determined by the Engineer. RPME shall contain asphalt, ground tire rubber and polymer modifiers. The RPME shall conform to the following quality requirements:

Viscosity, 25°C (77°F), Brookfield, Model RVT #6 Spindle @ 10 RPM (Centipoises)	2,500 min. 20,000 max.
Residue by Evaporation % ASTM D 244	50 min.
Sieve Test % retained on No. 20 screen ASTM D 244	2.0 max.[2]
Weight per Liter (Gallons)	8.33 lbs/gal min. 8.75 lbs/gal max.
Penetration of Residue, 25°C (77°F), 100 g. 5 sec. ASTM D 5	20 min. 40 max.
Percent Residue Soluble in Trichloroethylene ASTM D 2042	75 min.

[2]Sieve test of original emulsion is 0.10 max.

E. Ground Tire Rubber. The material shall be granulated scrap tire rubber free from fabric wires and other contaminants. Rubber shall be dry and free flowing. Calcium carbonate or talc may be added to a maximum of 4 percent by weight of rubber to prevent rubber particles from sticking together. The rubber shall have a specific gravity between 1.15 and 1.20. One hundred percent of the rubberized material shall pass a No. 16 sieve, 95 percent shall pass a No. 20 sieve, and a maximum of 2 percent shall pass a No. 200 sieve. The RPME shall contain between 0.55 lbs/gal and 0.65 lbs/gal of crumb rubber.

F. Polymer Modifier. Polymer modifier shall be latex, which is added at a minimum of 2 percent polymer solids by weight of the RPME.

G. Water. All water used in making the slurry shall be potable and free from harmful soluble salts and chemicals.

238.3. COMPOSITION: The Rubberized Emulsion Aggregate Slurry with Polymer shall consist of a mixture of RPME, mineral aggregate, and water.

A. Job Mix Formula. No slurry seal for payment shall be placed until the Engineer has approved a mix design. The mix design shall be developed by a laboratory with experience in designing slurry seal mixes and a signed copy shall be submitted in writing by the Contractor to the Engineer at least 10 days prior to the start of operations.

The laboratory report (mix design) shall indicate the proportions of aggregates, mineral filler (min. and max.), water (min. and max.) and RPME based on the dry aggregate weight. It shall also report the quantitative effects of moisture content on the unit weight of the aggregate (bulking effects) and shall report the particle charge of the RPME (anionic or cationic). The mix design shall be in effect until modified in writing by the Engineer. Should a change in sources of materials be made, a new mix design shall be established before the new material is used.

The main items of design in Rubberized Emulsion Slurry Seal with Polymer are aggregate gradation, RPME content and consistency of the mixture. The aggregates, RPME, and water

should form a creamy-textured slurry that, when spread, will flow ahead of the strike-off squeegee. Proportions shall be based on the mix design.

The Contractor shall submit to the Engineer for approval a complete mix design on the materials proposed for use, prepared and certified by an approved laboratory. Compatibility of the aggregate, emulsion, mineral filler, and other additives shall be verified by the mix design. The mix design shall be made with the same aggregate and RPME that the Contractor will provide on the project. At a minimum the required tests and values needed are as follows:

Test	Description	Specification
ISSA TB-100	Wet Track Abrasion Loss One Hour Soak	50 g/ftz max.

B. Application Rate. Unless otherwise specified, the slurry seal shall be applied at the application rates shown in Table 3 for that gradation of material used.

Table 3
Application Rates

Pounds of mixture per square yard	10 - 15

The rate of application shall not vary more than ± 2 pounds per square yard.

C. Test Sections. Test sections shall be placed prior to the start of the slurry seal work in the presence of the Engineer. The test area will be designated by the Engineer and will be located on the existing pavement. The test section shall be made after each machine has been calibrated. Samples of the slurry seal shall be taken and the mix consistency and proportions verified. The rate of application will also be verified. If the test section should prove to be unsatisfactory, the necessary adjustments to the materials, equipment and/or application rates shall be made. Additional test sections, as required, shall be conducted and evaluated for conformance to the specifications. When the test sections do not conform to specification requirements, the treatment shall be removed, and replaced at the contractor's expense. Test section in conformance with the specification will be paid for in accordance with "Basis of Payment" section. Full production shall not begin without the Engineer's approval.

238.4. EQUIPMENT: All methods employed in performing the work and all equipment, tools, and machinery used for handling the material and executing any part of the work shall be subject to the approval of the Engineer before the work is started, and whenever found unsatisfactory they shall be changed and improved as required. All equipment, tool, machinery and containers used must be kept clean and maintained in a satisfactory condition. The Contractor shall furnish all equipment, tools, and machinery necessary for the performance of this work.

A. Slurry Mixing Equipment. The machine shall be specifically designed and manufactured to lay slurry seal. The material shall be mixed by a self-propelled slurry mixing machine of either truck mounted or continuous run design. Either type machine shall be able to accurately deliver and proportion the aggregate, RPME, mineral filler, and water to a revolving mixer and discharge the mixed product on a continuous flow basis. The machine shall have sufficient storage capacity for materials to maintain an adequate supply to the proportioning controls.

If continuous run equipment is used, the machine shall be equipped to allow the operator to have full control of the forward and reverse speed of the machine during application of the

slurry seal, with a self-loading device, with opposite side driver stations, all part of original equipment manufacturer design.

The mixing unit of the mixing chamber shall be capable of thoroughly blending all ingredients. No excessive mixing shall be permitted. The mixing machine shall be equipped with a fines feeder that provides an accurate metering device or method to introduce a predetermined proportion of mineral filler into the mixer at the same time and location that the aggregate is fed into the mixer.

The mixing machine shall be equipped with a water pressure system and fog-type spray bar adequate for complete fogging of the surface with an application of 0.05 to 0.10 gallon per square yard preceding the spreading equipment.

Sufficient machine storage capacity to mix properly and apply a minimum of 5 tons of the slurry seal shall be provided. Proportioning devices shall be calibrated prior to placing the slurry seal.

B. Slurry Spreading Equipment. The mixture shall be spread uniformly by means of a conventional surfacing spreader box attached to the mixer and equipped to agitate and spread the material evenly throughout the box. A front seal shall be provided to insure no loss of the mixture at the surface contact point. The rear seal shall act as the final strike-off and shall be adjustable. The spreader box and rear strike-off shall be so designed and operated that a uniform consistency is achieved to produce a free flow of material to the rear strike-off. The spreader box shall have suitable means provided to side shift the box to compensate for variations in the pavement geometry. A burlap drag or other approved screed may be attached to the rear of the spreader box to provide a uniform mat.

C. Auxiliary Equipment. Other tools or equipment such as brushes, hand squeegees, hose equipment, tank trucks, water distributors and flushers, power blowers, barricades, etc., shall be provided as required.

D. Tack Coat and Distributor. Normally a tack coat is not required unless the surface to be covered is extremely dry and raveled or is concrete or brick. If required, the tack coat should consist of one part emulsified asphalt and three parts water. The Engineer shall determine the type of asphalt emulsion used for the tack coat. Pressure distributors used for application of the diluted asphalt emulsion tack coat shall be self-propelled, equipped with pneumatic tires, and capable of uniformly applying 0.05 to 0.15 gallon per square yard of the diluted emulsion over the required width of application. Distributors shall be equipped with tachometers, pressure gages, and volume-measuring devices. The tack coat shall be applied at least 2 hours before the slurry seal but within the same day.

E. Equipment Calibration. Each slurry seal-mixing unit to be used on the project shall be calibrated in the presence of the Engineer prior to construction. The Engineer may accept previous calibration documentation covering the exact materials to be used provided they were made during the calendar year. The documentation shall include an individual calibration of each material at various settings, which can be related to the machine's metering devices. No machine will be allowed to work on the project until the calibration has been completed and/or accepted.

238.5. CONSTRUCTION:

A. Weather Limitations. The REAS shall not be applied if either the pavement or air temperature is 60°F and falling but may be applied when both pavement and air temperatures are 55°F and rising. No REAS shall be applied when there is danger that the finished product will freeze before 24 hours. The mixture shall not be applied when weather conditions prolong opening to traffic beyond a reasonable time.

B. Traffic Control. It shall be the Contractor's responsibility to provide adequate traffic control measures, such as barricades, flagman, cones, etc., to protect the uncured slurry surface from all types of traffic and provide traffic safety in the construction area. Advance warning signs and barricades will be necessary. These measures shall be in accordance with the "Texas Manual on Uniform Traffic Control Devices for Streets and Highways." In the field, the Traffic Engineer will designate street closure and placement of barricades.

C. Application of REAS. The surface shall be pre-wet by fogging ahead of the slurry spreader box. Water used in pre-wetting the surface shall be applied at such a rate that the entire surface is damp with no apparent flowing water in front of the slurry spreader box. The slurry mixture shall be of the desired consistency when deposited on the surface, and no additional elements shall be added. Total time of mixing shall not exceed 2 minutes. A sufficient amount of slurry shall be carried in all parts of the spreader box at all times so that complete coverage of all surface voids and cracks is obtained. Care shall be taken not to overload the spreader box, which shall be towed at a slow and uniform rate not to exceed 5 miles per hour. No lumping, balling, or unmixed aggregate shall be permitted. No segregation of the emulsion and fines from the coarse aggregate will be permitted. If the coarse aggregate settles to the bottom of the mix, the slurry shall be removed from the pavement surface. A sufficient amount of slurry shall be fed into the box to keep a full supply against the full width of the spreader box. The mixture shall not be permitted to overflow the sides of the spreader box. No breaking of the emulsion will be allowed in the spreader box. The finished surface shall have no more than four (4) tear or drag marks greater then ½ inch wide and 4 inches long in any 12 foot by 22 foot section. It shall have no tear or drag marks greater than 1 inch wide and 3 inches long. The finished surface shall have no transverse ripples of ¼ inch or more in depth, as measured with a 10 foot straight edge laid upon the surface.

D. Preparation of Existing Surface. Prior to placing the tack coat and/or REAS, unsatisfactory areas shall be repaired and the surface shall be cleaned of dust, dirt, or other loose foreign matter, grease, oil, excessive rubber accumulation, or any type of objectionable surface film. Any standard cleaning method will be acceptable except that water flushing will not be permitted in areas where considerable cracks are present in the pavement surface. Any painted stripes or markings on the surface of the pavement to be treated shall be removed.

Cracks wider than ¼ inch shall be cleaned with compressed air, and sealed with a compatible crack sealer prior to applying the slurry seal. Cracks wider than ¾ inch should be pre-filled and sealed with the slurry mixture prior to surfacing. Cracks that show evidence of vegetation shall be cleaned and treated with an approved herbicide. Crack sealing and herbicide treatment are subsidiary to this item.

E. Personnel. The contractor shall furnish adequate trained, experienced and qualified personnel to supervise and operate the equipment. The Engineer or the Owners Agent shall have the authority to suspend operations if, in their opinion, such personnel are not present during construction operations.

Adjacent lanes shall be lapped at the edges a minimum of 2 inches with a maximum of 4 inches to provide complete sealing at the overlap. Construction longitudinal and transverse joints shall be neat and uniform without buildup, uncovered areas, or unsightly appearance. All joints shall have no more than ¼ inch difference in elevation when measured across with a 10-foot straight edge.

The fresh slurry seal application shall be protected by barricades and markers and permitted to dry for 4 to 24 hours, depending on weather conditions. Any damage to uncured slurry shall be repaired at the expense of the Contractor.

In areas where the spreader box cannot be used, the slurry shall be applied by means of a hand squeegee. Upon completion of the work, the seal coat shall have no holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement. The cured slurry shall have a homogeneous appearance, fill all cracks, adhere firmly to the surface and have skid resistant texture satisfactory to the Engineer. All wasted and unused material and all debris shall be removed from the site prior to final acceptance. Barricades to protect the slurry seal during curing shall not be measured and paid for separately, but will be considered as subsidiary to slurry seal item.

Upon completion of the project, the Contractor shall sweep the finished surface with a conventional power rotary broom, to remove any potential loose material from the surface. The material removed by sweeping shall be disposed of in a manner satisfactory to the Engineer.

F. Rubberized Polymer Modified Emulsion (Contractor's Responsibility). Samples of the RPME that the Contractor proposes to use, together with a statement as to its source, shall be submitted, and approval shall be obtained before using such material. The Contractor shall submit to the Engineer a manufacturer's certified report for each consignment of the RPME. The manufacturer's certified report shall not be interpreted as a basis for final acceptance. All such reports shall be subject to verification by testing samples of the RPME as received for use on the project.

G. Notification. It shall be the Contractor's responsibility to notify all residents adjacent to the project of REAS operations and schedules. The City will provide printed notification material to the Contractor for his distribution to the effected citizens.

238.6. MEASUREMENT: This Item will be measured by the square yard of Rubberized Emulsion Aggregate Slurry with Polymer (REAS) installed and accepted.

238.7. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for Rubberized Emulsion Aggregate Slurry with Polymer (REAS). This price shall be full compensation for furnishing and placing materials, surface preparation, and for all labor, tools, equipment and incidentals necessary to complete the work.

238.8. BID ITEM:

Item 238.1 - Rubberized Emulsion Aggregate Slurry with Polymer (REAS) - per square yard

ITEM

239 MICRO-SURFACING

239.1. DESCRIPTION: *This specification shall govern the application of a micro-surfacing product, which shall consist of a mixture of polymer-modified asphalt emulsion, mineral aggregate, mineral filler, water, and other additives, properly proportioned, mixed and spread on a paved surface. The mix shall be capable of being spread in variable thick cross-sections (wedges, ruts, scratch courses, and surfaces) which, after curing and initial traffic consolidation, resist compaction throughout the entire design tolerance range of bitumen content and variable thickness to be encountered. The end product shall maintain a skid-resistant surface in variable thick sections throughout the service life.*

239.2. MATERIALS: Provide materials in conformance with the following Items and requirements:

A. Cationic Polymer-Modified Asphalt Emulsion. Provide CSS-1P in accordance with TxDOT Item 300, Section 2.D. "Emulsified Asphalt."

B. Mineral Aggregate. Provide a crushed aggregate from a single source meeting the requirements of Table 1 and Table 2. Unless otherwise shown on the plans, furnish aggregate with a minimum "B" Surface Aggregate Classification (SAC) as defined in TxDOT's Bituminous Rated Source Quality Catalog (BRSQC). Include the amount of mineral filler added to the mix in determining the total minus No. 200 aggregate fraction.

Table 1
Aggregate Gradation Requirements
Tex-200-F, Part II (Washed)
Cumulative % Retained

Sieve Size	Type I	Type II
½"	0	0
⅜"	0	0 – 1
#4	0 – 10	6 – 14
#8	10 – 35	35 – 55
#16	30 – 55	54 – 75
#30	50 – 70	65 – 85
#50	70 – 82	75 – 90
#100	79 – 90	82 – 93
#200	85 – 95	85 – 95

Table 2
Aggregate Quality Requirements

Property	TxDOT Standard Laboratory Test Method	Requirement
Magnesium sulfate soundness, %, max.[1]	Tex-411-A	30
Sand equivalent value, %, min.	Tex-203-F	70
Los Angeles abrasion, %, max	Tex-410-A	30

1. Use design gradation for the soundness test.

C. Mineral Filler. Provide mineral filler that is free of lumps and foreign matter consisting of non-air-entrained cement meeting the requirements of DMS-4600, "Hydraulic Cement," or hydrated lime meeting the requirements of DMS-6350, "Lime and Lime Slurry." The type and amount of mineral filler needed shall be determined by a laboratory mix design and will be considered as part of the aggregate gradation. An increase or decrease of less than one

percent (1%) may be permitted when the micro-surfacing is being placed if it is found to be necessary for better consistency or set times.

D. Water. Provide water that is potable and free of harmful soluble salts.

E. Other Additives. Use approved additives as recommended by the emulsion manufacturer in the emulsion mix or in any of the component materials when necessary to adjust mix time in the field.

F. Job-Mix Formula (JMF). Provide a mix design conforming to the proportions shown in Table 3 and meeting the requirements shown in Table 4. The mix design is subject to verification using laboratory produced mixes or trial batch mix before approval.

Provide emulsion and aggregate that are compatible so that the mixing process will completely and uniformly coat the aggregate. Design the mix so that the mixture will have sufficient working life to allow for proper placement at the predicted ambient temperature and humidity.

Table 3
JMF Proportions

Material	Proportion
Residual Asphalt	6.0 to 9.0% by wt. of dry aggregate
Mineral Filler (Hydraulic Cement or Hydrated Lime)	0.5 to 3.0% by wt. of dry aggregate
Field Control Additive	As required to provide control of break and cure
Water	As required to provide proper consistency

Table 4
JMF Requirements

Property	TxDOT Standard Laboratory Test Method	Requirement
Wet track abrasion, g/sq. ft., max. wear value	Tex-240-F, Part IV	75
Gradation (aggregate and mineral filler)	Tex-200-F, Part II (Washed)	Table 1
Mix time, controlled to 120 sec.	Tex-240-F, Part I	Pass

G. Rate of Application. The micro-surfacing mixture shall be of the proper consistency at all times, so as to provide the application rate required by the surface condition. Suggested application rates are based upon the weight of dry aggregate in the mixture. Application rates are affected by the unit weight of the aggregate.

Micro-surfacing is often put down in two full-width passes in place of rut-filling when the rutting or deformation is not severe. When two passes are used, the first pass (scratch course) is made using a metal or stiff rubber strike-off and applying only what the surface demands for leveling. The second course is typically applied at 15 - 30 lb/yd^2.

Unless a specific aggregate type and application rate are shown in the plans, the following recommended aggregate types and average single application rates are suggested for the various street classifications and situations:

Aggregate Type	Suggested Placement Locations	Suggested Application Rate
Type I	Local Type A and B Streets	10 - 20 lb/yd^2 (5.4 - 10.8 kg/m^2)
Type II	Collectors and Arterials Wheel Ruts	15 - 30 lb/yd^2 (8.1 - 16.3 kg/m^2) See Section 239.4.K., “Ruts”

239.3. EQUIPMENT: Maintain equipment in good repair and operating condition.

A. Furnish a self-propelled micro-surfacing mixing machine with:

- self-loading devices to promote continuous laying operations;
- sufficient storage capacity for mixture materials;
- individual volume or weight controls that will proportion each material to be added to the mix;
- continuous flow mixing with a revolving multi-blade mixer capable of discharging the mixture on a continuous flow basis;
- opposite side driving stations;
- full hydrostatic control of the forward and reverse speed during operation;
- a water pressure system and nozzle-type spray bar immediately ahead of the spreader box and capable of spraying the roadway for the width of the spreader box;
- a mechanical-type spreader box equipped with paddles or other devices capable of agitating and spreading the materials throughout the box;
- a spreader box with devices capable of providing lateral movement or side shift abilities; and
- a spreader box with a front seal, adjustable rear strike-off, and an adjustable secondary rear strike-off.

Calibrate and properly mark each control device that proportions the individual materials. Equip the aggregate feed with a revolution counter or similar device capable of determining the quantity of aggregate used at all times. Provide a positive-displacement-type emulsion pump with a revolution counter or similar device capable of determining the quantity of emulsion used at all times. Provide an approved mineral filler feeding system capable of uniformly and accurately metering the required material.

B. Scales. Scales used for weighing aggregates and emulsion must meet all requirements of TxDOT Item 520, "Weighing and Measuring Equipment." The weighing equipment for aggregates may be either a suspended hopper or a belt scale.

C. Asphalt Storage and Handling Equipment. When storage tanks are used, furnish a thermometer in each tank to indicate the asphalt temperature continuously. Keep equipment clean and free of leaks. Keep asphalt materials free from contamination.

239.4. CONSTRUCTION:

A. General. Produce, transport, and place micro-surfacing as specified in this Item or on the plans. Ensure that the finished surface has a uniform texture and the micro-surface mat is fully adhered to the underlying pavement.

B. Temporary Material Storage.

1. **Aggregate Storage.** Stockpile materials in a manner that will prevent segregation or contamination. Remix stockpiles with suitable equipment when necessary to eliminate segregation. Use a scalping screen while transferring aggregates to the mixing machine to remove oversize material.

2. **Mineral Filler Storage.** Store the mineral filler in a manner that will keep it dry and free from contamination.

3. **Asphalt Material Storage.** Keep asphalt materials free from contamination.

C. Weather Limitations. Place the material when the atmospheric temperature is at least 50°F and rising and the surface temperature is at least 50°F. Cease placement when the atmospheric temperature is below 60°F and falling, when weather is foggy or rainy, or when rain is imminent as determined by the Engineer. Cease placement 24 hr. before forecasted temperatures below 32°F.

D. Surface Preparation. Thoroughly clean the surface of all vegetation, loose aggregate, and soil. Remove existing raised pavement markers. When existing surface conditions require, provide a water spray immediately ahead of the spreader box. Apply water at a rate that will dampen the entire surface without any free-flowing water ahead of the spreader box. If water is used, cracks shall be allowed to dry thoroughly before applying micro-surfacing.

Manholes, valve boxes, drop inlets and other service entrances shall be protected from the micro-surfacing by a suitable method. The Contractor shall cover all raised pavement markers in a manner to protect and insure the integrity of the markers prior to placing the micro-surfacing and shall remove such covers after the completion of micro-surfacing so that the markers will remain fully functional. Any markers damaged by the Contractor's operations shall be repaired or replaced at no cost to the City.

The Engineer shall approve the surface preparation prior to surfacing. No dry aggregate either spilled from the lay-down machine or existing on the road, will be permitted.

If shown on the plans, pre-treat the cracks in the surface with an acceptable crack sealer prior to the application of the micro-surfacing.

E. Material Transfer. Minimize construction joints by providing continuous loading of material while placing micro-surfacing. Ensure that oversized material has been removed prior to transferring the aggregates to the mixing machine.

F. Placing. Spread the mixture uniformly to the lines and grades shown on the plans or as directed by means of a mechanical type spreader box. Shift the spreader box when necessary to maintain proper alignment. Clean the spreader box as necessary to minimize clumps. Set and maintain the spreader box skids to prevent chatter in the finished mat. Prevent loss of material from the spreader box by maintaining contact between the front seal and the road surface. Adjust the rear seal to provide the desired spread. Adjust the secondary strike-off to provide the desired surface texture.

G. Curing. Protect the finished mat from traffic until the mix cures and will not be damaged by traffic. Adjust mixture properties according to humidity conditions and ambient air temperatures to allow uniformly moving traffic on completed travel lanes within 1 hr. after

placement with no damage to the surface. Protect other locations subject to sharp turning or stopping and starting traffic for longer periods when necessary.

H. Production Testing. Provide access to the mixing unit discharge stream for sampling purposes. Produce a micro-surfacing mixture that will meet the tolerances specified in Table 5. Remove and replace or use other approved means to address material that does not meet these requirements, at no additional cost.

Table 5
Production Tests

Property	TxDOT Standard Laboratory Test Method	Requirement
Asphalt content, % by wt.	Tex-236-F1 or asphalt meter readings	Design target ±0.5% and within limits of Table 1
Gradation, % retained	Tex-200-F, Part II (washed)[1]	#8 sieve and larger: ±5 from design gradation. #16 sieve and smaller: ±3 from design gradation.[2]

1. Dried to constant wt. at 230°F ±10°F.
2. Material passing #200 sieve including the mineral filler must conform to the limitations of the master gradation shown in Table 1.

I. Workmanship. Remove and replace micro-surfacing material exhibiting evidence of poor workmanship at no additional cost.

1. Finished Surface. Provide a finished surface that has a uniform texture free from excessive scratch marks, tears, or other surface irregularities. Marks, tears, or irregularities are considered excessive if:

- more than 1 is at least ¼ in. wide and at least 10 ft. long in any 100 ft. of machine pull,
- more than 3 are at least ½ in. wide and more than 6 in. long in any 100 ft. of machine pull, or
- any are 1 in. wide or wider and more than 4 in. in length.

2. Construction Joints. Place longitudinal joints on lane lines unless otherwise directed. Provide longitudinal and transverse joints that are uniform and neat in appearance. Provide construction joints that have limited buildup and that have no gaps between applications. Joints with buildup will be considered acceptable if:

- no more than ½ in. vertical space exists between the pavement surface and a 4-ft. straightedge placed perpendicular to the longitudinal joint and
- no more than ¼ in. vertical space exists between the pavement surface and a 4-ft. straightedge placed perpendicular to the transverse joint.

3. Edges. Provide an edge along the roadway centerline, lane lines, shoulder, edge of pavement, or curb line that is uniform and neat in appearance. The edge is considered acceptable when:

- it varies no more than ±3 in. from a 100-ft. straight line on a tangent section and
- it varies no more than ±3 in. from a 100-ft. arc on a curved section.

J. Miscellaneous Areas. Use a single-batch-type lay-down machine or other approved method to place materials on ramps or other short sections. Lightly dampen the surface before placing the mix. Provide 100% coverage that is uniform in appearance and comparable to that produced by the spreader box.

K. Ruts. When shown on the plans, fill ruts, utility cuts, and depressions in the existing surface in a separate pass from the final surface. Fill ruts as follows:

- Fill irregular or shallow ruts less than ½ in. deep with a full-width scratch coat pass. Use a rigid primary strike-off plate unless otherwise approved.
- Fill ruts ½ in. deep or deeper independently using a rut-filling spreader box that is at least 5 ft. wide. Crown the spreader box to compensate for traffic compaction.
- Fill ruts deeper than 1-½ in. in multiple placements unless otherwise approved.

239.5. MEASUREMENT: Micro-surfacing will be measured by the ton or square yard of the composite micro-surfacing mixture as shown in the plans. The composite micro-surfacing mixture is defined as the asphalt emulsion, aggregate, and mineral filler.

A. Aggregate. The quantity of aggregate used in the accepted portion of work will be measured by net ticket weight of each individual load of aggregate based on dry weight of aggregate. Weigh the aggregate at the project stockpile site unless otherwise approved. Use either a suspended hopper scale or a belt scale meeting the requirements of TxDOT Item 520, "Weighing and Measuring Equipment." The calculated weight of mineral filler based on the accepted portion of work will be used for measurement and included in the total aggregate weight.

B. Polymer-Modified Asphalt Emulsion. The quantity of polymer-modified asphalt emulsion in the accepted portion of work will be measured by the ton of material based on the accepted load tickets issued from the manufacturer. At the completion of the project, any unused emulsion will be weighed back and deducted from the accepted asphalt emulsion quantity delivered.

239.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per ton or square yard for "Micro-Surfacing." This price is full compensation for preparing the existing surface (including removing existing raised pavement markers); furnishing, hauling, preparing, and placing materials; and equipment, labor, tools, and incidentals.

239.7. BID ITEM:

Item 239.1 - Micro-Surfacing - per square yard

Item 239.2 - Micro-Surfacing - per ton

ITEM

240 WARM MIX ASPHALTIC CONCRETE

240.1. DESCRIPTION: *Construct a pavement layer composed of a compacted, dense-graded mixture of aggregate and asphalt binder mixed in a mixing plant.*

240.2. MATERIALS: Furnish all material(s) meeting the following requirement, unless otherwise shown on the plans or unless otherwise authorized by the Engineer.

A. Tack Coat. Unless otherwise shown on the plans or approved, furnish CSS-1H, SS-1H, or a PG binder with a minimum high-temperature grade of PG 58 for tack coat binder and in accordance with Item 203, "Tack Coat." Do not dilute emulsified asphalts at the terminal, in the field, or at any other location before use.

B. Asphalt Binder. Provide the type and grade of performance-graded asphalt binder shown on the plans in accordance with TxDOT Item 300.2.J. "Performance-Graded Binders" prescribed for Hot-Mixed, Hot-Laid Asphalt Mixtures. Provide asphalt binders that are compatible with the materials defined in 240.2. C. "Synthetic, Foaming, Chemical or Other Additives."

C. Synthetic, Foaming, Chemical or Other Additives. Provide an additive that reduces the viscosity of the asphalt binder, allows the binder to fully coat the aggregates, and provides good workability during laying and compaction at temperatures lower than typical hot-mixed asphaltic concrete. Mix or disperse the additive to the asphaltic binder or asphaltic mixture in accordance with the manufacturer's recommendations.

D. Warm Mix Asphalt (WMA). Furnish the types of asphalt concrete materials meeting Item 205, "Hot-Mix Asphaltic Concrete Pavement." The item, type, and grade of aggregate, binder, and state aggregate classification (SAC) and other material requirements will be as shown on the plans when applicable. Unless allowed by the Engineer, different warm mix asphalt technologies (i.e. additives and equipment) may not be used on the same project.

E. EQUIPMENT: Furnish equipment to produce, haul, place, compact, and test the warm mix asphalt concrete in accordance with Item 205.3. "Equipment."

Modify production and placement equipment in the manner required for proper production and placement of the WMA and in conformance with the manufacturer's recommendations.

Maintain all equipment for the handling, mixing, and placing of all materials in good repair and operating condition, as approved. Replace any equipment found defective and affecting the quality of the paving mixture or the compacted pavement.

240.3. CONSTRUCTION: Design, produce, store, transport, place, and compact the warm mix asphalt concrete paving mixture in accordance with the following:

A. General. Transport, place, and compact the specified paving mixture, in accordance with Item 205.4. "Construction" and as approved. Place mixture, when placed with a spreading and finishing machine, or the tack coat when the roadway surface temperature is 60°F or higher unless otherwise approved. Measure the roadway surface temperature with a handheld infrared thermometer. Unless otherwise shown on the plans, place mixtures only when weather conditions and moisture conditions of the roadway surface are suitable in the opinion of the Engineer.

It is further provided that the tack coat or asphaltic mixture shall be placed only when the humidity, general weather conditions, temperature and moisture condition of the base are suitable.

B. Mixture Design and Job Mix Formula. For the WMA paving mixture, the Engineer may accept an HMA mixture design from the Contractor which was derived using materials conforming to the requirements of Item 205. Mixture design shall be conducted in accordance with Tex-204-F, Section 6 – Part IV, "Mix Design for Performance-Designed Mixtures Using the Superpave Gyratory Compactor (SGC)." The number of gyrations (N_{ini}, N_{des}, and N_{max}) and the mixing/compaction temperatures shall be shown on the plans. The laboratory mixture density at N_{des} shall conform to the values shown in Table 5 of Item 205. Evaluate the moisture susceptibility of the WMA paving mixture conforming to the HMA JMF in accordance with TxDOT standard laboratory test procedure Tex-530-C.

C. Tack Coat. The surface upon which the tack coat is to be placed shall be cleaned thoroughly to the satisfaction of the Inspector. The surface shall be given a uniform application of tack coat using asphaltic materials of this specification. Unless otherwise shown on the plans, tack coat shall be applied with an approved sprayer at a rate directed by the Engineer between 0.04 and 0.10 gallon residual asphalt per square yard of surface. The Engineer may use TxDOT standard laboratory test procedure Tex-243-F to verify that the tack coat has adequate adhesive properties. The Engineer may suspend paving operations until there is adequate adhesion. Where the mixture will adhere to the surface on which it is to be placed without the use of a tack coat, the tack coat may be eliminated by the Inspector. All contact surfaces of curbs and structures, as well as all joints, shall have a thin, uniform application of tack coat. During the application of tack coat, care shall be taken to prevent splattering of adjacent pavement, curb and gutter, and other structures.

D. Placement. Place the asphalt concrete mixture in accordance with this specification, the plans, and with Item 205, "Hot Mix Asphaltic Concrete Pavement" or as directed. Limits, areas, and/or locations of the warm mix asphalt pavement must be shown on the plans. Air void control must also be shown on the plans. Furnish the type, size, and number of steel and pneumatic rollers to compact the warm mix asphalt paving mixture as required.

1. **Lift Thicknesses.** Do not exceed compacted lift thicknesses specified in Table 8 in Item 205.4.G, when placing this asphalt concrete mixture unless authorized by the Engineer.

2. **WMA Placement Temperature.** Unless otherwise shown on the plans, the temperature of the warm mix asphalt delivered to the paver shall be in conformance with the manufacturer's recommendations (Manufacturer is defined as the entity that provides the additive defined in 204.2.C. "Synthetic, Foaming, Chemical or Other Additive").

240.4. MEASUREMENT: Warm mix asphalt concrete which includes asphalt, aggregate and the warm mix additive defined in 240.2.C. "Synthetic, Foaming, Chemical or Other Additives" will be measured by the square yard in place.

240.5. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Warm Mix Asphaltic Concrete," of the type, surface, aggregate classification, binder, and additive specified. Costs to modify production or placement equipment for this Item will not be paid by the City.

240.6. BID ITEM:

Item 240.1 - Warm Mix Asphaltic Concrete Type A - per square yard __inches pavement thickness

Item 240.2 - Warm Mix Asphaltic Concrete Type B - per square yard __inches pavement thickness

Item 240.3 - Warm Mix Asphaltic Concrete Type C - per square yard __inches pavement thickness

Item 240.4 - Warm Mix Asphaltic Concrete Type D - per square yard __inches pavement thickness

Item 240.5 - Warm Mix Asphaltic Concrete Type F - per square yard __inches pavement thickness

DIVISION III - CONCRETE & CONCRETE STRUCTURES

ITEM

300 CONCRETE

300.1. DESCRIPTION: *Furnish hydraulic cement concrete for concrete pavements, concrete structures, and other concrete construction.*

300.2. MATERIALS:

A. Cement. Furnish cement conforming to TxDOT's DMS-4600, "Hydraulic Cement."

B. Supplementary Cementing Materials (SCM).

1. **Fly Ash.** Furnish fly ash conforming to TxDOT's DMS-4610, "Fly Ash."

2. **Ultra-Fine Fly Ash (UFFA).** Furnish UFFA conforming to TxDOT's DMS-4610, "Fly Ash."

3. **Ground Granulated Blast-Furnace Slag (GGBFS).** Furnish GGBFS conforming to TxDOT's DMS-4620, "Ground Granulated Blast-Furnace Slag," Grade 100 or 120.

4. **Silica Fume.** Furnish silica fume conforming to TxDOT's DMS-4630, "Silica Fume."

5. **Metakaolin.** Furnish metakaolin conforming to TxDOT's DMS-4635, "Metakaolin."

C. Chemical Admixtures. Furnish admixtures conforming to TxDOT's DMS-4640, "Chemical Admixtures for Concrete." Do not use calcium chloride.

D. Water. Furnish mixing and curing water that is free from oils, acids, organic matter, or other deleterious substances. Water from municipal supplies approved by the Texas Department of Health will not require testing. When using water from other sources, provide test reports showing compliance with Table 1 before use.

Water that is a blend of concrete wash water and other acceptable water sources, certified by the concrete producer as complying with the requirements of both Table 1 and Table 2, may be used as mix water. Test the blended water weekly for 4 weeks for compliance with Table 1 and Table 2 or provide previous test results. Then test every month for compliance. Provide water test results upon request.

Table 1
Chemical Limits for Mix Water

Contaminant	Test Method	Maximum Concentration (ppm)
Chloride (Cl)		
Prestressed concrete	ASTM C 114	500
Bridge decks and superstructure		500
All other concrete		1,000
Sulfate (SO_4)	ASTM C 114	2,000
Alkalies ($N_{A2}O + 0.658K_2O$)	ASTM C 114	600
Total Solids	ASTM C 1603	50,000

Table 2
Acceptance Criteria for Questionable Water Supplies

Property	Test Method	Limits
Compressive strength, min. % control at 7 days	ASTM C 31, ASTM C 39[1,2]	90
Time of set, deviation from control, h:min.	ASTM C 403[1]	From 1:00 early to 1:30 later

[1.] Base comparisons on fixed proportions and the same volume of test water compared to the control mix using 100% potable water or distilled water.
[2.] Base comparisons on sets consisting of at least two standard specimens made from a composite sample.

Do not use mix water that has an adverse effect on the air-entraining agent, on any other chemical admixture, or on strength or time of set of the concrete. When using white hydraulic cement, use mixing and curing water free of iron and other impurities that may cause staining or discoloration.

E. Aggregate. Supply aggregates that meet the definitions in TxDOT standard laboratory test procedure Tex-100-E. Provide coarse and fine aggregates from sources listed in TxDOT's Concrete Rated Source Quality Catalog (CRSQC). Provide aggregate from non-listed sources only when tested and approved by the Engineer before use. Allow 30 calendar days for the Engineer to sample, test, and report results for non-listed sources. Do not combine approved material with unapproved material.

1. Coarse Aggregate. Provide coarse aggregate consisting of durable particles of gravel, crushed blast furnace slag, recycled crushed hydraulic cement concrete, crushed stone, or combinations thereof that are free from frozen material and from injurious amounts of salt, alkali, vegetable matter, or other objectionable material, either free or as an adherent coating. Provide coarse aggregate of uniform quality throughout.

Provide coarse aggregate that, when tested in accordance with TxDOT standard laboratory test procedure Tex-413-A, has:

- at most 0.25% by weight of clay lumps,
- at most 1.0% by weight of shale, and
- at most 5.0% by weight of laminated and friable particles.

Wear must not be more than 40% when tested in accordance with TxDOT standard laboratory test procedure Tex-410-A.

Unless otherwise shown on the plans, provide coarse aggregate with a 5 cycle magnesium sulfate soundness of not more than 18% when tested in accordance with TxDOT standard laboratory test procedure Tex-411-A. Crushed recycled hydraulic cement concrete is not subject to the 5 cycle soundness test.

The loss by decantation as tested in accordance with TxDOT standard laboratory test procedure Tex-406-A, plus the allowable weight of clay lumps, must not exceed 1.0% or the value shown on the plans, whichever is smaller. In the case of aggregates made primarily from crushing stone, if the material finer than the No. 200 sieve is established to be the dust of fracture and essentially free from clay or shale as established by TxDOT

standard laboratory test procedure Tex-406-A, Part III, the limit may be increased to 1.5%. When crushed limestone coarse aggregate is used in concrete pavements, the decant may exceed 1.0% but not more than 3.0% if the material finer than the No. 200 sieve is determined to be at least 67% calcium carbonate in accordance with TxDOT standard laboratory test procedure Tex-406-A, Part III.

Unless otherwise specified, provide aggregate conforming to the gradation requirements shown in Table 3 when tested in accordance with TxDOT standard laboratory test procedure Tex-401-A.

Table 3
Coarse Aggregate Gradation Chart

Aggregate Grade No.[1]	Nominal Size	Percent Passing on Each Sieve								
		2-1/2"	2"	1-1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8
1	2"	100	80–100	50–85		20–40			0–5	
2 (467)	1–1/2"		100	95–100		35–70		10–30	0–5	
3	1–1/2"		100	95–100		60–90	25–60		0–5	
4 (57)	1"			100	95–100		25–60		0–10	0–5
5 (67)	3/4"				100	90–100		20–55	0–10	0–5
6 (7)	1/2"					100	90–100	40–70	0–15	0–5
7	3/8"						100	70–95	0–25	
8	3/8"						100	95–100	20–65	0–10

1. Corresponding ASTM C 33 gradation shown in parentheses.

2. **Fine Aggregate.** Provide fine aggregate consisting of clean, hard, durable particles of natural or manufactured sand or a combination thereof with or without mineral filler. Provide fine aggregate free from frozen material and from injurious amounts of salt, alkali, vegetable matter, or other objectionable material, and containing no more than 0.5% clay lumps by weight in accordance with TxDOT standard laboratory test procedure Tex-413-A.

   Provide fine aggregate that does not show a color darker than standard when subjected to the color test for organic impurities in accordance with TxDOT standard laboratory test procedure Tex-408-A.

   Unless otherwise shown on the plans, use fine aggregate with an acid insoluble residue of at least 60% by weight when tested in accordance with TxDOT standard laboratory test procedure Tex-612-J in all concrete subject to direct traffic.

   Unless otherwise shown on the plans, when necessary, blend the fine aggregate to meet the acid insoluble residue requirement. When blending, use the following equation:

   Acid insoluble (%) = {(A1)(P1)+(A2)(P2)}/100

   where:

   A1 = acid insoluble (%) of aggregate 1

   A2 = acid insoluble (%) of aggregate 2

   P1 = percent by weight of aggregate 1 of the fine aggregate blend

   P2 = percent by weight of aggregate 2 of the fine aggregate blend

Provide fine aggregate or combinations of aggregates, including mineral filler, conforming to the gradation requirements shown in Table 4 when tested in accordance with TxDOT standard laboratory test procedure Tex-401-A unless otherwise specified.

Table 4
Fine Aggregate Gradation Chart (Grade 1)

Sieve Size	Percent Passing
3/8 in.	100
No. 4	95–100
No. 8	80–100
No. 16	50–85
No. 30	25–65
No. 50	10–35[1]
No. 100	0–10
No. 200	0–3[2]

1. 6–35 when sand equivalent value is greater than 85.
2. 0–6 for manufactured sand.

Unless otherwise shown on the plans, provide fine aggregate with a sand equivalent of at least 80 in accordance with TxDOT standard laboratory test procedure Tex-203-F.

For all classes of concrete, provide fine aggregate with a fineness modulus between 2.30 and 3.10 as determined by TxDOT standard laboratory test procedure Tex-402-A.

3. **Mineral Filler.** Provide mineral filler consisting of stone dust, clean crushed sand, or other approved inert material with 100% passing the No. 30 sieve and 65 to 100% passing the No. 200 sieve when tested in accordance with TxDOT standard laboratory test procedure Tex-401-A.

F. Mortar and Grout. When required or shown on the plans, provide mortar and grout consisting of 1 part hydraulic cement, 2 parts sand, and sufficient water to provide the desired consistency. Provide mortar with a consistency such that the mortar can be easily handled and spread by trowel. Provide grout of a consistency that will flow into and completely fill all voids. Section 300.4.A.6, "Mix Design Options," does not apply for mortar and grout.

300.3. EQUIPMENT:

A. Concrete Plants and Mixing Equipment. Except for volumetric mixers (auger/mixer), each plant and truck mixer must be currently certified by the National Ready Mixed Concrete Association (NRMCA) or have an inspection report signed and sealed by a licensed professional engineer showing that concrete measuring, mixing, and delivery equipment meets all requirements of ASTM C-94. A new certification or signed and sealed report is required every time a plant is moved. Plants with a licensed engineer's inspection require reinspection every 2-years. Provide a copy of the certification or the signed and sealed inspection report to the Engineer. When equipment or facilities fail to meet specification requirements, remove them from service until corrected. When allowed by the plans or the Engineer, for concrete classes not identified as structural concrete in Table 5 or for Class "C" concrete not used for bridge-class structures, the Engineer may inspect and approve all plants and trucks in lieu of the NRMCA or non-City engineer sealed certifications. The criteria and frequency of Engineer approval of plants and trucks is the same used for NRMCA certification.

1. **Scales.** Check all scales prior to beginning of operations, after each move, or whenever their accuracy or adequacy is questioned, and at least once every 6 months. Immediately correct deficiencies, and recalibrate. Provide a record of calibration showing scales in compliance with ASTM C-94 requirements. Check batching accuracy of volumetric water batching devices and admixture dispensing devices at least every 90 days. Perform daily checks as necessary to confirm measuring accuracy.

2. **Volumetric Mixers.** Provide volumetric mixers with rating plates defining the capacity and the performance of the mixer in accordance with the Volumetric Mixer Manufacturers Bureau or equivalent. Provide volumetric mixers that comply with ASTM C-685. Provide test data showing mixers meet the uniformity test requirements of TxDOT standard laboratory test procedure Tex-472-A. Unless allowed by the plans or the Engineer, volumetric mixers may not supply classes of concrete identified as structural concrete in Table 5.

3. **Agitators and Truck and Stationary Mixers.** Inspect and furnish inspection reports on truck mixers and agitators annually. If an inspection within 12 months is not practical, a 2 month grace period (for a maximum of 14 months between inspections) is permitted. Include in the report the condition of blades and fins and their percent wear from the original manufacturer's design. Repair mixing equipment exhibiting 10% or more wear before use. Provide truck mixers and agitators equipped with means to readily verify the number of revolutions of the drum, blades, or paddles.

   Provide stationary and truck mixers capable of combining the ingredients of the concrete within the specified time or the number of revolutions specified into a thoroughly mixed and uniform mass and capable of discharging the concrete so that at least 5 of the 6 requirements of TxDOT standard laboratory test procedure Tex-472-A are met.

   As directed, to resolve issues of mix uniformity and mixer performance, perform concrete uniformity tests on mixers or agitators in accordance with TxDOT standard laboratory test procedure Tex-472-A.

   Perform the mixer or agitator uniformity test at the full rated capacity of the equipment and within the maximum mixing time or maximum number of revolutions. Remove from service all equipment that fails the uniformity test.

   Inspect and maintain mixers and agitators. Keep them reasonably free of concrete buildup, and repair or replace worn or damaged blades or fins.

   Confirm all mixers have a plate affixed showing manufacturer's recommended operating speed and rated capacity for mixing and agitating.

   Previous inspections performed for TxDOT are acceptable for submittal provided the inspection meets the 12-month inspection period referenced above.

B. Hauling Equipment. Provide hauling equipment capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

When using non-agitating equipment for transporting concrete, provide equipment with smooth, mortar-tight metal containers equipped with gates that prevent accidental discharge of the concrete.

C. Testing Equipment. Unless otherwise shown on the plans or specified, in accordance with the pertinent test procedure, furnish and maintain:

- test molds,
- curing facilities,
- maturity meters if used, and
- wheelbarrow or other container acceptable for the sampling of the concrete.

Provide strength-testing equipment in accordance with the Contract controlling test unless shown otherwise.

300.4. CONSTRUCTION:

A. Classification and Mix Design. Furnish mix designs using ACI 211, "Standard Practice for Selecting Proportions for Normal, Heavy Weight, and Mass Concrete," or other approved procedures for the classes of concrete required in accordance with Table 5. Do not exceed the maximum water-to-cementitious-material ratio. Perform mix design and cement replacement using the design by weight method unless otherwise approved.

A higher-strength class of concrete with equal or lower water-to-cementitious-material ratio may be substituted for the specified class of concrete.

To account for production variability and confirm minimum compressive strength requirements are met, over-design the mix in accordance with Table 6.

1. Cementitious Materials. Use cementitious materials from TxDOT prequalified sources; otherwise, request sampling and testing for approval before use. Unless otherwise specified or approved, limit cementitious material content to no more than 700 pounds per cubic yard. When supplementary cementing materials are used, "cement" is defined as "cement plus supplementary cementing material."

Use Type III cement only in precast concrete or when specified or permitted.

For monolithic placements, use cement of the same type and from the same source.

When sulfate-resistant concrete is required, use mix design options 1, 2, 3, or 4 given in Section 300.4.A.6, "Mix Design Options," using Type I/II, II, V, IP, or IS cement. Do not use Class C fly ash in sulfate-resistant concrete.

Do not use supplementary cementing materials when white hydraulic cement is specified.

The upper limit of 35% replacement of cement with Class F fly ash specified by mix design options 1 and 3 may be increased to a maximum of 45% for mass placements, high performance concrete, and precast members when approved.

Table 5
Concrete Classes

Class of Concrete	Design Strength, Min. 28-day f'_c (psi)	Maximum W/C Ratio[1]	Coarse Aggregate Grades[2,3]	General Usage[4]
A	3,000	0.60	1–4, 8	Inlets, manholes, curb, gutter, curb & gutter, conc. retards, sidewalks, driveways, backup walls, anchors
B	2,000	0.60	2–7	Riprap, small roadside signs, and anchors
C[5]	3,600	0.45	1–6	Drilled shafts, bridge substructure, bridge railing, culverts except top slab of direct traffic culverts, headwalls, wing walls, approach slabs, concrete traffic barrier (cast-in-place)
C(HPC)[5]	3,600	0.45	1-6	As shown on the plans
D	1,500	0.60	2–7	Riprap
E	3,000	0.50	2–5	Seal concrete
F[5]	Note 6	0.45	2–5	Railroad structures; occasionally for bridge piers, columns, or bents
F(HPC)[5]	Note 6	0.45	2–5	As shown on the plans
H[5]	Note 6	0.45	3–6	Prestressed concrete beams, boxes, piling, and concrete traffic barrier (precast)
H(HPC)[5]	Note 6	0.45	3–6	As shown on the plans
S[5]	4,000	0.45	2–5	Bridge slabs, top slabs of direct traffic culverts
S(HPC)[5]	4,000	0.45	2-5	As shown on the plans
P	See Item 209	0.45	2–3	Concrete pavement, bus pads
DC[5]	5,500	0.40	6	Dense conc. overlay
CO[5]	4,600	0.40	6	Conc. overlay
LMC[5]	4,000	0.40	6–8	Latex-modified concrete overlay
SS[5]	3,600[7]	0.45	4–6	Slurry displacement shafts, underwater drilled shafts
K[5]	Note 6	0.45	Note 6	Note 6
HES	Note 6	0.45	Note 6	Note 6

[1]. Maximum water-cement or water-cementitious ratio by weight.
[2]. Unless otherwise permitted, do not use Grade 1 coarse aggregate except in massive foundations with 4-in. minimum clear spacing between reinforcing steel bars. Do not use Grade 1 aggregate in drilled shafts.
[3]. Unless otherwise approved, use Grade 8 aggregate in extruded curbs.
[4]. For information only.
[5]. Structural concrete classes.
[6]. As shown on the plans or specified.
[7]. Use a minimum cementitious material content of 650 lb/cy of concrete. Do not apply Table 6 over design requirements to Class SS concrete.

Table 6
Over Design to Meet Compressive Strength Requirements[1]

No. of Tests[2,3]	Standard Deviation, psi				
	300	**400**	**500**	**600**	**700**
15	470	620	850	1,120	1,390
20	430	580	760	1,010	1,260
30 or more	400	530	670	900	1,130

1. When designing the mix, add the tabulated amounts to the minimum design strength in Table 5.
2. Number of tests of a concrete mixture used to estimate the standard deviation of a concrete production facility. Test of another mix within 1,000 psi of the specified strength may be used.
3. If less than 15 prior tests are available, the overdesign should be 1,000 psi for specified strength less than 3,000 psi, 1,200 psi for specified strengths from 3,000 to 5,000 psi and 1,400 psi for specified strengths greater than 5,000 psi. For Class K and concrete classes not identified as structural concrete in Table 5 or for Class "C" concrete not used for bridge-class structures, the Engineer may designate on the plans an alternative over-design requirement up to and including 1,000 psi for specified strengths less than 3,000 psi and up to and including 1,200 psi for specified strengths from 3,000 to 5,000 psi.

2. **Aggregates.** Limit the use of recycled crushed hydraulic cement concrete as a coarse or fine aggregate to Class A, B, D, E, and P concrete. Limit recycled crushed concrete fine aggregate to a maximum of 20% of the fine aggregate.

   When white hydraulic cement is specified, use light-colored aggregates.

3. **Chemical Admixtures.** Use only preapproved concrete chemical admixtures from the list of prequalified concrete admixtures maintained by the TxDOT Construction Division. Submit non-preapproved admixtures for testing to the Engineer for approval. Do not use high-range water-reducing admixtures (Type F or G) or accelerating admixtures (Type C or E) in bridge deck concrete.

   When a corrosion-inhibiting admixture is required, use a 30% calcium nitrite solution. The corrosion inhibiting admixture must be set neutral unless otherwise approved. Dose the admixture at the rate of gallons of admixture per cubic yard of concrete shown on the plans.

4. **Slump.** Unless otherwise specified, provide concrete slump in accordance with Table 7 using the lowest slump possible that can be placed and finished efficiently without segregation or honeycombing.

   Concrete that exceeds the maximum acceptable placement slump at time of delivery will be rejected.

   When approved, the slump of a given concrete mix may be increased above the values shown in Table 8 using chemical admixtures, provided that the admixture-treated concrete has the same or lower water–cement or water–cementitious-material ratio and does not exhibit segregation or excessive bleeding. Request approval for the mix design sufficiently in advance for proper evaluation by the Engineer.

Table 7
Slump Requirements

Concrete Designation	Recommended Design and Placement Slump, in.	Maximum Acceptable Placement Slump, in.
Drilled shafts	See TxDOT Item 416	See TxDOT Item 416
Thin walled section (9 in. or less)	4	6-1/2
Approach slabs, concrete overlays, caps, columns, piers, wall sections (over 9 in.)	3	5
Bridge slabs	4	5-1/2
Prestressed concrete members[1]	4	6-1/2
Concrete traffic barrier, concrete bridge railing	4	6-1/2
Dense concrete overlay	3/4	2
Latex-modified conc. for bridge deck overlays	3	7-1/2
Concrete placed underwater	6	8-1/2
Concrete pavement (slip-formed)	1-1/2	3
Concrete pavement (formed)	4	6-1/2
Riprap, curb, gutter, slip-formed, and extruded concrete	As approved	As approved

1. If a high-range water reducer (HRWR) is used, maximum acceptable placement slump will be 9 in.

5. Mix Design Options. For structural concrete identified in Table 5 and any other class of concrete designed using more than 520 pounds of cementitious material per cubic yard, use one of the mix design Options 1–8 shown below.

For concrete classes not identified as structural concrete in Table 5 and designed using less than 520 pounds of cementitious material per cubic yard, use one of the mix design Options 1–8 shown below, except that Class C fly ash may be used instead of Class F fly ash for Options 1, 3, and 4 unless sulfate-resistant concrete is shown on the plans.

Do not use mix design options 6 or 7 when High Performance Concrete (HPC) is required. Option 8 may be used when HPC is required provided: a minimum of 20% of the cement is replaced with a Class C fly ash; TxDOT standard laboratory test procedure Tex-440-A, "Initial Time of Set of Fresh Concrete" is performed during mix design verification; the additional requirements for permeability are met; and the concrete is not required to be sulfate-resistant.

a. Option 1. Replace 20 to 35% of the cement with Class F fly ash.

b. Option 2. Replace 35 to 50% of the cement with GGBFS.

c. Option 3. Replace 35 to 50% of the cement with a combination of Class F fly ash, GGBFS, UFFA, metakaolin, or silica fume. However, no more than 35% may be fly ash, and no more than 10% may be silica fume.

d. Option 4. Use Type IP or Type IS cement. (Up to 10% of a Type IP or Type IS cement may be replaced with Class F fly ash, GGBFS, or silica fume.)

e. Option 5. Replace 35 to 50% of the cement with a combination of Class C fly ash and at least 6% of silica fume, UFFA, or metakaolin. However, no more than 35% may be Class C fly ash, and no more than 10% may be silica fume.

f. Option 6. Use a lithium nitrate admixture at a minimum dosage of 0.55 gallon of 30% lithium nitrate solution per pound of alkalis present in the hydraulic cement.

g. Option 7. When using hydraulic cement only, confirm that the total alkali contribution from the cement in the concrete does not exceed 4.00 pounds per cubic yard of concrete when calculated as follows:

$$\text{lb. alkali per cu. yd.} = \frac{(\text{lb. cement per cu. yd.}) \times (\%\ Na_2O \text{ equivalent in cement})}{100}$$

In the above calculation, use the maximum cement alkali content reported on the cement mill certificate.

h. Option 8. For any deviations from Options 1–7, perform testing on both coarse and fine aggregate separately in accordance with ASTM C 1567. Before use of the mix, provide a certified test report signed and sealed by a licensed professional engineer, from a laboratory on TxDOT's List of Approved ASTM C 1260 Laboratories, demonstrating that the ASTM C-1567 test result for each aggregate does not exceed 0.10% expansion.

When HPC is required, provide a certified test report signed and sealed by a licensed professional engineer demonstrating that AASHTO T 277 test results indicate the permeability of the concrete is less than 1,500 coulombs tested immediately after either of the following curing schedules:

- Moist cure specimens 56 days at 73ºF.
- Moist cure specimens 7 days at 73ºF followed by 21 days at 100ºF.

B. Trial Batches. Perform all preliminary trial batches and testing necessary to substantiate the proposed mix designs, and provide documentation including mix design, material proportions, and test results substantiating that the mix design conforms to specification requirements. Once a trial batch substantiates the mix design, the proportions and mixing methods used in the trial batch become the mix design of record.

Make all final trial batches using the proposed ingredients in a mixer that is representative of the mixers to be used on the job. Make the batch size at least 50% of the mixer's rated capacity. Perform fresh concrete tests for air and slump, and make, cure, and test strength specimens for compliance with specification requirements. Test at least 1 set of design strength specimens, consisting of 2 specimens per set, at 7-day, 28-day, and at least one additional age. Before placing, provide the Engineer the option of witnessing final trial batches, including the testing of the concrete. If not provided this option, the Engineer may require additional trial batches, including testing, before the concrete is placed.

Establish 7-day compressive strength target values using the following formula for each concrete mix to be used:

$$\text{Target value} = \text{Minimum design strength} \times \frac{\text{7 - day avg. trial batch strength}}{\text{28 - day avg. trial batch strength}}$$

When there are changes in aggregates or in type, brand, or source of cement, SCM, or chemical admixtures, reevaluate the mix as a new mix design. A change in vendor does not necessarily constitute a change in materials or source. When only the brand or source of cement is changed and there is a prior record of satisfactory performance of the cement with the ingredients, new trial batches may be waived by the Engineer.

When the maturity method is specified or permitted, establish the strength–maturity relationship in accordance with TxDOT standard laboratory test procedure Tex-426-A. When using the maturity method any changes in any of the ingredients, including changes in proportions, will require the development of a new strength–maturity relationship for the mix.

C. Storage of Materials.

1. **Cement, Supplementary Cementing Materials, and Mineral Filler.** Store all cement, supplementary cementing materials, and mineral filler in weatherproof enclosures that will protect them from dampness or absorption of moisture.

   When permitted, small quantities of sacked cement may be stored in the open, on a raised platform, and under waterproof covering for up to 48 hours.

2. **Aggregates.** Handle and store concrete aggregates in a manner that prevents contamination with foreign materials. If the aggregates are stored on the ground, clear the sites for the stockpiles of all vegetation, level the sites, and do not use the bottom 6 inch layer of aggregate without cleaning the aggregate before use.

   When conditions require the use of 2 or more grades of coarse aggregates, maintain separate stockpiles and prevent intermixing. Where space is limited, separate the stockpiles using physical barriers. Store aggregates from different sources in different stockpiles unless the Engineer authorizes pre-blending of the aggregates. Minimize segregation in stockpiles. Remix and test stockpiles when segregation is apparent.

   Sprinkle stockpiles to control moisture and temperature as necessary. Maintain reasonably uniform moisture content in aggregate stockpiles.

3. **Admixtures.** Store admixtures in accordance with manufacturer's recommendations and prevent admixtures from freezing.

D. Measurement of Materials. Except for volumetric mixers, measure concrete materials by weight. Measure mixing water, consisting of water added to the batch, ice added to the batch, water occurring as surface moisture on the aggregates, and water introduced in the form of admixtures, by volume or weight. Measure ice by weight. Measure cement and supplementary cementing materials in a weigh hopper and on a separate scale from those used for other materials. Measure the cement first when measuring the cumulative weight. Measure concrete chemical admixtures in powdered form by weight. Measure concrete chemical admixtures in liquid form by weight or volume. Measure batch materials within the tolerances of Table 8.

Table 8
Measurement Tolerances – Non-Volumetric Mixers

Material	Tolerance (%)
Cement, wt.	±1
Mineral admixture, wt.	±1
Cement + SCM (cumulative weighing), wt.	±1
Water, wt. or volume	±3
Fine aggregate, wt.	±2
Coarse aggregate, wt.	±2
Fine + coarse aggregate (cumulative weighing), wt.	±1
Chemical admixtures, wt. or volume	±3

When measuring cementitious materials at less than 30% of scale capacity, confirm that the quantity measured is accurate to not less than the required amount and not more than 4% in excess. When measuring aggregates in a cumulative weigh batcher at less than 30% of the scale capacity, confirm that the cumulative quantity is measured accurate to ±0.3% of scale capacity or ±3% of the required cumulative weight, whichever is less.

For volumetric mixers, base tolerances on volume–weight relationship established by calibration, and measure the various ingredients within the tolerances of Table 9.

Correct batch weight measurements for moisture.

When approved, under special circumstances, measure cement in bags of standard weight. Weighing of sacked cement is not required. Do not use fractional bags except for small hand-mixed batches of approximately 5 cubic feet or less and when an approved method of volumetric or weight measurement is used.

Table 9
Measurement Tolerances – Volumetric Mixers

Material	Tolerance
Cement, wt. %	0 to +4
SCM, wt. %	0 to +4
Fine aggregate, wt. %	±2
Coarse aggregate, wt. %	±2
Admixtures, wt. or volume %	±3
Water, wt. or volume %	±1

E. Mixing and Delivering Concrete. Mix and deliver concrete by means of one of the following operations:

- central-mixed,
- shrink-mixed,
- truck-mixed,
- volumetric mixer-mixed, or
- hand-mixed.

Operate mixers and agitators within the limits of the rated capacity and speed of rotation for mixing and agitation as designated by the manufacturer of the equipment.

For shrink-mixed and truck-mixed concrete, when there is a reason to suspect the uniformity of concrete delivered using a truck mixer or truck agitator, conduct slump tests of 2 individual samples taken after discharging approximately 15% and 85% of the load as a quick check of the probable degree of uniformity. Take the 2 samples within an elapsed time of at most 15 minutes. If the slumps of the 2 samples differ by more than the values shown in Table 10, investigate the causes and take corrective actions including adjusting the batching sequence at the plant and the mixing time and number of revolutions. Delivery vehicles that fail to meet the mixing uniformity requirements must not be used until the condition is corrected.

Table 10
Slump Tolerance[1]

Average Slump	Slump Tolerance[2]
4 in. or less	1.0 in.
4 to 6 in.	1.5 in.

1. Do not apply these tolerances to the required slumps in Table 8.
2. Maximum permissible difference in results of test of samples from 2 locations in the concrete batch.

Re-tempering or adding concrete chemical admixtures is only permitted at the job site when concrete is delivered in a truck mixer. Do not add water after the introduction of mixing water at the batch plant except on arrival at the job site, with approval, to adjust the slump of the concrete. When this water is added, do not exceed the mix design water–cementitious-material ratio. Turn the drum or blades at least 30 additional revolutions at mixing speed to confirm thorough and uniform mixing of the concrete. Do not add water or chemical admixtures to the batch after any concrete has been discharged.

Maintain concrete delivery and placement rates sufficient to prevent cold joints.

Before unloading, furnish the computer generated delivery ticket for the batch of concrete containing the information required on TxDOT Form 596, "Concrete Batch Ticket."
When the concrete contains silica fume, adjust mixing times and batching operations as necessary to confirm the material is completely and uniformly dispersed in the mix. The dispersion of the silica fume within the mix will be verified by the City, using cylinders made from trial batches. If uniform dispersion is not achieved, make necessary changes to the batching operations until uniform and complete dispersion of the silica fume is achieved.

1. **Central-Mixed Concrete.** Provide concrete that is mixed completely in a stationary mixer. Mix concrete for a period of 1 minute for 1 cubic yard and 15 seconds for each additional cubic yard of rated capacity of the mixer unless mixer performance test data demonstrate that shorter mixing times can be used to obtain a uniform mix in accordance with TxDOT standard laboratory test procedure Tex-472-A. Count the mixing time from the time all the solid materials are in the drum. Charge the mixer so that some water will enter before the cement and aggregate. Confirm that all water is in the drum by the end of the first ¼ of the specified mixing time. Adjust the mixing time if necessary to achieve a uniform mix. Concrete mixed completely in a stationary mixer must be delivered to the project in a truck mixer, truck agitator, or non-agitating delivery vehicle. When a truck mixer or truck agitator is used for transporting concrete, use the manufacturer's designated agitating speed for any turning during transportation. Non-agitating delivery vehicles must be clean and free of built-up concrete with adequate means to control concrete discharge. Deliver the concrete to the project in a thoroughly mixed and uniform

mass, and discharge the concrete with a satisfactory degree of uniformity. Resolve questions regarding the uniformity of the concrete by testing when directed by the Engineer in accordance with TxDOT standard laboratory test procedure Tex-472-A.

2. **Shrink-Mixed Concrete.** Provide concrete that is first partially mixed in a stationary mixer and then mixed completely in a truck mixer. Partially mix for the minimum time required to intermingle the ingredients in the stationary mixer, and then transfer to a truck mixer and mix the concrete at the manufacturer's designated mixing speed for an adequate amount of time to produce thoroughly mixed concrete. Deliver the concrete to the project in a thoroughly mixed and uniform mass, and discharge the concrete with a satisfactory degree of uniformity.

3. **Truck-Mixed Concrete.** Mix the concrete in a truck mixer from 70 to 100 revolutions at the mixing speed designated by the manufacturer to produce a uniform concrete mix. Deliver the concrete to the project in a thoroughly mixed and uniform mass and discharge the concrete with a satisfactory degree of uniformity. Additional mixing at the job site at the mixing speed designated by the manufacturer is allowed as long as concrete is discharged before the drum has revolved a total of 300 revolutions after the introduction of the mixing water to the cement and the aggregates.

4. **Volumetric Mixer-Mixed Concrete.** Unless otherwise specified or permitted, perform all mixing operations in accordance with manufacturer's recommended procedures. Provide an accurate method of measuring all ingredients by volume, and calibrate equipment to assure correct measurement of materials within the specified tolerances.

5. **Hand-Mixed Concrete.** When permitted, for small placements of less than 2 cubic yards, mix up to a 2 sack batch of concrete by hand methods or in a small motor-driven mixer. For such placements, proportion the mix by volume or weight.

F. Placing, Finishing, and Curing Concrete. Place, finish, and cure concrete in accordance with the pertinent Items.

G. Sampling and Testing of Concrete. Unless otherwise specified, all fresh and hardened concrete is subject to testing as follows:

1. **Sampling Fresh Concrete.** Provide all material to be tested. Fresh concrete will be sampled for testing at the discharge end if using belt conveyors or pumps. When it is impractical to sample at the discharge end, a sample will be taken at the time of discharge from the delivery equipment and correlation testing will be performed and documented to confirm specification requirements are met at the discharge end.

2. **Testing of Fresh Concrete.**

   a. **Air Content.** TxDOT standard laboratory test procedure Tex-414-A or Tex-416-A.

   b. **Slump.** TxDOT standard laboratory test procedure Tex-415-A.

   c. **Temperature.** TxDOT standard laboratory test procedure Tex-422-A.

   d. **Making and Curing Strength Specimens.** TxDOT standard laboratory test procedure Tex-447-A.

3. **Testing of Hardened Concrete.** Only compressive strength testing will be used unless otherwise specified or shown on the plans.

   a. **Compressive Strength.** TxDOT standard laboratory test procedure Tex-418-A.

   b. **Flexural Strength.** TxDOT standard laboratory test procedure Tex-448-A.

   c. **Maturity.** TxDOT standard laboratory test procedure Tex-426-A.

4. **Certification of Testing Personnel.** Contractor personnel performing testing must be ACI-certified for the tests being performed. Personnel performing these tests are subject to City approval. Use of a commercial laboratory is permitted. All personnel performing testing using the maturity method must be qualified by a training program recognized by TxDOT before using this method on the job.

5. **Adequacy and Acceptance of Concrete.** The Engineer will sample and test the fresh and hardened concrete for acceptance. The test results will be reported to the Contractor and the concrete supplier. For any concrete that fails to meet the required strengths as outlined below, investigate the quality of the materials, the concrete production operations, and other possible problem areas to determine the cause. Take necessary actions to correct the problem including redesign of the concrete mix. The Engineer may suspend all concrete operations under the pertinent Items if the Contractor is unable to identify, document, and correct the cause of the low strengths in a timely manner. Resume concrete operations only after obtaining approval for any proposed corrective actions.

   a. **Structural Concrete.** For concrete classes identified as structural concrete in Table 5, the Engineer will make and test 7 day and 28 day specimens. Acceptance will be based on the design strength given in Table 5.

      The Engineer will evaluate the adequacy of the concrete by comparing 7 day test results to the target value established in accordance with Section 300.4.B, "Trial Batches."

   b. **All Other Concrete.** For concrete classes not identified as structural concrete in Table 5, the Engineer will make and test 7-day specimens. The Engineer will base acceptance on the 7 day target value established in accordance with Section 300.4.B, "Trial Batches."

6. **Test Sample Handling.** Unless otherwise shown on the plans or directed, remove forms and deliver department test specimens to curing facilities, in accordance with pertinent test procedures. Clean and prepare forms for reuse.

300.5. MEASUREMENT AND PAYMENT: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to pertinent Items.

300.6. BID ITEM:

N/A

ITEM

301 REINFORCING STEEL

301.1. DESCRIPTION: *Furnish and place reinforcing steel of the sizes and details shown on the plans.*

301.2. MATERIALS:

A. Approved Mills. Before furnishing steel, producing mills of reinforcing steel for the City must be pre-approved in accordance with TxDOT's DMS-7320, "Qualification Procedure for Reinforcing Steel Mills," by the TxDOT's Construction Division, which maintains a list of approved producing mills. Reinforcing steel obtained from unapproved sources will not be accepted.

B. Deformed Bar and Wire Reinforcement. Unless otherwise shown on the plans, reinforcing steel must be Grade 60, and bar reinforcement must be deformed. Reinforcing steel must conform to one of the following:

- ASTM A 615, Grades 40 or 60;
- ASTM A 996, Type A, Grades 40 or 60;
- ASTM A 996, Type R, Grade 60, permitted in concrete pavement only (Furnish ASTM A 996, Type R bars as straight bars only and do not bend them. Bend tests are not required.); or
- ASTM A 706.

The provisions of this Item take precedence over ASTM provisions.

The nominal size, area, and weight of reinforcing steel bars covered by this Item are shown in Table 1. Designate smooth bars up to No. 4 by size number and above No. 4 by diameter in inches.

C. Smooth Bar and Spiral Reinforcement. Smooth bars and dowels for concrete pavement must have a minimum yield strength of 60 ksi and meet ASTM A 615. For smooth bars that are larger than No. 3, provide steel conforming to ASTM A 615 or meet the physical requirements of ASTM A 36.

Spiral reinforcement may be smooth or deformed bars or wire of the minimum size or gauge shown on the plans. Bars for spiral reinforcement must comply with ASTM A 615, Grade 40; ASTM A 996, Type A, Grade 40; or ASTM A 675, Grade 80, meeting dimensional requirements of ASTM A 615. Smooth wire must comply with ASTM A 82, and deformed wire must comply with ASTM A 496.

D. Weldable Reinforcing Steel. Reinforcing steel to be welded must comply with ASTM A 706 or have a carbon equivalent (C.E.) of at most 0.55%. A report of chemical analysis showing the percentages of elements necessary to establish C.E. is required for reinforcing steel that does not meet ASTM A 706 to be structurally welded. These requirements do not pertain to miscellaneous welds on reinforcing steel as defined in TxDOT's Section 448.4.B.1.a, "Miscellaneous Welding Applications."

Calculate C.E. using the following formula:

$$C.E. = \%C + \frac{\%Mn}{6} + \frac{\%Cu}{40} + \frac{\%Ni}{20} + \frac{\%Cr}{10} - \frac{\%Mo}{50} - \frac{\%V}{10}$$

E. Welded Wire Fabric. For fabric reinforcement, use wire that conforms to ASTM A 82 or A 496. Use wire fabric that conforms to ASTM A 185 or A 497. Observe the relations shown in Table 2 among size number, diameter in inches, and area when ordering wire by size numbers, unless otherwise specified. Precede the size number for deformed wire with "D" and for smooth wire with "W."

Designate welded wire fabric as shown in the following example: 6 × 12 – W16 × W8 (indicating 6 in. longitudinal wire spacing and 12 in. transverse wire spacing with smooth No. 16 wire longitudinally and smooth No. 8 wire transversely).

Table 2
Wire Size Number, Diameter, and Area

Size Number (in.)	Size Number (mm)	Diameter (in.)	Area (sq. in.)
31	200	0.628	0.310
30	194	0.618	0.300
28	181	0.597	0.280
26	168	0.575	0.260
24	155	0.553	0.240
22	142	0.529	0.220
20	129	0.505	0.200
18	116	0.479	0.180
16	103	0.451	0.160
14	90	0.422	0.140
12	77	0.391	0.120
10	65	0.357	0.100
8	52	0.319	0.080
7	45	0.299	0.070
6	39	0.276	0.060
5.5	35	0.265	0.055
5	32	0.252	0.050
4.5	29	0.239	0.045
4	26	0.226	0.040
3.5	23	0.211	0.035
2.9	19	0.192	0.035
2.5	16	0.178	0.025
2	13	0.160	0.020
1.4	9	0.134	0.014
1.2	8	0.124	0.012
0.5	3	0.080	0.005

Note: Size numbers (in.) are the nominal cross-sectional area of the wire in hundredths of a square inch. Size numbers (mm) are the nominal cross-sectional area of the wire in square millimeters. Fractional sizes between the sizes listed above are also available and acceptable for use.

F. Epoxy Coating. Epoxy coating will be required as shown on the plans. Before furnishing epoxy-coated reinforcing steel, an epoxy applicator must be pre-approved in accordance with TxDOT's DMS 7330, "Qualification Procedure for Reinforcing Steel Epoxy Coating Applicators." The TxDOT Construction Division maintains a list of approved applicators.

Coat reinforcing steel in accordance with Table 3.

Table 3
Epoxy Coating Requirements for Reinforcing Steel

Material	Specification
Bar	ASTM A 775 or A 934
Wire or fabric	ASTM A 884 Class A or B
Mechanical couplers	As shown on the plans
Hardware	As shown on the plans

Use epoxy coating material and coating repair material that complies with TxDOT's DMS 8130, "Epoxy Powder Coating for Reinforcing Steel." Do not patch more than ¼-inch total length in any foot at the applicator's plant.

Epoxy-coated reinforcement will be sampled and tested in accordance with TxDOT standard laboratory test procedure Tex-739-I.

Maintain identification of all reinforcing throughout the coating and fabrication and until delivery to the project site.

Furnish 1 copy of a written certification that the coated reinforcing steel meets the requirements of this Item and 1 copy of the manufacturer's control tests.

G. Mechanical Couplers. When mechanical splices in reinforcing steel bars are shown on the plans, use couplers of the type specified in TxDOT's DMS-4510, "Mechanical Couplers," under the section "General Requirements."

Furnish only couplers that have been produced by a manufacturer that has been prequalified in accordance with TxDOT's DMS-4510. Do not use sleeve-wedge type couplers on coated reinforcing. Sample and test couplers for use on individual projects in accordance with TxDOT's DMS-4510. Furnish couplers only at locations shown on the plans.

301.3. CONSTRUCTION:

A. Bending. Cold-bend the reinforcement accurately to the shapes and dimensions shown on the plans. Fabricate in the shop if possible. Field-fabricate, if permitted, using a method approved by the Engineer. Replace improperly fabricated, damaged, or broken bars at no additional expense to the City. Repair damaged or broken bars embedded in a previous concrete placement using a method approved by the Engineer.

Unless otherwise shown on the plans, the inside diameter of bar bends, in terms of the nominal bar diameter (d), must be as shown in Table 4.

Table 4
Minimum Inside Diameter of Bar Bends

Bend	Bar Size Number (in.)	Bar Size Number (mm)	Diameter
Bends of 90° and greater in stirrups, ties, and other secondary bars that enclose another bar in the bend	3, 4, 5	10, 13, 16	4d
	6, 7, 8	19, 22, 25	6d
Bends in main bars and in secondary bars not covered above	3 through 8	10 through 25	6d
	9, 10, 11	29, 32, 36	8d
	14, 18	43, 57	10d

Note: Bar size numbers (in.) are based on the number of eighths of an inch included in the nominal diameter of the bar. Bar size numbers (mm) approximate the number of millimeters included in the nominal diameter of the bar.

Where bending No. 14 or No. 18 Grade 60 bars is required, bend-test representative specimens as described for smaller bars in the applicable ASTM specification. Make the required 90° bend around a pin with a diameter of 10 times the nominal diameter of the bar.

B. Tolerances. Fabrication tolerances for bars are shown in Figure 1.

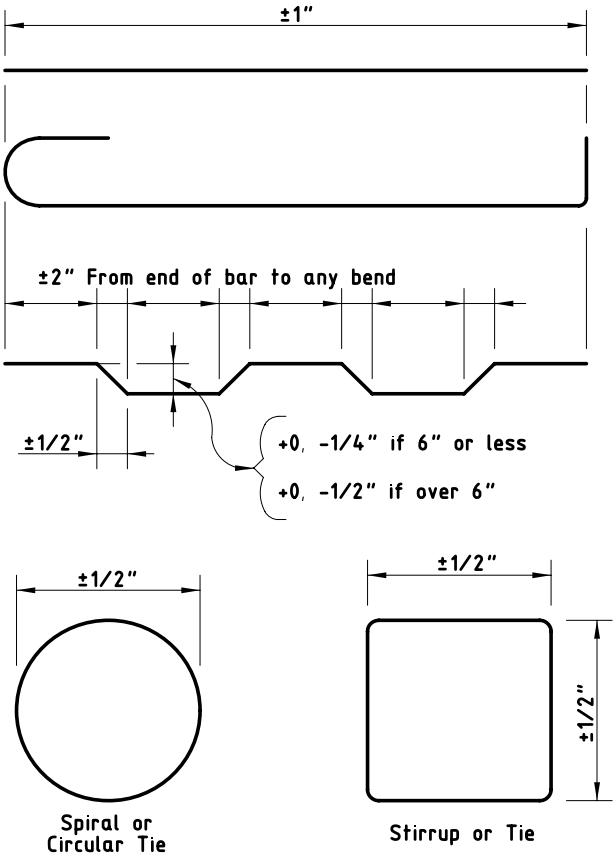


Figure 1. Fabrication tolerances for bars.

C. Storage. Store steel reinforcement above the ground on platforms, skids, or other supports, and protect it from damage and deterioration. Ensure that reinforcement is free from dirt, paint, grease, oil, and other foreign materials when it is placed in the work. Use reinforcement free from defects such as cracks and delaminations. Rust, surface seams, surface irregularities, or mill scale will not be cause for rejection if the minimum cross-sectional area of a hand wire-brushed specimen meets the requirements for the size of steel specified.

D. Splices. Lap-splice, weld-splice, or mechanically splice bars as shown on the plans. Additional splices not shown on the plans will require approval. Splices not shown on the plans will be permitted in slabs 15-inches or less in thickness, columns, walls, and parapets.

- Unless otherwise approved, splices will not be permitted in bars 30 feet or less in plan length. For bars exceeding 30 feet in plan length, the distance center-to-center of splices must be at least 30 feet minus 1 splice length, with no more than 1 individual bar length less than 10 feet. Make lap splices not shown on the plans, but otherwise permitted, in accordance with Table 5. Maintain the specified concrete cover and spacing at splices, and place the lap-spliced bars in contact, securely tied together.

Table 5
Minimum Lap Requirements for Bar Sizes through No. 11

Bar Size Number (in.)	Bar Size Number (mm)	Uncoated Lap Length	Coated Lap Length
3	10	1 ft. 4 in.	2 ft. 0 in.
4	13	1 ft. 9 in.	2 ft. 8 in.
5	16	2 ft. 2 in.	3 ft. 3 in.
6	19	2 ft. 7 in.	3 ft. 11 in.
7	22	3 ft. 5 in.	5 ft. 2 in.
8	25	4 ft. 6 in.	6 ft. 9 in.
9	29	5 ft. 8 in.	8 ft. 6 in.
10	32	7 ft. 3 in.	10 ft. 11 in.
11	36	8 ft. 11 in.	13 ft. 5 in.

Note: Bar size numbers (in.) are based on the number of eighths of an inch included in the nominal diameter of the bar. Bar size numbers (mm) approximate the number of millimeters included in the nominal diameter of the bar.

- Do not lap No. 14 or No. 18 bars.
- Lap spiral steel at least 1 turn.
- Splice welded wire fabric using a lap length that includes the overlap of at least 2 cross wires plus 2-inches on each sheet or roll. Splices using bars that develop equivalent strength and are lapped in accordance with Table 5 are permitted.
- For box culvert extensions with less than 1-foot of fill, lap the existing longitudinal bars with the new bars as shown in Table 3. For extensions with more than 1-foot of fill, lap at least 1-foot 0-inch.
- Ensure that welded splices conform to the requirements of the plans and of TxDOT's Item 448, "Structural Field Welding." Field-prepare ends of reinforcing bars if they will be butt-welded. Delivered bars must be long enough to permit weld preparation.

- Install mechanical coupling devices in accordance with the manufacturer's recommendations at locations shown on the plans. Protect threaded male or female connections, and make sure the threaded connections are clean when making the connection. Do not repair damaged threads.

- Mechanical coupler alternate equivalent strength arrangements, to be accomplished by substituting larger bar sizes or more bars, will be considered if approved in writing before fabrication of the systems.

E. Placing. Unless otherwise shown on the plans, dimensions shown for reinforcement are to the centers of the bars. Place reinforcement as near as possible to the position shown on the plans. In the plane of the steel parallel to the nearest surface of concrete, bars must not vary from plan placement by more than 1/12 of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars must not vary from plan placement by more than ¼-inch. Cover of concrete to the nearest surface of steel must be at least 1-inch unless otherwise shown on the plans.

For bridge slabs, the clear cover tolerance for the top mat of reinforcement is −0, +½-inch.

Locate the reinforcement accurately in the forms, and hold it firmly in place before and during concrete placement by means of bar supports that are adequate in strength and number to prevent displacement and to keep the steel at the proper distance from the forms. Support bars by standard bar supports with plastic tips, approved plastic bar supports, or precast mortar or concrete blocks when supports are in contact with removable or stay-in-place forms. Use bright basic bar supports to support reinforcing steel placed in slab overlays on concrete panels or on existing concrete slabs. Bar supports in contact with soil or subgrade must be approved.

For bar supports with plastic tips, the plastic protection must be at least 3/32-inch thick and extend upward on the wire to a point at least ½-inch above the formwork.

All accessories such as tie wires, bar chairs, supports, or clips used with epoxy-coated reinforcement must be of steel, fully coated with epoxy or plastic. Plastic supports approved by the Engineer may also be used with epoxy-coated reinforcement.

Cast mortar or concrete blocks to uniform dimensions with adequate bearing area. Provide a suitable tie wire in each block for anchoring to the steel. Cast the blocks to the thickness required in approved molds. The surface placed adjacent to the form must be a true plane, free of surface imperfections. Cure the blocks by covering them with wet burlap or mats for a period of 72-hours. Mortar for blocks should contain approximately 1 part hydraulic cement to 3 parts sand. Concrete for blocks should contain 850 lb. of hydraulic cement per cubic yard of concrete.

Place individual bar supports in rows at 4 feet maximum spacing in each direction. Place continuous type bar supports at 4 feet maximum spacing. Use continuous bar supports with permanent metal deck forms.

The exposure of the ends of longitudinals, stirrups, and spacers used to position the reinforcement in concrete pipe and in precast box culverts or storm drains is not cause for rejection.

Tie reinforcing steel for bridge slabs, top slabs of direct traffic culverts, and top slabs of prestressed box beams at all intersections, except tie only alternate intersections where spacing is less than 1 foot in each direction. For reinforcing steel cages for other structural members, tie the steel at enough intersections to provide a rigid cage of steel. Fasten mats of wire fabric securely at the ends and edges.

Before concrete placement, clean mortar, mud, dirt, debris, oil, and other foreign material from the reinforcement. Do not place concrete until authorized.

If reinforcement is not adequately supported or tied to resist settlement, reinforcement is floating upward, truss bars are overturning, or movement is detected in any direction during concrete placement, stop placement until corrective measures are taken.

F. Handling, Placement, and Repair of Epoxy-Coated Reinforcing Steel.

1. **Handling.** Provide systems for handling coated reinforcement with padded contact areas. Pad bundling bands or use suitable banding to prevent damage to the coating. Lift bundles of coated reinforcement with a strongback, spreader bar, multiple supports, or a platform bridge. Transport the bundled reinforcement carefully, and store it on protective cribbing. Do not drop or drag the coated reinforcement.

2. **Construction Methods.** Do not flame-cut coated reinforcement. Saw or shear-cut only when approved. Coat cut ends as specified in Section 301.3.F.3, "Repair of Coating."

   Do not weld or mechanically couple coated reinforcing steel except where specifically shown on the plans. Remove the epoxy coating at least 6-inches beyond the weld limits before welding and 2-inches beyond the limits of the coupler before assembly. After welding or coupling, clean the steel of oil, grease, moisture, dirt, welding contamination (slag or acid residue), and rust to a near-white finish. Check the existing epoxy for damage. Remove any damaged or loose epoxy back to sound epoxy coating.

   After cleaning, coat the splice area with epoxy repair material to a thickness of 7 to 17-mils after curing. Apply a second application of repair material to the bar and coupler interface to ensure complete sealing of the joint.

3. **Repair of Coating.** For repair of the coating, use material that complies with the requirements of this Item and ASTM D 3963. Make repairs in accordance with procedures recommended by the manufacturer of the epoxy coating powder. For areas to be patched, apply at least the same coating thickness as required for the original coating. Repair all visible damage to the coating.

   Repair sawed and sheared ends, cuts, breaks, and other damage promptly before additional oxidation occurs. Clean areas to be repaired to ensure that they are free from surface contaminants. Make repairs in the shop or in the field as required.

301.4. MEASUREMENT AND PAYMENT: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be considered subsidiary to pertinent Items.

301.5. BID ITEM:

N/A

ITEM

302 METAL FOR STRUCTURES

302.1. DESCRIPTION: *This item shall govern for materials, such as structural steels, alloy steels, rivet steel, high strength bolts, forgings, steel casting, iron castings, wrought iron, bronze, steel pipe and tubing, aluminum castings and tubing, and other metals used in structures, except reinforcing steel and metal culvert pipe, and for the fabrication and erection of structural steel and other metals, except reinforcing steel, which are used for steel or steel portions of structures.*

302.2. MATERIALS: Provide materials that meet the requirements as set forth below:

A. Metal for Structures. Metal for structures shall comply with the requirements as set forth under the Texas Department of Transportation Standard Specifications Item 442, "Metal for Structures," Subsection 442.2, "Materials" including requirements for materials stated in the latest Special Provision dictated by TxDOT for Statewide use.

B. Paint. Paint shall comply with the requirements as set forth under Item 514, "Paint and Painting."

302.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

302.4. CONSTRUCTION: Construction of "Metal for Structures" shall comply with the requirements as set forth under the Texas Department of Transportation Standard Specifications Item 441, "Steel Structures," Subsection 441.3, "Construction" including requirements for construction stated in the latest Special Provision dictated by TxDOT for Statewide use. Contact the local District office of the Texas Department of Transportation for information pertaining to Subsection 441.3.A.5, "Qualification of Plant, Laboratories, and Personnel." Submit documentation required by Subsection 441.3.A.7, "Welding and Fabrication Procedures" to the City Engineer. Other references to the "Department" and "Engineer" in TxDOT Item 441 shall be deemed to mean the appropriate City Department and the City Engineer or their representative.

302.5. MEASUREMENT: Measurement of the quantity of structural metal furnished and placed will be based on the weight of metal in the fabricated structure. The weight of erection bolts, paint, and all boxes, crates, or other containers used for packing, together with sills, blocking and rods used for supporting or protecting members during transportation shall be excluded. When increases in size or weights of members have been made which were not ordered by the Engineer, but approved by the Engineer, the measurement will be made on the sizes or weights shown on the contract plans.

In determining the weight of structural metal in steel or concrete structures, such items as castings, bearing plates, anchor bolts, drains, deck plates, armor joints, finger joints, and all other metal for which no separate measurement is specified, will be considered as metal for structures.

The weights of rolled shapes and of plates shall be computed on the basis of their nominal weights and dimensions, as shown on the approved shop plans.

The weight of castings will be computed from the dimensions shown on the approved shop drawings. Shoes will be measured by the weights as shown on the standard shoe details, or as specified for castings above, if weights are not shown.

Deductions will be made for all cuts, copes, perforations, and all holes except rivet or bolt holes. The weight of rivet heads will be included for payment. No weight shall be allowed for weld metal.

A change in design which either increases or reduces the quantity of metal going into the structure or structures will be measured by the actual computed weights of the metal, and the quantity as shown on the plans and in the contract, will be increased or decreased by the revised weights, as the case may be.

302.6. PAYMENT: Structural metal will be paid for at the contract unit price bid per pound for "Metal for Structures," or for such other classifications as shown on the plans and in the proposal.

Payment will not be made until shop bills of materials, based on approved shop drawings, indicating total weight of material used have been received and checked by the Engineer.

This price shall be full compensation for furnishing all materials and for all fabrication, shop work, transportation, erection, paint and painting, galvanizing, and for furnishing all equipment tools, labor, and incidentals necessary to complete the work.

302.7. BID ITEM:

Item 302.1 - Metal for Structures - per pound

ITEM

303 WELDED WIRE FLAT SHEETS

303.1. DESCRIPTION: *This item shall govern the furnishing of the various sizes of welded wire flat sheets as indicated on the plans or as directed by the Engineer.*

303.2. MATERIALS: For fabric reinforcement, use wire that conforms to ASTM A 82 or A 496. Use wire fabric that conforms to ASTM A 185 or A 497. Observe the relations shown in Table 1 among size number, diameter in inches, and area when ordering wire by size numbers, unless otherwise specified. Precede the size number for deformed wire with "D" and for smooth wire with "W." Designate welded wire fabric as shown in the following example:

6 × 12 – W16 × W8 (indicating 6-in. longitudinal wire spacing and 12-in. transverse wire spacing with smooth No. 16 wire longitudinally and smooth No. 8 wire transversely).

Welded wire rolls shall not be used.

303.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

303.4. CONSTRUCTION: Splice welded wire fabric using a lap length that includes the overlap of at least 2 cross wires plus 2 in. on each sheet.

Distances from forms or concrete surfaces shall be maintained by means of stays, precast blocks, ties, hangers, metal chairs or other approved supports. The use of pebbles, pieces of broken stones or brick, metal pipe and wooden blocks shall not be permitted.

At the edge of the construction, the wire fabric shall not be less than 1 inch nor more than 3 inches from the edge of the concrete and shall have no wires projecting beyond the last member parallel to the edge of the concrete.

303.5. MEASUREMENT: No measurement of welded wire flat sheets will be made.

303.6. PAYMENT: No direct payment for furnishing and placing welded wire flat sheets will be made. All materials and labor required will be considered subsidiary to the item in which it is used and shall be included in the unit price bid for said item.

303.7. BID ITEM:

N/A

Table 1
Wire Size Number, Diameter, and Area

Size Number (in.)	Size Number (mm)	Diameter (in.)	Area (sq. in.)
31	200	0.628	0.310
30	194	0.618	0.300
28	181	0.597	0.280
26	168	0.575	0.260
24	155	0.553	0.240
22	142	0.529	0.220
20	129	0.505	0.200
18	116	0.479	0.180
16	103	0.451	0.160
14	90	0.422	0.140
12	77	0.391	0.120
10	65	0.357	0.100
8	52	0.319	0.080
7	45	0.299	0.070
6	39	0.276	0.060
5.5	35	0.265	0.055
5	32	0.252	0.050
4.5	29	0.239	0.045
4	26	0.226	0.040
3.5	23	0.211	0.035
2.9	19	0.192	0.035
2.5	16	0.178	0.025
2	13	0.16	0.020
1.4	9	0.134	0.014
1.2	8	0.124	0.012
0.5	3	0.08	0.005

Note: Size numbers (in.) are the nominal cross-sectional area of the wire in hundredths of a square inch. Size numbers (mm) are the nominal cross-sectional area of the wire in square millimeters. Fractional sizes between the sizes listed above are also available and acceptable for use.

ITEM

306 STRUCTURAL EXCAVATION

306.1. DESCRIPTION: *Only when indicated on the plan details and bid proposals will this item govern the excavation for the placing of structures, and for the disposal of all material obtained from such excavation, and for backfilling around completed structures to the level of the original ground. The work to be done under this item shall include all necessary pumping or bailing, sheathing, drainage and the removal of all structures or portions thereof, such as wingwalls, pipe culverts, inlets, trees and all other obstructions necessary to the proposed construction.*

306.2. MATERIALS: All structural excavation shall be unclassified, and shall include all materials encountered regardless of their nature or the manner in which they are removed, except those covered by other pay items of the contract. Use materials that meet the requirements of the following Items, when indicated on the plans or required:

A. Flexible Base. Item 200, "Flexible Base."

B. Subgrade Filler. Item 410, "Subgrade Filler."

C. Cement Stabilized Sand. Item 412, "Cement Stabilized Sand."

D. Flowable Fill. Item 413, "Flowable Fill."

E. Filter Fabric. TxDOT DMS 6200, "Filter Fabric," Type1.

306.3. EQUIPMENT: Provide applicable equipment to conduct work as described in this specification or as specified on the plans.

306.4. CONSTRUCTION:

A. Excavation. In instances where the structure is stepped outward near the top, the limits of excavation will be increased accordingly. In all cases where excavation diagrams are shown on the plans, such diagrams shall take precedence over these provisions. Suitable excavated materials shall be utilized, insofar as practicable, in backfilling around the drainage structures or in constructing required embankments, if applicable. Excavated material suitable for backfilling may be stockpiled by the Contractor at points convenient for re-handling, provided stockpiles do not constitute a hazard and all hubs and survey lines are kept free of any obstruction. Unsuitable materials below footing grade shall be removed and replaced with gravel subgrade filler as defined in Item 410, "Subgrade Filler."

Excavated materials which are unsuitable for embankments or backfilling, or excavation in excess of that needed for construction shall become the property of the Contractor and it shall become his sole responsibility to properly dispose of this material outside the limits of the project. Proper disposal shall be in conformance with, but not limited to, the following provisions:

- Do not deposit excavated material within jurisdictional wetlands, and
- Obtain appropriate permits and apply provisions pertaining to soil erosion and stream pollution, when necessary, to meet federal, state, and/or local regulations, rules, and procedures.

1. **Hazardous Materials.** If the Contractor encounters hazardous substances, industrial waste, other environmental pollutants, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.

2. **Existing Structures/Obstructions.** Removal of structures and other obstructions prior to excavation and finishing of all other earthwork described herein shall be completed and paid for in accordance with Item 101, "Preparing Right-of-Way" unless otherwise stated on the plans.

B. Backfilling. Backfilling to the top of the pipe culvert or structure (initial backfill) shall be completed by one of the four methods 1., 2., 3., or 4. below. Backfilling from the top of the culvert to the top of the trench (secondary backfill), or proposed subgrade elevation, shall be completed in accordance with Item 400, "Excavation, Trenching, and Backfilling." Backfill behind cast-in-place culvert walls shall not begin until the concrete has attained a compressive strength of 2,000 psi. Backfill on top of cast-in-place supporting slabs shall not begin until the concrete has attained a compressive strength of 3,000 psi. Avoid wedging action of backfill against structures. If necessary to prevent such action, step or serrate slopes bounding the excavation. Place backfill along both sides of culverts equally and in uniform layers.

1. **Suitable On-Site Excavated Material.** Material for backfill shall be placed in uniform layers not more than 12 inches in depth (loose measurement) and shall be compacted to the density specified herein. Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density, by means of a mechanical tamper.

   Each lift of fill shall be compacted to the required density and moisture content as shown below, unless otherwise shown on the plans:

Subgrade Material	**Density**	**Moisture Content**
PI ≤ 20	≥ 95% of Max Dry Density	- 2% of Opt. or greater
PI > 20	≥ 95% of Max Dry Density	≥ Opt. Moisture

   The maximum dry density and optimum moisture content shall be determined in accordance with TxDOT Standard Laboratory Test Method Tex-114-E. Tests for in place

density shall be made in accordance with TxDOT standard laboratory test method Tex-115-E and within 24 hours after compacting operations are completed. If the material fails to meet the density specified, it shall be re-worked as necessary to obtain the density required.

2. **Select Fill.** A clean gravel, or gravel approved by the Engineer, conforming to the requirements of article 410.3.B. "Gravel" of Item No.410, "Subgrade Filler" may be used for backfill material from the bottom of the trench to the top of the conduit. The gravel shall be placed in the trench in loose lifts not to exceed 12 inches in depth and lightly tamped to consolidate and seat the mass against conduit and earthen surfaces.

   A filter fabric shall be placed between the gravel backfill (initial backfill) and secondary backfill. The filter fabric shall conform to the requirements of Texas Department of Transportation Material Specification 6200, Type1. Filter fabric shall be considered incidental to construction and no separate payment for filter fabric will be made.

   Where conditions permit and with approval of the Engineer, material conforming to Item 200, "Flexible Base" may be used from the top of the gravel filter bed to the top of the box culvert. This backfill material shall be placed in uniform layers not more than 12 inches in depth (loose measurement) and shall be compacted to the required density. Each layer of material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density by means of a mechanical tamper.

   Compaction of the Flexible Base shall be such that the density of each layer shall be not less than 95% of the maximum dry density as determined by TxDOT Standard Laboratory Test Method TEX-113-E, unless otherwise shown on the plans.

3. **Controlled Low Strength Material (CLSM).** CLSM shall be placed by direct discharge from a mixer truck or other approved method. A minimum of 30 psi at 3 days and maximum strength of 800 psi at 28 days is required. There is no separate pay item for Controlled Low Strength Material, unless shown on the plans as a separate pay item for culvert backfill.

4. **Flowable Backfill.** When shown on the plans, backfill the excavation with flowable backfill that conforms to Item 413, "Flowable Backfill" to the elevations shown on the plans. Prevent the structure from being displaced during the placement of the flowable backfill and prevent flowable backfill from entering culverts. There is no separate pay item for Flowable Backfill material, unless shown on the plans as a separate pay item for culvert backfill.

C. Quality Control. After each layer of embankment backfill or flexible base is complete, tests as necessary will be made by the Engineer. If the material fails to meet the density specified, the course shall be reworked, as necessary, to obtain the specified compaction.

Should the backfill, due to any reason or cause, lose the required stability, density/moisture, or finish before the next lift is placed, it shall be re-compacted and refinished at the sole expense of the Contractor. Excessive loss of moisture in the backfill shall be prevented by sprinkling or other approved methods.

306.5. MEASUREMENT: Limits of excavation for payment shall be to a vertical plane 1 foot outside and parallel to the footing and will be computed by the method of average end areas. No

measurement will be made of any excavation, made by the Contractor for his convenience, beyond the limits specified above.

306.6. PAYMENT: The work performed as prescribed by this item will be paid for at the unit price bid per cubic yard for "Structural Excavation," which price shall be full compensation for all excavation (within the limits set forth) and backfill including compaction, pumping, bailing, sheathing, bracing, and for furnishing all materials, labor, equipment tools, and incidentals necessary to complete the work.

306.7. BID ITEM:

Item 306.1 - Structural Excavation - per cubic yard

ITEM

307 CONCRETE STRUCTURES

307.1. DESCRIPTION: *Construct concrete structures.*

307.2. MATERIALS:

A. Concrete. Provide concrete conforming to Item 300, "Concrete." For each type of structure or unit, provide the class of concrete shown on the plans or in pertinent governing specifications.

B. Grout or Mortar. Provide grout or mortar conforming to Section 300.2.F, "Mortar and Grout."

C. Latex. Provide an acrylic-polymer latex admixture (acrylic resin emulsion per TxDOT's DMS-4640, "Chemical Admixtures for Concrete") suitable for producing polymer-modified concrete or mortar. Do not allow latex to freeze.

D. Reinforcing Steel. Provide reinforcing steel conforming to Item 301, "Reinforcing Steel."

E. Expansion Joint Material. Provide materials that conform to the requirements of TxDOT's DMS-6310, "Joint Sealants and Fillers":

- Provide preformed fiber expansion joint material that conforms to the dimensions shown on the plans. Provide preformed bituminous fiber material unless otherwise specified.
- Provide a Class 4, 5, or 7 low-modulus silicone sealant unless otherwise directed.
- Provide asphalt board that conforms to dimensions shown on the plans.
- Provide re-bonded neoprene filler that conforms to the dimensions shown on the plans.

F. Waterstop. Provide rubber or polyvinyl chloride (PVC) waterstops that conform to TxDOT's DMS-6160, "Waterstops, Nylon Reinforced Neoprene Sheet, and Elastomeric Pads," unless otherwise shown on the plans.

G. Evaporation Retardants. Provide evaporation retardants that conform to the requirements of TxDOT's DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

H. Curing Materials. Provide membrane curing compounds that conform to the requirements of TxDOT's DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants."

Provide cotton mats that consist of a filling material of cotton "bat" or "bats" (at least 12 ounces per square yard) completely covered with unsized cloth (at least 6 oz. per square yard) stitched longitudinally with continuous parallel rows of stitching spaced at less than 4 inches, or tuft both longitudinally and transversely at intervals less than 3 inches. Provide cotton mats that are free from tears and in good general condition. Provide a flap at least 6 inches wide consisting of 2 thicknesses of the covering and extending along 1 side of the mat.

Provide polyethylene sheeting that is at least 4 mils thick and free from visible defects. Provide only clear or opaque white sheeting when the ambient temperature during curing exceeds 60°F or when applicable to control temperature during mass pours.

Provide burlap-polyethylene mats made from burlap impregnated on 1 side with a film of opaque white pigmented polyethylene, free from visible defects. Provide laminated mats that have at least 1 layer of an impervious material such as polyethylene, vinyl plastic, or other acceptable material (either as a solid sheet or impregnated into another fabric) and are free of visible defects.

I. Epoxy. Unless otherwise specified, provide epoxy materials that conform to TxDOT's DMS-6100, "Epoxy and Adhesives."

J. Cast Iron Castings. Provide cast iron castings that conform to Item 409, "Cast Iron Castings."

K. Metal for Structures. Provide metal for structures that conform to Item 302, "Metal for Structures."

307.3. EQUIPMENT:

A. Fogging Equipment. Use fogging equipment that can apply water in a fine mist, not a spray. Produce the fog using equipment that pumps water or water and air under high pressure through a suitable atomizing nozzle. Use hand-held mechanical equipment portable enough to use in the direction of any prevailing wind and adaptable for intermittent use to prevent excessive wetting of the concrete.

B. Transporting and Placing Equipment. Use appropriate transporting and placing equipment such as buckets, chutes, buggies, belt conveyors, pumps, or other equipment as necessary. Do not transport or convey concrete through equipment made of aluminum. Use carts with pneumatic tires for carting or wheeling concrete over newly placed slabs.

Use tremies to control the fall of concrete or for underwater placement. Use tremies that are watertight and of large enough diameter to allow the placement of the concrete but less than 14 inches in diameter. For underwater placements, construct the tremie so that the bottom can be sealed and opened once the tremie has been fully charged with concrete.

Use pumps with lines at least 5 inches I.D. where Grade 2 or smaller coarse aggregate is used and at least 8 inches I.D. for Grade 1 coarse aggregate.

C. Vibrators. Use immersion-type vibrators that maintain a speed of 6,000 impulses per minute for consolidation of concrete. Provide at least 1 standby vibrator for emergency use.

D. Screeds and Work Bridges for Bridge Slabs. For bridge slabs use a self-propelled transverse screed or a mechanical longitudinal screed. Use transverse screeds that are able to follow the skew of the bridge for skews greater than 15° unless otherwise approved. Equip transverse screeds with a pan float. Manually operated screeding equipment may be used if approved for top slabs of culverts, small placements, or unusual conditions. Use screeds that are rigid and heavy enough to hold true to shape and have sufficient adjustments to provide for the required camber or section. Equip the screeds, except those of the roller drum type, with metal cutting edges.

For bridge slabs, use sufficient work bridges for finishing operations. Mount a carpet drag to a work bridge or a moveable support system that can vary the area of carpet in contact with the concrete. Use carpet pieces long enough to cover the entire width of the placement. Splice or overlap the carpet as necessary. Confirm that enough carpet is in contact longitudinally with the concrete being placed to provide the desired surface finish. Use artificial grass-type carpeting having a molded polyethylene pile face with a blade length between 5/8 and 1 inch and with a minimum weight of 70 oz. per square yard. Confirm that the carpet has a strong, durable backing not subject to rot and that the facing is adequately bonded to the backing to withstand the intended use. A burlap drag, attached to the pan float on a transverse screed, may be used instead of the carpet drag.

E. Temperature Recording Equipment. For mass concrete operations or as otherwise specified, use strip chart temperature recording devices, recording maturity meters in accordance with TxDOT standard laboratory test procedure Tex-426-A, or other approved devices that are accurate to within ±2°F within the range of 32 to 212°F.

F. Artificial Heating Equipment. Use artificial heating equipment as necessary for maintaining the concrete temperatures as specified in Section 307.4.G.11, "Placing Concrete in Cold Weather."

G. Sawing Equipment. Use sawing equipment capable of cutting grooves in completed bridge slabs and top slabs of direct-traffic culverts. Provide grooves that are 1/8 to 3/16 inch deep and nominally 1/8 inch wide. Groove spacing may range from 5/8 to 1 inch. Use sawing equipment capable of cutting grooves in hardened concrete to within 18 inches of the barrier rail or curb.

H. Spraying Equipment. Use mechanically powered pressure sprayers, either air or airless, with appropriate atomizing nozzles for the application of membrane curing. Mechanically driven spraying equipment, adaptable to the rail system used by the screeds, may be used for applying membrane curing to bridge slabs. If approved, use hand-pressurized spray equipment equipped with 2 or 3 fan-spray nozzles. Confirm that the spray from each nozzle overlaps the spray from adjacent nozzles by approximately 50%.

I. Concrete Testing Equipment. Provide testing equipment for use by the Engineer in accordance with Section 300.3.C, "Testing Equipment."

307.4. CONSTRUCTION: Before starting work, obtain approval for proposed construction methods. Approval of construction methods and equipment does not relieve the Contractor's responsibility for safety or correctness of methods, adequacy of equipment, or completion of work in full accordance with the Contract.

Unless otherwise shown on the plans, it is the Contractor's option to perform testing on structural concrete (structural classes of concrete are identified in Table 5 of Section 300.4.A, "Classification and Mix Design") to determine the in-situ strength to address the schedule restrictions in Section 307.4.A, "Schedule Restrictions." The Engineer may require the Contractor to perform this testing for concrete placed in cold weather. For Contractor-performed testing, make enough test specimens to confirm that strength requirements are met for the operations listed in Section 307.4.A. Make at least 1 set of test specimens for each element cast each day. Cure these specimens under the same conditions as the portion of the structure involved for all stages of construction. Confirm safe handling, curing, and storage of all test specimens. Provide testing personnel, and sample and test the hardened concrete in accordance with Section 300.4.G, "Sampling and Testing of Concrete." The maturity method, TxDOT standard laboratory test

procedure Tex-426-A, may be used for in-situ strength determination for schedule restrictions if approved. Coring will not be allowed for in-situ strength determination for schedule restrictions. Provide the Engineer the opportunity to witness all testing operations. Report all test results to the Engineer.

If the Contractor does not wish to perform schedule restriction testing, the Engineer's 7 day lab-cured tests, performed in accordance with Section 300.4.G.5, "Adequacy and Acceptance of Concrete," will be used for schedule restriction determinations. The Engineer may require additional time for strength gain to account for field curing conditions such as cold weather.

A. Schedule Restrictions. Unless otherwise shown on the plans, construct and open completed structures to traffic with the following limitations:

1. **Setting Forms.** Attain at least 2,500 psi compressive strength before erecting forms on concrete footings supported by piling or drilled shafts, or on individual drilled shafts. Erect forms on spread footings and culvert footings after the footing concrete has aged at least 2 curing days as defined in Section 307.4.J, "Curing Concrete." Place concrete only after the forms and reinforcing steel have been inspected by the Engineer.

   Support tie beam or cap forms by falsework on previously placed tie beams only if the tie beam concrete has attained a compressive strength of 2,500 psi and the member is properly supported to eliminate stresses not provided for in the design. Maintain curing as required until completion of the curing period.

   Place superstructure forms or falsework on the substructure only if the substructure concrete has attained a compressive strength of 3,000 psi.

2. **Removal of Forms and Falsework.** Keep in place weight-supporting forms and falsework for bridge components and culvert slabs until the concrete has attained a compressive strength of 2,500 psi in accordance with Section 307.4.K, "Removal of Forms and Falsework." Keep all forms for mass placements defined in Section 307.4.G.14, "Mass Placements," in place for 4 days following concrete placement.

3. **Placement of Superstructure Members.** Do not place superstructure members before the substructure concrete has attained a compressive strength of 3,000 psi.

4. **Longitudinal Screeding of Bridge Slabs.** Place a longitudinal screed directly on previously placed concrete slabs to check and grade an adjacent slab only after the previously placed slab has aged at least 24 hours. Place and screed the concrete after the previously placed slabs have aged at least 48 hours. Maintain curing of the previously placed slabs during placement.

5. **Staged Placement of Bridge Slabs on Continuous Steel Units.** When staged placement of a slab is required, confirm that the previously placed concrete attains a compressive strength of 3,000 psi before placing the next stage placement. Multiple stages may be placed in a single day if approved.

6. **Storage of Materials on the Structure.** Obtain approval to store materials on completed portions of a structure once a compressive strength of 3,000 psi has been attained. Maintain proper curing if materials will be stored on structures before completion of curing.

7. **Placement of Equipment and Machinery.** Do not place erection equipment or machinery on the structure until the concrete has attained the design strength specified in Section 300.4.A, "Classification and Mix Design," unless otherwise approved.

8. **Carting of Concrete.** Once the concrete has attained a compressive strength of 3,000 psi, it may be carted, wheeled, or pumped over completed slabs. Maintain curing during these operations.

9. **Placing Bridge Rails.** Reinforcing steel and concrete for bridge rails may be placed on bridge slabs once the slab concrete has attained a compressive strength of 3,000 psi. If slipforming methods are used for railing concrete, confirm the slab concrete has attained its design strength specified in Section 300.4.A, "Classification and Mix Design," before placing railing concrete.

10. **Opening to Construction Traffic.** Bridges and direct-traffic culverts may be opened to all construction traffic when the design strength specified in Section 300.4.A, "Classification and Mix Design," has been attained if curing is maintained.

11. **Opening to Full Traffic.** Bridges and direct-traffic culverts may be opened to the traveling public when the design strength specified in Section 300.4.A, "Classification and Mix Design," has been attained for all structural elements including railing subject to impact from traffic, when curing has been completed for all slabs, and when the concrete surface treatment has been applied in accordance with TxDOT's Item 428, "Concrete Surface Treatment." Obtain approval before opening bridges and direct-traffic culverts to the traveling public. Other noncritical structural and nonstructural concrete may be opened for service upon the completion of curing unless otherwise specified or directed.

12. **Post-Tensioned Construction.** For structural elements designed to be post-tensioned confirm that strength requirements on the plans are met for stressing and staged loading of structural elements.

13. **Backfilling.** Backfill in accordance with TxDOT's Section 400.3.C, "Backfill."

B. Plans for Falsework and Forms. Submit 2 copies of plans for falsework and forms for piers, superstructure spans over 20 feet long, bracing systems for girders when the overhang exceeds 3 feet 6 inches, and bridge widening details. Submit similar plans for other units of the structure as directed. Show all essential details of proposed forms, falsework, and bracing. Have a licensed professional engineer design, seal, and sign these plans. City approval is not required, but the City reserves the right to request modifications to the plans. The Contractor is responsible for the adequacy of these plans.

C. Falsework. Design and construct falsework to carry the maximum anticipated loads safely, including wind loads, and to provide the necessary rigidity. Submit details in accordance with Section 307.4.B, "Plans for Falsework and Forms."

Design job-fabricated falsework assuming a weight of 150 pcf for concrete, and include a liveload allowance of 50 psf of horizontal surface of the form. Do not exceed 125% of the allowable stresses used by the City for the design of structures.

For commercially produced structural units used in falsework, do not exceed the manufacturer's maximum allowable working loads for moment and shear or end reaction.

Include a liveload allowance of 35 psf of horizontal form surface in determining the maximum allowable working load for commercially produced structural units.

Provide timber that is sound, in good condition, and free from defects that would impair its strength. Provide timber that meets or exceeds the species, size, and grade requirements in the submitted falsework plans.

Provide wedges made of hardwood or metal in pairs to adjust falsework to desired elevations to confirm even bearing. Do not use wedges to compensate for incorrectly cut bearing surfaces.

Use sills or grillages that are large enough to support the superimposed load without settlement. Take precautions to prevent settling of the supporting material unless the sills or grillages are founded on solid rock, shale, or other hard materials.

Place falsework that cannot be founded on a satisfactory spread footing on piling or drilled shafts with enough bearing capacity to support the superimposed load without settlement. Drive falsework piling to the required resistance determined by the applicable formula in TxDOT Item 404, "Driving Piling." Design drilled shafts for falsework to carry the superimposed load using both skin friction and point bearing.

Weld in conformance with TxDOT Item 448, "Structural Field Welding." Securely brace each falsework bent to provide the stiffness required, and securely fasten the bracing to each pile or column it crosses.

Remove falsework when it is no longer required or as indicated on the submitted falsework plan. Pull or cut off foundations for falsework at least 2 feet below finished ground level. Completely remove falsework, piling, or drilled shafts in a stream, lake, or bay to the approved limits to prevent obstruction to the waterway.

D. Forms. Submit formwork plans in accordance with Section 307.4.B, "Plans for Falsework and Forms."

1. General. Except where otherwise specified or permitted, provide forms of either timber or metal.

Design forms for the pressure exerted by a liquid weighing 150 pcf. Take the rate of concrete placement into consideration in determining the depth of the equivalent liquid. Include a liveload allowance of 50 psf of horizontal surface for job-fabricated forms. Do not exceed 125% of the allowable stresses used by the City for the design of structures.

For commercially produced structural units used for forms, do not exceed the manufacturer's maximum allowable working loads for moment and shear or end reaction. Include a liveload allowance of 35 psf of horizontal form surface in determining the maximum allowable working load for commercially produced structural units.

Provide steel forms for round columns unless otherwise approved. Refer to Item 311, "Concrete Surface Finish," for additional requirements for off-the-form finishes.

Provide commercial form liners for imprinting a pattern or texture on the concrete surface as shown on the plans and specified in TxDOT's Section 427.4.B.2.d, "Form Liner Finish."

Provide forming systems that are practically mortar-tight, rigidly braced, and strong enough to prevent bulging between supports, and maintain them to the proper line and grade during concrete placement. Maintain forms in a manner that prevents warping and shrinkage. Do not allow offsets at form joints to exceed 1/16 inch.

For forms to be left in place, use only material that is inert, non-biodegradable, and non-absorptive.

Attachment of forms or screed supports for bridge slabs to steel I beams or girders may be by welding subject to the following requirements:

- Do not weld to tension flanges or to areas indicated on the plans.
- Weld in accordance with Item 448, "Structural Field Welding."

Take into account:

- deflections due to cast-in-place slab concrete and railing shown in the dead load deflection diagram in the setting of slab forms,
- differential beam or girder deflections due to skew angles and the use of certain stay-in-place slab forming systems, and
- deflection of the forming system due to the wet concrete.

For bridge approach slabs, securely stake forms to line and grade and maintain in position. Rigidly attach inside forms for curbs to the outside forms.

Construct all forms to permit their removal without marring or damaging the concrete. Clean all forms and footing areas of any extraneous matter before placing concrete. Provide openings in forms if needed for the removal of laitance or foreign matter

Treat the facing of all forms with bond-breaking coating of composition that will not discolor or injuriously affect the concrete surface. Take care to prevent coating of the reinforcing steel.

Complete all preparatory work before requesting permission to place concrete.

If the forms show signs of bulging or sagging at any stage of the placement, cease placement and remove the portion of the concrete causing this condition immediately if necessary. Reset the forms and securely brace them against further movement before continuing the placement.

2. Timber Forms. Provide properly seasoned good-quality lumber that is free from imperfections that would affect its strength or impair the finished surface of the concrete. Provide timber or lumber that meets or exceeds the requirements for species and grade in the submitted formwork plans.

Maintain forms or form lumber that will be reused so that it stays clean and in good condition. Do not use any lumber that is split, warped, bulged, or marred or that has defects that will produce inferior work, and promptly remove such lumber from the work.

Provide form lining for all formed surfaces except:

- the inside of culvert barrels, inlets, manholes, and box girders;
- the bottom of bridge slabs between beams or girders;
- surfaces that are subsequently covered by backfill material or are completely enclosed; and
- any surface formed by a single finished board or by plywood.

Provide form lining of an approved type such as masonite or plywood. Do not provide thin membrane sheeting such as polyethylene sheets for form lining.

Use plywood at least ¾ inch thick. Place the grain of the face plies on plywood forms parallel to the span between the supporting studs or joists unless otherwise indicated on the submitted form drawings.

Use plywood for forming surfaces that remain exposed that meets the requirements for B-B Plyform Class I or Class II Exterior of the U.S. Department of Commerce Voluntary Product Standard PS 1.

Space studs and joists so that the facing form material remains in true alignment under the imposed loads.

Space wales closely enough to hold forms securely to the designated lines, scabbed at least 4 feet on each side of joints to provide continuity. Place a row of wales near the bottom of each placement.

Place facing material with parallel and square joints, securely fastened to supporting studs.

For surfaces exposed to view and receiving only an ordinary surface finish as defined in Section 307.4.M, "Ordinary Surface Finish," place forms with the form panels symmetrical (long dimensions set in the same direction). Make horizontal joints continuous.

Make molding for chamfer strips or other uses of materials of a grade that will not split when nailed and that can be maintained to a true line without warping. Dress wood molding on all faces. Unless otherwise shown on the plans, fill forms at all sharp corners and edges with triangular chamfer strips measuring 3/4 inch on the sides.

To hold forms in place, use metal form ties of an approved type or a satisfactory substitute of a type that permits ease of removal of the metal. Cut back wire ties at least ½ inch from the face of the concrete.

Use devices to hold metal ties in place that are able to develop the strength of the tie and adjust to allow for proper alignment.

Entirely remove metal and wooden spreaders that separate the forms as the concrete is being placed.

Provide adequate clean-out openings for narrow walls and other locations where access to the bottom of the forms is not readily attainable.

3. **Metal Forms.** Requirements for timber forms regarding design, mortar-tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse, and wetting also apply to metal forms except that metal forms do not require lining unless specifically noted on the plans.

   Use form metal thick enough to maintain the true shape without warping or bulging. Countersink all bolt and rivet heads on the facing sides. Design clamps, pins, or other connecting devices to hold the forms rigidly together and to allow removal without damage to the concrete. Use metal forms that present a smooth surface and that line up properly. Keep metal free from rust, grease, and other foreign materials.

4. **Form Supports for Overhang Slabs.** Form supports that transmit a horizontal force to a steel girder or beam or to a prestressed concrete beam are permitted provided a satisfactory structural analysis has been made of the effect on the girder or beam as indicated in the submitted formwork plans.

   When overhang brackets are used on prestressed concrete beam spans with slab overhangs not exceeding 3 feet 6 inches, use beam bracing as indicated in the plans. For spans with overhangs exceeding this amount, use additional support for the outside beams regardless of the type of beam used. Submit details of the proposed bracing system in accordance with Section 307.4.B, "Plans for Falsework and Forms."

   Punch or drill holes full size in the webs of steel members for support of overhang brackets, or torch-cut them to 1/4 inch under size and ream them full size. Do not burn the holes full size. Leave the holes open unless otherwise shown on the plans. Never fill the holes by welding.

E. Drains. Install and construct weep holes and roadway drains as shown on the plans.

F. Placing Reinforcement. Place reinforcement as provided in Item 301, "Reinforcing Steel." Do not weld reinforcing steel supports to I beams or girders or to reinforcing steel except where shown on the plans.

Place post-tensioning ducts in accordance with the approved prestressing details and in accordance with TxDOT's Item 426, "Prestressing." Keep ducts free of obstructions until all post-tensioning operations are complete.

G. Placing Concrete. Give the Engineer sufficient advance notice before placing concrete in any unit of the structure to permit the inspection of forms, reinforcing steel placement, and other preparations.

Follow the sequence of placing concrete shown on the plans or specified.

Do not place concrete when impending weather conditions would impair the quality of the finished work. If conditions of wind, humidity, and temperature are such that concrete cannot be placed without the potential for shrinkage cracking, place concrete in early morning or at night or adjust the placement schedule for more favorable weather. Consult the evaporation rate nomograph in the Portland Cement Association's Design and Control of Concrete Mixtures for shrinkage cracking potential. When mixing, placing, and finishing concrete in non-daylight hours, adequately illuminate the entire placement site as approved.

If changes in weather conditions require protective measures after work starts, furnish adequate shelter to protect the concrete against damage from rainfall or from freezing temperatures as outlined in this Item. Continue operations during rainfall only if approved. Use protective coverings for the material stockpiles. Cover aggregate stockpiles only to the extent necessary to control the moisture conditions in the aggregates.

Allow at least 1 curing day after the concrete has achieved initial set before placing strain on projecting reinforcement to prevent damage to the concrete.

1. **Placing Temperature.** Place concrete according to the following temperature limits for the classes of concrete defined in Section 300.4.A, "Classification and Mix Design":

   - Place Class C, F, H, K, or SS concrete only when its temperature at time of placement is between 50 and 95°F. Increase the minimum placement temperature to 60°F if ground-granulated blast furnace (GGBF) slag is used in the concrete.

   - When used in a bridge slab or in the top slab of a direct-traffic culvert, place Class CO, DC, or S concrete only when its temperature at the time of placement is between 50 and 85°F. Increase the minimum placement temperature to 60°F if GGBF slag is used in the concrete. The maximum temperature increases to 95°F if these classes are used for other applications.

   - Place Class A, B, and D concrete only when its temperature at the time of placement is greater than 50°F.

   - Place mass concrete, defined by Section 307.4.G.14, "Mass Placements," only when its temperature at the time of placement is between 50 and 75°F.

2. **Transporting Time.** Place concrete delivered in agitating trucks within 60 minutes after batching. Place concrete delivered in non-agitating equipment within 45 minutes after batching. Revise the concrete mix design as necessary for hot weather or other conditions that contribute to quick setting of the concrete. Submit for approval a plan to demonstrate that these time limitations can be extended while ensuring the concrete can be properly placed, consolidated, and finished without the use of additional water.

3. **Workability of Concrete.** Place concrete with a slump as specified in Section 300.4.A.5, "Slump." Concrete that exceeds the maximum slump will be rejected. Water may be added to the concrete before discharging any concrete from the truck to adjust for low slump provided that the maximum mix design water–cement ratio is not exceeded. After introduction of any additional water or chemical admixtures, mix concrete in accordance with Section 300.4.E, "Mixing and Delivering Concrete." Do not add water or chemical admixtures after any concrete has been discharged.

4. **Transporting Concrete.** Use a method and equipment capable of maintaining the rate of placement shown on the plans or required by this Item to transport concrete to the forms. Transport concrete by buckets, chutes, buggies, belt conveyors, pumps, or other methods.

   Protect concrete transported by conveyors from sun and wind to prevent loss of slump and workability. Shade or wrap with wet burlap pipes through which concrete is pumped as necessary to prevent loss of slump and workability.

Arrange and use chutes, troughs, conveyors, or pipes so that the concrete ingredients will not be separated. When necessary to prevent segregation, terminate such equipment in vertical downspouts. Extend open troughs and chutes, if necessary, down inside the forms or through holes left in the forms.

Keep all transporting equipment clean and free from hardened concrete coatings. Discharge water used for cleaning clear of the concrete.

5. **Preparation of Surfaces.** Thoroughly wet all forms, prestressed concrete panels, T beams, and concrete box beams on which concrete is to be placed before placing concrete on them. Remove any remaining puddles of excess water before placing concrete. Provide surfaces that are in a moist, saturated surface-dry condition when concrete is placed on them.

   Confirm that the subgrade or foundation is moist before placing concrete for bridge approach slabs or other concrete placed on grade. Lightly sprinkle the subgrade if dry.

6. **Expansion Joints.** Construct joints and devices to provide for expansion and contraction in accordance with plan details and the requirements of this Section and TxDOT's Item 454, "Bridge Expansion Joints."

   Prevent bridging of concrete or mortar around expansion joint material in bearings and expansion joints.

   Use forms adaptable to loosening or early removal in construction of all open joints and joints to be filled with expansion joint material. To avoid expansion or contraction damage to the adjacent concrete, loosen these forms as soon as possible after final concrete set to permit free movement of the span without requiring full form removal.

   When the plans show a Type A joint, provide preformed fiber joint material in the vertical joints of the roadway slab, curb, median, or sidewalk, and fill the top 1 inch with the specified joint sealing material unless noted otherwise. Install the sealer in accordance with TxDOT's Item 438, "Cleaning and Sealing Joints and Cracks (Rigid Pavement and Bridge Decks)," and the manufacturer's recommendations.

   Use light wire or nails to anchor any preformed fiber joint material to the concrete on 1 side of the joint.

   Confirm that finished joints conform to the plan details with the concrete sections completely separated by the specified opening or joint material.

   Remove all concrete within the joint opening soon after form removal and again where necessary after surface finishing to confirm full effectiveness of the expansion joint.

7. **Construction Joints.** A construction joint is the joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set. Monolithic placement means that the manner and sequence of concrete placing does not create a construction joint.

   Make construction joints of the type and at the locations shown on the plans. Do not make joints in bridge slabs not shown on the plans unless approved. Additional joints in

other members are not permitted without approval. Place authorized additional joints using details equivalent to those shown on the plans for joints in similar locations.

Unless otherwise required, make construction joints square and normal to the forms. Use bulkheads in the forms for all vertical joints.

Thoroughly roughen the top surface of a concrete placement terminating at a horizontal construction joint as soon as practical after initial set is attained.

Thoroughly clean the hardened concrete surface of all loose material, laitance, dirt, and foreign matter, and saturate it with water. Remove all free water and moisten the surface before concrete or bonding grout is placed against it.

Draw forms tight against the existing concrete to avoid mortar loss and offsets at joints.

Coat the joint surface with bonding mortar, grout, epoxy, or other material as indicated in the plans or other Items. Provide Type V epoxy per TxDOT's DMS-6100, "Epoxies and Adhesives," for bonding fresh concrete to hardened concrete. Place the bonding epoxy on a clean, dry surface, and place the fresh concrete while the epoxy is still tacky. Place bonding mortar or grout on a surface that is saturated surface-dry, and place the concrete before the bonding mortar or grout dries. Place other bonding agents in accordance with the manufacturer's recommendations.

8. **Handling and Placing.** Minimize segregation of the concrete and displacement of the reinforcement when handling and placing concrete. Produce a uniform dense compact mass.

   Do not allow concrete to free-fall more than 5 feet except in the case of drilled shafts, thin walls such as in culverts, or as allowed by other Items. Remove any hardened concrete splatter ahead of the plastic concrete.

   Fill each part of the forms by depositing concrete as near its final position as possible. Do not deposit large quantities at 1 point and run or work the concrete along the forms.

   Deposit concrete in the forms in layers of suitable depth but not more than 36 inches deep unless otherwise permitted.

   Avoid cold joints in a monolithic placement. Sequence successive layers or adjacent portions of concrete so that they can be vibrated into a homogeneous mass with the previously placed concrete before it sets. When re-vibration of the concrete is shown on the plans, allow at most 1 hour to elapse between adjacent or successive placements of concrete except as otherwise allowed by an approved placing procedure. This time limit may be extended by ½ hour if the concrete contains at least a normal dosage of retarding admixture.

   Use an approved retarding agent to control stress cracks and cold joints in placements where differential settlement and setting time may induce cracking.

9. **Consolidation.** Carefully consolidate concrete and flush mortar to the form surfaces with immersion type vibrators. Do not use vibrators that operate by attachment to forms or reinforcement except where approved on steel forms.

Vibrate the concrete immediately after deposit. Systematically space points of vibration to confirm complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. Insert the vibrator vertically where possible except for slabs where it may be inserted in a sloping or horizontal position. Vibrate the entire depth of each lift, allowing the vibrator to penetrate several inches into the preceding lift. Do not use the vibrator to move the concrete to other locations in the forms. Do not drag the vibrator through the concrete. Thoroughly consolidate concrete along construction joints by operating the vibrator along and close to but not against the joint surface. Continue the vibration until the concrete surrounding reinforcements and fixtures is completely consolidated. Hand-spade or rod the concrete if necessary to confirm flushing of mortar to the surface of all forms.

10. **Installation of Dowels and Anchor Bolts.** Install dowels and anchor bolts by casting them in-place or by grouting with grout, epoxy, or epoxy mortar unless noted otherwise. Form or drill holes for grouting.

    Drill holes for anchor bolts to accommodate the bolt embedment required by the plans. Make holes for dowels at least 12 inches deep unless otherwise shown on the plans. When using grout or epoxy mortar, make the diameter of the hole at least twice the dowel or bolt diameter, but the hole need not exceed the dowel or bolt diameter plus 1 1/2 inches. When using epoxy, make the hole diameter 1/16 to 1/4 inch greater than the dowel or bolt diameter.

    Thoroughly clean holes of all loose material, oil, grease, or other bond-breaking substance, and blow them clean with filtered compressed air. Confirm that holes are in a surface dry condition when epoxy type material is used and in a surface moist condition when hydraulic cement grout is used. Develop and demonstrate for approval a procedure for cleaning and preparing the holes for installation of the dowels and anchor bolts. Completely fill the void between the hole and dowel or bolt with grouting material. Follow exactly the requirements for cleaning outlined in the product specifications for prepackaged systems.

    For cast-in-place or grouted systems, provide hydraulic cement grout in accordance with Section 300.2.F, “Mortar and Grout,” epoxy, epoxy mortar, or other prepackaged grouts as approved. Provide a Type III epoxy per TxDOT’s DMS-6100, “Epoxies and Adhesives,” when neat epoxy is used for anchor bolts or dowels. Provide Type VIII epoxy per TxDOT’s DMS-6100 when an epoxy grout is used. Provide grout, epoxy, or epoxy mortar as the binding agent unless otherwise indicated on the plans.

    Provide other anchor systems as required in the plans.

11. **Placing Concrete in Cold Weather.** Protect concrete placed under weather conditions where weather may adversely affect results. Permission given by the Engineer for placing during cold weather does not relieve the Contractor of responsibility for producing concrete equal in quality to that placed under normal conditions. If concrete placed under poor conditions is unsatisfactory, remove and replace it as directed at Contractor’s expense.

    Do not place concrete in contact with any material coated with frost or having a temperature of 32°F or lower. Do not place concrete when the ambient temperature in the shade is below 40°F and falling unless approved. Concrete may be placed when the ambient temperature in the shade is 35°F and rising or above 40°F.

Provide and install recording thermometers, maturity meters, or other suitable temperature measuring devices to verify that all concrete is effectively protected as follows:

- Maintain the temperature of the top surface of bridge slabs and top slabs of direct-traffic culverts at 50°F or above for 72 hours from the time of placement and above 40°F for an additional 72 hours.

- Maintain the temperature at all surfaces of concrete in bents, piers, culvert walls, retaining walls, parapets, wingwalls, bottoms of bridge slab or culvert top slabs, and other similar formed concrete at 40°F or above for 72 hours from the time of placement.

- Maintain the temperature of all other concrete, including the bottom slabs (footings) of culverts, placed on or in the ground above 32°F for 72 hours from the time of placement.

Use additional covering, insulated forms, or other means and, if necessary, supplement the covering with artificial heating. Avoid applying heat directly to concrete surfaces. Cure as specified in Section 307.4.J, "Curing Concrete," during this period until all requirements for curing have been satisfied.

When impending weather conditions indicate the possible need for temperature protection, have on hand all necessary heating and covering material, ready for use, before permission is granted to begin placement.

12. **Placing Concrete in Hot Weather.** Use an approved retarding agent in all concrete for superstructures and top slabs of direct-traffic culverts, except concrete containing GGBF slag, when the temperature of the air is above 85°F unless otherwise directed.

    Keep the concrete at or below the maximum temperature at time of placement as specified in Section 307.4.G.1, "Placing Temperature." Sprinkle and shade aggregate stockpiles or use ice, liquid nitrogen systems, or other approved methods as necessary to control the concrete temperature.

13. **Placing Concrete in Water.** Deposit concrete in water only when shown on the plans or with approval. Make forms or cofferdams tight enough to prevent any water current passing through the space in which the concrete is being deposited. Do not pump water during the concrete placing or until the concrete has set for at least 36 hours.

    Place the concrete with a tremie or pump, or use another approved method, and do not allow it to fall freely through the water or disturb it after it is placed. Keep the concrete surface approximately level during placement.

    Support the tremie or operate the pump so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow. Submerge the lower end of the tremie or pump hose in the concrete at all times. Use continuous placing operations until the work is complete.

    For concrete to be placed under water, design the concrete mix in accordance with Item 300, "Concrete," with a minimum cement content of 650 pounds per cubic yard. Include

an anti-washout admixture in the mix design as necessary to produce a satisfactory finished product.

14. **Mass Placements.** Mass placements are defined as placements with a least dimension greater than or equal to 5 feet, or designated on the plans. For monolithic mass placements, develop and obtain approval for a plan to confirm the following during the heat dissipation period:

    - the temperature differential between the central core of the placement and the exposed concrete surface does not exceed 35°F and
    - the temperature at the central core of the placement does not exceed 160°F.

    Base this plan on the equations given in the Portland Cement Association's Design and Control of Concrete Mixtures. Cease all mass placement operations and revise the plan as necessary if either of the above limitations is exceeded.

    Include a combination of the following elements in this plan:

    - selection of concrete ingredients including aggregates, gradation, and cement types, to minimize heat of hydration;
    - use of ice or other concrete cooling ingredients;
    - use of liquid nitrogen dosing systems;
    - controlling rate or time of concrete placement;
    - use of insulation or supplemental external heat to control heat loss;
    - use of supplementary cementing materials; or
    - use of a cooling system to control the core temperature.

    Furnish and install 2 sets of temperature recording devices, maturity meters, or other approved equivalent devices at designated locations. Use these devices to simultaneously measure the temperature of the concrete at the core and the surface. Maintain temperature control methods for 4 days unless otherwise approved. Maturity meters may not be used to predict strength of mass concrete.

15. **Placing Concrete in Foundation and Substructure.** Do not place concrete in footings until the depth and character of the foundation has been inspected and permission has been given to proceed by the Engineer.

    Placing of concrete footings upon seal concrete is permitted after the cofferdams are free from water and the seal concrete cleaned. Perform any necessary pumping or bailing during the concreting from a suitable sump located outside the forms.

    Construct or adjust all temporary wales or braces inside cofferdams as the work proceeds to prevent unauthorized construction joints.

When footings can be placed in a dry excavation without the use of cofferdams, omit forms if approved, and fill the entire excavation with concrete to the elevation of the top of footing.

Place concrete in columns monolithically between construction joints unless otherwise directed. Columns and caps or tie beams supported on them may be placed in the same operation or separately. If placed in the same operation, allow for settlement and shrinkage of the column concrete by placing it to the lower level of the cap or tie beam, and delay placement between 1 and 2 hours before proceeding with the cap or tie beam placement.

16. **Placing Concrete in Box Culverts.** Where the top slab and walls are placed monolithically in culverts more than 4 feet in clear height, allow between 1 and 2 hours to elapse before placing the top slab to allow for settlement and shrinkage in the wall concrete.

    Accurately finish the footing slab at the proper time to provide a smooth uniform surface. Finish top slabs that carry direct-traffic as specified in this Item. Give top slabs of fill type culverts a float finish.

17. **Placing Concrete in Superstructure.** Unless otherwise shown on the plans, place simple span bridge slabs without transverse construction joints by using either a self-propelled transverse finishing machine or a mechanical longitudinal screed. For small placements or for unusual conditions such as narrow widening, variable cross slopes, or transitions, use of manually operated screeding equipment may be permitted. Support the screed adequately on a header or rail system stable enough to withstand the longitudinal or lateral thrust of the equipment. Adjust the profile grade line as necessary to account for variations in beam camber and other factors to obtain the required slab thickness and concrete cover over the slab reinforcement. Set beams and verify their surface elevations in a sufficient number of spans so that when adjustment is necessary, the profile grade line can be adjusted over suitable increments to produce a smooth riding surface. Take dead load deflection into account in setting the grades of headers and rail systems. Use construction joints, when required or permitted for slab placements on steel or prestressed concrete beams, as shown on the plans. Before placing concrete on steel girder or truss spans, release falsework under the spans and swing the spans free on their permanent supports.

    Make 1 or more passes with the screed over the bridge slab segment before placing concrete on it to confirm proper operation and maintenance of grades and clearances. Use an approved system of checking to detect any vertical movement of the forms or falsework. Maintain forms for the bottom surface of concrete slabs, girders, and overhangs to the required vertical alignment during concrete placing.

    Fog unformed surfaces of slab concrete in bridge slabs and in top slabs of direct-traffic culverts from the time of initial strikeoff of the concrete until finishing is completed and required interim curing is in place. Do not use fogging as a means to add finishing water, and do not work moisture from the fog spray into the fresh concrete.

    For simple spans, retard the concrete only if necessary to complete finishing operations or as required by this Section. When filling curb forms, bring the top of curb and sidewalk section to the correct camber and alignment, and finish them as described in this Item.

a. Transverse Screeding. Install rails for transverse finishing machines that are supported from the beams or girders so that the supports may be removed without damage to the slab. Prevent bonding between removable supports and the concrete in an acceptable manner. Do not allow rail support parts that remain embedded in the slab to project above the upper mat of reinforcing steel. Rail or screed supports attached to I beams or girders are subject to the requirements of this Item. Unless otherwise shown on the plans, for transverse screeding the minimum rate of concrete placement is 30 linear feet of bridge slab per hour. Deposit concrete parallel to the skew of the bridge so that all girders are loaded uniformly along their length. Deposit slab concrete between the exterior beam and the adjacent beam before placing concrete in the overhang portion of the slab. Furnish personnel and equipment capable of placing, finishing, and curing the slab at an acceptable rate to confirm compliance with the specifications. Place concrete in transverse strips. On profile grades greater than 1½%, start placement at the lowest end.

b. Longitudinal Screeding. Unless otherwise shown on the plans, use of temporary intermediate headers will be permitted for placements over 50 feet long if the rate of placement is rapid enough to prevent a cold joint and if these headers are designed for easy removal to permit satisfactory consolidation and finish of the concrete at their locations. Deposit slab concrete between the exterior beam and the adjacent beam before placing concrete in the overhang portion of the slab. Place concrete in longitudinal strips starting at a point in the center of the segment adjacent to 1 side except as this Section indicates, and complete the strip by placing uniformly in both directions toward the ends. For spans on a profile grade of 1½% or more, start placing at the lowest end. Use strips wide enough that the concrete within each strip remains plastic until placement of the adjacent strip. Where monolithic curb construction is specified, place the concrete in proper sequence to be monolithic with the adjacent longitudinal strips of the slabs.

c. Placements on Continuous Steel Units. Unless otherwise shown on the plans, place slabs on continuous steel units in a single continuous operation without transverse construction joints using a self-propelled transverse finishing machine or a mechanical longitudinal screed. Retard the initial set of the concrete sufficiently to confirm that concrete remains plastic in at least 3 spans immediately preceding the slab being placed. Use construction joints, when required for slab placements on steel beams or girders, as shown on the plans. When staged placement of a slab is required in the plans, confirm that the previously placed concrete attains a compressive strength of 3,000 psi before placing the next stage concrete. Multiple stages may be placed in a single day if approved. Where plans permit staged placing without specifying a particular order of placement, use an approved placing sequence that will not overstress of any of the supporting members.

d. Slab and Girder Units. Unless otherwise shown on the plans, place girders, slab, and curbs of slab and girder spans monolithically. Fill concrete girder stems first, and place the slab concrete within the time limits specified in this Item. If using a transverse screed, place concrete in the stems for a short distance and then place the concrete in transverse strips. If using a longitudinal screed, fill the outside girder stem first, beginning at the low end or side, and continue placement in longitudinal strips.

H. Treatment and Finishing of Horizontal Surfaces Other Than Bridge Slabs. Strike off to grade and finish all unformed upper surfaces. Do not use mortar topping for surfaces constructed under this Section.

After the concrete has been struck off, float the surface with a suitable float. Give bridge sidewalks a wood float or broom finish, or stripe them with a brush.

Slightly slope the tops of caps and piers between bearing areas from the center toward the edge, and slope the tops of abutment and transition bent caps from the backwall to the edge, as directed, so that water drains from the surface. Give the concrete a smooth trowel finish. Construct bearing areas for steel units in accordance with TxDOT's Section 441.3.K.5, "Bearing and Anchorage Devices." Give the bearing area under the expansion ends of concrete slabs and slab and girder spans a steel-trowel finish to the exact grades required. Give bearing areas under elastomeric bearing pads or nonreinforced bearing seat buildups a textured, wood float finish. Do not allow the bearing area to vary from a level plane more than 1/16 inch in all directions.

Cast bearing seat buildups or pedestals for concrete units integrally with the cap or with a construction joint. Provide a latex-based mortar, an epoxy mortar, or an approved proprietary bearing mortar for bearing seat buildups cast with a construction joint. Mix mortars in accordance with the manufacturer's recommendations. Construct pedestals of Class C concrete, reinforced as shown on the plans or as indicated in Figure 1 and Figure 2.

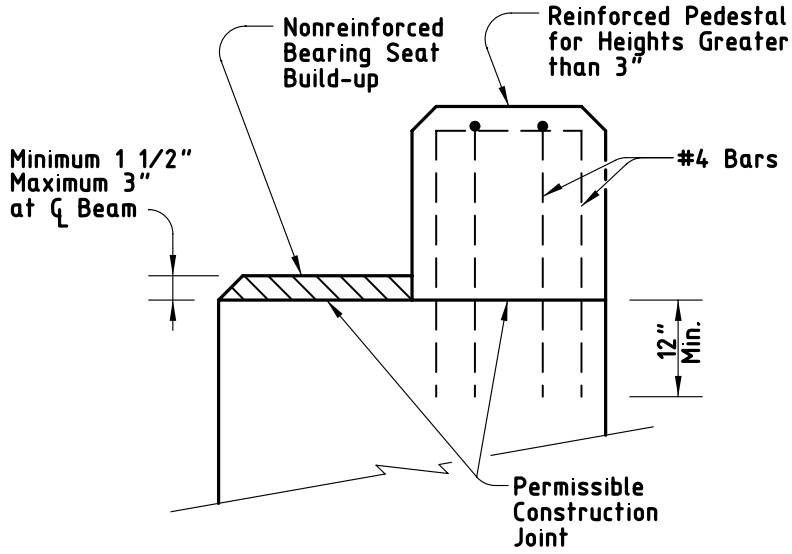


Figure 1
Section through bearing seat buildups.

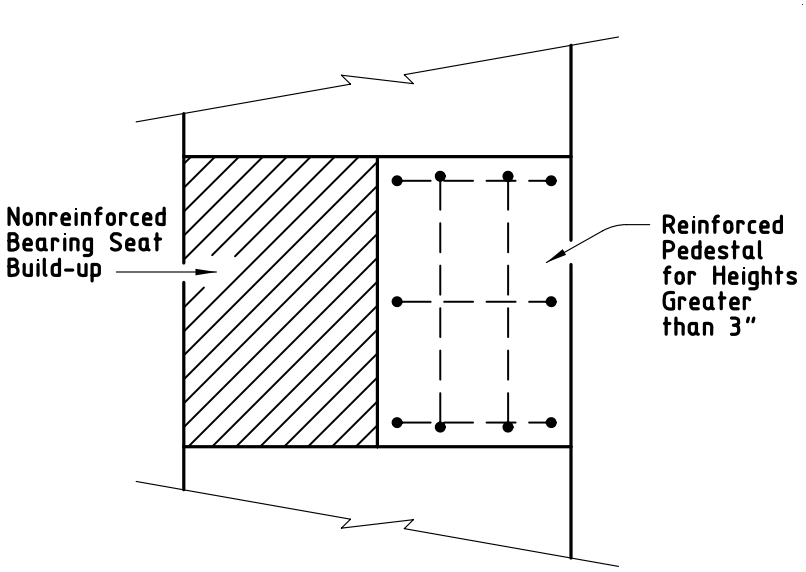


Figure 2
Plan view of bearing seat buildups.

I. Finish of Bridge Slabs. Provide camber for specified vertical curvature and transverse slopes.

For concrete flat slab and concrete slab and girder spans cast in place on falsework, provide additional camber to offset the initial and final deflections of the span as indicated in the plans. For concrete slab and girder spans using pan forms, provide camber of approximately 3/8 inch for 30 foot spans and 1/2 inch for 40 foot spans to offset initial and final deflections unless otherwise directed. For concrete flat slab and concrete slab and girder spans not using pan forms, when dead load deflection is not shown on the plans, provide a camber of 1/8 inch per 10 feet of span length but no more than 1/2 inch

Provide a camber of 1/4 inch in addition to deflection for slabs without vertical curvature on steel or prestressed concrete beams.

Use work bridges or other suitable facilities to perform all finishing operations and to provide access, if necessary, for the Engineer to check measurements for slab thickness and reinforcement cover.

As soon as the concrete has been placed and vibrated in a section wide enough to permit working, level, strike off, and screed the surface, carrying a slight excess of concrete ahead of the screed to fill all low spots.

Move longitudinal screeds across the concrete with a saw-like motion while their ends rest on headers or templates set true to the roadway grade or on the adjacent finished slab. Move transverse screeds longitudinally approximately 1/5 of the drum length for each complete out-and-back pass of the carriage.

Screed the surface of the concrete enough times and at intervals to produce a uniform surface true to grade and free of voids.

Work the screeded surface to a smooth finish with a long-handled wood or metal float or hand-float it from work bridges over the slab. Floating may not be necessary if the pan float attached to a transverse screed produces an acceptable finish. Avoid overworking the surface of the concrete. Avoid overuse of finish water.

Perform sufficient checks, witnessed by the Engineer, with a long-handled 16 foot straightedge on the plastic concrete to confirm that the final surface will be within specified tolerances. Make the check with the straightedge parallel to the centerline. Lap each pass half over the preceding pass. Remove all high spots, and fill and float all depressions over 1/16 inch deep with fresh concrete. Continue checking and floating until the surface is true to grade and free of depressions, high spots, voids, or rough spots. Fill screed-rail support holes with concrete, and finish them to match the top of the slab.

Finish the concrete surface to a uniform texture using a carpet drag, burlap drag, or broom finish. Finish the surface to a smooth sandy texture without blemishes, marks, or scratches deeper than 1/16 inch. Apply the surface texturing using a work bridge or platform immediately after completing the straightedge checks. Draw the carpet or burlap drag longitudinally along the concrete surface, adjusting the surface contact area or pressure to provide a satisfactory coarsely textured surface. A broom finish may be performed using a fine bristle broom transversely. For bridge approach slabs the carpet drag, burlap drag, or broom finish may be applied either longitudinally or transversely.

Coat the concrete surface immediately after the carpet or burlap drag, or broom finish with a single application of evaporation retardant at a rate recommended by the manufacturer. Do not allow more than 10 minutes to elapse between the texturing at any location and application of evaporation retardant. The evaporation retardant may be applied using the same work bridge used for surface texturing. Do not work the concrete surface once the evaporation retardant has been applied.

Apply interim and final curing in accordance with Section 307.4.J, “Curing Concrete.”

The Contractor is responsible for the ride quality of the finished bridge slab. The Engineer will use a 10 foot straightedge (1/8 inch in 10 feet) to verify ride quality and to determine locations where corrections are needed. If the Engineer determines that the ride quality is unacceptable, submit a plan for approval to produce a ride of acceptable quality. Make all corrections for ride before saw-cutting grooves.

Unless noted otherwise, saw-cut grooves in the hardened concrete of bridge slabs, bridge approach slabs, and direct-traffic culverts to produce the final texturing after completion of the required curing period. Cut grooves perpendicular to the structure centerline. Cut grooves continuously across the slab to within 18 inches of the barrier rail, curb, or median divider. At skewed metal expansion joints in bridge slabs, adjust groove cutting by using narrow-width cutting heads so that all grooves end within 6 inches of the joint, measured perpendicular to the centerline of the metal joint. Leave no ungrooved surface wider than 6 inches adjacent to either side of the joint. Confirm that the minimum distance to the first groove, measured perpendicular to the edge of the concrete joint or from the junction between the concrete and the metal leg of the joint, is 1 inch Cut grooves continuously across construction joints or other joints in the concrete that are less than 1/2 inch wide. Apply the same procedure described above where barrier rails, curbs, or median dividers are not parallel to the structure centerline to maintain the 18 inches maximum dimension from the end of the grooves to the gutter line. Cut grooves continuously across formed concrete joints.

When saw-cut grooves are not required in the plans, provide either a carpet drag or broom finish for micro-texture. In this case insure that an adequate and consistent micro-texture is achieved by applying sufficient weight to the carpet and keeping the carpet or broom from getting plugged with grout. For surfaces that do not have adequate texture, the Engineer may require corrective action including diamond grinding or shot blasting.

When the plans call for a concrete overlay to be placed on the slab (new construction) or on prestressed concrete box beams or other precast elements, give a carpet drag, burlap drag, or broom finish to all concrete surfaces to be overlaid. Saw-grooving is not required in this case. Provide an average texture depth for the finish of approximately 0.035 inch with no individual test falling below 0.020 inch, unless otherwise shown on the plans, when tested in accordance with TxDOT standard laboratory test procedure Tex-436 A. If the texture depth falls below what is intended, revise finishing procedures to produce the desired texture.

When the plans require an asphalt seal, with or without overlay, on the slab (new construction), on prestressed concrete box beams, or on other precast elements, give all concrete surfaces to be covered a lightly textured broom or carpet drag finish. Provide an average texture depth of approximately 0.025 inch when tested in accordance with TxDOT standard laboratory test procedure Tex-436-A.

J. Curing Concrete. Obtain approval of the proposed curing methods, equipment, and materials before placing concrete. The Engineer may require the same curing methods for like portions of a single structure. Inadequate curing or facilities may delay all concrete placement on the job until remedial action is taken.

A curing day is a calendar day when the temperature, taken in the shade away from artificial heat, is above 50°F for at least 19 hours or, on colder days if the temperature of all surfaces of the concrete is maintained above 40°F, for the entire 24 hours. The required curing period begins when all concrete has attained its initial set. TxDOT standard laboratory test procedure Tex-440-A may be used to determine when the concrete has attained its initial set.

Cure all concrete for 4 consecutive days except as noted in Table 1.

Table 1
Exceptions to 4-Day Curing

Description	Type of Cement	Required Curing Days
Upper surfaces of bridge slabs, top slab of direct-traffic culverts, and concrete overlays	I or III	8
	II or I/II	10
	All types with supplementary cementing materials	10
Concrete piling buildups	All	6

For upper surfaces of bridge slabs, bridge approach slabs, median and sidewalk slabs, and culvert top slabs constructed using Class S concrete, apply interim curing using a Type 1-D curing compound before the water sheen disappears but no more than 45 minutes after application of the evaporation retardant. Do not allow the concrete surface to dry before applying the interim cure, and do not place the interim cure over standing water. Apply membrane interim curing using a work bridge or other approved apparatus to confirm a uniform application. Water-cure for final curing in accordance with this Section, starting as soon as possible without damaging the surface finish. Maintain the water curing for the duration noted in Table 1. Place polyethylene sheeting, burlap-polyethylene blankets,

laminated mats, or insulating curing mats in direct contact with the slab when the air temperature is expected to drop below 40°F during the first 72 hours of the curing period. Weigh down these curing materials with dry mats to maintain direct contact with the concrete and to provide insulation against cold weather. Supplemental heating or insulation may be required in cold and wet weather if the insulating cotton mats become wet or if the concrete drops below the specified curing temperature. Avoid applying heat directly to concrete surfaces.

For the top surface of any concrete unit upon which concrete is to be placed and bonded at a later interval (stub walls, risers, etc.) and other superstructure concrete (curbs, wingwalls, parapet walls, etc.), use only water curing in accordance with this Section.

Cure all other concrete as specified in the pertinent Items. Use the following methods for curing concrete, subject to the requirements of this Item.

1. **Form Curing.** When forms are left in intimate contact with the concrete, other curing methods are not required except for exposed surfaces and for cold weather protection. If forms are removed before the 4 day required curing period, use another approved curing method.

2. **Water Curing.** Keep all exposed surfaces of the concrete wet continuously for the required curing time. Use water curing that meets the requirements for concrete mixing water in Section 300.2.D, "Water." Do not use seawater or water that stains or leaves an unsightly residue.

    a. **Wet Mats.** Keep the concrete continuously wet by maintaining wet cotton mats in direct contact with the concrete for the required curing time. If needed, place damp burlap blankets made from 9 ounce stock on the damp concrete surface for temporary protection before applying cotton mats. Then place the dry mats and wet them immediately after they are placed. Weight the mats adequately to provide continuous contact with all concrete. Cover surfaces that cannot be cured by direct contact with mats, forming an enclosure well anchored to the forms or ground so that outside air cannot enter the enclosure. Provide sufficient moisture inside the enclosure to keep all surfaces of the concrete wet.

    b. **Water Spray.** Overlap sprays or sprinklers to keep all unformed surfaces continuously wet.

    c. **Ponding.** Cover the surfaces with at least 2 inches of clean granular material, kept wet at all times, or at least 1 inch deep water. Use a dam to retain the water or saturated granular material.

3. **Membrane Curing.** Unless otherwise shown on the plans, choose either Type 1-D or Type 2 membrane-curing compound when membrane curing is permitted. Type 1-D (Resin Base Only) is required for interim curing bridge slabs and top slabs of direct-traffic culverts and all other surfaces that require a higher grade of surface finish. For substructure concrete provide only 1 type of curing compound on any 1 structure.

    Apply membrane curing just after free moisture has disappeared at a rate of approximately 180 square feet per gallon. Do not spray curing compound on projecting reinforcing steel or concrete that will later form a construction joint. Do not apply

membrane curing to dry surfaces. Dampen formed surfaces and surfaces that have been given a first rub so that they are moist at the time of application of the membrane.

When membrane is used for complete curing, leave the film unbroken for the minimum curing period specified. Correct damaged membrane immediately by reapplication of membrane. Polyethylene sheeting, burlap-polyethylene mats, or laminated mats in close contact with the concrete surfaces are equivalent to membrane curing.

K. Removal of Forms and Falsework. Unless otherwise directed, forms for vertical surfaces may be removed after the concrete has aged 12 hours after initial set provided the removal can be done without damage to the concrete. Keep forms for mass placements, defined in Section 307.4.G.14, "Mass Placements," in place for 4 days following concrete placement.

Remove forms for inside curb faces and for bridge rails whenever removal can be done without damage to the curb or railing.

Leave in place weight-supporting forms and falsework spanning more than 1 foot for all bridge components and culvert slabs except as directed otherwise until the concrete has attained a compressive strength of 2,500 psi. Remove forms for other structural components as necessary.

Remove inside forms (walls and top slabs) for box culverts and sewers after concrete has attained a compressive strength of 1,800 psi if an approved overhead support system is used to transfer the weight of the top slab to the walls of the box culvert or sewer before removal of the support provided by the forms.

Forms or parts of forms may be removed only if constructed to permit removal without disturbing forms or falsework required to be left in place for a longer period on other portions of the structure.

Remove all metal appliances used inside forms for alignment to a depth of at least 1/2 inch from the concrete surface. Make the appliances so that metal may be removed without undue chipping or spalling of the concrete, and so that it leaves a smooth opening in the concrete surface when removed. Do not burn off rods, bolts, or ties.

Remove all forms and falsework unless otherwise directed.

L. Defective Work. Repair defective work as soon as possible. Remove and replace at the expense of the Contractor any defect that cannot be repaired to the satisfaction of the Engineer.

M. Ordinary Surface Finish. Apply an ordinary surface finish to all concrete surfaces as follows:

- Chip away all loose or broken material to sound concrete where porous, spalled, or honeycombed areas are visible after form removal.

- Repair spalls by saw-cutting and chipping at least 1/2 inch deep, perpendicular to the surface to eliminate feather edges. Repair shallow cavities using a latex adhesive grout, cement mortar, or epoxy mortar as approved. Repair large areas using concrete as directed or approved.

- Clean and fill holes or spalls caused by the removal of form ties, etc., with latex grout, cement grout, or epoxy grout as approved. Fill only the holes. Do not blend the patch with the surrounding concrete. On surfaces to receive a rub finish in accordance with Item 311, "Concrete Surface Finish," chip out exposed parts of metals chairs to a depth of 1/2 inch and repair the surface.

- Remove all fins, runs, drips, or mortar from surfaces that will be exposed. Smooth all form marks and chamfer edges by grinding or dry-rubbing.

- Confirm that all repairs are dense, well bonded, and properly cured. Finish exposed large repairs to blend with the surrounding concrete where a higher class of finish is not specified.

Unless noted otherwise, apply an ordinary surface finish as the final finish to the following exposed surfaces:

- inside and top of inlets,

- inside and top of manholes,

- inside of sewer appurtenances,

- inside of culvert barrels,

- bottom of bridge slabs between girders or beams, and

- vertical and bottom surfaces of interior concrete beams or girders.

Form marks and chamfer edges do not need to be smoothed for the inside of culvert barrels and the bottom of bridge slabs between girders or beams.

307.5. MEASUREMENT: This Item will be measured by the cubic yard, square yard, foot, square foot, or by each structure.

A. General. Concrete quantities will be based on the dimensions shown on the plans or those established in writing by the Engineer.

In determining quantities, no deductions will be made for chamfers less than 2 inches or for embedded portions of steel or prestressed concrete beams, piling, anchor bolts, reinforcing steel, drains, weep holes, junction boxes, electrical or telephone conduit, ducts and voids for prestressed tendons, or embedded portions of light fixtures.

For slab and girder spans using pan forms, a quantity will be included for the screed setting required to provide proper camber in the roadway surface after form removal.

For slabs on steel or prestressed concrete beams, an estimated quantity for the haunch between the slab and beams will be included. No measurement will be made during construction for variation in the amount of haunch concrete due to variations in camber of the beams.

For cast-in-place slabs on slab beams, double T beams, or box beams, the combination of span length, theoretical camber in beams, computed deflections, and plan vertical curve will be taken into account in determining the quantity for the slab.

Additional concrete that may be required by an adjustment of the profile grade line during construction, to insure proper slab thickness, will not be measured for payment.

Variation in concrete headwall quantity incurred when an alternate bid for pipe is permitted will not be cause for payment adjustment.

Mass placements may be either a plans quantity item or measured in place as indicated.

Quantities revised by a change in design, measured as specified, will be increased or decreased and included for payment.

B. Plans Quantity. Structure elements designated in Table 2 and measured by the cubic yard are plans quantity measurement items. The quantity to be paid for plans quantity items is the quantity shown in the proposal unless modified by TxDOT's Article 9.2, "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

No adjustment will be made for footings or other in-ground elements where the Contractor has been allowed to place concrete in an excavation without forms.

Table 2
Plans Quantity Payment
(Cubic Yard Measurement Only)

Culverts and culvert wing walls	Abutments
Headwalls for pipe	Slab and girder spans (pan form)
Retaining walls	Footings
Inlets and manholes	Pile bent caps
Shear key concrete for box and slab beams	Concrete wearing surface on pre-cast box beams, slab beams or double-T beams
Bridge approach slabs	Cast-in-place concrete slab spans

Note: Other structure elements, including pier and bent concrete, may be paid for as "plans quantity" when shown on the plans.

C. Measured in Place. Items not paid for as "plans quantity" will be measured in place.

307.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the various structure elements specified of the various classes of concrete. Mass placements, as defined in Section 307.4.G.14, "Mass Placements," will be paid for separately for the various classes of concrete. This price is full compensation for furnishing, hauling, and mixing concrete materials; furnishing, bending, fabricating, splicing, welding and placing the required reinforcement; clips, blocks, metal spacers, ties, wire, or other materials used for fastening reinforcement in place; placing, finishing, curing, and grooving concrete; applying ordinary surface finish; furnishing and placing drains, metal flashing strips, and expansion-joint material; excavation, subgrade preparation, and disposal of excavated material for bridge approach slabs; and forms and falsework, equipment, labor, tools, and incidentals.

Diaphragm concrete will not be paid for directly but is subsidiary to the slab unless otherwise shown on the plans.

Design and installation of foundations for falsework is at the Contractor's expense.

The following procedure will be used to evaluate concrete where 1 or more project acceptance test specimens fail to meet the required design strength specified in Item 300, "Concrete," or in the plans:

- The concrete for a given placement will be considered structurally adequate and accepted at full price if the average of all test results for specimens made at the time of placement meets the required design strength provided that no single test result is less than 85% of the required design strength.

- The Engineer will perform a structural review of the concrete to determine its adequacy to remain in service if the average of all test results for specimens made at the time of placement is less than the required design strength or if any test results are less than 85% of the required design strength. If cores are required to determine the strength of the in-situ concrete, take cores at locations designated by the Engineer in accordance with TxDOT standard laboratory test procedure Tex-424-A. The coring and testing of the cores will be at the Contractor's expense. The Engineer will test the cores.

- If all of the tested cores meet the required design strength, the concrete will be paid for at the full price.

- If any of the tested cores do not meet the required design strength but the average strength attained is determined to be structurally adequate, the Engineer will determine the limits of the pay adjustment. The average strength of the cores tested will be used in the pay adjustment formula.

- Remove concrete that is not structurally adequate.

- Concrete that has been determined to be structurally adequate may be accepted at an adjusted price based on the following formula:

  $A = B_p[-5.37(S_a/S_s)^2 + 11.69(S_a/S_s) - 5.32]$

  Where:

  A = Amount to be paid

  S_a = Actual strength from cylinders or cores

  S_s = Specified design strength

  B_p = Unit bid price

- The decision to reject structurally inadequate concrete or to apply the pay adjustment will be made no later than 56 days after placement.

307.7. BID ITEM:

Item 307.1 - Concrete Structure - per cubic yard

Item 307.2 - Concrete Structure - per square yard

Item 307.3 - Concrete Structure - per foot

Item 307.4 - Concrete Structure - per square foot

Item 307.5 - Concrete Structure - per each structure

ITEM

308 DRILLED SHAFTS AND UNDER-REAMED FOUNDATIONS

308.1. DESCRIPTION: *This item shall govern for the construction of foundations consisting of reinforced concrete shafts with or without bell type concrete footings. Concrete shafts shall be placed in drilled excavation when the shafts are without bell type footings and in drilled and under-reamed excavation when shafts are with bell type footings. Such foundations shall be constructed in conformance with the details and governing dimensions shown on the plans.*

TEST HOLE INFORMATION: Logs of test holes dug at the sites are shown in the plans. Test holes have been shown for the purpose of establishing bottom of drilled shaft foundations and determining elevation of ground water, or other soil characteristics, and shall in no way guarantee, either explicit or implied, the actual soil condition encountered at each particular drilled shaft location. The Engineer reserves the right to either lengthen or shorten the depth of drilled shaft shown on the plans, due to actual soil conditions encountered in the field.

308.2. MATERIALS: Provide materials that meet the requirements as shown below:

A. Concrete. All concrete shall conform to the provisions of Item 300, "Concrete."

Unless otherwise shown on the plans, use concrete for drilled shafts that meets the requirements of Table 1.

Table 1
Concrete for Drilled Shafts

Drilled Shaft Type	Concrete
Non-reinforced	Class A
Reinforced	Class C
Slurry and underwater concrete placement	Class SS

Use coarse aggregate Grade 4, 5, or 6 for drilled shaft concrete in reinforced drilled shafts. Grade 2 or 3 may be used if the shaft is dry and reinforcing steel has a 5-in. minimum clear spacing. Use a water-reducing, retarding admixture in accordance with TxDOT DMS-4640, "Chemical Admixtures for Concrete," in all concrete when using casing that will be pulled or when placing shafts underwater or under slurry.

Use concrete with slump that meets the requirements of Table 2 as determined by TxDOT Test Method Tex-415-A.

Table 2
Slump Requirements

Placement Type	Minimum Acceptable Placement Slump, in.	Recommended Design and Placement Slump, in.	Maximum Acceptable Placement Slump, in.
Dry	5½	6½	7½
Under water and under slurry	7	8	9

When casing is to be pulled or when concrete is to be placed underwater or under slurry, perform a slump loss test in accordance with TxDOT Test Method Tex-430-A before beginning work. Provide concrete that will maintain a slump of at least 4 in. throughout the

entire anticipated time of concrete placement. Time of concrete placement is described in Sections 308.3.F, "Concrete," and 308.3.G, "Additional Requirements for Slurry Displacement or Underwater Concrete Placement Methods." Note the temperature of the concrete mix at the beginning of the slump loss test. If concrete temperature at the time of placement into the drilled shaft is more than 10° higher than the slump loss test temperature, do not place the concrete. Use ice or other concrete cooling ingredients to lower concrete temperature, or run additional slump loss tests at the higher temperatures. Slump loss testing will be waived if anticipated time of concrete placement is less than 90 minutes.

B. Slurry for Drilling. Use drilling slurry that meets the requirements of Table 3, as determined by Tex-130-E.

Table 3
Slurry Requirements

Before Introduction into the Excavation		Sampled from the Bottom of the Excavation before Concreting		
Specific Gravity	**Sand Content**	**Specific Gravity**	**Viscosity (seconds)**	**Sand Content**
≤ 1.10	≤ 1%	≤ 1.15	≤ 45	≤ 6%

Use mineral slurry consisting of processed bentonite or attapulgite clays mixed with clean fresh water. Do not use PHPA (partially hydrolyzed polyacrylamide) polymeric slurry or any other fluid composed primarily of a polymer solution.

Before placing concrete, sample slurry from the bottom of the hole, and test it in accordance with Tex-130-E. Use a pump or air lift to remove slurry that does not meet the requirements of Table 3 while adding fresh clean slurry to the top of the hole to maintain the slurry level. Continue this operation until the slurry sampled from the bottom of the hole meets the requirements.

C. Reinforcing Steel. All reinforcing steel shall conform to the provisions of Item 301, "Reinforcing Steel."

D. Welds. All field welds shall conform to Texas Department of Transportation Standard Specification Item 448, "Structural Field Welding."

308.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

308.4. CONSTRUCTION: Place the shaft to within the following tolerances.

- Vertical plumbness - 1 in. per 10 ft. of depth.
- Center of shaft located under column - 1 in. of horizontal plan position.
- Center of shaft located under footing - 3 in. of horizontal plan position.

Complete the embankment at bridge ends before installing drilled shafts that pass through the fill. Refer to Texas Department of Transportation Standard Specification Item 423, "Retaining Walls," for provisions for drilled shafts passing through the structural volume of retaining walls.

A. Excavation. The plans indicate the expected depths and elevations for encountering satisfactory bearing material. Excavate as required for the shafts and bell footings through all materials encountered to the dimensions and elevations shown on the plans or required by the

site conditions. Removal of man-made obstructions not shown on the plans will be paid for in accordance with Item 306, "Structural Excavation."

If satisfactory founding material is not encountered at plan elevation, adjust the bottom of the shaft or alter the foundation, as determined by the Engineer, to satisfactorily comply with design requirements. Blasting is not allowed for excavations.

If caving conditions are encountered, stop drilling and adopt a construction method that stabilizes the shaft walls. Do not excavate a shaft within 2 shaft diameters (clear) of an open shaft excavation, or one in which concrete has been placed in the preceding 24 hours.

Dispose of material excavated from shafts and bells and not incorporated into the finished project. Dispose of excavated material in accordance with the plans and with federal, state, and local laws.

Provide suitable access, lighting, and equipment for proper inspection of the completed excavation and for checking the dimensions and alignment of shafts and bell excavation.

B. Core Holes. If directed, take cores to determine the character of the supporting materials. Use a method that will result in recovery of an intact sample adequate for judging the character of the founding material. Such cores should be at least 5 ft. deeper than the proposed founding grade or a depth equal to the diameter of the shaft, whichever is greater. Take these cores when the excavation is approximately complete.

C. Casing. Use casing when necessary to prevent caving of the material or to exclude ground water. Provide casing with an outside diameter not less than the specified diameter of the shaft. Use casing strong enough to withstand handling stresses and pressures of concrete and of the surrounding earth or water, and that is watertight, smooth, clean, and free of accumulations of hardened concrete.

Drill the portion of the shaft below the casing as close as possible to the specified shaft diameter. The portion of shaft below the casing may be as much as 2 in. smaller than the specified shaft diameter.

Use construction methods that result in a minimal amount of disturbed soil being trapped outside the casing. This does not apply to temporary undersized casings used to protect workers inside shafts or to drilled shafts designed for point bearing only. Do not leave any casing in place unless authorized or shown on the plans.

Do not extract casing until after placing the concrete to an appropriate level. Maintain sufficient concrete in the casing at all times to counteract soil and water pressure. Before and during concrete placement, rotate or move the casing up or down a few inches if necessary to facilitate extraction of the casing.

D. Requirements for Slurry Displacement Method. Unless otherwise shown on the plans, the slurry displacement method may be used to construct drilled shafts. Use this method to support the sides of the excavation with processed mineral slurry that is then displaced by concrete to form a continuous concrete shaft.

Do not use casing other than surface casing. Do not use surface casing longer than 20 ft. without approval. Do not extract the surface casing until after placing the concrete.

For slurry mixed at the project site, pre-mix it in a reservoir of sufficient capacity to fill the excavation and for recovery of the slurry during concrete placement. Do not mix slurry in the shaft excavation or other hole. Allow adequate time for hydration of the slurry prior to introduction into the excavation.

During and after drilling maintain a head of slurry in the shaft excavation at or near ground level or higher as necessary to counteract ground water pressure.

Just before placing reinforcing steel, use an air lift or proper size cleanout bucket to remove any material that may have fallen from the sides of the excavation or accumulated on the bottom after the completion of drilling. Use a cleanout bucket if material is too large to be picked up with an air lift.

If concrete placement is not started within 4 hours of the completion of the shaft excavation, reprocess the hole with the auger as directed. Then clean the bottom with an air lift or cleanout bucket, and check the slurry at the bottom of the hole for compliance with the slurry requirements of Article 416.2, "Materials."

If the slurry forms a gel before concrete placement, agitate the congealed slurry to liquefaction just before concrete placement and whenever directed.

Recover and dispose of all slurry as approved by the Engineer, and in accordance with all federal, state, and local laws. Do not discharge slurry into or in close proximity to streams or other bodies of water.

E. Reinforcing Steel. Completely assemble the cage of reinforcing steel, and place it as a unit immediately before concrete placement. The cage consists of longitudinal bars and lateral reinforcement (spiral reinforcement, lateral ties, or horizontal bands). If overhead obstacles prevent placement of the cage as a single unit, connect individual segments with couplers or by lapping steel as approved.

If the shaft is lengthened beyond plan length, extend the reinforcing steel cage as follows, unless directed otherwise:

- For shafts supporting structures other than bridges, extend the cage to the bottom.
- For bridge shafts with plan lengths of less than 25 ft., extend the cage to 25 ft. or to the bottom, whichever is shorter.
- For bridge shafts with plan lengths at least 25 ft. that are lengthened less than 33% of plan length, extending the cage is not necessary.
- For bridge shafts with plan lengths at least 25 ft. that are lengthened more than 33% of plan length, extend the cage as directed.

If the cage does not reach the bottom of the shaft, it may be suspended, or a portion of the longitudinal steel may be extended to support the cage on the bottom of the shaft. Bars used to extend or support the cage may be lap spliced or welded by a qualified welder. Place the extension at the bottom of the shaft.

If using spiral reinforcement, tie it to the longitudinal bars at a spacing of at most 24 in., or as required for a stable cage. Do not weld lateral reinforcement to longitudinal bars unless otherwise shown on the plans.

Center the reinforcing steel cage in the excavation using approved centering devices. Use enough devices to hold the cage in position along its entire length. Do not use square concrete spacer blocks in cased shafts.

Support or hold down the cage to control vertical displacement during concrete placement or extraction of the casing. Use support that is concentric with the cage to prevent racking and distortion of the steel.

Check the elevation of the top of the steel cage before and after concrete placement or after casing extraction when casing is used. Downward movement of the steel up to 6 in. per 20 ft. of shaft length and upward movement of the steel up to 6 in. total are acceptable.

Maintain the minimum length of steel required for lap with column steel. Use dowel bars if the proper lap length is provided both into the shaft and into the column.

Locate and tie all dowel bars into the cage before placing concrete or insert dowel bars into fresh, workable concrete. Locate and tie anchor bolts when required prior to placement of concrete. Use templates or other devices to assure accurate placement of anchor bolts.

F. Concrete. Perform all work in accordance with requirements of Item 307, "Concrete Structures." Mass concrete placement requirements do not apply to drilled shafts.

Form portions of drilled shaft that project above natural ground.

Remove loose material and accumulated seep water from the bottom of the excavation before placing concrete. If water cannot be removed, place concrete using underwater placement methods.

Place concrete as soon as possible after all excavation is complete and reinforcing steel is placed. Provide workable concrete that does not require vibrating or rodding. Vibrate formed portions of drilled shafts.

Place concrete continuously for the entire length of the shaft. For dry shafts of 24 in. or smaller diameter, limit free fall of concrete to 25 ft. Use a suitable tube or tremie to prevent segregation of materials. Use a tube or tremie in sections to provide proper discharge and to permit raising as the placement progresses. For dry shafts over 24 in. diameter, concrete can be allowed to free fall an unlimited distance if it does not strike the reinforcing cage or sides of the hole during placement. When free fall is used, provide a hopper with a minimum 3-ft.-long drop tube at the top of the shaft to direct concrete vertically down the center of the shaft. Do not use a shovel or other means to simply deflect the concrete discharge from the truck.

For cased shafts, maintain a sufficient head of concrete at all times above the bottom of the casing to overcome hydrostatic pressure. Extract casing at a slow, uniform rate with the pull in line with the axis of the shaft. Monitor the concrete level in the casing during extraction. Stop the extraction and add concrete to the casing as required to ensure a completely full hole upon casing removal. The elapsed time from the mixing of the first concrete placed into the cased portion of the shaft until the completion of extraction of the casing must not exceed the time for which the concrete maintains a slump of over 4 in. in accordance with Article 308.2, "Materials." If the elapsed time is exceeded, modify the concrete mix, the construction procedures, or both for subsequent shafts.

Cure the top surface and treat any construction joint area in accordance with Item 307, "Concrete Structures."

G. Additional Requirements for Slurry Displacement or Underwater Concrete Placement Methods. Place concrete on the same day that the shaft is excavated and as soon as possible after all excavation is complete and reinforcing steel is placed. Use an air lift or cleanout bucket of the proper size to clean the bottom of the excavation prior to placing the reinforcing steel cage and concrete. Place concrete through a closed tremie or pump it to the bottom of the excavation. Initially seal the tremie or pump line to positively separate the concrete from the slurry or water. Place concrete continuously from the beginning of placement until the shaft is completed. If using a tremie, keep it full of concrete and well submerged in the previously placed concrete at all times. Raise the tremie as necessary to maintain the free flow of concrete and the stability of any casing used. If using a pump, keep the discharge tube submerged in the previously placed concrete at all times. Place additional concrete to ensure the removal of any contaminated concrete at the top of the shaft. At the completion of the pour, allow the top portion of concrete to flush completely from the hole until there is no evidence of slurry or water contamination. Do not attempt to remove this concrete with shovels, pumps or other means. Level the top of shaft with hand tools as necessary.

Use a sump or other approved method to channel displaced fluid and concrete away from the shaft excavation. Recover slurry and dispose of it as approved. Do not discharge displaced fluids into or in close proximity to streams or other bodies of water. For pours over water, provide a collar or other means of capturing slurry and the top portion of concrete flushed from the shaft.

If concrete placement is interrupted due to withdrawal of the submerged end of the tremie or pump discharge tube before completion, remove the tube, reseal it at the bottom, penetrate with the tube into the concrete already placed by at least 5 ft., and recharge it before continuing.

The elapsed time from the mixing of the first concrete placed until the completion of concrete placement, including extraction of the casing, must not exceed the time for which the concrete maintains a slump of over 4 in. in accordance with Article 416.2, "Materials." If the elapsed time is exceeded, modify the concrete mix, the construction procedures, or both for subsequent shafts.

H. Test Load. If required, test load shafts in accordance with TxDOT Standard Specification Item 405, "Foundation Test Load."

308.5. MEASUREMENT: Measurement shall be completed as follows:

A. Drilled Shaft. The drilled shaft of the specified diameter, in place in accordance with these specifications, complete and accepted, will be measured by the linear foot of acceptable shaft in place, between the bottom of the footing and the top of the shaft as indicated by the details shown on the plans.

B. Bell Footings. Bell Footings, in place in accordance with these specifications, complete and accepted, will be measured by the cubic yard of concrete. The bell shall be deemed to consist of the footing volume outside of the volume of the drilled shaft which, for purposes of measurement, is considered as extending to the bottom of the bell.

308.6. PAYMENT: Payment for drilled shafts and bell footings shall be at the unit price bid per linear foot for the specified diameter of "Drilled Shafts," and at the unit price bid per cubic yard for "Bell Footings," each measured as specified under "Measurement" and such unit prices shall be full compensation for making all excavations, doing any necessary pumping, placing and removing any required casing, furnishing and placing all-concrete and reinforcing steel, all backfilling, and furnishing all tools, labor, equipment and incidentals necessary to complete the work.

No extra payment will be made for casings left in place.

Where the bottom of the drilled shaft is ordered to be placed at an elevation below plan grade and a splice of reinforcement is required, payment will be made at the unit price bid per pound for Item 301, "Reinforcing Steel" for the extra reinforcement required to make one lap splice per bar of a length determined by the Engineer. The splice required above the top of the drilled shaft shall be considered as included in the unit price bid for drilled shafts.

No partial estimates will be allowed for "Bell Footings" or for "Drilled Shafts" until the concrete has been placed.

308.7. BID ITEM:

Item 308.1 - Drilled Shafts - per linear foot

Item 308.2 - Bell Footing - per cubic yard

ITEM

309 PRECAST REINFORCED CONCRETE BOX CULVERTS

309.1. DESCRIPTION: *This item shall govern for the fabrication and placing of precast reinforced concrete box culverts. The boxes shall be placed in accordance with the lines and grades shown on the plans and as staked in the field.*

309.2. MATERIALS: Materials shall conform to the following:

A. Precast Reinforced Concrete Box Culverts. Precast Reinforced Concrete Box Culverts shall be fabricated in accordance with one of the following design criteria:

1. ASTM Designation C 1433 per Texas Department of Transportation Item 462.

2. Texas Department of Transportation Item 424, "Precast Concrete Structures (Fabrication)."

3. Precast Design prepared by Registered Professional Engineer. Design plans covering the structural requirements of the precast section shall be prepared, signed and sealed by a Registered Professional Engineer. The precast box design shall be made at the Contractor's expense and must be approved by the Engineer.

B. Joint Material. Joint material for precast reinforced concrete box culverts of all kinds shall meet the requirements for cold applied, plastic asphalt sewer joint compound or cold applied pre-formed plastic gaskets as specified in Item 401, "Storm Drainage Pipe."

C. Bedding. Under any and all ground conditions encountered, clean gravel subgrade filler in conformance with Item 410, "Subgrade Filler" shall be used as bedding material.

D. Lifting Holes. For precast boxes, provide no more than 4 lifting holes in each section. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes of sufficient size for adequate lifting devices based on the size and weight of the box section. Do not use lifting holes larger than 3 in. in diameter. Do not cut more than 1 longitudinal wire or 2 circumferential wires per layer of reinforcing steel when locating lift holes. Repair spalled areas around lifting holes.

E. Marking. Mark precast boxes with the following:

- name or trademark of the producer;
- date of manufacture;
- box size;
- minimum and maximum fill heights; and
- match marks for proper installation, when required, under Section 309.2.F, "Tolerances."

For boxes without lifting holes, mark 1 end of each box section on the inside and outside walls to indicate the top or bottom as it will be installed. Indent markings into the box section or paint them on each box with waterproof paint.

F. Tolerances. Ensure that precast sections of either type meet the following requirements:

- The inside vertical and horizontal dimensions do not vary from plan requirements by more than ½ in. or 1%, whichever is greater.
- The horizontal or vertical plane at each end of the box section does not vary from perpendicular by more than ½ in. or 1%, whichever is greater, measured on the inside faces of the section.
- The sides of a section at each end do not vary from being perpendicular to the top and bottom by more than ½ in. or 1%, whichever is greater, when measured diagonally between opposite interior corners.

Ensure that wall and slab thicknesses are not less than shown on the plans except for occasional deficiencies not greater than ¼ in. or 5%, whichever is greater. If proper jointing is not affected, thicknesses in excess of plan requirements are acceptable.

Deviations from the above tolerances will be acceptable if the sections can be fitted at the plant or job site and the joint opening at any point does not exceed 1 in. Use match marks for proper installation on sections that have been accepted in this manner.

G. Defects and Repair. Fine cracks on the surface of the member that do not extend to the plane of the nearest reinforcement are acceptable unless the cracks are numerous and extensive. Repair cracks that extend into the plane of the reinforcing steel in an approved manner. Excessive damage, honeycomb, or cracking will be subject to structural review. The Engineer may accept boxes with repairs that are sound, properly finished, and cured in conformance with pertinent specifications. When fine cracks on the surface indicate poor curing practices, discontinue further production of precast sections until corrections are made and proper curing is provided.

H. Storage and Shipment. Store precast sections on a level surface. Do not place any load on the sections until design strength is reached and curing is complete. Shipment of sections is permissible when the design strength and curing requirements have been met.

309.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

309.4. CONSTRUCTION:

A. Excavation, Trenching and Backfilling. All excavation, trenching and backfilling shall be in accordance with Item 106, "Box Culvert Excavation and Backfilling." For all box structures where joints consist of materials other than mortar, immediate backfilling is permitted. Take precautions in placing and compacting the backfill to avoid any movement of the boxes or damage to the joints. Remove and replace boxes damaged by the Contractor at no expense to the City.

B. Bedding. The soil shall be excavated to a minimum depth of 4 inches below the established grade of the bottom of the box culvert for the full width of the culvert and replaced with graded-gravel conforming to Item 410, "Gravel Subgrade Filler." Additional excavation may be required by the presence of ground water, or other objectionable material. Such extra excavation shall be performed and replaced with graded gravel only upon approval of the Engineer.

C. Installation. Unless otherwise authorized by the Engineer, the laying of box culverts on the prepared foundation shall start at the outlet end. Box culverts shall be laid with the tongue end pointing downstream and shall proceed toward the inlet end with the abutting sections properly matched, true to the established lines and grades. For trench installations, lower the box sections into the trench without damaging the box or disturbing the bedding and the sides of the trench. Carefully clean the ends of the box before it is placed. Prevent the earth or bedding material from entering the box as it is laid. Remove and re-lay, without extra compensation, boxes that are not in alignment or that show excessive settlement after laying.

Multiple box sections shall be placed leaving a space of a minimum of 1 inch and a maximum of 2 inches between the outside face of adjacent walls of the boxes. After the boxes have been placed and jointed, this space shall be filled with a grout composed of one (1) part Portland Cement and two (2) parts of sand.

D. Jointing. All preparation and priming of joints, application of joint compound, and construction methods shall be in strict adherence to the manufacturer's recommendations.

E. Connections and Stub Ends. Make connections of boxes to existing boxes as shown on the plans. Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections. Connect boxes to any required headwalls, wingwalls, safety end treatments or riprap, or other structures as shown on the plans or as directed. Repair any damage to the existing structure resulting from making the connections. Finish stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the box. Fill lifting holes with mortar or concrete and cure. Precast concrete or mortar plugs may be used.

309.5. MEASUREMENT: Precast Reinforced Concrete Box Culverts will be measured by the linear foot of box of the various sizes. Measurement shall be made along the centerline of the box in place. Box culverts will not be classified as to depth.

309.6. PAYMENT: Payment for Precast Reinforced Concrete Box Culverts measured as set out above will be made at the contract unit bid price for various size boxes. Payment shall be full compensation for furnishing, hauling, placing and backfilling the box culverts. All excavation will be paid under Item No. 106, “Box Culvert Excavation and Backfilling.” Subgrade filler, regardless of thickness, will be paid under Item No. 410, “Gravel Subgrade Filler.”

309.7. BID ITEM:

Item 309.1 - Precast Reinforced Concrete Box Culverts - per linear foot

ITEM

310 PRECAST, PRESTRESSED BRIDGE BEAMS

310.1. DESCRIPTION: *This item shall govern for the completed construction, prestressing, and erection of precast, prestressed concrete beams, and for the furnishing, storing, and handling of materials for prestressing of the beams, except as otherwise noted on the plans.*

310.2. MATERIALS: The general requirements for fabrication, for materials shall conform to the following:

A. Hydraulic Cement Concrete. Item 300, "Concrete."

B. Reinforcing Steel. Item 301, "Reinforcing Steel."

C. Structural Steel. Item 302, "Metal For Structures."

D. Precast Prestressed Concrete Structural Members. Texas Department of Transportation Item 425, "Precast Prestressed Concrete Structural Members."

E. Prestressing. Texas Department of Transportation Item 426, "Prestressing."

F. Elastomeric Materials. Texas Department of Transportation Item 434, "Elastomeric Bridge Bearings."

G. Concrete Curing Compound and Evaporation Retardants. Texas Department of Transportation DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants"

H. Epoxies and Adhesives. Texas Department of Transportation DMS-6100, "Epoxies and Adhesives."

310.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

310.4. CONSTRUCTION: The general requirements for construction methods of precast, prestressed bridge beams shall be in accordance with the appropriate articles of TxDOT Standard Specification Item 425, "Precast Prestressed Concrete Structural Members," Item 426, "Prestressing," and Item 434, "Elastomeric Bridge Bearings."

310.5. MEASUREMENT: Precast, Prestressed Bridge Beams, cast and stressed as required by the plans will be measured by the linear foot, along the centerline of beam, complete and in place in the bridge.

310.6. PAYMENT: Precast, prestressed concrete bridge beams will be paid for at the contract unit price bid per linear foot of beams of the type specified. The price paid shall be full compensation for constructing the members, furnishing and tensioning prestressing steel, furnishing and placing reinforcing steel, furnishing all anchorage hardware and elastomeric bridge bearing pads, grouting, and all other appurtenances which become an integral part of the beams, and shall be full compensation for furnishing all materials, tools, equipment, labor, and incidentals necessary to fabricate, transport, and erect the beams in the structure as indicated on the plans.

310.7. BID ITEM:

Item 310.1 - Precast, Prestressed Bridge Beams - per linear foot

ITEM

311 CONCRETE SURFACE FINISH

311.1. DESCRIPTION: *Finish concrete surface as specified.*

311.2. MATERIALS: Furnish materials in accordance with this Article for the type of surface finish specified.

A. Coatings.

1. **Adhesive Grout and Concrete Paint.** Provide coatings in accordance with TxDOT's DMS 8110, "Coatings for Concrete." Match color of coating with Federal Standard 595B color 35630, concrete gray, unless otherwise shown on the plans.

2. **Opaque Sealer.** Provide penetrating-type sealer in accordance with TxDOT's DMS 8110, "Coatings for Concrete." Match color of coating with Federal Standard 595B color 35630, concrete gray, unless otherwise shown on the plans.

3. **742 Appearance Coating.** Provide #742 gray appearance coating (Federal Standard 595B color 35630) in accordance with TxDOT's DMS 8100, "Structural Steel Paints-Formula."

4. **Epoxy Paint.** Provide Type X epoxy coating in accordance with TxDOT's DMS 6100, "Epoxies and Adhesives."

B. Exposed Aggregate Finish. Provide approved aggregates meeting the grading requirements shown on the plans. Unless otherwise shown on the plans, provide gravel consisting of predominantly rounded particles. When a bush-hammered finish is desired, use crushed stone. Provide a concrete surface retardant. Provide clear acrylic resin sealer in accordance with TxDOT's DMS 8110, "Coatings for Concrete," or clear Type II permanent anti-graffiti coating in accordance with TxDOT's DMS 8111, "Anti-Graffiti Coatings."

311.3. EQUIPMENT: The Engineer may require demonstration of the equipment's capabilities.

A. Low-Pressure Water Blasting. Use equipment capable of supplying a minimum pressure at the nozzle end of 3,000 psi at a minimum flow rate of 3 gpm. Use a 0° rotary, vibratory, or wobble-type nozzle. Use equipment capable of including abrasives in the water stream when specified on the plans.

B. Abrasive Blasting. Use equipment equipped with filters to produce oil-free air and also water-free air when dry air is required.

C. Slurry Blasting. Use equipment capable of combining air and abrasives with water to form a wet blast media capable of cleaning and preparing surface without creating dust.

D. Spraying. For spray applications, use equipment with fluid and air pressure regulators and gauges to allow for adjustment to produce a uniform spray pattern.

E. Off-the-Form Finish Forms. Use non-staining, nonporous, high-quality forming materials (e.g., steel or medium-density and high-density overlaid plywood forms). Use steel or high-density overlaid plywood forms when the same form will be used more than twice.

F. Form Liners. Provide form liners capable of producing a patterned finish as shown on the plans. Use form liners that provide a clean release from the concrete surface without pulling or breaking the textured concrete.

311.4. CONSTRUCTION: Provide the finish specified on the plans for the specific surface areas.

A. Surface Areas of Finish. "Surface area of finish" designates the areas where the specified surface is to be applied.

1. Surface Area I. Surface Area I includes:

- surfaces of railing;
- exterior vertical faces of fascia beams, slabs, slab spans, arches, and box girders;
- the outside bottom surface of fascia beams and girders;
- the underside of overhanging slabs to the point of juncture of the supporting beam;
- the entire underside of slab spans when shown on the plans;
- vertical and underside surfaces of bents and piers;
- all surfaces of tie beams, abutments, bridge wingwalls, culvert headwalls and wingwalls and retaining walls exposed to view after all backfill and embankment is placed; and
- all other exposed surfaces shown in the plans to require surface treatment.

2. Surface Area II. Surface Area II includes surfaces of railing, all wingwalls, and the exterior vertical faces of slabs.

3. Surface Area III. Surface Area III includes only the top and roadway faces of all concrete railing and bridge wingwalls.

4. Surface Area IV. Surface Area IV includes areas designated on the plans.

B. Surface Finishes. Apply the coating or special finish from Table 1 as specified on the plans.

Table 1
Surface Finishes

Coatings	Special Surface Finishes
Adhesive grout	Blast
Concrete paint	Rub
Opaque sealer	Off-the-form
742 appearance coating	Form liner
Epoxy paint	Exposed aggregate

1. Application of Coatings.

a. Preparation. Before applying a coating, thoroughly clean the surface by chemical cleaning, if required, and by blast cleaning.

(1) Chemical Cleaning. Clean surfaces contaminated with oil, grease, or other contaminants by scrubbing the area with an approved detergent or other concrete cleaning material before blast cleaning. Do not use a solvent that will stain the surface or inhibit coating adhesion. Perform the following test to check for surface contamination of oil type materials:

- Spray the surface with a fine mist of potable water.
- Examine the area to see if water beads up.
- If beading is found, clean the surface.

(2) Blast Cleaning. Before applying a specified coating, blast-clean the designated surface to remove weak surface material, curing compound, and other contaminants, leaving a lightly etched uniformly textured surface. Use an approved abrasive propelled by oil-free air with or without the addition of potable water, or blast with potable water with or without the addition of an approved abrasive at sufficient pressure to effectively clean and prepare the surface. When water-blasting, maintain the stand-off-distance of the nozzle to a maximum of 12-inches from the surface being cleaned.

Do not damage concrete surface by gouging, spalling, or exposing coarse aggregate by the blasting operation.

Immediately before application of any coating, blow clean oil- and moisture-free air on all surfaces with sufficient pressure to remove loose particles. Perform the following test to check for surface cleanliness as directed:

- Press a 10-inch long strip of 2-inches wide clear packing tape on the surface by rubbing with moderate pressure times.
- Grasp the free end of the tape, and remove the tape from the surface with a sharp jerk.
- Examine the surface of the tape for clinging particles.

Continue cleaning the concrete surface until there are no particles clinging to the tape surface for subsequent tests. An additional test that can be used to check the surface for dust is to wipe the surface with a dark cloth and then examine the cloth for discoloration.

b. Application. Mix coating materials thoroughly with a mechanical mixer at a speed that causes the mixture to rotate entirely in the container. Ensure complete mixing by probing the container with a stirring device searching for non-dispersed or settled material.

Do not apply coatings before the new concrete aging a minimum of 28-days unless approved otherwise. Do not apply coatings when weather conditions will be detrimental to the final surface finish as determined by the Engineer. Do not apply coatings when surface temperature of the concrete exceeds 110°F.

Apply coatings to obtain a consistent color and texture.

(1) Adhesive Grout. Apply coating on a moistened surface to a uniform minimum thickness of 1/16-inch. Do not apply when ambient temperature is less than 50°F.

(2) Concrete Paint. Apply the coating on a dry surface in 2 coats for a total maximum application rate of 150 square feet per gallon. Match the color of the applied coating with the color standard shown on the plans. Do not thin material unless approved. Apply when ambient temperature is between 50°F and 100°F.

(3) Opaque Sealer. Apply the coating to a dry surface in 2 coats for a total maximum application rate of 200 square feet per gallon. Match the color of the applied coating with the approved color standard shown on the plans. Do not thin the material unless approved. Apply when ambient temperature is between 40°F and 95°F.

(4) 742 Appearance Coating. Apply the coating on a dry surface at a rate of at most 400 square feet per gallon. Apply when ambient temperature is above 40°F.

(5) Epoxy Paint. Apply the coating on a dry surface at a maximum application rate of 100 square feet per gallon. Apply when ambient temperature is above 50°F.

Repair surface finish where coating has been applied that exhibits peeling, flaking, or discoloration or that has been damaged during construction. Remove defective or damaged coating. Clean and recoat repair area in accordance with the requirements of this Item.

2. Special Surface Finishes. Submit a work plan to the Engineer for any special finish shown on the plans. Include in the work plan the type of aggregates, materials, variation of panel or pattern arrangement, dimensions, construction methods, and other features affecting the work as is necessary for the "Special Surface Finish" specified.

a. Blast Finish. Provide surface profile as shown in the plans, or meet the minimum requirements of Section 311.4.B.1.a, "Preparation." Construct a 4 feet by 4 feet sample panel using the same concrete used in construction of the member to receive the blast finish. Prepare the surface of the sample panel to meet the specified finish, and obtain approval of the sample finish. Use the approved sample panel finish as the standard for surfaces requiring a blast finish.

b. Rub Finish. Provide a finish to the surface by rubbing the surface with a carborundum stone or other approved material. Begin rubbing the surface immediately after forms have been removed. If rubbing surface is delayed to the point where the surface is dry and unable to be rubbed to produce an acceptable finish, provide blast finish or other finish as directed at no additional cost to the City. Perform the requirements to obtain the ordinary surface finish specified in Section 307.4.M, "Ordinary Surface Finish," concurrently with rubbing the surface. Where concrete patching is performed, rub these areas after the patch material has thoroughly set and blend the patch in with the surrounding area to produce a surface with uniform color and texture.

After form removal, keep the surface continuously wet until the rubbing is complete. Rub the surface sufficiently to bring the wetted concrete surface to a paste producing a smooth dense surface without pits, form marks, or other irregularities. Do not use

cement grout to form the paste on the surface. Stripe the surface with a brush to conceal the rubbing pattern and allow the paste to reset. Wash the concrete with potable water after the paste has sufficiently set to leave it with a neat and uniform appearance and texture. If required, apply membrane curing in accordance with Item 307, "Concrete Structures," after rubbing is complete.

c. Off-the-Form Finish. Provide a finish with minimal surface defects and uniform color and texture by using non-staining, non-porous, high-quality forming materials. Use the same type of forming materials for like elements for the entire structure.

Use mortar-tight forms to prevent leakage and discoloration. If necessary, seal joints with compressible gasket material, caulk, tape or by other suitable means that are not detrimental to the concrete finish. Use one brand and type of form release agents for all surfaces unless another product produces a similar concrete surface appearance. Do not use barrier-type (wax, fuel oil, carrier oil, etc.) release agents. Use form release agents containing a rust inhibitor on steel forms. Clean rust off steel forms before use. Do not use plywood that will cause discoloration of the concrete surface.

Direct special attention to consolidation and vibration of the concrete around the form surfaces to minimize bug holes. Modify concrete placement and vibration techniques if surface contains an excessive amount of bug holes. Remove all forms without interruption once form removal begins to prevent discoloration due to differing form curing times.

Do not use membrane curing on surfaces with off-the-form finish.

Repair honeycombed and spall areas with least dimension larger than 2-inches in accordance with the concrete surface repair procedures outlined in Item 307, "Concrete Structures," to obtain an ordinary surface finish as defined in Section 307.4.M, "Ordinary Surface Finish." For honeycombed and spall areas with least dimension greater than ¾-inch but smaller than 2-inches, patch by filling defect with repair material omitting the chipping operation. Do not patch honeycombed and spall areas with least dimension smaller than ¾-inch. Perform required repairs as soon as forms are removed. Match repair material color and texture with surrounding concrete surfaces. Minimize the area of repair by not smearing the repair material over acceptable concrete surfaces in an attempt to blend the repair with the surrounding concrete. Cut out form ties at least ½-inch below the surface, and patch accordingly. Perform repair work as soon as possible after removing forms so that concrete and repair material have similar ages. Replace or refurbish the forms when the Engineer determines that defective formwork is causing an excessive amount of repair work.

d. Form Liner Finish. Provide patterned finish as shown on the plans. Do not splice form liner panels in a way that causes a noticeable transition or line between pieces. Wash and clean form liners after each use when the forms can be re-used. Replace form liners that have become damaged or worn.

Construct a sample panel for each form liner finish. Approval is required to verify that the sample panel meets the requirements of the plans and specifications before beginning work. Upon approval, the sample panel becomes the model panel that all other work will be compared against. Deviation in color, grade, or depth from the model panel is grounds for rejection of the form liner finish. Removal of defective

work may be necessary as determined by the Engineer and in accordance with the surface finish requirements outlined in Item 307, "Concrete Structures," to obtain an ordinary surface finish as defined in Section 307.4.M, "Ordinary Surface Finish."

Seal all form liner joints in a manner acceptable to the Engineer to prevent leakage at the surface.

e. **Exposed Aggregate Finish.** Provide exposed aggregate finish as indicated on the plans. Provide a depth of finish between 3/8-inch and ½-inch unless directed otherwise.

Apply a concrete surface retarder that penetrates approximately ¼-inch into the forms or concrete surface to help achieve the desired finish. Apply 2 or 3 coats to wood forms to account for absorption if necessary. Tape or caulk form joints to prevent escape of the retarder during the placing operations. Protect the form surfaces from sun and rain while exposed to the atmosphere. Re-treat form surfaces with retarder if disturbed. Protect adjacent areas of concrete not requiring exposed aggregate finish from the retarder.

Remove forms 12 to 15 hours after concrete placement but not before concrete has gained sufficient strength to support the self-weight of the member unless directed otherwise. Expose the aggregate for the finish immediately after form removal. Remove the grout paste covering the aggregate to be exposed by an approved method. Do not loosen the aggregate by the grout removal operation. Maintain required curing on all surfaces except for the time while the aggregate is being exposed. Cure using wet mats or membrane after the aggregate is exposed.

Repair defective areas as determined by the Engineer.

Re-clean exposed aggregate surfaces by an approved method. Apply a coat of acrylic resin sealer or clear Type II permanent anti-graffiti coating to cleaned exposed aggregate surface. Apply a single coat or multiple coats for a total maximum application rate of 250 square feet per gallon.

311.5. MEASUREMENT: When surface finishes for concrete is shown on the plans to be a pay item, measurement will be by the square foot of the type of surface finish specified.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by TxDOT's Article 9.2, "Plans Quantity Measurement." Additional measurement or calculations will be made if adjustments of quantities are required.

311.6. PAYMENT: Unless otherwise specified on the plans, the work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly, but will be considered subsidiary to pertinent Items.

When a surface finish for concrete is specified as a pay item, the work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Adhesive Grout Finish," "Concrete Paint Finish," "Opaque Sealer Finish," "742 Appearance Coating Finish," "Epoxy Paint Finish," "Blast Finish," or "Rub Finish." This price is full compensation for materials; cleaning and preparing surfaces; application of materials; and equipment, labor, tools, and incidentals.

Off-the-form, form liner, or exposed aggregate finishes (including anti-graffiti coating) will not be paid for under this Item but are subsidiary to other pertinent Items.

311.7. BID ITEM:

Item 311.1 - Concrete Surface Finish - Adhesive Grout Finish - per square yard

Item 311.2 - Concrete Surface Finish - Concrete Paint Finish - per square yard

Item 311.3 - Concrete Surface Finish - Opaque Sealer Finish - per square yard

Item 311.4 - Concrete Surface Finish - 742 Appearance Coating Finish - per square yard

Item 311.5 - Concrete Surface Finish - Epoxy Paint Finish - per square yard

Item 311.6 - Concrete Surface Finish - Blast Finish - per square yard

Item 311.7 - Concrete Surface Finish - Rub Finish - per square yard

DIVISION IV - STORM SEWERS

ITEM

400 EXCAVATION, TRENCHING AND BACKFILLING

400.1. DESCRIPTION: *Excavate, trench, and backfill storm drainage pipe, and pipe culverts, unless otherwise noted on the plans, details and the specifications. The work shall include all necessary pumping or bailing, sheeting, drainage and the construction and removal of any required cofferdams. All existing utilities shall be protected from damage during the excavation and backfilling of trenches, and if damaged, shall be replaced or repaired by the Contractor at his expense. Unless otherwise shown on the plans and bid proposal all excavation shall be unclassified, and shall include all materials encountered regardless of their nature or the manner in which they are removed.*

400.2. MATERIALS: Use materials that meet the requirements of the following Items:

A. Aggregate. Item 200, "Flexible Base."

B. Gravel. Item 410, "Subgrade Filler."

C. Cement Stabilized Sand. Item 412, "Cement Stabilized Sand."

D. Glass Cullet. Item 411, "Glass Cullet use for Utility Bedding and Backfill."

E. Flowable Fill. Item 413, "Flowable Fill."

F. Filter Fabric. TxDOT DMS 6200, "Filter Fabric," Type1.

400.3. CONSTRUCTION:

A. Excavation.

1. General. The Contractor shall perform all excavation of every description and of whatever substances encountered, to the lines and grades shown on the plans or determined by the Engineer. Unless otherwise indicated, excavation shall be by open cut except that short sections may be tunneled, if in the opinion of the Engineer, the pipe or structure can be safely and properly installed or constructed, and backfill can be properly tamped in such tunnel sections.

2. Safety. Provide slopes, benching, sheeting, bracing, pumping, and bailing as necessary to maintain the stability and safety of excavations. Excavation protection is governed by Item 550, "Trench Excavation Safety Protection," and Item 551, "Special Shoring."

3. Excavated Materials. During excavation, material suitable for backfilling shall be stockpiled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or not suitable for backfill shall be removed and properly disposed of by the Contractor or as directed by the Engineer. Proper disposal shall be in conformance with, but not limited to, the following provisions:

a. Do not deposit excavated material within jurisdictional wetlands, and

b. Obtain appropriate permits and apply provisions pertaining to soil erosion and stream pollution, when necessary, to meet federal, state, and/or local regulations, rules, and procedures.

4. **Hazardous Materials.** If the Contractor encounters hazardous substances, industrial waste, environmental damage, underground storage tanks, or conditions conducive to environmental damage, Contractor shall immediately stop work in the area affected and report the condition to the Owner's representative in writing. Contractor shall not be responsible for or required to conduct any investigation, site monitoring, containment, cleanup, removal, restoration or other remedial work of any kind or nature (the "remedial work") under any applicable level, state or federal law, regulation or ordinance, or any judicial order. If the Contractor agrees in writing to commence and/or prosecute some or all of the remedial work, all costs and expenses, to include any extension of the contract time, of such remedial work shall be paid by Owner to Contractor as additional compensation.

5. **Existing Structures/Obstructions.** Unless otherwise stated on the plans, remove structures and other obstructions over the width of the excavation to a depth of 1 ft. below the bottom of excavation. If abandoned storm drains, sewers, or other drainage systems are encountered, remove as required to clear the new structure, and plug in an approved manner. After removing obstructions, restore the bottom of the excavation to grade by backfilling in accordance with this Item. Dispose of surplus materials in accordance with federal, state, and local regulations.

6. **Existing Asphaltic Materials.** All asphaltic material shall be disposed of or recycled at a facility authorized to accept the material for such purposes.

7. **Excavation in Streets.** When structures are installed in streets, highways, or other paved areas, cut pavement and base in accordance with Item 230, "Base and Pavement Replacement." Restore pavement structure after completion of excavation and backfilling in accordance with Item 230, "Base and Pavement Replacement."

   Unless otherwise shown on the plans, maintain and control traffic in accordance with the approved traffic control plan or in conformance with the Texas MUTCD.

8. **Utilities.** Conduct work with minimum disturbance of existing utilities, and coordinate work in or near utilities with the utility owners. Inform utility owners sufficiently before work begins to allow them time to identify, locate, reroute, or make other adjustments to utility lines.

   Avoid cutting or damaging underground utility lines that are to remain in place. If damage occurs, promptly notify the utility company. If an active sanitary sewer line is damaged during excavation, provide temporary flumes across the excavation while open, and restore the lines when backfilling has progressed to the original bedding lines of the cut sewer.

9. **De-Watering.** Do not construct or place structures in the presence of water unless approved. Place precast units or pour structural concrete only on a dry, firm surface. Remove water by bailing, pumping, well-point installation, deep wells, underdrains, or other approved method.

Do not pump or bail while placing structural concrete or for a period of at least 36 hr. thereafter unless from a suitable sump separated from the concrete work. Pump or bail during placement of seal concrete only to the extent necessary to maintain a static head of water within the cofferdam. Do not pump or bail to de-water inside a sealed cofferdam until the seal has aged at least 36 hours.

If the bottom of an excavation cannot be de-watered to the point that the subgrade is free of mud or it is difficult to keep reinforcing steel clean, place a stabilizing material in the bottom of the excavation. Stabilizing material may be controlled low strength material, flowable backfill, or other material approved by the Engineer. Stabilizing material placed for the convenience of the Contractor will be at the Contractor's expense.

B. Trenching.

1. **General.** Trench walls shall be vertical in excavations through stable rock, as classified and substantiated during construction by a competent professional as defined by OSHA, and the practice of undercutting at the bottom or flaring at the top will not be permitted unless approved by the Engineer. In special cases where trench flaring is permitted and directed by the Engineer, the trench walls shall remain vertical to a depth of at least 1 foot above the top of the pipe. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of pipe on the undisturbed soil at every point along its entire length, except for the portions of pipe sections where it is necessary for bells and for the proper sealing of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded in order that the pipe may rest upon the prepared bottom for as much of its full length as practicable.

2. **Depth of Cut.** The depth of cut shall be measured from the offset or cut hub elevation to the invert of the pipe and shall be determined by the Contractor. The width of the trench shall be at least the outside diameter of the pipe plus 6 inches on each side of the pipe for pipe sizes less than 42 inches in diameter.

   It shall be understood that the depth of cut as initially indicated may be more or less than the actual excavated depth due to ground conditions existing at the site. For this reason the Engineer shall determine the depth for pay purposes based on the surface elevation prior to the Contractor's operation and the invert of the sewer line. The Engineer's decision shall be final.

3. **Working Space.** The maximum working room for pipe 42 inches in diameter and under shall not exceed ½ of the outside diameter of the pipe or 12 inches whichever is greater, from the edge of the pipe to the face of the trench walls, or inside face of the shoring protection.

   For pipe over 42 inches in diameter the maximum width of the trench shall be such that the working space from the pipe to the trench wall, or shoring protection as the case may be, will be a minimum of 12 inches, and a maximum of 24 inches. If allowable trench widths are exceeded through over-shooting of rock, caving of earth trenches or over-excavation, the Contractor shall employ corrective measures or alternative designs as determined by the Engineer.

C. Over Excavation.

1. **Unstable Material.** Whenever wet or otherwise unstable soil that is incapable of properly supporting the structure or pipe, as determined by the Engineer, is encountered in the bottom of the excavation or trench, such soil shall be removed to the depth shown on the plans or determined by the Engineer and the excavation or trench backfilled to the proper grade with a gravel subgrade filler as specified in Item No. 410, "Subgrade Filler" or other suitable bedding material.

2. **Incompressible Material.** Where trash, debris, rock, boulder or coarse gravel with a particle size larger than 1 ¾ inch is encountered at the bearing level, the Contractor shall, as directed by the Inspector, over-excavate and remove such materials to a depth not less than 4 inches below the bottom of the pipe and replace with a gravel material conforming to the requirements of Item 410, "Subgrade Filler" or other suitable bedding material.

3. **Unauthorized Excessive Excavation.** Whenever over-excavation occurs that is not a result of unstable or incompressible material as defined above, the under-cut trench shall be restored to grade, to the satisfaction of the Inspector, by replacement of excavated material compacted to the same density as the surrounding natural ground.

D. Bedding. When bedding material is required by the plans, place the material to the depth specified and in the manner described herein.

1. Bedding material may consist of lean clay, gravel, clean sand, cement stabilized sand, glass cullet that conforms to the requirements of Item 411, "Glass Cullet use for Utility Bedding and Backfill," or other materials approved by the Engineer.

2. Remove loose, sloughing, or caving soil from the bottom and sidewall of trenches immediately prior to placement of bedding materials. Place bedding to the depths shown on the Standard Details or project plans.

3. For pipe installation, manually spread bedding materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction directly against undisturbed soils in trench sidewalls, or against sheeting which is to remain in place.

4. Do not place trench shields or shoring within the height of the bedding zone unless means to maintain density of compacted bedding material are used. If moveable supports are used in the bedding zone, lift supports incrementally to allow placement and compaction of material against undisturbed soil.

5. If shown on the plans or directed by the Engineer, place geotextile on the bottom of the excavated trench prior to the placement of any sand, glass cullet, or granular bedding to prevent particle migration from in-situ soil into open-graded bedding materials or drainage layers, when used.

6. Compact bedding material to its specific compaction requirements using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.

E. Backfilling.

1. **General.** Trench shall not be backfilled until the constructed structures or appurtenances as installed conform to the requirements specified. The trench shall be carefully backfilled with the materials approved for backfilling as described in 400.3.E.2. "Pipe Backfilling" or other materials approved by the Engineer.

   Where pipe is specially coated for protection against corrosion, care shall be taken not to damage the coating.

   Any trench improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and compacted with the surface restored to the required grade and compaction.

2. **Pipe Backfilling.** Initial backfill that is defined as backfilling to a point 12 inches above the top of the pipe shall be done by either method a., b., c., or d. below. Secondary backfill that is defined as backfilling from a point 12 inches above the top of the pipe to the top of the trench or proposed subgrade elevation shall be completed in accordance with 400.3.E.2.e. "Secondary Backfill."

   a. **Suitable Excavated Material.** Fine compactable soil material may be used as the initial backfill; examples would include loam, sandy clay, sand and gravel, or soft shale, all of which shall be free from large clods of earth or stones. It shall be placed in uniform layers not more than 6 inches in depth (loose measurement) and shall be compacted to the density specified herein. Each layer of backfill material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density, by means of a hand or mechanical tamper.

      The maximum dry density and optimum moisture content shall be determined in accordance with TxDOT Test Method Tex-114-E. Tests for in place density shall be made in accordance with TxDOT Test Method Tex-115-E and within 24 hours after compacting operations are completed. If the material fails to meet the density specified, it shall be re-worked as necessary to obtain the density required.

      Care shall be exercised to thoroughly compact the backfill under the haunches of the pipe and to insure that the backfill soil is in intimate contact with the sides of the pipe. Backfill material shall be kept at the same elevation on both sides of pipe.

      Each lift of fill shall be compacted to the required density and moisture content as shown below, unless otherwise shown on the plans:

Subgrade Material	Density	Moisture Content
PI $\leq$ 20	$\geq$ 95% of Max Dry Density	- 2% of Opt. or greater
PI > 20	$\geq$ 95% of Max Dry Density	$\geq$ Opt. Moisture

   b. **Cement Stabilized Sand.** When shown on the plans, backfill the excavation with cement stabilized sand backfill that conforms to Item 412, "Cement Stabilized Sand" to the elevations shown on the plans. Prevent the structure from being displaced during the placement of the cement stabilized sand and prevent the backfill from entering pipes. There is no separate pay item for Cement Stabilized Sand material, unless shown on the plans as a separate pay item for pipe backfill.

Before placing cement stabilized sand, the trench shall be cleaned of any extraneous material and thoroughly wet. All surplus dirt excavated from the trench shall be removed from the site.

c. Flowable Backfill. When shown on the plans, backfill the excavation with flowable backfill that conforms to Item 413, "Flowable Backfill" to the elevations shown on the plans. Prevent the structure from being displaced during the placement of the flowable backfill and prevent flowable backfill from entering pipes. There is no separate pay item for Flowable Backfill material, unless shown on the plans as a separate pay item for pipe backfill.

Before placing flowable backfill, the trench shall be cleaned of any extraneous material and thoroughly wet. All surplus dirt excavated from the trench shall be removed from the site.

d. Select Fill or Flexible Base. A clean gravel, or gravel approved by the Engineer, conforming to the requirements of article 410.3.B. "Gravel" of Item No.410, "Subgrade Filler" may be used for backfill material from the bottom of the trench to the top of the pipe. The gravel shall be placed in the trench in loose lifts not to exceed 10 inches in depth and lightly tamped to consolidate and seat the mass against conduit and earthen surfaces. Backfill material shall be kept at the same elevation on both sides of pipe.

A filter fabric shall be placed between the gravel backfill (initial backfill) and secondary backfill completely covering the top and sides of the gravel backfill. The filter material shall have an apparent opening size of U.S. Sieve No. 40.The filter fabric shall conform to the requirements of TxDOT DMS 6200, "Filter Fabric," Type1.

Where conditions permit and with approval of the Engineer, a gravel material conforming to Item 200 "Flexible Base" may be used from the top of the gravel filter bed to the top of the pipe. This backfill material shall be placed in uniform layers not more than 10 inches in depth (loose measurement) and shall be compacted to the required density. Each layer of material, if dry, shall be wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to the required density by means of a mechanical tamper.

Compaction of the Flexible Base shall be such that the density of each layer shall be not less than 95% of the maximum dry density as determined by TxDOT Test Method TEX-114-E, unless otherwise shown on the plans.

e. Glass Cullet. Glass cullet approved by the engineer, conforming to the requirements Item 411, "Glass Cullet use for Utility Bedding and Backfill," may be used for initial backfill. The glass cullet shall be placed in the trench and lightly tamped to consolidate and seat the mass against the conduit and earthen surfaces. Backfill material shall be kept at the same elevation on both sides of pipe.

A filter fabric shall be placed at the bottom of the trench directly on top of the exposed soil when bedding material is not used as well as between the top of the glass cullet (initial backfill) and the secondary backfill for the entire length and width of the trench. The filter fabric shall conform to the requirements of TxDOT DMS 6200, "Filter Fabric," Type1.

f. Secondary Backfill. After the initial backfill has been completed to a point 12 inches above the top of the pipe by one of the methods outlined above, suitable rolling equipment may be used on these portions which are accessible to such equipment to obtain the compaction effect. Material for backfill shall be placed in uniform layers no more than 10 inches in depth (loose measurement) and shall be compacted to the density specified herein. Each layer of backfill material, if dry, shall be wetted uniformly prior to placement in the trench to the moisture content required to obtain the specified density, and shall be compacted to the required density by means of rolling equipment or other suitable mechanical method. No rolling equipment shall be used which may damage the pipe.

Each lift of fill shall be compacted to the required density and moisture content as shown below, unless otherwise shown on the plans:

Subgrade Material	Density	Moisture Content
PI ≤ 20	≥ 95% of Max Dry Density	- 2% of Opt. or greater
PI > 20	≥ 95% of Max Dry Density	≥ Opt. Moisture

3. Quality Control. In-place density tests shall be conducted by Engineer. The frequency and location of testing shall be in accordance with the following table:

Secondary Backfill Depth (Ft)	Number of Tests per 400 Linear Feet
0 – 6	3
6 – 12	5
> 12	7 or as directed by the Engineer

The number of tests shown above is a minimum. The Engineer may require more tests if there is a need.

Any failed test shall require the Contractor to remove and replace or rework as required the layer of backfill to points halfway to the next test location at no additional cost. Retests of these areas shall be at the Contractor's expense

The Contractor shall provide access to the test area, associated trench excavation safety protection, and backfilling of the test areas at the Contractor's expense.

400.4. MEASUREMENT: Excavation, Trenching and Backfill will not be measured for payment.

400.5. PAYMENT: No direct payment shall be made for excavation, trenching and backfilling for pipe culverts, pipe storm sewers, and all costs in connection therewith shall be included in the applicable contract price for the item to which the work pertains. No direct payment shall be made for placement of filter fabric and all costs in connection therewith shall be included in the applicable contract price for the item to which the work pertains.

400.6. BID ITEM:

N/A

ITEM

401 REINFORCED CONCRETE PIPE

401.1. DESCRIPTION: *Furnish and install reinforced concrete pipe, materials for precast concrete pipe culverts, or precast concrete storm drain mains, laterals, stubs, and inlet leads.*

401.2. MATERIALS:

A. Fabrication. Provide precast reinforced concrete pipe that conforms to the design shown on the plans and to the following:

- ASTM C 76 or ASTM C 655 unless otherwise shown on the plans for circular pipe, or
- ASTM C 506 for arch pipe, or
- ASTM C 507 for horizontal elliptical pipe.

Provide precast concrete pipe that is machine-made or cast by a process that will provide for uniform placement of the concrete in the form and compaction by mechanical devices that will assure a dense concrete.

Mix concrete in a central batch plant or other approved batching facility where the quality and uniformity of the concrete is assured. Do not use transit-mixed concrete for precast concrete pipe. When sulfate-resistant concrete is required, do not use Class C fly ash.

Do not place more than 2 holes for lifting and placing in the top section of precast pipe. Cast, cut, or drill the lifting holes in the wall of the pipe. The maximum hole diameter is 3 in. at the inside surface of the pipe wall and 4 in. at the outside surface. Do not cut more than 1 longitudinal wire or 2 circumferential wires per layer of reinforcing steel when locating lift holes.

B. Design.

1. General. The class and D-load equivalents are shown in Table 1. Furnish arch pipe in accordance with ASTM C 506 and the dimensions shown in Table 2. Furnish horizontal elliptical pipe in accordance with ASTM C 507 and the dimensions shown in Table 3. For arch pipe and horizontal elliptical pipe the minimum height of cover required is 1 ft.

Table 1
Circular Pipe
ASTM C 76 & ASTM C 655

Class	D-Load (lb./ft./ft.)
I	800
II	1,000
III	1,350
IV	2,000
V	3,000

Table 2
Arch Pipe

Design Size	Equivalent Diameter, (in.)	Rise, (in.)	Span (in.)
1	18	13-1/2	22
2	21	15-1/2	26
3	24	18	28-1/2
4	60	22-1/2	36-1/4
5	36	26-5/8	43-3/4
6	42	31-5/16	51-1/8
7	48	36	58-1/2
8	54	40	65
9	60	45	73
10	72	54	88

Table 3
Horizontal Elliptical Pipe

Design Size	Equivalent Diameter, (in.)	Rise, (in.)	Span (in.)
1	18	14	23
2	24	19	30
3	27	22	34
4	30	24	38
5	33	27	42
6	36	29	45
7	39	32	49
8	42	34	53
9	48	38	60
10	54	43	68

2. **Jacking, Boring, or Tunneling.** Design pipe for jacking, boring, or tunneling considering the specific installation conditions such as the soil conditions, installation methods, anticipated deflection angles, and jacking stresses. When requested, provide design notes and drawings signed and sealed by a Texas licensed professional engineer.

C. Physical Test Requirements. Acceptance of the pipe will be determined by the results of the following tests:

- material tests required in ASTM C 76, C 655, C 506, or C 507,
- absorption tests in accordance with ASTM C 497,
- three-edge bearing tests in accordance with ASTM C 497 (Perform 3-edge bearing tests on 1 pipe for each 300 pipes or fraction thereof for each design or shape, size, class, or D-load produced within 30 calendar days. Test for the load to produce a 0.01-in. crack or 15% in excess of the required D-load, whichever is less. Test the pipe to ultimate load if so directed. Three-edge bearing test to ultimate load is not required for any class of pipe 60 in. or less in diameter listed in Tables 1-5 of ASTM C 76 provided all other requirements of ASTM C 76 are met.. Tested pipe that satisfies the requirements of Section 401.2.F., “Causes for Rejection,” may be used for construction. As an alternate to

the 3-edge bearing test, concrete pipe 54 in. in diameter and larger may be accepted on the basis of compressive strength of cores cut from the wall of the pipe. The manufacturer must determine the compressive strength of the samples. Obtain, cure, prepare, and test the cores in accordance with ASTM C 497 (the manufacturer must plug and seal core holes in the pipe wall after testing), and

- inspection of the finished pipe to determine its conformance with the required design and its freedom from defects.

D. Marking. Clearly mark the following information on each section of pipe:

- class or D-load of pipe,
- ASTM designation,
- date of manufacture,
- name or trademark of the manufacturer, and
- pipe to be used for jacking and boring.

For pipe with elliptical reinforcement, clearly mark 1 end of each section during the process of manufacture or immediately thereafter. Mark the pipe 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 unless the external shape of the pipe is such that the correct position of the top and bottom is obvious. Mark the pipe section by indenting or painting with waterproof paint.

E. Inspection. Provide facilities and access to allow for inspection regarding the quality of materials, the process of manufacture, and the finished pipe at the pipe manufacturing plant. In addition, provide access for inspection of the finished pipe at the project site before and during installation.

F. Causes for Rejection. Individual sections of pipe may be rejected for any of the following:

- fractures or cracks passing through the shell (wall), with the exception of a single end crack that does not exceed the depth of the joint;
- defects that indicate proportioning, mixing, and molding, not in compliance with the appropriate Section of ASTM C76, C655, C506, or C507;
- Surface defects indicating honeycombed or open texture that would adversely affect the function of the pipe;
- damaged ends where such damage would prevent making a satisfactory joint;
- any continuous crack having a surface width of 0.01 in. or more and extending for a length of 12 in. or more.

G. Repairs. Make repairs if necessary because of occasional imperfections in manufacture or accidental damage during handling. The Engineer may accept pipe with repairs that are sound, properly finished, and cured in conformance with pertinent specifications.

H. Rejections. Allow access for the marking of rejected pipe. Rejected pipe will be plainly marked by the Engineer by painting colored spots over the City monogram on the inside wall of the pipe and on the top outside wall of the pipe. The painted spots will be no larger than 4 in. in diameter. The rejected pipe will not be defaced in any other manner. Remove the rejected pipe from the project and replace with pipe meeting the requirements of this Item.

I. Jointing Materials. Use any of the materials described herein for the making of joints, unless otherwise shown on the plans. Furnish a manufacturer's certificate of compliance for all jointing materials except mortar.

1. Mortar. Provide mortar for joints that meets the requirements of Section 401.4.C, "Jointing."

2. Cold-Applied, Plastic Asphalt Sewer Joint Compound. Provide a material that consists of natural or processed asphalt base, suitable volatile solvents, and inert filler. The consistency is to be such that the ends of the pipe can be coated with a layer of the compound up to ½ in. thick by means of a trowel. Provide a joint compound that cures to a firm, stiff plastic condition after application. Provide a material of a uniform mixture. If any small separation occurs in the container, stir to a uniform mix before using.

Provide a material that meets the requirements of Table 4 when tested in accordance with TxDOT Standard Test Method Tex-526-C.

Table 4
Cold-Applied, Plastic Asphalt Sewer Joint Compound
Material Requirements

Composition	Analysis
Asphalt base, 100%–% volatiles–% ash, % by weight	28 - 45
Volatiles, 212°F evaporation, 24 hr., % by weight	10 - 26
Mineral matter, determined as ash, % by weight	30 - 75
Consistency, cone penetration, 150 q, 5 sec., 77°F	150 - 275

3. Rubber Gaskets. Provide gaskets that conform to ASTM C 361 or C 443. Meet the requirements of ASTM C 443 for design of the joints and permissible variations in dimensions.

4. Pre-Formed Flexible Joint Sealants. Pre-formed flexible joint sealants may be used for sealing joints of tongue-and-groove concrete pipe. Provide flexible joint sealants that meet the requirements of ASTM C 990. Use flexible joint sealants that do not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. Supply in extruded rope form of suitable cross section. Provide a size of the pre-formed flexible joint sealant in accordance with the manufacturer's recommendations and large enough to properly seal the joint. Flexible joint sealants must be protected by a suitable wrapper, and the jointing material must maintain integrity when the wrapper is removed.

401.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

401.4. CONSTRUCTION:

A. Excavation, Shaping, Bedding, and Backfill. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation, Trenching and Backfilling," except where jacking,

boring, or tunneling methods are permitted. Jack, bore, or tunnel the pipe in accordance with Item 406, "Jacking, Boring, or Tunneling." If joints consist of materials other than mortar, immediate backfilling is permitted. Take special precautions in placing and compacting the backfill to avoid any movement of the pipe or damage to the joints. Unless otherwise shown on the plans or permitted in writing, do not use heavy earth-moving equipment to haul over the structure until a minimum of 4 ft. of permanent or temporary compacted fill has been placed over the structure. Remove and replace pipe damaged by the Contractor at no expense to the City.

B. Laying Pipe. Unless otherwise authorized, start the laying of pipe on the bedding at the outlet end with the spigot or tongue end pointing downstream, and proceed toward the inlet end with the abutting sections properly matched, true to the established lines and grades. Fit, match, and lay the pipe to form a smooth, uniform conduit. Where bell-and-spigot pipe is used, cut cross trenches in the foundation to allow the barrel of the pipe to rest firmly upon the bedding. Do not cut cross trenches more than 2 in. larger than the bell ends of the pipe. Lower sections of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Carefully clean the ends of the pipe before the pipe is placed. Prevent the earth or bedding material from entering the pipe as it is laid. When elliptical pipe with circular reinforcing or circular pipe with elliptical reinforcing is used, lay the pipe in the trench so that the markings for the top or bottom are not more than 5° from the vertical plane through the longitudinal axis of the pipe. Remove and re-lay, without extra compensation, pipe that is not in alignment or that shows excessive settlement after laying.

Lay multiple lines of reinforced concrete pipe with the centerlines of the individual barrels parallel. Unless otherwise shown on the plans, use the clear distances between outer surfaces of adjacent pipes shown in Table 5. For arch pipe or horizontal elliptical pipe use the equivalent diameter from Table 2 or Table 3 to determine the clear distance requirement in Table 5.

Table 5
Minimum Clear Distance between Pipes

Equivalent Diameter	Min. Clear Distance
18 in.	9 in.
24 in.	11 in.
30 in.	1 ft. 1 in.
36 in.	1 ft. 3 in.
42 in.	1 ft. 5 in.
48 in.	1 ft. 7 in.
54 in.	1 ft. 11 in.
60 to 84 in.	2 ft.

C. Jointing. Make available an appropriate rolling device similar to an automobile mechanic's "creeper" for conveyance through small-size pipe structures.

1. **Joints Sealed with Hydraulic Cement Mortar.** Use mortar consisting of 1 part cement, 2 parts sand, and enough water to make a plastic mix. Clean and wet the pipe ends before making the joint. Plaster the lower half of the bell or groove and the upper half of the tongue or spigot with mortar. After the pipes are tightly jointed, pack mortar into the joint from both inside and outside the pipe. Finish the inside smooth and flush with adjacent joints of pipe. For tongue-and-groove joints, form a bead of semicircular cross section over the joint outside the pipe, extending at least 1 in. on each side of the joint. For bell-and-spigot joints, form the mortar to a 45° fillet between the outer edge of the bell and

the spigot. Cure mortar joints by keeping the joints wet for at least 48 hr. or until the backfill has been completed, whichever comes first. When mortar joints are used, do not place fill or backfill until the jointing material has cured for at least 6 hr. Do not conduct jointing when the atmospheric temperature is at or below 40°F. Protect mortared joints against freezing by backfilling or other approved methods for at least 24 hr.

Driveway culverts do not require mortar banding on the outside of the pipe.

With approval, pipes that are large enough for a person to enter may be furnished with the groove between ½ in. and ¾ in. longer than the tongue. Such pipe may be laid and backfilled without mortar joints. After the backfilling has been completed, clean the space on the interior of the pipe between the end of the tongue and the groove of all foreign material, thoroughly wet and fill with mortar around the entire circumference of the pipe, and finish flush.

2. **Joints Using Cold-Applied, Plastic Asphalt Sewer Joint Compound.** Ensure that both ends of the pipes are clean and dry. Trowel or otherwise place a ½-in.-thick layer of the compound in the groove end of the pipe covering at least ⅔ of the joint face around the entire circumference. Next, shove home the tongue end of the next pipe with enough pressure to make a tight joint. After the joint is made, remove any excess mastic projecting into the pipe. Backfill after the joint has been inspected and approved.

3. **Joints Using Rubber Gaskets.** Make the joint assembly according to the recommendations of the gasket manufacturer. When using rubber gaskets, make joints watertight. Backfill after the joint has been inspected and approved.

4. **Joints Using Pre-Formed Flexible Joint Sealants.** Install pre-formed flexible joint sealants in accordance with the manufacturer's recommendations. Place the joint sealer so that no dirt or other deleterious materials come in contact with the joint sealing material. Pull or push home the pipe with enough force to properly seal the joint. Remove any joint material pushed out into the interior of the pipe that would tend to obstruct the flow. When the atmospheric temperature is below 60°F, store pre-formed flexible joint sealants in an area warmed to above 70°F or artificially warm to this temperature in an approved manner. Apply flexible joint sealants to pipe joints immediately before placing pipe in trench, and then connect pipe to previously laid pipe. Backfill after the joint has been inspected and approved.

D. Connections and Stub Ends. Make connections of concrete pipe to existing pipes, pipe storm drains, or storm drain appurtenances as shown on the plans.

Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections. Repair any damage to the existing structure resulting from making the connections.

Unless otherwise shown in the plans, make connections between concrete pipe and corrugated metal pipe with a suitable concrete collar having a minimum thickness of 4 in.

Finish stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the pipe.

Fill lift holes with concrete, mortar, or precast concrete plugs after the pipe is in place.

401.5. MEASUREMENT: This Item will be measured by the foot. Measurement will be made between the ends of the pipe barrel along the flow line, not including safety end treatments. Safety end treatments, if used, will be measured in accordance with TxDOT Standard Specification Item 467, "Safety End Treatment." Pipe that will be jacked, bored, or tunneled will be measured in accordance with Item 406, "Jacking, Boring, or Tunneling." Measurement of spurs, branches, or new connecting pipe will be made from the intersection of the 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, the 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 included. For multiple pipes, the measured length will be the sum of the lengths of the barrels.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by the Engineer. Additional measurements or calculations will be made if adjustments of quantities are required.

401.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reinforced Concrete Pipe," "Reinforced Concrete Pipe (Arch)," or "Reinforced Concrete Pipe (Elliptical)" of the size and D-load specified or of the size and class specified. This price is full compensation for constructing, furnishing, transporting, placing, and joining pipes; shaping the bed; cutting pipes on skew or slope; connecting to new or existing structures; breaking back, removing, and disposing of portions of the existing structure; replacing portions of the existing structure; cutting pipe ends on skew or slope; and equipment, labor, tools, and incidentals.

Protection methods for excavations greater than 5 ft. deep will be measured and paid for as required under Item 550, "Trench Excavation safety Protection," or Item 551, "Special Shoring." Excavation, shaping, bedding, and backfill will be paid for in accordance with Item 400, "Excavation, Trenching and Backfilling." When jacking, boring, or tunneling is used at the Contractor's option, payment will be made under this Item. When jacking, boring or tunneling is required, payment will be made under Item 406, "Jacking, Boring or Tunneling Pipe or Box."

401.7. BID ITEM:

Item 401.1 - Reinforced Concrete Pipe - per linear foot (Class _) (_ inches dia.)

Item 401.2 - Reinforced Concrete Pipe (Arch) - per linear foot (Design Size _)

Item 401.3 - Reinforced Concrete Pipe (Elliptical) - per linear foot (Design Size _)

Item 401.4 - Safety End Treatment (Type __) - per barrel of each structure end

ITEM

402 HIGH DENSITY CURROGATED POLYETHYLENE PIPE

402.1. DESCRIPTION: *This Item shall govern the furnishing and installing of all 18 inch to 60 inch High Density Corrugated Polyethylene pipe for constructing culverts and storm sewer mains, laterals, and stubs. The pipes shall be of the sizes, types, design and dimensions shown on the plans and shall include all connections and joints to new or existing pipes, manholes, inlets, headwalls and other appurtenances as may be required to complete the work.*

402.2. MATERIALS: Unless otherwise specified on the plans or herein, High Density Corrugated Polyethylene (HDPE) pipe and joint fittings shall conform to the following:

A. HDPE pipe and fittings shall be manufactured in accordance with requirements of ASTM F 2306, latest edition. The pipe shall have a full circular cross section, with an outer corrugated pipe wall and a smooth inner wall.

B. Virgin material for pipe and fitting production shall be used and be high density polyethylene conforming with the minimum requirements of cell classification, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%.

C. Minimum Pipe Stiffness (PS) at five percent deflection shall be as described in ASTM F 2306, Section 6.3 when tested in accordance with ASTM D 2412.

D. All HDPE Corrugated and Smooth Lined Pipe shall be certified through the Plastics Pipe Institute (PPI) Third Party Certification program. All HDPE pipe delivered and used shall bear the Third Party Administered PPI seal.

402.3. MARKING: All pipe shall be clearly marked at intervals of not more than 10 ft, and fittings and couplings shall be clearly marked as follows:

A. Manufacturer's name, trade name, or trademark

B. Nominal size

C. Specification designation (e.g. ASTM F 2306)

D. Plant location

E. Date of manufacture

F. Legend polyethylene (PE)

402.4. JOINTS: Joints shall be installed such that the connection of pipe sections will form a continuous line free from irregularities in the flow line. Joints shall conform to one of the following:

A. Integral Bell and Spigot. The bell shall overlap a minimum of two corrugations of the spigot end when fully engaged. The spigot end shall have an O-ring gasket that meets ASTM F 477 "Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe."

B. Exterior Bell and Spigot. The bell shall be fully welded to the exterior of the pipe and overlap the spigot end so that the flow lines and ends match when fully engaged. The spigot

end shall have an O-ring gasket that meets ASTM F 477 "Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe."

C. Watertight Joints. When required, watertight joints shall be in accordance with the requirements of ASTM 3212.

402.5. CONSTRUCTION METHODS:

A. Only trench installation of HDPE pipe will be permitted.

B. Excavation. All excavation shall be in accordance with the requirements of Item 400, "Excavation, Trenching and Backfilling."

1. The width of the trench for pipe installation shall be sufficient, but no greater than necessary, to ensure working room as well as to properly and safely place and compact haunching and other embedment materials. The space between the pipe and trench wall must be wider than the compaction equipment used in the pipe zone. Minimum trench widths are provided in Table 1.

Table 1
Minimum Trench Width

Nominal Pipe Diameter (Inches)	Minimum Trench Width (Inches)
18	39
24	48
30	56
36	64
42	72
48	80
54	88
60	96

2. When flowable backfill is used, the minimum trench width is the pipe outside diameter plus 12 inches.

C. Installation in Embankment. If any portion of the pipe projects above the existing ground level, an embankment shall be constructed as shown in the plans or as directed by the Engineer for a distance outside each side of the pipe location of not less than five times the diameter and to a minimum elevation of 2 feet above the top of the pipe. The trench shall then be excavated to a minimum width as specified in section 402.5.B. above.

D. Bedding. The pipe shall be bedded in accordance with the requirements of Item 400, "Excavation, Trenching and Backfilling," ASTM D 2321, and manufacturer's recommendations. A minimum of 6 inches of bedding shall be provided prior to placement and shall be loosely compacted. Maximum material size limited to 1½ inches.

E. Handling and Storage. Store pipe above ground on adequate blocking. Keep pipe clean and fully drained at all times during storage. Handling and storage of HDPE pipe shall be in accordance with the pipe manufacturer's instructions. Proper facilities shall be provided for

hoisting and lowering pipe into the trench without damaging the pipe or disturbing the bedding or the walls of the trench.

F. Laying Pipe. Unless otherwise authorized by the Engineer, the laying of pipes on the bedding shall be started at the outlet end with the separate sections firmly joined together. Proper facilities shall be provided for hoisting and lowering the section of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Any pipe which is not in alignment or which shows any undue settlement after laying shall be removed and relayed at the Contractor's expense.

G. Parallel Pipe. Multiple installation of HDPE pipe shall be laid with the center lines of individual barrels parallel. Unless otherwise indicated on the plans, the spacing between outer surfaces of adjacent pipes shall be maintained as identified in Table 2.

Table 2
Minimum Parallel Pipe Spacing

Nominal Pipe Diameter (inches)	Spacing Between Pipes (inches)
18	12
24	12
30	15
36	18
42	21
48	24
54	27
60	30

H. Reuse Of Existing Appurtenance.

1. When existing appurtenances are specified on the plans for reuse, the portion to be reused shall be severed from the existing culvert and moved to the new position previously prepared by methods approved by the Engineer.

2. Connections shall conform to the requirements for joining sections of pipes as indicated herein or as shown on the plans. Any headwalls and any aprons or pipe attached to the headwall that are 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.

I. Connections And Stub Ends Connections of pipe to existing pipe or appurtenance shall be as shown on the plans or as directed by the Engineer. The bottom of the existing structure shall be mortared or concreted if necessary, to eliminate any drainage pockets created by the new connection. Where the pipe is connected into existing structures, which are to remain in service, any damage to the existing structure resulting from making the connection shall be restored by the Contractor to the satisfaction of the Engineer. Stub ends, for connections to future work not shown on the plans, shall be sealed by installing watertight plugs into the free end of the pipe.

J. Backfilling.

1. Backfilling shall be in accordance with the requirements of Item 400, "Excavation, Trenching and Backfilling," ASTM D 2321, and manufacturer's recommendations.

2. Maximum material size limited to 1½ inches.

3. Initial backfill shall extend to 12 inches above the top of the pipe. Care shall be taken to insure proper backfill under the pipe in the haunch zone and to insure uniform compacted density throughout the length of the pipe. Backfill material shall be kept at the same elevation on both sides of the pipe.

K. Minimum Cover. For HS-25 Live Loads, the minimum cover is 12 inches for 18 inch to 48 inch diameter pipe and 24 inches for 54 inch and 60 inch diameter pipes.

L. Protection Of The Pipe.

1. Unless otherwise shown on the plans or permitted in writing by the Engineer, no heavy earth moving equipment will be permitted over the structure until a minimum of 3 feet of compacted fill (permanent or temporary) has been placed over the top of the structure.

2. Prior to adding each new layer of loose backfill material, until a minimum of 12 inches 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.

3. Pipe damaged by the Contractor shall be removed and replaced by the Contractor at no additional cost to the City.

402.6. MEASUREMENT:

A. This Item will be measured by the linear foot. Such measurements will be made between the ends of the barrel along its flow line. Where spurs, 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, the 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.

B. For multiple pipes, the measured length will be the sum of the lengths of the barrels, measured as prescribed above.

402.7. PAYMENT:

A. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "HDPE Pipe" of the size and backfill type specified. This price shall be full compensation for furnishing, hauling, placing and joining of pipes; for all connections to new or existing structures; for moving and reusing headwalls where required; for removing and disposing of portions of existing structures as required; for cutting of pipe ends on skew; and for all labor, tools, equipment and incidentals necessary to complete the work.

B. No direct payment shall be made for Excavation, bedding, and backfilling for pipe.

402.8. BID ITEM:

Item 402.1 - Corrugated Polyethylene Pipe - per linear foot (per depth of cut)

ITEM

403 STORM SEWER JUNCTION BOXES AND INLETS

403.1. DESCRIPTION: *Construct junction boxes and inlets, complete in place or to the stage detailed, including excavation and backfilling; furnishing and installing frames, grates, rings and covers. Storm sewer (drainage) junction boxes are classified as junction boxes.*

403.2. MATERIALS: Furnish materials in accordance with the following:

- Item 300, "Concrete"
- Item 301, "Reinforcing Steel"
- Item 307, "Concrete Structures"
- Item 407, "Frames, Grates, Rings, and Covers."

Precast junction boxes, inlets, risers, and appurtenances are acceptable unless otherwise shown. Alternate designs for precast items must be acceptable to the Engineer and not deviate from the functional dimensions given. Alternate designs are to be designed and sealed by a licensed professional engineer.

A. Concrete. Furnish Class A concrete for cast-in-place junction boxes and inlets unless otherwise shown on the plans. Furnish Class A concrete or concrete meeting ASTM C 478 for precast junction boxes and inlets. Air-entrained concrete will not be required in precast concrete members.

B. Mortar. Furnish mortar composed of 1 part hydraulic cement and 2 parts clean sand. Hydrated lime or lime putty may be added to the mix to a maximum of 10% by weight of the total dry mix.

C. Bricks. Furnish first-quality, sound, properly shaped bricks. Provide clay or shale bricks that are homogeneous and thoroughly and uniformly hard-burned and that meet ASTM C 32, Grade MS or MM. Provide concrete bricks meeting ASTM C 55, Type I (Grade S-I). The maximum allowable water absorption of completely dry bricks is 16% by weight when submerged in water for 24-hours.

D. Concrete Blocks. Provide concrete blocks that meet ASTM C 139.

E. Cast Iron or Aluminum. Provide supports and steps conforming to the shape and dimensions shown on the plans that meet the requirements of ASTM A 48, Class 35B, for gray iron castings or ASTM A 536, Grade 65-45-12, for ductile iron castings. Steps may also be aluminum meeting ASTM B 221, Alloy 6005-T5. Provide steps in accordance with ASTM C 478, Section 16, "Steps and Ladders."

F. Timber. Provide sound timber for temporary covers when used with Stage I construction (see Section 403.3, "Construction") that is a minimum of 3 inches nominal thickness and reasonably free of knots and warps.

G. Other Materials. Commercial-type hardware of other materials may be used with prior approval.

403.3. CONSTRUCTION:

A. General. All types of junction boxes and inlets may be built either in 1 stage or in 2 stages, described as Stage I and Stage II. Build junction boxes and inlets designed to match the final roadway surface in stages. Construct Stage II after the pavement structure is substantially complete unless otherwise approved by the Engineer.

Construct the Stage I portion of junction boxes and inlets as shown on the plans or as specified in this Item. Furnish and install a temporary cover as approved by the Engineer.

For Stage I construction of cast iron or steel inlet units, furnish and install the sewer pipe and a temporary plug for the exposed end of the sewer pipe from the storm sewer to a point below the top of curb indicated on the plans.

For Stage II, construct the remaining wall height and top of junction boxes or inlet and furnish and install any frames, grates, rings and covers, junction boxes steps, curb beams, or collecting basins required.

Construct precast junction boxes and inlets in accordance with Item 307, "Concrete Structures," or ASTM C 478. Construct cast-in-place junction boxes and inlets in accordance with Item 307. Forms will be required for all concrete walls. Multi-project fabrication plants (as defined in TxDOT Item 424, "Precast Concrete Structures (Fabrication)") that produce junction boxes and inlets will be approved by the TxDOT Construction Division in accordance with TxDOT DMS 7340, "Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Junction boxes and Inlets." The TxDOT Construction Division maintains a list of approved multi-project plants. Outside wall forms for cast-in-place concrete may be omitted with the approval of the Engineer if the surrounding material can be trimmed to a smooth vertical face. The outside form for concrete bases supporting brick walls may be omitted. Cast steps into the concrete walls when the concrete is placed, or drill and grout steps in place after concrete placement. Mortar steps into joints for brick walls. Use a full bed of mortar for brick work so the brick will thoroughly bond to the mortar. Construct full mortar joints no more than ½-inch wide for brick walls. Furnish a header course or bond course (laid perpendicular to the preceding courses) every fifth course of brick.

B. Junction boxes and Inlets for Precast Concrete Pipe Sewers. Construct junction boxes and inlets for precast concrete pipe sewers as soon as is practicable after sewer lines into or through the junction box or inlet locations are completed. Neatly cut all sewers at the inside face of the walls of the junction box or inlet and point up with mortar.

C. Junction boxes and Inlets for Monolithic Pipe Sewers. Construct bases for junction boxes and inlets on monolithic pipe sewers either monolithically with the sewer or after the sewer is constructed.

D. Junction boxes for Box Sewers. Cast bases for junction boxes for box sewers as an integral part of the sewer. Construct junction boxes before backfilling, or cover the junction box opening temporarily and backfill the sewer as a whole.

E. Inverts. Shape and route floor inverts passing out or through the junction box or inlet as shown on the plans. Shape by adding and shaping mortar or concrete after the base is cast or by placing the required additional material with the base.

F. Finishing Complete Junction boxes and Inlets. Complete junction boxes and inlets in accordance with the plans. Backfill to original ground elevation in accordance with Item 106, "Box Culvert Excavation and Backfilling."

G. Finishing Stage I Construction. Complete Stage I construction by constructing the walls to the elevations shown on the plans and backfilling to required elevations in accordance with Item 106, "Box Culvert Excavation and Backfilling."

H. Stage II Construction. Construct subgrade and base course or concrete pavement construction over Stage I junction box or inlet construction, unless otherwise approved by the Engineer. Excavate to expose the top of Stage I construction and complete the junction box or inlet in accordance with the plans and these Specifications, including backfill and cleaning of all debris from the bottom of the junction box or inlet.

I. Inlet Units. Install cast iron or steel inlet units in conjunction with the construction of concrete curb and gutter. Set the inlet units securely in position before placing concrete for curb and gutter. Form openings for the inlets and recesses in curb and gutter as shown on the plans. Place and thoroughly consolidate concrete for curb and gutter adjacent to inlets and around the inlet castings and formed openings and recesses without displacing the inlet units.

403.4. MEASUREMENT: All junction boxes and inlets satisfactorily completed in accordance with the plans and specifications will be measured by each junction boxes or inlet, complete, or by each junction box or inlet completed to the stage of construction required by the plans. Extension to inlets will be measured by each extension separately from the inlet.

403.5. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for as follows:

A. Complete Junction boxes. Payment for complete junction boxes will be made at the unit price bid for "Junction Box (Complete)" of the type specified.

B. Complete Inlets. Payment for inlets will be made at the unit price bid for "Inlet (Complete)," of the type specified.

C. Inlet Extensions. Payment for inlet extensions will be made at the unit price bid for "Inlet Extension" of the type specified.

These price are full compensation for concrete, reinforcing steel, brick, mortar, aluminum and cast iron castings, frames, grates, rings and covers, excavation, and backfill and for all other materials, tools, equipment, labor, and incidentals.

403.6. BID ITEMS:

Item 403.1 - Junction Box (Complete) 4'x4'x4'

Item 403.2 - Junction Box (Complete) 5'x5'x5'

Item 403.3 - Junction Box (Complete) 6'x6'x6'

Item 403.4 - Junction Box (Complete) 7'x7'x7'

Item 403.5 - Junction Box (Complete) 8'x8'x8'

Item 403.6 - Special Junction Boxes (Complete)

Item 403.7 - Inlet (Complete) 5’

Item 403.8 - Inlet (Complete) 10’

Item 403.9 - Inlet (Complete) 15’

Item 403.10 - Inlet (Complete) 20’

Item 403.11 - Inlet (Complete) 25’

Item 403.12 - Inlet (Complete) 30’

Item 403.13 - Special Inlets (Complete)

Item 403.14 - Inlet Extensions

ITEM

404 CORRUGATED METAL PIPE

404.1. DESCRIPTION: *Furnish and install corrugated metal pipes, materials for constructing corrugated metal pipe culverts, or corrugated metal storm drain mains, laterals, stubs, and inlet leads.*

404.2. MATERIALS:

A. Fabrication. Furnish corrugated metal pipe in accordance with Table 1.

Table1
Specifications for Corrugated Metal Pipe

Pipe Type	AASHTO Specification
Galvanized steel and aluminized steel	M 36
Pre-coated galvanized steel	M 245
Aluminum	M 196

The pipe type and corresponding AASHTO designations are shown in Table 2.

Table2
Corrugated Metal Pipe Types

Pipe Type	AASHTO Classification
Circular	Type I
Circular, smooth-lined	Type IA
Circular, spiral rib	Type IR
Arch	Type II
Arch, smooth-lined	Type IIA
Arch, sprial rib	Type IIR

Provide corrugated metal pipe of all types with annular corrugations, helical corrugations, or spiral ribs (corrugations) projecting outward. Provide pipe with helical end corrugations only when necessary to join new pipe to existing pipe with helical end corrugations.

For pre-coated galvanized steel pipe, provide a minimum polymer coating thickness of 10 mils on each side. Galvanized metal sheets and coils used for galvanized corrugated metal pipe may be sampled and tested in accordance with Tex-708-I.

Repair damaged galvanized coating in accordance with Item 404.3.D, “Repairs.” Repair damaged aluminized or polymer coating in accordance with AASHTO M 36 and M 245 respectively.

B. Protective Coating. When required, furnish bituminous coating that meets AASHTO M 190 and that tightly adheres to the metal, does not chip off in handling, and protects the pipe from deterioration as evidenced by samples prepared from the coating material successfully meeting the Shock Test and Flow Test in accordance with TxDOT Standard Test Method Tex-522-C.

Uniformly coat the pipe inside and out to a minimum thickness of 0.05 in. measured on the crests of the corrugations. When smooth lining is specified, coat the pipe with additional

material applied to the full inner circumference to form a smooth inside lining with a minimum thickness of ⅛ in. above the crest of the corrugations.

C. Design. For full-circle pipe, the diameter, permissible corrugations, and required gauges will be shown. For pipe arch, the design size and permissible corrugations will be shown. For smooth lined pipe, the required gauges of the shell and the liner will also be shown. For steel pipe arch, furnish the shape and minimum gauge in accordance with Tables 3, 4, 5, or 6 for the specified design size and corrugation. For aluminum pipe arch, use Table 7 or 8. Where reference is made to gauge of metal, the reference is to U.S. Standard Gauge for uncoated sheets.

Measure dimensions from the inside crests of the corrugations. A tolerance of ±1 in. or 2% of the equivalent circular diameter, whichever is greater, is allowed for span and rise.

Table 3
Steel Pipe Arch
2-2/3 by 1/2-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
1	17	13	12	16	0.064	15
2	21	15	12	16	0.064	18
2A	23	19	12	16	0.064	21
3	28	20	12	16	0.064	24
4	35	24	12	16	0.064	30
5	42	29	12	14	0.079	36
6	49	33	12	14	0.079	42
7	57	38	12	12	0.109	48
8	64	43	12	12	0.109	54
9	71	47	12	10	0.138	60

Table 4
Steel Pipe Arch
3 by 1-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
7	53	41	12	14	0.079	48
8	60	46	12	14	0.079	54
9	66	51	12	14	0.079	60
10	73	55	12	14	0.079	66
11	81	59	12	14	0.079	72
12	87	63	12	14	0.079	78
13	95	67	12	12	0.109	84
14	103	71	18	12	0.109	90
15	112	75	18	12	0.109	96
16	117	79	18	12	0.109	102
17	128	83	24	10	0.138	108
18	137	87	24	10	0.138	114
19	142	91	24	10	0.138	120

Table 5
Steel Pipe Arch
5 by 1-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
11	81	59	12	12	0.109	72
12	87	63	12	12	0.109	78
13	95	67	12	12	0.109	84
14	103	71	18	12	0.109	90
15	112	75	18	12	0.109	96
16	117	79	18	12	0.109	102
17	128	83	24	10	0.138	108
18	137	87	24	10	0.138	114
19	142	91	24	10	0.138	120

Table 6
Steel Pipe Arch, Spiral Rib
7-1/2 by 3/4 by 3/4-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
2	20	16	12	16	0.064	18
2A	23	19	12	16	0.064	21
3	27	21	12	16	0.064	24
4	33	26	12	16	0.064	30
5	40	31	12	14	0.064	36
6	46	36	12	12	0.064	42
7	53	41	12	12	0.079	48
8	60	46	12	12	0.079	54
9	66	51	15	12	0.079	60

Table 7
Aluminum Pipe Arch
2-2/3-in. by 1/2-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
1	17	13	12	16	0.06	15
2	21	15	12	16	0.06	18
2A	23	19	12	16	0.06	21
3	28	20	12	14	0.075	24
4	35	24	12	14	0.075	30
5	42	29	18	12	0.105	36
6	49	33	18	12	0.105	42
7	57	38	18	10	0.135	48
8	64	43	18	10	0.135	54
9	71	47	18	8	0.164	60

Table 8
Aluminum Pipe Arch, Spiral Rib
7-1/2 by 3/4 by 3/4-in. Corrugations

Design Size	Span (in.)	Rise (in.)	Min. Cover (in.)	Min. Gauge Required	Coated Thickness (in.)	Equivalent Diameter Full-Circle Pipe (in.)
2	20	16	12	16	0.064	18
2A	23	19	12	16	0.064	21
3	27	21	15	16	0.064	24
4	33	26	18	16	0.064	30
5	40	31	18	14	0.075	36
6	46	36	18	12	0.105	42
7	53	41	21	12	0.105	48
8	60	46	18	10	0.135	54
9	66	51	21	10	0.135	60

D. Coupling Bands. Furnish coupling bands and other hardware for galvanized or aluminized steel pipe in accordance with AASHTO M 36 for steel pipe and AASHTO M 196 for aluminum pipe. Do not use coupling bands that are more than 3 nominal sheet thicknesses lighter than the thickness of the pipe to be connected or that are lighter than 0.052 in. for steel or 0.048 in. for aluminum. Provide coupling bands made of the same base metal and coating as the pipe.

404.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

404.4. CONSTRUCTION:

A. Designation of Type. The types of pipes will be indicated on the plans by the following descriptions:

- **Pipe type:** Corrugated metal pipe (CMP), corrugated metal pipe arch (CMP ARCH), spiral rib corrugated metal pipe (SRCMP), or spiral rib corrugated metal pipe arch (SRCMP ARCH);
- **Type of material:** Galvanized steel, aluminum-coated (Type 2), or aluminum;
- **Pipe coating:** Bituminous coated or polymer coated;
- **Special requirements:** Paved invert or smooth lining; and
- **Pipe size:** Diameter or design number.

When pipe is designated as "Corrugated Metal Pipe" without a type of material or pipe coating designation, furnish any of the material types specified above.

B. Excavation, Shaping, Bedding, and Backfill. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation, Trenching and Backfilling," except where jacking, boring, or tunneling methods are shown on the plans or are permitted. Jack, bore, or tunnel in accordance with Item 406, "Jacking, Boring, or Tunneling."

Provide uniform backfill material and uniformly compacted density throughout the length of the structure so that equal pressure is provided. Unless otherwise shown on the plans or permitted in writing, no heavy earth-moving equipment is allowed over the structure until a minimum of 4 ft. of compacted fill (permanent or temporary) has been placed over the top of the structure. Before adding each new layer of loose backfill material, inspect the inside periphery of the structure for local or unequal deformation caused by improper construction methods. Continue inspections until a minimum of 24 in. of cover is obtained. Evidence of such deformation will be reason for corrective measures as directed. Remove and replace pipe damaged by the Contractor at no additional cost to the Department.

C. Laying Pipe. Unless otherwise authorized, lay pipes on the bedding from the outlet end and join the separate sections firmly together with outside laps of annular joints pointing upstream and longitudinal laps on the sides. If any metal in joints is not protected by galvanizing or aluminizing, coat it with a suitable asphalt paint. Lower sections of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Remove and

re-lay, without extra compensation, pipe that is not in alignment or that shows excessive settlement after laying.

Lay multiple installations of corrugated metal pipe and pipe arches with the centerlines of individual barrels parallel. Unless otherwise indicated on the plans, maintain the clear distances between outer surfaces of adjacent pipes given in Table 9.

Table 9
Required Pipe Clear Distances

Diameter Full-Circle Pipe (in.)	Pipe Arch Design Size	Clear Distance Between Pipes (Full-Circle Pipe and Pipe Arch)
18	2	1 ft. 2 in.
21	2A	1 ft. 3 in.
24	3	1 ft. 5 in.
30	4	1 ft. 8 in.
36	5	1 ft. 11 in.
42	6	2 ft. 2 in.
48	7	2 ft. 5 in.
54	8	2 ft. 10 in.
60 to 84	9	3 ft. 2 in.
90 to 120	10 and over	3 ft. 5 in.

D. Jointing. Provide field joints that maintain pipe alignment during construction and prevent infiltration of side material during the life of the installation. Unless otherwise shown on the plans, provide one of the following jointing systems:

1. Coupling Bands. Use coupling bands with annular corrugations only with pipe with annular corrugations or with helical pipe or spiral rib pipe in which the ends have been rerolled to form annular corrugations. Provide bands with corrugations that have the same dimensions as the corrugations in the pipe end or that are designed to engage the first or second corrugation from the end of each pipe. The band may also include a U-shaped channel to accommodate upturned flanges on the pipe.

When helical end corrugations are allowed, field-join pipe with helically corrugated bands or bands with projections (dimples). Coupling bands with projections may be used with pipe that has annular or helical end corrugations or spiral ribs. Provide bands formed with the projections in annular rows with 1 projection for each corrugation of helical pipe or spiral rib pipe. Provide 2 annular rows for bands 10½ in. or 12 in. wide and 4 annular rows of projections for bands 16½ in. or 22 in. wide.

Use a coupling band width that conforms to Table 10. Connect the bands using suitable galvanized devices in accordance with AASHTO M 36. Lap coupling bands equally on each of the pipes to form a tightly closed joint after installation. For corrugations not shown in Table 10, provide at least the minimum coupling band width recommended by the manufacturer.

Table 10
Coupling Band Width Requirements

Nominal Corrugation Size[1] (in.)	Nominal Inside Pipe Diameter[2] (in.)	Minimum Coupling Band Width (in.)		
		Annular Corrugated Bands	Helically Corrugated Bands	Band With Projections
2-2/3 by 1/2	12 to 36	7	12	10-1/2
	42 to 72	10-1/2	12	10-1/2
	78 to 84[3]	10-1/2	12	16-1/4
3 by 1	36 to 72	12	14	10-1/2
	78 to 120	12	14	16-1/4
5 by 1	36 to 72	20	22	12
	78 to 120	20	22	22
7-1/2 by 3/4 by 3/4	18 to 60	10-1/2	12	10-1/2
	66 to 102	10-1/2	12	16-1/4

1. For helically corrugated pipe or spiral rib pipe with rerolled ends, the nominal size refers to the dimensions of the end corrugations in the pipe.
2. Equivalent circular diameter for Type II pipe.
3. Diameter through 120 in. for annular corrugated bands used on rerolled ends of helically corrugated pipe or spiral rib pipe.

The minimum diameter of bolts for coupling bands is ⅜ in. for pipe diameters 18 in. and less and ½ in. for pipe diameters 21 in. and greater. For bands 12 in. wide or less, provide at least 2 bolts. For bands wider than 12 in., provide at least 3 bolts.

Provide galvanized hardware in accordance with Item 445, "Galvanizing."

2. **Bell and Spigot.** Attach the bell to one end of the corrugated metal pipe at the manufacturing plant before shipment. Provide a bell with a minimum 6-in. stab depth. Install the gasket on the spigot end and apply lubricant in accordance with the manufacturer's recommendations. Provide gaskets that meet ASTM F 477 with Type A Shore durometer hardness of 45 ±5. Do not use thermoplastic elastomer as the basic polymer. During laying of the pipe, push the spigot end of the pipe into the bell end of the previously laid pipe.

3. **Pipe Connections and Stub Ends.** Make connections of pipe to existing pipe or appurtenances as shown on the plans or as directed. Mortar or concrete the bottom of the existing structure, if necessary, to eliminate any drainage pockets created by the new connection.

   Insulate portions of aluminum pipe that are to be in contact with metal other than aluminum by a coating of bituminous material meeting the requirements of Section 404.2.B, "Protective Coating." Extend the coating a minimum of 1 ft. beyond the area of contact.

   When connecting pipe into existing structures that will remain in service, restore any damage that results from making the connection. Seal stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the pipe.

404.5. MEASUREMENT: This Item will be measured by the foot. Pipe will be measured between the ends of the barrel along the flow line, not including safety end treatments. Safety end treatments

will be measured in accordance with TxDOT Standard Specification Item 467, "Safety End Treatment." Pipe that is required to be jacked, bored, or tunneled will be measured in accordance with Item 406, "Jacking, Boring, or Tunneling." Where spurs, branches, or connections to existing pipe lines are involved, measurement of the spur or new connecting pipe will be made from the intersection of the 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, the 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 included.

For multiple pipes, the measured length will be the sum of the lengths of the barrels.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by the Engineer. Additional measurements or calculations will be made if adjustments of quantities are required.

404.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Corrugated Metal Pipe," "Corrugated Metal Pipe Arch," "Spiral Rib Corrugated Metal Pipe," or "Spiral Rib Corrugated Metal Pipe Arch" of the type, size, and coating specified. This price is full compensation for furnishing, hauling, placing, and joining of pipes; jointing materials; all connections to new or existing structures; breaking back, removing, and disposing of portions of the existing structure; replacing portions of the existing structure; cutting pipe ends on skew or slope; and equipment, labor, tools, and incidentals.

Protection methods for excavations greater than 5 ft. deep will be measured and paid for as required under Item 550, "Trench Excavation safety Protection," or Item 551, "Special Shoring." Excavation, shaping, bedding, and backfill will be paid for in accordance with Item 400, "Excavation, Trenching and Backfilling." When jacking, boring, or tunneling is used at the Contractor's option, payment will be made under this Item. When jacking, boring or tunneling is required, payment will be made under Item 406, "Jacking, Boring or Tunneling Pipe or Box."

404.7. BID ITEM:

Item 404.1 - Corrugated Metal Pipe - per linear foot

Item 404.2 - Corrugated Metal Pipe Arch - per linear foot

Item 404.3 - Spiral Rib Corrugated Metal Pipe - per linear foot

Item 404.4 - Spiral Rib Corrugated Metal Pipe Arch - per linear foot

ITEM

405 FIBER REINFORCED CONCRETE PIPE

405.1. DESCRIPTION: *Furnish and place fiber reinforced concrete pipe. Include all required joints or connections to new or existing pipe, sewer, manholes, inlets, headwalls, and other appurtenances as may be required to complete the work.*

405.2. MATERIALS:

A. Fabrication. Provide fiber reinforced concrete pipe that conforms to the design shown on the plans and to the latest revision of ASTM C1450.

B. Design. Table 1 shows class and the ultimate saturated D-load equivalents.

Table 1
Minimum Crushing Load
(Circular Pipe)

Class	D-Load (lb./ft./ft.)
I	1,200
II	1,500
III	2,000
IV	3,000
V	3,750

C. Physical Test Requirements. Results of the following tests determine acceptance of the pipe:

- Material tests required in ASTM C 1450.
- Three-edge bearing tests to ultimate load of saturated pipe samples in accordance with ASTM C 497. Perform ultimate 3-edge bearing tests on 1 pipe for each 300 pipes or fraction thereof for each size and class produced within 30 calendar days. Test for the load to produce a 0.01-in. crack or 15% over the required D-load, whichever is less. Test the pipe to ultimate load if so directed. Tested pipe that satisfies the requirements of Section F, "Causes for Rejection," may be used for construction.
- Inspection of the finished pipe to determine its conformance with required design and freedom from defects.

D. Marking. Clearly mark the following information on each section of pipe:

- Class or D-load of pipe
- ASTM designation
- Date of manufacture
- Name or trademark of the manufacturer

E. Inspection. Provide facilities and access to allow for inspection regarding quality of materials, process of manufacture, and finished pipe at the pipe manufacturing plant. In

addition, provide access for inspection of finished pipe at the project site before and during installation.

F. Causes for Rejection. Individual sections of pipe may be rejected for any of the following reasons:

- Fractures or cracks passing through the shell, except for a single-end crack that does not exceed the depth of the joint
- Defects that indicate imperfect proportioning, mixing, or molding
- Surface defects
- Damaged ends where such damage would prevent making a satisfactory joint

G. Repairs. Make repairs if necessary because of occasional imperfections in manufacture or accidental damage during handling. The Engineer may accept pipe with repairs that are sound, properly finished, and cured in conformance with pertinent specifications.

H. Rejections. Allow access for the marking of rejected pipe. Rejected pipe will be plainly marked by the Engineer by painting colored spots over the Department monogram on the inside wall of the pipe and on the top outside wall of the pipe. The painted spots will be no larger than 4 in. in diameter. The rejected pipe will not be defaced in any other manner. Remove the rejected pipe from the project and replace with pipe meeting the requirements of this Item.

I. Joints. All joints must meet requirements of ASTM C443 unless otherwise shown on the plans. Furnish the Manufacturer's Certificate of Compliance for all jointing materials.

Provide rubber gaskets that conform to ASTM C 443. Meet the requirements of ASTM C 443 for design of the joints and permissible variations in dimensions.

405.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

405.4. CONSTRUCTION: Only trench installation of fiber reinforced concrete pipe is permitted.

A. Excavation. Excavate in accordance with the requirements of Item 400, "Excavation, Trenching and Backfilling," following the exceptions stated herein.

The width of the trench for pipe installation must be sufficient but no greater than necessary to ensure working room to place and compact haunching and other embedment materials properly and safely. The space between the pipe and trench wall must be wider than the compaction equipment used in the pipe zone.

When Type I backfill as defined in Article 403.4.H, "Backfilling" is used, the minimum trench width is the pipe outside diameter plus 12 in. When Type II or Type III backfill, as defined in Article 403.4.H, "Backfilling" is used, the minimum trench width is specified in Table 2. The contractor can use any trench width above the pipe zone.

Table 2
Minimum Trench Width

Normal Pipe Diameter (In.)	Minimum Trench Width (In.)
18	44
24	54
30	66
36	78

B. Installation in Embankment. If any portion of the pipe projects above the existing ground level, construct an embankment for a distance outside each side of the pipe location of not less than 5 times the diameter and to a minimum elevation of 2 ft. above the top of the pipe. Then excavate the trench to a width specified herein under "Excavation" in Section 4.

C. Shaping and Bedding. Bed the pipe in a foundation of compacted cohesionless material such as sand, crushed stone, or pea gravel, with a maximum size not exceeding ⅜ inch. Extend this material at least 6 in. below the bottom of the pipe, and shape it carefully and accurately to fit the lowest part of the pipe exterior for a least 10% of the overall height. When requested by the Engineer, furnish a template for each size and shape of pipe to be placed for use in checking the shaping of the bedding. The template must consist of a thin plate or board cut to match the lower half of the cross section of the pipe.

D. Handling and Storage. Handle and store fiber reinforced concrete pipe in accordance with the pipe manufacturer's instructions. Provide proper facilities for hoisting and lowering pipe into the trench without damaging the pipe or disturbing the bedding or the walls of the trench.

E. Laying Pipe. Unless otherwise authorized by the Engineer, start the laying of pipes on the bedding at the outlet end with the separate sections firmly joined together. Provide proper facilities for hoisting and lowering the section of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Remove and relay at the Contractor's expense any pipe not in alignment or showing any undue settlement after laying.

Lay multiple installations of fiber reinforced concrete pipe with the center lines of individual barrels parallel. Maintain clear distances between outer surfaces of adjacent pipes as shown in Table 3:

Table 3
Clear Distances between Outer Edges of Adjacent Pipes

Nominal Pipe Diameter	Clear Distance between Pipes
18 in.	1 ft. 2 in.
24 in.	1 ft. 5 in.
30 in.	1 ft. 8 in.
36 in.	1 ft. 11 in.

F. Reuse of Existing Appurtenance. When existing appurtenances are specified for reuse, use approved methods to sever the portion to be reused from the existing culvert and move it to the new position previously prepared.

Connections must conform to requirements for joining sections of pipes. Restore to their original condition at the Contractor's expense any headwalls and any aprons or pipe attached to the headwall that are damaged during moving operations. The Contractor may remove and dispose of existing headwalls and aprons and construct new headwalls at the Contractor's expense.

G. Sewer Connections and Stub Ends. Make connections of pipe sewer to existing sewers or sewer appurtenance as shown on the plans or as directed by the Engineer. Mortar the bottom of the existing structure or concrete it if necessary to eliminate any drainage pockets created by the new connection. Where the sewer is connected into existing structures that are to remain in service, restore to the satisfaction of the Engineer any damage to the existing structure resulting from making the connection. Seal stub ends, for connections to future work not shown on the plans, by installing watertight plugs into the free end of the pipe.

H. Backfilling. Backfill from the pipe bedding up to 1 ft. above the top of the pipe to provide necessary structural support to the pipe and to control pipe deflection. Take special care in the placement and compaction of the backfill material. Obtain uniform backfill material and uniformly compact it throughout the length of the pipe to avoid unequal pressure. Take care to ensure proper backfill under the pipe in the haunch zone.

Backfill material must meet the following specifications:

- **Type I.** Backfill consists of Item 413, "Flowable Backfill." Place the flowable backfill across the entire width of the trench maintaining a minimum depth of 12 in. above the pipe. Let at least 24 hours elapse before backfilling the remaining portion of the trench with other backfill material in accordance with Item 400, "Excavation, Trenching and Backfilling."

- **Type II.** Backfill consists of Item 412, "Cement Stabilized Sand." Place cement stabilized sand backfill and compact it so that all voids are filled completely.

- **Type III.** Backfill consists of hard, durable, clean granular material that is free of organic matter, clay lumps, and other deleterious matter. It must meet gradation requirements shown in Table 4. Place the backfill material along both sides of the completed structure(s) to a depth of 12 in. above the pipe. Place the backfill in uniform layers not exceeding 6 in. in depth (loose measurement), wetted if required, and thoroughly compacted between adjacent structures and between the structure and the sides of the trench. Until a minimum cover of 12 in. is obtained, only hand-operated tamping equipment is allowed within vertical planes 2 ft. beyond the horizontal projection of the outside surfaces of the structure.

If Type III backfill is utilized, filter fabric shall be placed between the native soil and the backfill. Filter fabric shall conform to the requirements of TxDOT Material Specification DMS - 6200, Type I.

Table 4
Gradation Requirements for Type III Backfill Material

Sieve Number	% Retained (Cumulative)
1 in.	0 - 5
7/8 in.	0 - 35
1/2 in.	0 - 75
3/8 in.	0 - 95
No. 4	35 - 100
No. 10	50 - 100
No. 200	90 - 100

I. Protection of the Pipe. Unless otherwise shown on the plans or permitted in writing by the Engineer, haul no heavy earth moving equipment over the structure until a minimum of 4 ft. of compacted fill (permanent or temporary) has been placed over the top of the structure.

Before adding each new layer of loose backfill material until a minimum of 12 in. of cover is obtained, inspect 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 directed by the Engineer.

Remove and replace any pipe damaged by the Contractor at no additional cost to the State.

405.5. MEASUREMENT: This Item will be measured by the foot. Measurements will be made between the ends of the barrel along its flow line, exclusive of safety end treatments. Safety end treatments shall be measured in accordance with TxDOT Standard Specification Item 467, "Safety End Treatment." Measurement of spurs, branches, 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, the 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 included.

For multiple pipes, the measured length will be the sum of the lengths of the barrels.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by the Engineer. Additional measurements or calculations will be made if adjustments of quantities are required.

405.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Fiber Reinforced Concrete Pipe" of the backfill type, size, and D-load class specified. This price shall be full compensation for constructing, furnishing, transporting, placing, and joining of pipes; cutting pipes on skew or slope; connecting to new or existing structures; breaking back, removing, and disposing of portions of existing structures as required; for cutting of pipe ends on skew; and for all labor, tools, equipment and incidentals necessary to complete the work.

Excavation, bedding, and backfill will be paid for in accordance with Item 400, "Excavation, Trenching and Backfilling."

Type I backfill will be paid for in accordance with Item 413, "Flowable Backfill."

Type II backfill will be paid for in accordance with Item 412, "Cement Stabilized Sand."

405.7. BID ITEM:

Item 405.1 - Fiber Reinforced Concrete Pipe - per linear foot (Class _) (_ inches dia.) (Type _)

ITEM

406 JACKING, BORING, OR TUNNELING PIPE

406.1. DESCRIPTION: *Furnish and install pipe or box by jacking, boring, or tunneling.*

406.2. MATERIALS: Use the following types of pipe or box:

A. Reinforced Concrete Pipe. Reinforced concrete pipe meeting the special requirements for jacking, boring, or tunneling of Item 401, "Storm Drainage Pipe," of the size, strength, and dimension shown on the plans.

B. Reinforced Concrete Box. Reinforced concrete box meeting Item 307, "Concrete Structures" and Item 309, "Precast Reinforced Concrete Box Culverts," of the size and type shown on the plans.

C. Other. Other types specified by the plans.

406.3. CONSTRUCTION: Excavate suitable shafts or trenches for conducting the jacking, boring, or tunneling operations and for placing end joints of the pipe or box if the grade at the jacking, boring, or tunneling end is below the ground surface. Protect excavations deeper than 5-feet as specified in Item 550, "Trench Excavation Safety Protection" or Item 551, "Special Shoring."

Install pipe or box so there is no interference with the operation of street, highway, railroad, or other facility and no embankment or structure is weakened or damaged.

Repair any pipe or box damaged in jacking, boring, or tunneling. Remove and replace any pipe or box damaged beyond repair at the Contractor's expense.

Immediately after installation of pipe or box, backfill shafts or trenches excavated to facilitate jacking, boring, or tunneling. When the excavated shaft or trench lies within the boundaries of the roadbed, backfill the shaft or trench in accordance with Item 306, "Structural Excavation," Section 3, Subpart B. "Backfilling." Backfilling will not be paid for separately but will be considered subsidiary to the work described in this item.

A. Jacking. Provide jacks suitable for forcing the pipe or box through the embankment. Use even pressure to all jacks during operation. Provide a suitable jacking head and suitable bracing between the jacks and the jacking head to apply uniform pressure around the ring of the pipe or circumference of the box. Use joint cushioning of plywood or other approved material. For plywood cushioning material, use ½ inch minimum thickness for pipe diameter 30-inches or less, and use ¾ inch minimum thickness for pipe diameter greater than 30-inches. Use ¾ inch minimum thickness for all boxes. Use cushioning rings of single or multiple pieces. Provide a suitable jacking frame or backstop. Set the pipe or box to be jacked on guides that support the section of the pipe or box, and direct it on the proper line and grade. Place the entire jacking assembly in line with the direction and grade of the pipe or box. In general, excavate the embankment material just ahead of the pipe or box, remove the material through the pipe or box, and force the pipe or box through the embankment with jacks into the space provided.

Furnish a plan showing the proposed method of jacking for approval. Include the design for the jacking head, jacking support or backstop, arrangement and position of jacks, and guides in the plan.

Confirm that excavation for the underside of the pipe for at least ⅓ of the circumference of the pipe conforms to the contour and grade of the pipe. Confirm that the excavation for the bottom slab of the box conforms to the grade of the box. If desired, over excavate to provide not more than 2 inches of clearance for the upper portion of the pipe or box. Taper this clearance to zero at the point where the excavation conforms to the contour of the pipe or box. Pressure-grout any over excavation of more than 1-inch.

The distance that the excavation extends beyond the end of the pipe or box must not exceed 2-feet. Decrease this distance as necessary to maintain stability of the material being excavated.

Jack the pipe or box from the low or downstream end. The final position of the pipe or box must not vary from the line and grade shown on the plans by more than 1 inch in 10 feet. Variation must be regular and in 1 direction, and the final flow line must be in the direction shown on the plans.

If desired, use a cutting edge of steel plate around the head end of the pipe or box extending a short distance beyond the end.

B. Boring. Bore from a shaft in an approved location provided for the boring equipment and workmen.

Dispose of excavated material using a method approved by the Engineer. Use water or other fluids in connection with the boring operation only as necessary to lubricate cuttings; do not use jetting.

In unconsolidated soil formations, use a gel-forming colloidal drilling fluid consisting of high-grade, carefully processed bentonite to consolidate cuttings of the bit, seal the walls of the hole, and furnish lubrication for subsequent removal of cuttings and immediate installation of the pipe.

Allowable variations from line and grade are specified in Section 406.3.A, "Jacking." Pressure-grout any over excavation of more than 1 inch.

Use a pilot hole or auger method for the boring.

1. **Pilot Hole Method.** Bore a 2 inch pilot hole the entire length of the crossing, and check it for line and grade on the opposite end of the bore from the work shaft. This pilot hole will serve as centerline for the larger diameter hole to be bored.

2. **Auger Method.** Use a steel encasement pipe of the appropriate diameter equipped with a cutter head to mechanically perform the excavation. Use augers of sufficient diameter to convey the excavated material to the work shaft.

C. Tunneling. Use an approved tunneling method where the characteristics of the soil, the size of the proposed pipe, or the use of monolithic pipe would make the use of tunneling more satisfactory than jacking or boring or when shown on the plans.

When tunneling is permitted, confirm that the lining of the tunnel is of sufficient strength to support the overburden. Submit the proposed liner method for approval. Approval does not relieve the Contractor of the responsibility for the adequacy of the liner method.

Pressure-grout the space between the liner plate and the limits of excavation.

D. Joints. If corrugated metal pipe is used, make joints by field bolting or by connecting bands, whichever is feasible. If reinforced concrete pipe is used, make the joints in accordance with Item 401, "Storm Drainage Pipe." If reinforced concrete box is used, make the joints in accordance with Item 307, "Concrete Structures" and Item 309, "Precast Reinforced Concrete Box Culverts."

406.4. MEASUREMENT: This Item will be measured by the foot between the ends of the pipe or box along the flow line.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by a Change Order. Additional measurements or calculations will be made if adjustments of quantities are required.

406.5. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Jacking, Boring, or Tunneling Pipe" of the type, size, and class specified; or "Jacking, Boring, or Tunneling Pipe" of the type, size, and design specified; or "Jacking or Tunneling Box Culvert" of the size specified.

This price is full compensation for excavation, grouting, backfilling, and disposal of surplus material; furnishing pipe, box, and pipe liner materials required for tunnel operations; preparation, hauling, and installing of pipe, box, and pipe liner materials; and materials, tools, equipment, labor, and incidentals.

Protection methods for open excavations deeper than 5-feet will be measured and paid for as required under Item 550, "Trench Excavation Safety Protection" or Item 551, "Special Shoring."

406.6. BID ITEM:

Item 406.1 - Jacking, Boring, or Tunneling Pipe - per linear foot

Item 406.2 - Jacking or Tunneling Box Culvert - per linear foot

ITEM

407 CONCRETE ENCASEMENT, CRADLES, SADDLES, AND COLLARS

407.1. DESCRIPTION: *Place concrete encasements, cradles, saddles and collars, when called for by the plans or as directed by the Engineer.*

407.2. MATERIALS: All concrete shall conform to the provisions as shown below or as directed by the Engineer

A. Concrete. Item No. 300, "Concrete (Class B)" or shall be of the class as noted on the plans.

407.3. EQUIPMENT: Provide equipment as required to complete the work specified herein or as directed by the Engineer.

407.4. CONSTRUCTION:

A. Concrete Encasement. When concrete encasement is shown on the plans or when directed by the Engineer, the trench shall be excavated and fine graded to a depth conforming to the details and sections shown on the plans. The pipe shall be supported by precast concrete blocks of the same strength as the concrete for encasement and securely tied down to prevent floatation. Encasement shall then be placed to a depth and width conforming to the details and sections shown on the plans.

B. Concrete Cradles. When concrete cradles are shown on the plans or when called for by the Engineer the trench shall be prepared and the pipe supported in the same manner as described in concrete encasement of this specification and shall be constructed in accordance with details and sections shown on the plans.

C. Concrete Saddles. When shown on the plans or when directed by the Engineer, pipe to receive concrete saddles shall be backfilled in accordance with Item No. 400, "Excavation, Trenching, and Backfill" to the spring line and concrete placed for a depth and width conforming to the details and sections shown on the plans.

D. Concrete Collars. When shown on the plans or when directed by the Engineer concrete collars shall be constructed in accordance with details and sections shown on the plans.

407.5. MEASUREMENT: "Concrete Encasement, Cradles, Saddles, and Collars," will be measured by the cubic yard of accepted work, complete in place.

Reinforcing, if required, shall not be measured for payment.

407.6. PAYMENT: "Concrete Encasement, Cradles, Saddles and Collars" will be paid for at the unit price bid per cubic yard, which price shall be full compensation for furnishing and placing all materials, manipulation, labor, tools, equipment and incidentals necessary to complete the work.

407.7. BID ITEM:

Item 407.1 - Concrete Encasement - per cubic yard

Item 407.2 - Concrete Cradles - per cubic yard

Item 407.3 - Concrete Saddles - per cubic yard

Item 407.4 - Concrete Collars - per cubic yard

ITEM

409 CAST IRON CASTINGS

409.1. DESCRIPTION: *Furnish and install frames, grates, rings and covers for inlets, manholes, and other structures.*

409.2. MATERIALS:

A. Welded Steel Grates and Frames. Provide welded steel grates and frames as an assembly conforming to the member size, dimensions, and details shown on the plans. Fabricate these assemblies in accordance with TxDOT Item 441, "Steel Structures." Use steel that meets ASTM A 36 or equal.

B. Frame, Grate, Ring, and Cover Castings. Provide clean castings conforming to the shape and dimensions shown on the plans. Ensure that the castings are free from sand and blow holes or other defects and that surfaces of the castings are reasonably smooth. Remove runners, risers, fins, and other cast-on pieces from the castings, and grind these areas smooth. Cast or machine the bearing surfaces between manhole rings and covers and between grates and frames with such precision that uniform bearing is provided throughout the perimeter area of contact. Matchmark pairs of machined castings for proper identification at installation.

Provide steel castings conforming to ASTM A 27. Furnish Grade 70 36 unless otherwise specified. Provide gray iron castings conforming to ASTM A 48, Class 35B. Provide ductile iron castings conforming to ASTM A 536. Use Grade 65 45 12 unless otherwise specified. Frame, grate, ring, and cover castings must meet the proof-load testing requirements of AASHTO M 306. Use commercial type frames, rings, risers or appurtenances only with prior approval of the Engineer.

C. Documentation. Furnish mill test reports or manufacturer's certification to the Engineer for each lot or shipment of steel and iron materials. For castings, also furnish a manufacturer's certification stating that the casting meets the proof-load testing requirements of AASHTO M 306.

409.3. CONSTRUCTION: Construct and install frames, grates, rings, and covers in accordance with the details shown on the plans. Weld in accordance with TxDOT Item 448, "Structural Field Welding." Tack-weld grates and covers to the frame or ring when directed by the Engineer.

Galvanize steel castings and welded steel grates and frames in accordance with TxDOT Item 445, "Galvanizing." Galvanizing is not required for iron castings unless used in conjunction with structural steel shapes or shown on the plans.

Provide galvanized bolts and nuts in accordance with TxDOT Item 445, "Galvanizing."

409.4. MEASUREMENT: Frames, grates, rings, and covers, when a part of the complete manhole or inlet, will not be measured for payment but will be considered subsidiary to Item 403, "Storm Sewer Manholes and Inlets." Frames, grates, rings, and covers, when not a part of a Manhole (complete) or Inlet (complete), will be measured by the each.

409.5. PAYMENT: When payment is required in accordance with "Measurement," payment for frames, grates, rings, and covers will be made at the unit price bid for "Grate," "Frame," "Grate and

Frame," "Frame and Cover," or "Ring and Cover." This price is full compensation for equipment, materials, labor, tools, and incidentals.

409.6. BID ITEM:

Item 409.1 - Grate - per each

Item 409.2 - Frame - per each

Item 409.3 - Grate and Frame - per each

Item 409.4 - Frame and Cover - per each

Item 409.5 - Ring and Cover - per each

ITEM

410 SUBGRADE FILLER

410.1. DESCRIPTION: *Furnish and install materials for stabilizing subgrade in trenches, channels, under conduits, cast in-place concrete box culverts, bedding for pre-cast box culverts, or unstable material such as quicksand or muck.*

410.2. MATERIALS: Provide the following subgrade filler materials:

A. Concrete. Concrete subgrade filler composed of concrete conforming to the provisions of Item No. 300, "Concrete (Natural Aggregate)," Class B.

B. Gravel. Gravel subgrade filler composed of well graded, crushed stone or gravel, approved by the Engineer and meeting the gradation requirements of Table 1. Wear must not be more than 40% when tested in accordance with TxDOT standard laboratory test procedure Tex-410-A.

Table 1
Gradation Requirements

Sieve Size	Criteria
2-inch	100% passing
1-3/4-inch	95% passing
¼-inch	90% retained

410.3. CONSTRUCTION: Remove unstable material, such as quicksand and muck, in the subgrade for channel bottoms, box culverts, box conduits, storm sewers, or other structures at established footing or pipe bearing grade, as directed and replace with the specified material:

A. Concrete Subgrade Filler. On subgrade material which is saturated but regarded as stable and where otherwise the construction operations would disturb the subgrade surface, establish a working surface with the material. As directed, remove and replace with the concrete filler material to a depth below the established footing or bearing elevation, compact, and grade the surface to allow forming a subgrade surface of accuracy equivalent to that obtained for normal fine grading of subgrade.

B. Gravel Subgrade Filler. On wet subgrade or other unstable materials regarded as unsatisfactory for support of the structure involved, as directed remove and replace with gravel subgrade material to a depth below the established footing or bearing elevation. Place the material in uniform layers of suitable depth, as directed and grade the surface to allow forming a subgrade surface of accuracy equivalent to that obtained for normal fine grading of subgrade.

410.4. MEASUREMENT: Subgrade Filler will be measured by the cubic yard. The cubic yard will be measured in its final position using the average end area method. The volume is computed between the original ground surface or the surface upon which the embankment is to be constructed and the lines, grades, and slopes of the embankment.

410.5. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Subgrade Filler (Concrete)," or "Subgrade Filler (Gravel)," of the compaction method and type specified.

This price is full compensation for furnishing fill material; hauling; placing, compacting, finishing, and reworking; disposal of waste material; and equipment, labor, tools, and incidentals.

410.6. BID ITEM:

Item 410.1 - Concrete Subgrade Filler - per cubic yard

Item 410.2 - Gravel Subgrade Filler - per cubic yard

ITEM

411 GLASS CULLET USE FOR UTILITY BEDDING AND BACKFILL

411.1. DESCRIPTION: *This item shall consist of furnishing and placing recycled container glass (glass cullet) in utility trenches for bedding and backfill. Glass cullet shall consist of broken food and beverage containers. China dishes, ceramics, or plate glass shall be limited to a maximum of 5 percent by mass of glass cullet.*

411.2. MATERIALS: Glass cullet used for utility bedding and backfill shall be free from vegetation and other objectionable matter and reasonably free from lumps of earth. The glass cullet shall also be free of hazardous products and the contractor is responsible for furnishing the engineer with documentation certifying that the glass cullet complies with Class 3 industrial waste requirements in accordance with 30 TAC 335.507. The source shall be approved by the engineer prior to use.

A. Bedding. Utility bedding material may comprise of up to 100 percent of glass cullet material. The glass cullet material shall conform to the following grading unless shown in plans.

Aggregate Gradation Requirements

Sieve Size	Percent Retained on Sieve
⅝"	0
⅜	0 - 10
#4	30 - 50
#10	50 - 75
#40	80 - 90
#200	90 - 100

A certain amount of debris is allowed in the glass cullet. Such debris may include pieces of paper labels, plastic caps, metal caps, and cork. The level of debris allowed in glass cullet when used as utility bedding shall not exceed 5 percent as estimated using the American Geological Institute Visual Method.

Precautions shall be taken for the safety of the construction personnel handling glass cullet. When glass cullet is to be used in combination with other types of materials, they shall be mixed thoroughly until a uniform mix is achieved to the satisfaction of the engineer.

B. Backfill.

1. **Initial Backfill.** Initial backfill is defined as backfill having a thickness in its compacted state from the surface of bedding to a point one foot (1') above the top of the pipe. Initial backfill shall consist of glass cullet which conforms to the grading requirements of bedding material.

2. **Secondary Backfill.** Secondary backfill is defined as backfill from one foot (1') above the top of the pipe to the top of the trench.

   Glass cullet will not be used for secondary backfill.

411.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

411.4. CONSTRUCTION:

A. Bedding. Where the soil encountered in the utility trench bottom is a quicksand, muck, or other unstable material, the inspector may order its removal to any depth deemed necessary and replacement within uniform layers of glass cullet or other suitable material.

B. Backfill. Glass cullet approved by the engineer, conforming to the requirements set above, may be used for initial backfill. The glass cullet shall be placed in the trench and lightly tamped to consolidate and seat the mass against the conduit and earthen surfaces. Backfill material shall be kept at the same elevation on both sides of pipe.

A filter fabric shall be placed between the top of the glass cullet (initial backfill) and the secondary backfill for the entire length and width of the trench. The filter fabric shall conform to the requirements of Texas Department of Transportation Material Specification 6200, Type1.

411.5. MEASUREMENT: Glass cullet used for bedding and backfill will be measured for payment by the cubic yard of material in place in accordance with this specification, complete and accepted.

411.6. PAYMENT: Payment for glass cullet will be made at the contract unit price bid. Such prices shall include full compensation for removal and disposal of materials below the established subgrade for bedding, backfilling for utility trenches, disposal of the excess excavated material, placement of filter fabric, and all costs in connection therewith shall be included with this item.

411.7. BID ITEM:

Item 411.1 - Glass Cullet Use for Utility Bedding and Backfill - per cubic yard

ITEM

412 CEMENT STABILIZED SAND

412.1. DESCRIPTION: *Construct backfill or bedding composed of sand, hydraulic cement, and water, mixed in an approved plant.*

412.2. MATERIALS: Use materials that meet the following requirements:

A. Cement. Furnish hydraulic cement that meets the requirements of TxDOT's DMS 4600, "Hydraulic Cement," TxDOT's Hydraulic Cement Quality Monitoring Program (HCQMP), and ASTM C-150 Type I Portland Cement. Sources not on the HCQMP or other sources to be used in combination with an approved source will require approval before use.

B. Sand. Furnish sand that is clean, durable, and meeting the following requirements:

1. Deleterious Materials:

a. Clay lumps less than 0.5 percent when tested in accordance with TxDOT standard laboratory test procedure Tex-413-A.

b. Lightweight pieces less than 5.0 percent when tested in accordance with ASTM C123.

c. Organic impurities show a color darker than the standard color when tested in accordance with TxDOT standard laboratory test procedure Tex-408-A.

2. The plasticity index less than or equal to six (6) when tested in accordance with TxDOT standard laboratory test procedure Tex-106-E.

3. Meet the following gradation requirement when tested in accordance with TxDOT standard laboratory test procedure Tex-401-A:

Gradation Chart

Sieve Size	Percent Passing
3/8 in.	100
No. 200	5–30

C. Water. Furnish mixing and curing water that is free from oils, acids, organic matter, or other deleterious substances. Water from municipal supplies approved by the Texas Department of Health will not require testing. When using water from other sources, provide test reports showing compliance with Table 1 of Item 300, "Concrete" before use.

D. Sand-Cement Mixture. Unless otherwise shown on the plans, use a sand-cement mixture that produces a minimum unconfined compressive strength of 100 psi at 48-hours. The minimum percentage of cement to be added with the sand to meet the minimum compressive strength will be determined in accordance with TxDOT standard laboratory test procedure Tex-120-E, Part I or will be based on prior experience with the project materials. If Tex-120-E is utilized to determine the minimum cement percentage, observe the following modifications to the test procedure:

1. Determine the optimum moisture content and maximum density for a soil-cement mixture containing 3% cement, using TxDOT standard laboratory test procedure "Tex-113-E, Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials."

2. Mold 3 specimens for each cement content using 2, 4, and 6% cement to complete the full set.

3. Store test specimens the same day they are molded, with top and bottom porous stones, in the damp room for 48 hours.

Use no less than 1.0 sack of Portland cement per ton of material mixture. Add sufficient water to the mixture to hydrate the cement.

412.3. EQUIPMENT: Provide machinery, tools, and equipment necessary for proper execution of the work.

412.4. CONSTRUCTION: Unless otherwise shown on the plans or directed by the Engineer, mix, place, compact, and accept the cement stabilized sand as described below:

A. Mixing. Mix the cement, sand and water in a pugmill type mixer, which meets the approval of the Engineer. Mix for a minimum period of two minutes per batch.

B. Placing. Place the sand cement mixture in maximum 8 inch thick lifts, loose measure, and thoroughly compact into place around the structure. Perform the placement and compaction in a manner that thoroughly fills all voids without placing undue strain on or displacement of the structure.

Place the cement stabilized sand backfill below the top of sewers, manholes, inlets or other structures equally along all sides of the structure. Place the cement stabilized sand for bedding and/or backfill in a manner that fills all voids in the trench. Should compaction be required to fill all voids in the areas described, hand operated tampers may be used.

C. Compaction. Compact the cement stabilized sand bedding or backfill that is placed in trench bottoms or as initial backfill to a minimum of 95% of the maximum density determined from TxDOT standard laboratory test procedure Tex-120-E, Part II. Refer to the appropriate construction standard specification or project plans for specific details regarding other compaction requirements.

D. Quality Acceptance. Perform in-place density tests at each location, each day, on the placement of bedding and/or backfill materials. The Engineer will perform a minimum of one (1) in-place density on the bedding and two (2) in-place densities on backfill per 50 tons or less per day. For placements greater than 50 tons per day, the Engineer will perform at each location the frequency of one (1) in-place density test per 200 linear feet of bedding and one (1) in-place density test per 100 linear feet of backfill per lift placed above the top of pipe. In-place density tests will be determined in accordance with TxDOT standard test procedure Tex-115-A.

412.5. MEASUREMENT: Cement stabilized sand used for bedding and backfill will be measured for payment by the cubic yard of material in place in accordance with this specification, complete and accepted.

412.6. PAYMENT: Payment for cement stabilized sand will be made at the contract unit price bid. The prices for this item include full compensation for removal and disposal of materials below the established subgrade for bedding, backfilling, disposal of the excess excavated material, and all costs in connection therewith.

When shown on the plans or when other specifications indicate the use of cement stabilized sand is incidental to another pay item, no direct payment for the material will be made.

412.7. BID ITEM:

Item 412.1 - Cement Stabilized Sand - per cubic yard

ITEM

413 FLOWABLE FILL

413.1. DESCRIPTION: *Furnish, mix, test and install flowable fill. Flowable fill is a concrete material suitable as a backfill for utility trenches, abandoned pipes, manholes and valves. It is a heavy material and will exert a high fluid pressure against any forms, embankment, or wall used to contain the backfill.*

413.2. MATERIALS:

A. Cement. Furnish hydraulic cement that meets the requirements of TxDOT's DMS-4600, "Hydraulic Cement," TxDOT's Hydraulic Cement Quality Monitoring Program (HCQMP), and ASTM C-150 Type I Portland Cement. Sources not on the HCQMP or other sources to be used in combination with an approved source will require approval before use.

B. Fly Ash. Furnish fly ash conforming to TxDOT DMS-4610, "Fly Ash."

C. Chemical Admixtures. Furnish chemical admixtures conforming to TxDOT DMS-4640, "Chemical Admixtures for Concrete."

D. Fine Aggregate. Provide fine aggregate that will stay in suspension in the mortar to the extent required for proper flow and that meets the gradation requirements of Table 1. Test fine aggregate gradation in accordance with TxDOT standard laboratory test procedure Tex-401-A. Plasticity Index (PI) must not exceed 6 when tested in accordance with TxDOT standard laboratory test procedure Tex-106-A.

Table 1
Aggregate Gradation Chart

Sieve Size	Percent Passing
¾ in.	100
No. 200	0–30

E. Mixing Water. Use mixing water conforming to the requirements of Item 300, "Concrete."

413.3. CONSTRUCTION: Submit a construction method and plan, including mix design and shrinkage characteristics of the mix, for approval. Provide a means of filling the entire void area, and be able to demonstrate that this has been accomplished. Prevent the movement of any inserted structure from its designated location. If voids are found in the fill or if any of the requirements are not met as shown on the plans, remove and replace or correct the problem without additional cost to the City.

Unless otherwise shown on the plans, furnish a mix meeting the requirements of Sections 413.3.A, "Strength," and 413.3.B, "Consistency."

A. Strength. The compressive strength range, when tested in accordance with TxDOT standard laboratory test procedure Tex-418-A, must be between the following strength values unless otherwise directed by the Engineer or shown on the plans:

1. Low Strength. Between 80 psi and 150 psi at 28 days,

2. **High Strength.** Greater than 500 psi at 28 days. For emergency repairs, strength shall be greater than 50 psi at 2 hours.

Two specimens are required for a strength test, and the compressive strength is defined as the average of the breaking strength of the 2 cylinders.

B. Consistency. Design the mix to be placed without consolidation and to fill all intended voids. Fill an open-ended, 3 inch diameter by 6 inch high cylinder to the top to test the consistency. Immediately pull the cylinder straight up. The correct consistency of the mix must produce a minimum 8 inch diameter circular spread with no segregation.

When necessary, use specialty type admixtures to enhance the flowability, reduce shrinkage, and reduce segregation by maintaining solids in suspension. All admixtures must be used and proportioned in accordance with the manufacturer's recommendations.

Mix the flowable fill using a central-mixed concrete plant, ready-mix concrete truck, pug mill, or other approved method.

Furnish all labor, equipment, tools, containers, and molds required for sampling, making, transporting, curing, removal, and disposal of test specimens. Furnish test molds meeting the requirements of TxDOT standard laboratory test procedure Tex-447-A. Transport, strip, and cure the test specimens as scheduled at the designated location. Cure test specimens in accordance with TxDOT standard laboratory test procedure Tex-447-A. The Engineer will sample, make, and test all specimens. Dispose of used, broken specimens in an approved location and manner. The frequency of job control testing will be at the direction of the Engineer.

C. Shrinkage and Bleeding. Limit shrinkage to 0.5% or less based upon the results from ASTM C 827, "Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures."

413.4. MEASUREMENT: This Item will be measured by the cubic yard of material placed. Measurement will not include additional volume caused by slips, slides, or cave-ins resulting from the Contractor's operations.

413.5. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Flowable Fill (Low Strength)," "Flowable Fill (High Strength)," or "Flowable Fill (High Strength emergency Repair)." This price is full compensation for furnishing, hauling, and placing materials and for equipment, tools, labor, and incidentals.

When shown on the plans or when other specifications indicate the use of flowable fill is incidental to another pay item, no direct payment for the material will be made.

413.6. BID ITEMS:

Item 413.1 - Flowable Fill (Low Strength) - per cubic yard

Item 413.2 - Flowable Fill (High Strength) - per cubic yard

Item 413.3 - Flowable Fill (High Strength Emergency Repair) - per cubic yard

ITEM

414 FLEXIBLE PIPE-TO-MANHOLE CONNECTOR

414.1. DESCRIPTION: *This item shall govern for the furnishing and installation of flexible pipe to manhole connector in accordance with the plans and specifications.*

414.2. MATERIALS: A flexible Pipe-to-Manhole connector shall be employed in the connection of the sanitary and drain sewer pipe to precast manholes.

A. Connector Assembly. The connector assembly shall be the sole element relied on to assure a flexible watertight seal of the pipe to the manhole. The connector shall consist of a rubber gasket, an internal expansion sleeve, and one or more external compression take-up clamps.

1. **Rubber Gasket.** The rubber gasket element shall be constructed solely of poly-isoprene or natural rubber, and shall meet/exceed the requirements of ASTM C-923, and shall have a minimum tensile strength of 1600 PSI. Minimum thickness of the cross-section shall be 0.275 inches.

2. **Internal Expansion Sleeve.** If metal, the internal expansion sleeve shall be made of 11-gauge non-magnetic stainless steel and shall utilize no welds in its construction. Installation shall be performed using either a hydraulic or mechanical insertion tool available from the connector manufacturer.

3. **External Compression Take-Up Clamp.** The external compression take-up clamp(s) shall be constructed of non-magnetic stainless steel and shall utilize no welds in its construction. The clamp(s) shall be installed by torquing the adjusting screw using a torque-setting wrench available from the connector manufacturer.

414.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

414.4. CONSTRUCTION: Selection of the proper size connector for the manhole and pipe requirement, and installation thereof, shall be in strict conformance with the recommendations of the connector manufacturer.

Any dead end pipe stubs installed in connectors shall be restrained from movement per ASTM C-923.

The finished connection shall provide sealing to 13 psi (minimum), and shall accommodate deflection of pipe to 7 degrees (minimum) without loss of seal.

Testing of complete joints, if required, shall be conducted in strict conformance with the requirements of the connector manufacturer.

414.5. MEASUREMENT: No measurement for Flexible Pipe-to-Manhole Connector will be made for furnishing and installing the connector.

414.6. PAYMENT: No direct payment for Flexible Pipe-to-Manhole Connector will be made for furnishing and installing the connector. All materials and labor required will be considered

subsidiary to Item 403, “Storm Sewer Manholes and Junction Boxes” and shall be included in the unit price bid for said item.

414.7. BID ITEM:

N/A

DIVISION V - INCIDENTAL CONSTRUCTION

ITEM

500 CONCRETE CURB, GUTTER, AND CONCRETE CURB AND GUTTER

500.1. DESCRIPTION: *Construct hydraulic cement concrete curb, gutter, and combined curb and gutter.*

500.2. MATERIALS: Furnish materials conforming to:

A. Concrete. Item 300, "Concrete." Use Class A concrete or material specified in the plans. Use Grade 8 coarse aggregate for extruded Class A concrete. Use other grades if approved by the Engineer.

B. Reinforcing Steel. Item 301, "Reinforcing Steel."

C. Expansion Joint Materials. Item 304, "Expansion Joint Materials."

D. Membrane Curing Compound. Item 305, "Membrane Curing."

500.3. EQUIPMENT:

A. General. Provide machinery, tools, and equipment necessary for proper execution of the work.

B. Concrete Forms. Forms shall be of metal and shall extend for the full depth of the concrete. Wooden forms may be used, when authorized by the Engineer, on short radius curves such as at street intersections and at such other locations for which curved metal forms may not be available. Wooden forms may be used in other situations when authorized by the Engineer.

All forms shall be free from warp and of sufficient strength to resist the pressure of the concrete without displacement. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. All forms shall be cleaned and coated with an approved form release agent or form oil before concrete is placed. Divider plates shall be of metal. Forms shall conform to the specified radius when placed on curves.

C. Concrete Curbing Machine. The curb, gutter, or curb and gutter may be constructed by the use of an automatic curb forming machine meeting the following requirements:

1. The weight of the machine shall be such that required compaction is obtained without the machine riding above the bed on which curbing is constructed.

2. The machine shall form curbing that is uniform in texture, shape and density.

3. The forming tube of the extrusion machine or the form of the slipform machine must be easily adjustable vertically during the forward motion of the machine to provide variable heights necessary to conform to the established gradeline.

4. A pointer or gauge shall be attached to the machine so that a continual comparison can be made between the extruded or slipform work and the grade guideline. Other methods may be used when approved by the Engineer.

500.4. CONSTRUCTION: Curbs, gutters, or curb and gutter combinations may be placed using conventionally formed concrete placement or using a City approved self-propelled concrete curbing machine.

Provide finished work with a well-compacted mass and a surface free from voids and honeycomb, in the required shape, line, and grade. Round exposed edges with an edging tool of the radius shown on the plans. Mix, place, and cure concrete in accordance with Item 307, "Concrete Structures." Construct joints at locations shown on the plans. Cure for at least 72 hours unless approved by the Engineer.

Furnish and place reinforcing steel in accordance with Item 301, "Reinforcing Steel."

Set and maintain a guideline that conforms to alignment data shown on the plans, with an outline that conforms to the details shown on the plans.

A. Formed Concrete.

1. **Excavation and Foundation.** Excavate, shape and compact subgrade, foundation, or pavement surface to the line, grade, and cross section shown on the plans. Lightly sprinkle subgrade or foundation material immediately before concrete placement.

   If the subgrade is undercut, or the natural ground is below "top of subgrade," the necessary backfill shall be made with an approved material and compacted with a mechanical tamper. Hand tamping will not be permitted.

2. **Placement.** Place concrete into forms, and strike off with a template ¼ to ⅜ inch less than the dimensions of the finished curb unless otherwise approved. After initial set, plaster surface with mortar consisting of 1 part hydraulic cement and 2 parts fine aggregate. Brush exposed surfaces to a uniform texture.

   Place curbs, gutters, and combined curb and gutters in 50 foot maximum sections unless otherwise approved.

   The reinforcing steel, if required, shall be placed in position as shown on the typical section. Care shall be exercised to keep all steel in its proper location.

   Expansion joint material shall be provided at intervals not to exceed 50 feet, and shall extend the full width and depth of the concrete. Templates for joints shall be of steel, not less than 3/16 of an inch in thickness and patterned to the shape of the curb. Templates shall be cleaned and oiled and spaced to cut the curb in sections 10 feet in length. The templates shall extend a distance of 8 inches into the curb from the top down.

   Two round smooth dowel bars ⅜ of an inch in diameter and 18 inches in length shall be installed at each expansion joint. One 9 inch end of each dowel shall be thoroughly coated with hot oil asphalt so that it will not bond to the concrete; approved types of slip joints may be used in lieu of coating ends of dowels. The dowels shall be placed on the vertical centerline 3 inches from the top and bottom.

Immediately after finishing the curb, it shall be protected by a membrane-compound curing agent.

The curb shall be backfilled to the full height of the concrete, tamped and sloped as directed by the Inspector. The top 4 inches of fill shall be of clean top soil, free of stones and debris.

B. Machine Laid Concrete.

1. **Foundation.** Hand-tamp and sprinkle subgrade or foundation material before concrete placement. Provide clean surfaces for concrete placement. If required, coat cleaned surfaces with approved adhesive or coating at the rate of application shown on the plans or as directed.

2. **Placement.** The concrete shall be fed into the machine in such a manner and at such consistency that the finished curb will present a well compacted mass with a surface free from voids and honeycomb and true to established shape, line and grade.

   Immediately following extrusion any voids between the trench walls and curb shall be filled with well compacted concrete and finished off flush with the surface of the base. Any additional surface finishing specified and/or required shall be performed immediately after the above void-filling operation. Joints shall be cut to a depth of ½ inch at 10 foot intervals or as directed by the Inspector.

   Whenever the curb end abuts a concrete structure a ½ inch, pre-molded, expansion joint, conforming to the curb section, shall be placed between the two concrete surfaces.

   Whenever extrusion is suspended long enough to produce a cold joint, ⅜ inch smooth dowel bars, 18 inches long, shall be embedded 9 inches into the completed curb, one-quarter (¼) curb height from top and bottom. The end of the curb at the point of suspension of extrusion shall be cut back until all remaining concrete is of a dense well compacted nature.

   Any addition of concrete to the extruded curb is to be applied and finished before the extruded curb has achieved its initial set.

   When finishing operations are completed the curb is to be coated with membrane curing compound.

   When the curb has cured, it shall be backfilled to the full height of the concrete, tamped and sloped as directed by the Inspector. The top 4-inches of fill shall be clean top soil, free of stones and debris.

500.5. MEASUREMENT: Accepted work as prescribed by this item will be measured by the linear foot of concrete curb, complete in place.

500.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Curb," "Concrete Curb (Mono)," "Concrete Gutter," or "Concrete Curb and Gutter" of the type specified. This price is full compensation for surface preparation of base, equipment, labor, materials, tools, and incidentals. Topsoil to be paid under Item 515, "Topsoil."

500.7. BID ITEM:

Item 500.1 - Concrete Curb - per linear foot

Item 500.2 - Concrete Curb (Mono) - per linear foot

Item 500.3 - Concrete Gutter - per linear foot

Item 500.4 - Concrete Curb and Gutter - per linear foot

ITEM

502 CONCRETE SIDEWALKS

502.1. DESCRIPTION: *Construct or repair hydraulic cement concrete sidewalks.*

502.2. MATERIALS: Furnish materials conforming to the following:

A. Hydraulic Cement Concrete. Item 300, "Concrete." Use Class A concrete or other concrete as specified. Use Grade 8 course aggregate for extruded Class A concrete. Use other grades if approved by the Engineer.

B. Reinforcing Steel. Item 301, "Reinforcing Steel."

C. Wire Mesh. Item 303, Welded Wire Flat Sheets."

D. Expansion Joint Material: Item 304, "Expansion Joint Materials."

E. Membrane Curing Compound: Item 305, "Membrane Curing."

F. Concrete Structures. Item 307, "Concrete Structures."

502.3. EQUIPMENT: Furnish equipment as required and/or in accordance with the pertinent Items.

502.4. CONSTRUCTION: Routing and location of sidewalks shall be indicated by plans or as directed by the Engineer. Grading of sidewalks shall be a minimum of two feet wider than sidewalk width on straight sections and three feet wider than sidewalk at turns. Grading for sidewalks shall be in accordance with direction by the Engineer. Generally, where sidewalks occur on slopes, grading shall be performed so as to result in curved contours rather than abrupt banks. Fine grading shall prevent pocketing of water. Contractor shall complete final excavation and preparation of subgrade achieving slope, drainage and compaction.

Where a sidewalk crosses a concrete driveway, confirm that the sidewalk depth and reinforcement are not less than the driveway cross-sectional details shown on the plans.

A. Trees and Roots.

1. **Tree Protection.** Trees that are near sidewalk construction shall be protected from construction equipment through the use of fencing or boarding in accordance with *City of San Antonio Tree Protection Details – Tree Preservation Standard Details 1.1.3, "Level II A Fence Protection," 1.1.4, "Level II B Fence Protection,"* or as shown on the plans. Whenever possible, the entire drip line of the tree should be protected from construction activities in accordance with *Tree Preservation Standard Details 1.1.2, "Level I & Fence Protection."*

2. **Root Barriers.** When shown on the plans, install root barriers near the edge of the sidewalk to reduce potential future damage to the sidewalk in accordance with the locations and depths shown on the plans. Unless otherwise shown on the plans, the root barrier shall be thermoplastic panels or sheets.

3. **Root Damage to Existing Sidewalks.** When roots have damaged the sidewalk and repairs are undertaken, the tree roots causing the damage shall be removed. Unless

otherwise shown on the plans, retain the City Arborist to review the trees affected before sidewalk reconstruction begins. The City Arborist will identify roots to be removed and branches to be pruned, if required. Utilize equipment that will provide a sharp clean cut to minimize damage to the tree roots and branches. Prune the tree in accordance with the City Arborist's requirements.

B. Removal of Existing Sidewalk. If an existing sidewalk is to be reconstructed or repaired, remove existing sidewalk to the depths and limits shown on the plans or identified by the Engineer. All concrete sidewalks to be repaired shall be cut with a concrete saw or other equipment approved by the Engineer from existing sidewalks, driveways or other concrete structures. If necessary, remove adjacent soil and vegetation to prevent contamination of the sidewalk area, and place it in a windrow or stockpile. Do not damage adjacent sidewalk or other structures during removal and reconstruction operations. Remove and dispose of existing concrete and other materials from the work area.

C. Subgrade Preparation. Shape and compact subgrade to the line, grade, and cross-section shown on the plans. Mechanically tamp and sprinkle foundation when placement is directly on subgrade.

D. Subbase Placement. A cushion, 2 inch minimum thickness, of crusher screenings, gravel, crushed rock or flexible base material shall be spread, wetted thoroughly, tamped and leveled. The cushion shall be moist at the time the concrete is placed. Where the subgrade is rock or gravel, 70% of which is rock, the 2 inch cushion need not be used. The Engineer will determine if the subgrade meets the above requirement.

If the subgrade is undercut, or the natural ground is below "top of subgrade," the necessary backfill shall be made with an approved material and compacted with a mechanical tamper. Hand tamping will not be permitted.

The foundation shall be level and uniformly compacted to prevent future settlement.

E. Reinforcement. Concrete sidewalks shall be reinforced as shown in the plans. Concrete reinforcement for sidewalks may consist of longitudinal reinforcing steel without traverse reinforcement or as specified by the manufacturer or the Engineer. Steel reinforcement may be omitted if approved by the Engineer.

An alternate method of reinforcing using nylon or polypropylene fibers may be used if approved by Engineer or slip-form paver equipment manufacturer. Nylon fibers shall be used at a rate of one pound (1 lb) per cubic yard or polypropylene fibers at one and a half pounds (1.5 lbs) per cubic yard, unless otherwise specified by the Engineer or slip-form paver manufacturer.

F. Joints. Unless otherwise specified on plans or as agreed to by Engineer, tooled joints with rounded edges will be placed every ten feet (10') and will be opened with one-half inch (½") radius by one and one-half inch (1 ½") depth and closed by one-half inch (½") radius by one-inch (1") depth.

1. **Expansion Joints.** Provide sidewalk sections separated by pre-molded or board joint ½ inch thick, or as shown on the plans, in lengths greater than 8 feet but less than 50 feet, unless otherwise directed. Terminate workday production at an expansion joint. Expansion joint material shall also be placed where the new construction abuts the existing curbs or driveways if the Engineer deems it necessary. The expansion joint

material shall be placed vertically and shall extend the full depth and width of the concrete.

2. **Expansion Joint Dowels.** Unless otherwise shown own the plans, a minimum of two (2) round smooth dowel bars ⅜ inch in diameter and 18 inches in length shall be spaced 18 inches apart at each expansion joint. Nine inches (9") of each dowel shall be thoroughly coated with hot oil asphalt or greased, so that it will not bond to the concrete. Approved types of slip joints may be used in lieu of coating ends of dowels.

3. **Transverse Joints.** Sidewalks shall be marked with transverse "dummy" joints as shown on detail sheets, by the use of City approved jointing tools.

G. Curb Ramps. Curb ramps must include a detectable warning surface and conform to details shown on the plans. Confirm that abrupt changes in sidewalk elevation do not exceed ¼ inch, sidewalk cross slope does not exceed 2%, curb ramp grade does not exceed 8.3%, and flares adjacent to the ramp do not exceed 10% slope.

H. Concrete Placement. Provide a smooth, uniform surface free of debris and loose foundation material for concrete placement. Lightly sprinkle subgrade or foundation material immediately before concrete placement. Mix and place concrete in accordance with the pertinent Items. Hand-finishing is allowed for any method of construction. Finish exposed surfaces to a uniform transverse broom finish surface.

1. **Conventionally Formed Concrete.** Forms shall be of metal or wood and shall extend for the full depth of the concrete. All forms shall be free from warp and of sufficient strength to resist the pressure of the concrete without displacement. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. All forms shall be cleaned and coated with an approved form release agent or form oil before concrete is placed. Divider plates shall be of metal. Forms shall conform to the specified radius when placed on curves.

2. **Extruded or Slip-Formed Concrete.** A slip form paver approved by the Engineer shall lay the sidewalk. Contractor shall set guidelines or guide-rails from survey marks established by the Engineer. Guidelines shall be set to avoid obstacles in the path that may interfere with operation of equipment and overall quality of sidewalk. Sidewalk outline shall strictly conform to the details shown on the plans or as set by Engineer. Slip form equipment shall be operated according to machine specifications and manual for paving accuracy. Slip form equipment shall spread, consolidate and finish the concrete to produce a dense homogeneous concrete true to grade and cross section. Concrete shall be consolidated by the use of internal vibrators. The concrete shall be of such consistency that it will maintain the shape of the sidewalk section without support.

   Where forms are required for transitional zones the forms shall conform to 502.4.G.2. "Conventionally Formed Concrete."

I. Finish and Curing. Provide finished work with a well-compacted mass, a surface free from voids and honeycomb, and the required true-to-line shape and grade. After finishing each portion of the sidewalk, the surface shall be textured with heavy broom finish. Within twenty minutes of broom finish, a curing compound shall be used to protect the sidewalk. The curing compound shall be of a high solid content, greater than thirty percent (+30%). All edges shall be tooled to have slight radius. Surface water retention is not acceptable. Finished surface of

sidewalks shall generally be one-half inch (½ inch) to one inch (1 inch) above existing grade. Concrete must be cured and protected from freezing temperatures for at least three (3) days.

J. Exposed Aggregate Surface. For exposed Aggregate finished sidewalks, wash concrete surface after initial set with staff bristle brush and water to remove matrix and clean each piece of exposed coarse aggregate. Unless otherwise acceptable to the Engineer, perform washing and brushing 3 - 4 hours after casting. Care shall be taken to uniformly expose about a third of each piece of coarse aggregate, removing no more of the matrix than necessary across the panel surface and as required to achieve appearance similar to adjacent existing work. After seven days, follow with a final cleaning with a mild acid solution and final rinsing with clear water.

K. Backfilling. Once sidewalk has cured, sidewalk will need to be backfilled to the full height of the sidewalk with material approve by the Engineer. The top 4 inches of fill shall be tamped and sloped using clean topsoil. Heavy equipment must remain off sidewalks at all times.

All necessary excavation for the sidewalk section, will be considered incidental work pertaining to this item, and will not be paid for directly. The adjacent excavation and grading of the slopes shall be done in a manner acceptable to the Engineer.

502.5. MEASUREMENT: Sidewalks will be measured by the square yard of surface area at the depth specified. Curb ramps will be measured by the square yard of surface area or by each unit. The unit will consist of the curb ramp, landing, adjacent flares or side curb, and detectable warning surface as shown on the plans.

502.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid per square yard for "Concrete Sidewalks - Conventionally Formed" or "Concrete Sidewalks - Machine Laid" an includes curb ramps where applicable. This price is full compensation for surface preparation of base; materials; removal and disposal of existing concrete; excavation, hauling and disposal of excavated material; drilling and doweling into existing concrete curb, sidewalk, and pavement; repair of adjacent street or pavement structure damaged by these operations; and equipment, labor, materials, tools, and incidentals.

Sidewalks that cross and connect to concrete driveways will be measured and paid for in accordance with Item 503, "Asphaltic Concrete, Portland Cement Concrete, and Gravel Driveways."

502.7. BID ITEM:

Item 502.1 - Concrete Sidewalks - Conventionally Formed - per square yard

Item 502.2 - Concrete Sidewalks - Machine Laid - per square yard

ITEM

503 ASPHALTIC CONCRETE, PORTLAND CEMENT CONCRETE, AND GRAVEL DRIVEWAYS

503.1. DESCRIPTION: *Construct and pave driveways. Reconstruct existing driveways.*

503.2. MATERIALS: Furnish materials in accordance with the requirements herein unless otherwise shown on the plans. Provide materials of the type and grade as shown on the plans or directed by the Engineer and in accordance with the pertinent Items listed below:

A. Embankment. Item 107, "Embankment."

B. Lime Treated Subgrade. Item 108, "Lime Treated Subgrade."

C. Cement Treated Subgrade. Item 109, "Cement Treated Subgrade."

D. Flexible Base. Item 200, "Flexible Base."

E. Cement Treated Base. Item 201, "Cement Treated Base."

F. Prime Coat. Item 202, "Prime Coat."

G. Tack Coat. Item 203, "Tack Coat."

H. Surface Treatments. Item 204, "Surface Treatments."

I. Hot Mix Asphaltic Concrete Pavement. Item 205, "Hot Mixed Asphaltic Concrete Pavement."

J. Asphalt Treated Base. Item 206, "Asphalt Treated Base."

K. Concrete Pavement. Item 209, "Concrete Pavements."

L. Concrete. Item 300, "Concrete."

M. Reinforcing Steel. Item 301, "Reinforcing Steel."

N. Welded Wire Reinforcement. Item 303, "Welded Wire Flat Sheets."

O. Epoxy. TxDOT DMS 6100, "Epoxies and Adhesives."

503.3. EQUIPMENT: Furnish equipment as required and/or in accordance with the pertinent Items. Use of a motor grader will be permitted for asphalt concrete pavement unless otherwise shown on the plans.

503.4. CONSTRUCTION:

A. Removal of Existing Driveway or Curbs. If an existing driveway is to be reconstructed, remove existing driveway pavement to the depths and limits shown on the plans or identified by the Engineer using the methods described herein. All concrete and asphaltic concrete driveway pavements shall be cut with a concrete saw or other equipment approved by the

Engineer from existing pavement lanes and/or parking areas. Existing gravel driveways shall be removed with appropriate excavation equipment as shown on the plans or approved by the Engineer. If necessary, remove adjacent soil and vegetation to prevent contamination of the driveway area, and place it in a windrow or stockpile. Do not damage adjacent pavement structure during removal and reconstruction operations.

1. **Existing Asphaltic Concrete Driveway.** Unless otherwise shown on the plans or directed by the Engineer, saw-cut the existing driveway from existing pavement lanes and/or parking areas. The depth of the cut shall be such that upon removal of asphaltic concrete, the sides of the cut will be straight and square. Where existing base materials are to remain, driveway pavements shall be removed to their full depth up to the top of the base material. Care shall be taken not to damage the existing base. Remove or repair loose or damaged base material if present, and replace or repair it with approved base material to the original top of base grade. If subgrade work is required, remove flexible pavement structure layers to the top of subgrade and remove material from work area.

2. **Existing Portland Cement Concrete Driveway.** If required, saw-cut full depth through the concrete around the perimeter of the existing driveway before removal. Do not spall or fracture concrete adjacent to the repair area. Remove or repair loose or damaged base material if present, and replace or repair it with approved base material to the original top of base grade. Allow treated materials used as base material to attain sufficient strength to prevent displacement when placing concrete pavement. If subgrade work is required, remove the entire pavement structure to the top of subgrade and remove material from work area.

3. **Curb Cuts.** If required, saw-cut full depth through the concrete curb before removal. Do not spall or fracture concrete adjacent to the repair area. Remove or repair loose or damaged base material if present, and replace or repair it with approved base material to the original top of base grade. Allow treated materials used as base material to attain sufficient strength to prevent displacement when placing concrete pavement.

B. Preparing Subgrade. For construction of new driveways or vertical and/or horizontal realignment of existing driveways, the subgrade shall be excavated to the depth below the finished grade of the driveway as shown on the plans or directed by the Engineer. For new construction, or reconstruction where the subgrade has been exposed, scarify the top 6 inches of the subgrade, recompact, and shape to the proper line and cross-section as shown on the plans or as directed by the Engineer. Compaction shall be controlled by "Ordinary Compaction" unless "Density Control" is shown in the plans or required by the Engineer.

1. **Ordinary Compaction.** Use approved equipment to compact the subgrade layer. The plans or the Engineer may require specific equipment. Before and during compaction, bring the scarified layer to the moisture content directed. Compact until there is no evidence of further consolidation. Maintain a level layer to ensure uniform compaction. If the required stability or finish is lost for any reason, recompact and refinish the subgrade at no additional expense to the City.

2. **Density Control.** Wet the subgrade to optimum moisture content but not exceeding 3% above the optimum moisture content (W_{opt}) and compact to at least 95% of the maximum dry density (D_a) determined using TxDOT standard laboratory test procedure Tex-114-E. Density of the completed subgrade will be measured in the field in accordance with TxDOT standard test procedure Tex-115-E.

If the subgrade is undercut, or the natural ground is below "top of subgrade," the necessary backfill shall be made with flexible base, or approved material as directed by the Engineer and the applicable item.

C. Placing Base Material. When shown on the plans, place, spread, and compact material in accordance with the applicable Item to the required or directed depth.

1. **Flexible Base.** Place or repair flexible base as required in accordance with Item 200, "Flexible Base," and details shown on the plans to achieve required section.

2. **Cement-Treated Base.** Use existing base, add flexible base if required, and stabilize with a minimum cement content of 3% by weight of the total mixture. Construct in accordance with details shown on the plans and Item 201, "Cement Treated Base," to achieve required section.

3. **Asphalt-Treated Base or Asphaltic Concrete Base.** Place asphalt-treated base in accordance with details shown on the plans and Item 206, "Asphalt Treated Base," or Item 205, "Hot Mix Asphaltic Concrete Pavement," to achieve required section.

D. Curing Base. Cure in accordance with the appropriate Item unless otherwise directed or approved by the Engineer. Maintain completed base sections until surfacing.

E. Surfacing. Apply surfacing with materials as shown on the plans to the completed base section.

1. **Gravel Driveway.** A gravel driveway is defined as a driveway consisting entirely of flexible base material without an asphaltic concrete, Portland cement concrete, or surface treatment layer. The surface of the compacted base shall be smooth and in conformity with typical sections and to the established lines and grades. Prime coat the surface if shown on the plans or directed.

2. **Prime Coat.** Protect the compacted, finished, and cured flexible or cement-treated base mixtures with a prime coat. Unless otherwise shown on the plans, apply prime coat with an approved sprayer at a rate not to exceed 0.20 gallons per square yard of surface. The type and grade shall be shown on the plans or directed by the Engineer.

3. **Surface Treatments.** If shown on the plans, apply surface treatment with the type and grade of asphalt and aggregate as shown on the plans in accordance with Item 204, "Surface Treatments."

4. **Asphalt Concrete Pavement.** Unless otherwise shown on the plans, apply tack coat at a rate not to exceed 0.10 gallons per square yard. The type and grade shall be shown on the plans or directed by the Engineer. Place asphaltic concrete in accordance with Item 205, "Hot Mixed Asphaltic Concrete Pavement," to achieve required section. Testing requirements may be altered or waived by the Engineer.

5. **Portland Cement Concrete Pavement.** If shown on the plans, tie the concrete driveway to concrete pavement or concrete parking lot pavement. Use only drilling operations that do not damage the surrounding operations when drilling holes for replacement steel. Unless otherwise shown on the plans, reinforcement shall consist of either one layer of 6" x 6" - W5 x W5 welded wire flat sheet or No. 3 (⅜") reinforcing steel placed not more than 12 inches on centers both directions. All reinforcement shall be placed equidistant

from the top and bottom of the concrete. Care shall be exercised to keep all steel in its proper position during the depositing of concrete. Splices in wire fabric shall conform to the requirements set forth in Item 303, "Welded Wire Flat Sheets." Splices in the No. 3 bars shall have a minimum lap of 12 inches. For existing driveways with existing steel, place new deformed reinforcing steel bars of the same size and spacing as the bars removed or as shown on the plans. Lap all reinforcing steel splices in accordance with Item 301, "Reinforcing Steel." Epoxy-grout all tiebars for at least a 12 inch embedment into existing concrete. Completely fill the tiebar hole with Type III, Class A or Class C epoxy before inserting the tiebar into the hole. Provide grout retention disks for all tiebar holes. Provide and place approved supports to firmly hold the new reinforcing steel, tiebars, and dowel bars in place.

Place a polyethylene sheet at least 4 mils thick as a bond breaker at the interface of the base or subgrade and new driveway pavement. Provide Class P concrete conforming to Item 209, "Concrete Pavement." Mix, place, and cure concrete to the requirements of Item 209, "Concrete Pavement," and Item 300, "Concrete," unless otherwise shown on the plans. Hand placement of concrete is allowed. The Engineer may wave testing requirements.

If the time frame designated for opening to traffic is less than 72 hours after concrete placement, provide Class HES concrete designed to attain a minimum average flexural strength of 255 psi or a minimum average compressive strength of 1,800 psi within the designated time frame. Type III cement is permitted for Class HES concrete. For driveways that are to be opened to traffic before 72 hours, use curing mats to maintain a minimum concrete surface temperature of 70°F when air temperature is less than 70°F.

Match the grade and alignment of existing concrete pavement. Broom-finish the concrete surface unless otherwise shown on the plans. Saw and seal contraction joints, if shown on the plans or directed by the Engineer, in accordance with Item 209, "Concrete Pavement."

a. Commercial Driveways. Reinforcing for commercial driveways shall consist of either one (1) layer of 6" x 6" - W10 x W10 welded wire flat sheets or No. 4 (½") reinforcing steel placed not more than 12 inches on center both directions. The concrete slab shall be a minimum of 6 inches thick or as shown on the plans.

b. Exposed Aggregate Surface. For exposed Aggregate finished driveways, wash concrete surface after initial set with staff bristle brush and water to remove matrix and clean each piece of exposed coarse aggregate. Unless otherwise acceptable to the Engineer, perform washing and brushing 3 - 4 hours after casting. Care shall be taken to uniformly expose about a third of each piece of coarse aggregate, removing no more of the matrix than necessary across the panel surface and as required to achieve appearance similar to adjacent existing work. After seven days, follow with a final cleaning with a mild acid solution and final rinsing with clear water.

503.5. MEASUREMENT: No separate measurement of excavation, base material, prime coat, tack coat, Portland cement concrete, or asphalt surfacing will be made. Accepted work as prescribed by this item will be measured by the square yard of Portland cement concrete driveway, asphaltic concrete driveway or gravel driveway.

503.6. PAYMENT: The work performed as prescribed by this item will be paid for at the contract unit price bid per square yard for "Portland Cement Concrete Driveway," "Portland Cement Concrete

Driveway - Commercial," "Asphaltic Concrete Driveway," or "Gravel Driveway," which price shall be full compensation for removal of existing driveway (if required), preparing the subgrade, for furnishing and placing all materials, manipulations, labor, tools, equipment and incidentals necessary to complete the work.

503.7. BID ITEM:

Item 503.1 - Portland Cement Concrete Driveway - per square yard

Item 503.2 - Portland Cement Concrete Driveway - Commercial - per square yard

Item 503.3 - Exposed Aggregate Driveway - per square yard

Item 503.4 - Asphaltic Concrete Driveway - per square yard

Item 503.5 - Gravel Driveway - per square yard

ITEM

504 CONCRETE MEDIANS AND ISLANDS

504.1. DESCRIPTION: *Construct cast-in-place concrete medians and directional islands.*

504.2. MATERIALS: Furnish materials in accordance with the following:

A. Hydraulic Cement Concrete. Item 300, "Concrete." Use Class A concrete or other concrete as specified. Use other grades if approved by the Engineer.

B. Reinforcing Steel. Item 301, "Reinforcing Steel."

C. Wire Mesh. Item 303, Welded Wire Flat Sheets."

D. Concrete Structures. Item 307, "Concrete Structures."

504.3. EQUIPMENT: Furnish equipment as required and/or in accordance with the pertinent Items.

504.4. CONSTRUCTION: When shown on the plans, install root barriers behind the curbs of the median or island to reduce potential future damage to the adjoining pavement in accordance with the locations and depths shown on the plans. Unless otherwise shown on the plans, the root barrier shall be thermoplastic panels or sheets.

Provide wood or metal forms securely held in place. Properly position and secure reinforcing steel and dowels. Place concrete for each section on the prepared foundation to line, grade, and cross-section, in accordance with Item 307, "Concrete Structures." Separate sections from adjacent curbs or adjoining sections using expansion or contraction joints of the type and size specified on the plans. A curb section may be used for the perimeter of the median or island when shown. Construct curbs in conformance with Item 500, "Concrete Curb, Gutter, and Combined Curb and Gutter."

Finish exposed surfaces with a wood float after sufficient concrete set. Round exposed edges as shown on the plans.

Remove forms after concrete has set. Point up exposed surfaces. Provide an ordinary surface finish in accordance with Item 307, "Concrete Structures." Use mortar consisting of 1 part hydraulic cement and 2 parts fine aggregate to plaster exposed formed surfaces when required. Apply the mortar with a template made to conform to the cross-section shown on the plans.

Cure at least 72-hours using a method specified in Item 307, "Concrete Structures."

504.5. MEASUREMENT: This Item will be measured by the square yard to the face of the curb.

504.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Median" or "Concrete Directional Island." This price is full compensation for preparing foundation surfaces; furnishing and operating equipment; curbs and gutters used as part of the concrete median or directional island; and labor, materials, tools, and incidentals.

504.7. BID ITEM:

Item 504.1 - Concrete Median - per square yard

Item 504.2 - Concrete Directional Island - per square yard

ITEM

505 CONCRETE RIPRAP

505.1. DESCRIPTION: *This item shall govern for cast in place concrete riprap, furnished in accordance with the details, sections, lines and grades shown on the plans, reinforced as shown thereon, complete with respect to all materials and workmanship in accordance with these specifications.*

505.2. MATERIALS: Materials shall conform to the provisions of the following Items:

A. Concrete. Item 300, "Concrete," Class "B" or shall be of the class as noted on the plans.

B. Reinforcing Steel. Item 301, "Reinforcing Steel"

C. Welded Wire-Flat Sheets. Item 303, "Welded Wire Flat Sheets"

D. Expansion Joint Materials. Item 307.2.E, "Expansion Joint Materials"

E. Membrane Curing Compound. Item 307.2.H, "Curing Materials"

505.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

505.4. CONSTRUCTION:

A. Concrete Reinforcement. Unless otherwise shown on the plans, reinforce concrete riprap with 6 × 6 – W2.9 × W2.9 welded wire fabric or with No. 3 reinforcing bars spaced at a maximum of 18 in. in each direction unless otherwise shown. Alternative styles of welded wire fabric that provide at least 0.058 sq. in. of steel per foot in both directions may be used if approved. A combination of welded wire fabric and reinforcing bars may be provided when both are permitted. Provide a minimum 6-in. lap at all splices. At the edge of the riprap, provide a minimum horizontal cover of 1 in. and a maximum cover of 3 in. Place the first parallel bar at most 6 in. from the edge of concrete. Use approved supports to hold the reinforcement approximately equidistant from the top and bottom surface of the slab. Adjust reinforcement during concrete placement to maintain correct position. Reinforcement protruding from existing riprap shall be thoroughly cleaned.

B. Excavation and Placement Surface. All earthen surfaces on which the riprap is to rest shall be accurately excavated and graded to provide firm bedding for the riprap. As directed, sprinkle or sprinkle and consolidate the subgrade before the concrete is placed. All surfaces must be moist when concrete is placed. It is the intent that the finished surface of the riprap be a continuation of the finished surface of the channel or embankment which it is to protect. All excavation for toe walls shall be, to the extent practicable, made to the neat lines of the concrete sections.

C. Dowels. The new riprap shall be doweled into all concrete that abuts it, both new and existing.

D. Weep Holes. Weep holes and graded fill shall be constructed as shown on the plans or as directed by the Engineer.

E. Expansion Joints. Expansion joint material, ½ inch thick, shall be provided where the new construction abuts existing construction as the Engineer deems it necessary. The expansion joint material shall be placed vertically and shall extend the full depth of the concrete. Similar expansion material shall be placed around all obstructions protruding through the concrete riprap.

F. Finish and Curing. After the concrete has set sufficiently to avoid slumping, compact and shape it to conform to the dimensions shown on plans. After it has set sufficiently to avoid slumping, finish the surface with a wood float to secure a smooth surface or broom finish as approved by the Engineer. Immediately after the finishing operation, cure the riprap according to Item 307, "Concrete Structures."

G. Air Entrainment. If the Contractor so elects, an air entraining admixture, approved as to brand and quality by the Engineer, may be employed to facilitate the placement and finish of the riprap. The entrained air range shall be from 3 to 6 percent.

505.5. MEASUREMENT: Accepted work as prescribed by this item will be measured by the square yard of concrete riprap, complete in place. The area measured for payment will be exposed finished surface which will include all vertical, horizontal and sloping surfaces. Toewalls shall not be measured and are included in the surface measurement of the riprap they protect.

505.6. PAYMENT: The work performed as prescribed by this item, will be paid for at the contract unit price bid per square yard for "Concrete Riprap," which price shall be full compensation for all required excavation, weep holes, graded fill, reinforcing, expansion joint material, dowels, curing and all other materials, labor, and incidentals necessary to complete the work.

Payment for excavation of toewall trenches and for all necessary excavation below natural ground or bottom of excavated channel will be included in the unit price bid per square yard of riprap.

505.7. BID ITEM:

Item 505.1 - Concrete Riprap - per square yard (__ inches thick)

ITEM

506 CONCRETE RETAINING WALL – COMBINATION TYPE

506.1. DESCRIPTION: *This item shall govern for retaining walls composed of Portland Cement Concrete, constructed on a specially doweled sidewalk as herein specified, in conformity with the lines, grades and details shown on the plans or as established by the Engineer.*

NOTE: Item 502, "Concrete Sidewalks" is hereby referenced and made a part of this specification.

506.2. MATERIALS: Materials shall conform to the provisions of the following Items:

A. Concrete. Item 300, "Concrete," Class "A" or shall be of the class as noted on the plans.

B. Reinforcing Steel. Item 301, "Reinforcing Steel"

C. Expansion Joint Materials. Item 307.2.E, "Expansion Joint Materials"

D. Membrane Curing Compound. Item 307.2.H, "Curing Materials"

E. Exposed Aggregate Retaining Walls (Natural Aggregate). All natural aggregate (fine and coarse) shall be obtained from a "Medina River Source" or other similar source. These aggregates shall be of a tan to brown color so as to impart an "earth-tone" color. Samples of the aggregates shall be submitted prior to construction for approval by the Engineer.

506.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

506.4. CONSTRUCTION:

A. Excavation. All excavation shall be performed in accordance with Item 502, "Concrete Sidewalks" and no direct payment shall be made.

B. Placement. All forms and forming, placement of reinforcement, placement of concrete, form removal, finishing and curing shall conform to the provisions of Item 307, "Concrete Structures."

C. Wall Height. The height of the wall will be determined by conditions on the ground, and shall be such that water will not be trapped on private or public property.

D. Reinforcement. Reinforcement for the wall shall be as shown on the plans.

E. Expansion Joints. All expansion joints shall extend the full height and width of the wall.

F. Dowels. The contractor shall provide dowel bars of the proper size, shape and spacing to tie the walk and wall together, as shown on the plans.

G. Walkway. The walk shall also be widened sufficiently so that the wall can be poured on the widened portion of the walk.

H. Exposed Aggregate Finish. Finish for exposed aggregate retaining walls shall conform to the requirements of Item 502, "Concrete Sidewalks."

506.5. MEASUREMENT: Accepted work as prescribed by this item will be measured by the cubic yard, complete in place. Sidewalk construction with retaining wall will not be paid for under this item, but shall be paid for under Item 502, "Concrete Sidewalks." Included for payment as sidewalk shall be that portion under the retaining wall.

506.6. PAYMENT: The work performed as prescribed by this item will be paid for at the contract unit price bid per cubic yard for "Concrete Retaining Wall - Combination Type," which price shall be full compensation for all excavation, forms, concrete, reinforcement, curing, backfilling, sloping, and for all labor, tools, materials, equipment and incidentals necessary to complete the work.

506.7. BID ITEM:

Item 506.1 - Concrete Retaining Walls - Combination Type - per cubic yard

Item 506.2 - Exposed Aggregate Retaining Walls - Combination Type - per cubic yard

ITEM

507 CHAIN LINK WIRE FENCE

507.1. DESCRIPTION: *This item shall govern for chain link fabric supported on posts and with bracing and accessories as shown in the plans or as specified herein, erected complete in place as shown in the plans or as directed by the inspector.*

507.2. MATERIALS: Before installation of the chain link fence, furnish certification from the fence materials manufacturer stating that all fencing materials comply with the requirements of this Item. Use only new materials.

A. General. Furnish materials in accordance with the following:

1. Concrete. Item 300, "Concrete," Class "B."

2. Galvanizing. Texas Department of Transportation Item 445, "Galvanizing."

B. Fabric. Provide wire fabric with:

1. Nine (9) gauge (0.148 in. diameter) steel wire with a minimum breaking strength of 1,290 lb. meeting ASTM A 392 Class I or ASTM A 491;

2. mesh size of 2 in. ±⅛ in. between parallel wires with at least 7 meshes in a vertical dimension of 23 in. along the diagonals of the openings; and

3. knuckled selvages at the top and bottom edge of the fabric, unless otherwise shown on the plans.

C. Posts. Provide posts of the size and weight shown on the plans. Do not provide rerolled or open-seam posts. Use material meeting ASTM F 1083 for all posts. When specified, furnish thin-wall, high-strength pipe posts manufactured by cold rolling using steel strip conforming to ASTM A 1011, CS (Commercial Steel).

D. Post Caps. Provide malleable iron post caps designed to exclude all moisture. If barbed wire is shown on the plans, furnish barbed wire support arms integral with the post caps. If top rail is shown on the plans, furnish post caps with an opening for the top rail. Post caps must have a 2-in. skirt.

E. Gates. Provide gates fabricated from round sections of pipe of the size and weight shown on the plans. Use material meeting ASTM F 1083 for all gate pipes. For each gate, include:

1. corner and tee fittings of malleable iron or pressed steel with means for attaching diagonal bracing members;

2. hinges of malleable iron allowing a full 180° swing, easily operated by one person;

3. ball-and-socket-type bottom hinges that do not twist or turn from the action of the gate and prevent the closed gate from being lifted off the hinges;

4. a positive stop that prevents any portion of the gate from swinging over an adjacent traffic lane;

5. malleable iron pulley systems for roll type gate (only when required);

6. diagonal braces consisting of ⅜-in.-diameter cable with turnbuckles, 2 to each gate frame, and, for vehicle gates, a vertical pipe brace of the size and weight shown on the plans at the center of each gate leaf;

7. latches of malleable iron or steel for single gates with a single-fork latch and padlock eye that will keep the gate closed;

8. two fork latches mounted on a center plunger rod with a padlock eye for double-leaf gates;

9. holdbacks for each leaf of vehicular gates, with a semi-automatic holdback catch anchored at least 12 in. into a 12 in.-diameter by 24 in.-deep concrete footing; and

10. a malleable iron center rest, designed to receive the plunger rod anchored as shown on the plans for all double-leaf gates.

F. Top Rail. When shown on the plans, provide top rail manufactured from 1.660 in. OD standard weight (Schedule 40) steel pipe weighing 2.27 lb. per foot or high-strength pipe weighing 1.82 lb. per foot. Use material meeting ASTM F 1083 for all top rail pipes. Provide pipe in sections at least 18 ft. long joined with outside steel sleeve couplings at least 6 in. long with a minimum wall thickness of 0.70 in. Use couplings designed to allow for expansion of the top rail.

G. Tension Wire. Unless shown on the plans, use 7 gauge (0.177-in.) carbon steel wire with a minimum breaking strength of 1,950 lb. for the bottom edge of all fence fabric, and for the top edge of fence fabric when a top rail is not specified.

H. Truss Bracing. Provide truss bracing as shown on the plans.

I. Stretcher Bars. Provide stretcher bars made of flat steel at least 3/16 in. by ¾ in. and not more than 2 in. shorter than the fabric height. Provide 1 stretcher bar for each gate and end post and 2 stretcher bars for each corner and pull post.

J. Grounds. Provide copper-clad steel rods 8 ft. long with a minimum diameter of ⅝ in., or other UL-listed ground rods.

K. Tie Wire. Wire for attaching fabric to tension wire and to top rail shall be not less than No. 12 gauge galvanized wire, or fastenings in accordance with the manufacturer's standard design. Sufficient fastening material shall be furnished to provide for attaching the fabric to the tension wire and to the top rail and posts at the spacing shown on the plans.

L. Braces and Cables. Braces or cables shall be installed at all corner, tension, terminal and gate posts and shall be extended to adjacent line posts, in accordance with the plans. Braces and trussing material shall be high carbon steel of good commercial quality and shall meet the dimensions and other requirements on the plans. Brace rods shall be ⅜ inch diameter and be equipped with turnbuckles. Cables shall be ⅜ inch diameter and shall be composed of seven wires. Cables shall be installed as shown on the plans, and shall include the use of ⅜ inch drop-forged eye-and-eye, or eye-and-clevis turnbuckles.

M. Steel Pipe. All steel pipe, except for thin-wall, high strength pipe, used for top rails, line posts, corner, tension, terminal or gate posts, braces or gate frames shall conform to the requirements of ASTM A 120. Thin-wall, high strength pipe shall be manufactured by cold rolling using steel strip conforming to ASTM A 569.

N. Galvanizing and Aluminum Coating. Unless specified on the plans, hot-dip galvanize all materials. Fabric and tension wire may be aluminum coated or alloy-coated if approved. When shown on the plans, additionally coat all material except bolts, nuts, and washers with thermally fused polyvinyl chloride (PVC) in accordance with ASTM F 668, Class 2B, meeting the specified color.

1. **Fabric.**

   a. **Galvanizing.** Hot-dip galvanize in accordance with ASTM A 392, Class I.

   b. **Aluminum Coating.** Aluminum-coat in accordance with ASTM A 491.

   c. **Alloy Coating.** Coat with zinc-5% aluminum-mischmetal alloy (Zn-5A1-MM) in accordance with ASTM F 1345, Class I.

2. **Posts.**

   a. **Inside and Outside Galvanizing.** Hot-dip galvanize inside and outside in conformance with ASTM F 1083.

   b. **Alloy Coating.** Coat inside and outside with Zn-5A1-MM in accordance with ASTM F 1043, Class C.

3. **Braces and Gates.**

   a. **Galvanizing.** Hot-dip galvanize braces and gates inside and out in conformance with ASTM F 1083.

   b. **Alloy Coating.** Coat inside and out with (Zn-5A1-MM) in accordance with ASTM F 1043, Class C.

4. **Fittings, Bolts, and Other Miscellaneous Hardware.** Galvanize all fittings, bolts and miscellaneous hardware in conformance with TxDOT Item 445, "Galvanizing."

5. **Tension Wire.** Zinc-coat tension wire with a minimum coating of 0.80 oz./sq. ft. or aluminum-coat with a minimum coating of 0.30 oz./sq. ft.

6. **Barbed Wire.** Zinc-coat barbed wire in accordance with ASTM A 121 (0.80 oz./sq. ft.) or aluminum-coat in accordance with ASTM A 585 (0.30 oz./sq. ft.).

7. **Pull Cable.** Zinc-coat pull cable with a minimum coating of 0.80 oz./sq. ft. of individual-wire surface when tested in conformance with ASTM A 116.

O. Sampling. If there is reason to confirm the Certification provided in 507.2, "Materials," the Contractor shall furnish, upon request of the Engineer, samples of each component part of the fence, including fittings. These samples shall be subjected to the galvanizing, weight and, where applicable, strength tests. A sample may be taken from each shipment and all samples shall be furnished to the City without cost. If a sample or specimen fails to meet the

requirements of this specification, two additional samples or specimens shall be taken from the same shipment and tested, either samples or specimens so tested shall meet the requirements in every respect, or the lot represented by the samples may be rejected.

507.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

507.4. CONSTRUCTION: Erect the chain link fence to the lines and grades established on the plans. Overall height of the fence when erected is the height above the grade shown.

A. Clearing and Grading. Clear all brush, rocks, and debris necessary for the installation of this fencing. Unless otherwise shown on the plans, stake the locations for corner posts and terminal posts. Follow the finished ground elevations for fencing panels between corner and terminal posts. Level off minor irregularities in the path of the fencing.

B. Erection of Posts. Install posts as shown on the plans. Plumb and permanently position posts with anchorages firmly set before fabric is placed. Brace corner and pull posts as shown on the plans.

1. Post Spacing. Space posts as shown in Table 1.

Table 1
Post Spacing and Placement

Post Type	Required Spacing of Placement
Line Posts	at most 10 ft. apart
Tension Posts	at most 330 ft. apart and at each change in direction exceeding 20° vertically
Corner Posts	at each horizontal angle point

Install cables on all terminal posts and extend to adjacent posts. Install cables on each side of corner and pull posts with a ⅜-in. drop-forged eye-and-eye or eye-and-clevis turnbuckle, unless otherwise shown on the plans.

2. Postholes. Drill holes for concrete footings for all posts to provide footings of the dimensions shown on the plans.

Where solid rock is encountered before reaching plan depth, penetrate the solid rock by at least 12 in. (18 in. for end, corner, gate, and pull posts) or to plan depth. Drill holes in the solid rock with a diameter at least 1 in. greater than the outside diameter of the post.

After the posts are set and plumbed, fill the hole in the solid rock with grout consisting of 1 part hydraulic cement and 3 parts clean, well-graded sand. Other grouting materials may be used if approved. Thoroughly work the grout into the hole, leaving no voids. Construct concrete footings from the solid rock to the top of the ground.

3. Gate Posts. Align the tops of all gate frames with the fencing top tension wire or top rail. If curbs are shown on the plans, provide vehicular gates that are greater in overall height than the adjacent fencing by the height necessary to extend to within 2 in. of the pavement between the curbs.

4. **Concrete Footings.** Center posts in their footings. Place concrete and compact by tamping or other approved methods. Machine mix all batches of concrete over ½ cu. yd. Hand mixing concrete is allowed on batches under ½ cu. yd.

   Use forms for footings where the ground cannot be satisfactorily excavated to neat lines. Crown the concrete or grout (for solid rock) to carry water from the post. Keep the forms in place for at least 24 hr. Backfill the footing with moistened material as soon as each form is removed, and thoroughly tamp. Cover concrete with at least 4 in. of loose moist material, free of clods and gravel, immediately after placing concrete. No other curing is required.

   Spread all excess excavated and loose material used for curing neatly and uniformly. Remove excess concrete and other construction debris from the site.

C. Erection of Fabric. After all posts have been permanently positioned and anchorages firmly set, place the fabric with the cables drawn taut with the turnbuckles. Secure one end and apply enough tension to the other end to remove all slack before making attachments. Unless otherwise shown on the plans, cut the fabric and independently attach each span at all corner posts and pull posts.

Follow the finished contour of the site with the bottom edge of fabric located approximately 2 in. above the grade. Grade uneven areas so the maximum distance between the bottom of fabric and ground is 6 in. or less. Fasten fabric at 12 in. intervals to the top and bottom tension wires between posts. When top rail is shown on the plans, fasten the fabric in the same manner. On gate frames, fasten the fabric to the top and bottom of the gate frame at 12 in. intervals. Use steel wire fabric ties of 9 gauge steel or larger.

Fasten fabric to terminal posts by steel stretcher bars and stretcher bar bands fitted with carriage bolts and nuts of the size and spacing shown on the plans. Use stretcher bars to fasten endposts, pull posts, corner posts, and gateposts with stretcher bar bands at intervals of at most 15 in. Attach stretcher bars to terminal posts with 1 in. × ⅛ in. flat steel bands with ⅜-in. carriage bolts at intervals up to 15 in.

D. Electrical Grounds. Provide at least 1 electrical ground for each 1,000 ft. of fence, located near the center of the run. Provide additional grounds directly under the point where power lines pass over the fence. Vertically drive or drill in the grounding rod until the top of the rod is approximately 6 in. below the top of the ground. Connect a No. 6 solid copper conductor to the rod and to the fence by a UL-listed method so that each element of the fence is grounded.

E. Repair of Coatings. Repair damaged zinc coating in accordance with TxDOT Item 445, Section 445.3.D, "Repairs."

507.5. MEASUREMENT: "Chain Link Wire Fence," of the height specified, will be measured by the linear foot of fence at the bottom of the fabric along the center line of the fence from center to center of end posts, exclusive of gates. "Chain Link Wire Fence" shall include all end posts, angle and corner posts, and tension posts, complete in place with all bracing and accessories.

Gates will be measured per each gate of each type, complete in place with gate posts, all bracing and all accessories.

507.6. PAYMENT: "Chain Link Wire Fence" measured as prescribed above, will be paid for at the contract unit price bid per linear foot for "Chain Link Wire Fence" of the height specified, which

price shall be full compensation for furnishing and installing all fencing materials, end posts, angle and corner posts, tension posts, line posts, caps, tension wires, top rail, and connection fittings; digging post holes or setting into retaining wall and structures; furnishing and placing concrete for setting posts; all hauling and hauling charges; and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

Gates measured as prescribed above will be paid for at the contract unit price bid for each "Gate, Pedestrian" or "Gate, Vehicular" of each size called for, which price shall be full compensation for furnishing all materials; fabrication, preparation, hauling, handling charges, and erecting; including gate and gate posts, posts caps, braces, miscellaneous fitting and fastenings, latches, hinges, stops and holding devices; and for all manipulation, labor, tools, concrete for setting posts, equipment and incidentals necessary complete installation.

507.7. BID ITEM:

Item 507.1 - Chain Link Wire Fence - (4 ft. high) - per linear foot

Item 507.2 - Chain Link Wire Fence - (6 ft. high) - per linear foot

Item 507.3 - Chain Link Wire Fence - (8 ft. high) - per linear foot

Item 507.4 - Gates - Pedestrian - per each

Item 507.5 - Gates - Vehicular - per opening

ITEM

508 RELOCATING WIRE FENCE

508.1. DESCRIPTION: *This item shall govern for the removing and relocating the chain link, barbed wire or a combination of woven fence fabric and barbed wire fence(s), maximum six feet high, at the locations designated on the plans, and for furnishing and installing any additional materials required as specified by this item or as indicated on the plans.*

508.2. MATERIALS: All materials furnished shall be equal to or better than the materials of the existing fence unless specifically designated otherwise on the plans.

508.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

508.4. CONSTRUCTION:

A. Chain Link Fence. Repair or replace damaged fence or gates. If posts cannot be repaired by straightening, remove and replace the post and foundation. Backfill all postholes with suitable material. Salvaged fence fabric to be stored shall be rolled in secured rolls not more than 50 ft. long. Dispose of unsalvageable material. All other construction methods shall conform to the provisions of Item 507, "Chain Link Wire Fence."

B. Barbed Wire or Woven Fence Fabric. Fence posts shall be spaced at 12 foot intervals and set in a vertical position to a depth of 2½ feet - 3 feet. Corner and pull (tension) posts shall be braced in two directions. End and gate posts shall be braced in one direction. Where alignment changes 30 degrees or more, a corner post shall be installed. At alignment angles varying between 15 and 30 degrees, the angle post shall be braced to adjacent line posts by diagonal tension wires. Where steel posts are used, a pull post assembly shall be installed at approximately 50 foot intervals and where wood posts are specified the spacing of pull post assemblies shall be approximately 1,000 feet, unless otherwise shown on the plans. Metal line posts may be driven in place providing such driving does not damage the posts. Metal corner, end, pull posts 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 as shown on the plans or as directed by the Inspector. Posts shall be set plumb and firm to the line and grade shown on the plans. Backfilling shall be thoroughly tamped in 4 inch layers.

The corner, end or angle post assembly shall be installed before stretching the wire between line posts. At all grade depressions where stresses tend to pull the posts out of the ground, the fencing shall be snubbed or guyed at the critical point by means of a double 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 pounds, buried in the ground as shown on plans. 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.

508.5. MEASUREMENT: Accepted work as performed and prescribed by this item will be measured by the linear foot of fence relocated.

Gates will not be measured as a separate pay item, but will be included in the linear foot quantity.

508.6. PAYMENT: The work performed and the materials furnished as prescribed by this item will be paid for at the contract unit bid price per linear foot for "Relocating Wire Fence," which price shall be full compensation for removing and reinstalling the existing fence and gates, and for furnishing all additional materials, for all labor, tools, equipment and incidentals necessary to complete the work.

508.7. BID ITEM:

Item 508.1 - Relocating Wire Fence - per linear foot

ITEM

509 METAL BEAM GUARD RAIL

509.1. DESCRIPTION: *This item shall govern for the installation of one line of metal beam rail element supported on timber posts. Metal beam guard rail shall be constructed of materials and workmanship as prescribed by these specifications, at such places as shown on the plans or as designated by the Engineer, and in conformity with the plans and typical details shown.*

509.2. MATERIALS: When directed, provide samples of metal beam rail elements, terminal sections, bolts, and nuts for testing for compliance with the physical and chemical property requirements of AASHTO M 180 in accordance with Texas Department of Transportation (TxDOT) Test Methods Tex-708-I and Tex-713-I.

A. Metal Beam Rail Elements. Furnish new metal beam rail elements for rail and terminal anchor sections that meet the requirements of Table 1. Type I or II is allowed unless otherwise shown on the plans. Base metal for metal beam rail elements must not contain more than 0.04% phosphorous nor more than 0.05% sulfur.

Furnish metal beam rail elements from TxDOT approved manufacturers. A list of approved manufacturers is maintained by the Construction Division of TxDOT.

Table 1
Post Spacing and Placement

Specification	AASHTO M 180
Class	A – Base metal nominal thickness 0.105 in. ±0.008 in., or B – Base metal nominal thickness 0.135 in. ±0.008 in.
Type	I – Zinc-coated 1.80 ounces per square foot minimum single-spot, or II – Zinc-coated 3.60 ounces per square foot minimum single-spot. IV – Weathering Steel (required when shown on the plans).
Shape	W-beam or thrie beam or W-beam-to-thrie-beam transition.
Markings	Permanently mark each metal beam rail element with the information required in AASHTO M 180. Permanently mark all curved sections of metal beam rail element with the radius of the curved section in the format "R = xx ft." Markings (die-imprinted letters and numerals no more than ½ in. high) must be on the back of the metal beam rail section away from traffic and visible after erection.

Where painting and/or striping is expressly required on the plans, the rail elements need not be galvanized, but shall be painted in accordance with Item 514, "Paint and Painting."

B. Posts. Furnish new round timber, rectangular timber, or rolled steel section posts in accordance with details shown in the plans and the following requirements:

1. Timber Posts. Meet the requirements of TxDOT DMS-7200, "Timber Posts and Blocks for Metal Beam Guard Fence."

2. Steel Posts. Provide rolled sections conforming to the material requirements of ASTM A 36. Drill or punch posts for rail attachment as shown on the plans. Galvanize in accordance with TxDOT Standard Specification Item 445, "Galvanizing."

C. Blocks. Furnish new rectangular timber or composite blocks in accordance with details shown in the plans and the following requirements:

1. **Timber.** Meet the requirements of TxDOT DMS-7200, "Timber Posts and Blocks for Metal Beam Guard Fence."

2. **Composite.** Meet the requirements of TxDOT DMS-7210, "Composite Material Posts and Blocks for Metal Beam Guard Fence."

D. Fittings. Furnish new fittings (bolts, nuts, and washers) in accordance with the details shown on the plans and galvanized in accordance with TxDOT Standard Specification Item 445, "Galvanizing."

E. Terminal Connectors. Furnish new terminal connectors, where required, meeting the material and galvanizing requirements specified for metal beam rail elements.

F. Concrete. Furnish concrete for terminal anchor posts meeting the requirements for Class A concrete as required in Item 300, "Concrete."

G. Curb. If indicated in the details, furnish the curb shown with metal beam guard fence transition as required by Item 500, "Concrete Curb, Gutter, And Concrete Curb And Gutter."

509.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

509.4. CONSTRUCTION: Install posts and rail elements in accordance with the details shown on the plans.

A. Posts. Install posts by either drilling or driving.

1. **Drilling.** Drill holes and set posts plumb and firm to the line and grade shown. Backfill posts by thoroughly tamping the fill material in 4 in. layers.

2. **Driving.** Drive posts plumb with approved power hammers (steam, compressed air, vibratory, or diesel) or gravity hammers to the line and grade shown. Use a structural steel driving head suitable for the type and size of post being driven with wood cushion blocks as necessary to prevent damage to the post. Rope mat, belting, or other similar cushioning material may be used in addition to wood cushion blocks. Use pilot holes when required or permitted. Determine the size and depth of pilot holes with the approval of the Engineer based on results of trial operations of the first few posts driven. Thoroughly tamp loosened soil around the post, fill with suitable material any void between the soil and the post resulting from the driving, and thoroughly compact to the density of adjacent undisturbed material.

B. Rail Elements. Erect metal beam rail elements to produce a smooth, continuous rail paralleling the line and grade of the roadway surface or as shown on the plans. Bolt rail elements end to end and lap in the direction of traffic in the lane adjacent to the guard fence. Curve metal beam rail elements during fabrication, to the radius shown. Field-drill or punch holes in rail elements for special details only when approved.

C. Terminal Anchor Posts. Embed terminal anchor posts in concrete unless otherwise shown on the plans.

D. Galvanizing Repair. After erection, repair all parts of galvanized steel posts, washers, bolts, and rail elements on which the galvanizing has become scratched, chipped, or otherwise damaged. Repair in accordance with TxDOT Item 445, Section 445.3.D, "Repairs."

E. Guard Rail Adjustment. Work includes vertical adjustment of the rail element. Perform work in accordance with details shown on the plans. Materials provided by the Department will be as shown on the plans.

F. Curb. If indicated in the details, construct the curb shown with metal beam guard fence transition as required by Item 500, "Concrete Curb, Gutter, And Concrete Curb And Gutter."

G. Painting. Where painting is specified, after erection all parts of painted steel rail elements on which the primer coat has been scratched or chipped shall be thoroughly cleaned and spot painted with the paint specified for the first field coat. The spot coat shall be allowed to dry for at least 12 hours, after which the beam and posts shall be painted with the first field coat. After the first field coat has dried for at least 48 hours, the second field coat shall be applied.

509.5. MEASUREMENT: Accepted work as prescribed by this item will be measured by the linear foot of rail, complete in place. Measurement shall be made upon the face of rail, from center to center of end posts or terminal anchor.

509.6. PAYMENT: The work performed as prescribed by this item will be paid for at the contract unit price bid per linear foot, measured as prescribed above, for "Metal Beam Guard Rail," which price shall include the terminal anchor section and be full compensation for furnishing all materials, for all preparation, hauling and erection and painting of same, for setting posts in concrete when specified, and for all labor, tools, equipment and incidentals necessary to complete the work, including excavation, backfilling and disposal of surplus material.

509.7. BID ITEM:

Item 509.1 - Metal Beam Guard Rail - per linear foot

ITEM

510 TIMBER GUARD POSTS

510.1. DESCRIPTION: *This item shall govern for installation of posts only and shall be constructed of materials and workmanship as prescribed by these specifications, at such places as shown on the plans or as designated by the Engineer, and in conformity with the designated plan and typical details shown.*

510.2. MATERIALS:

A. Timber Guard Posts. Meet the requirements of TxDOT DMS-7200, "Timber Posts and Blocks for Metal Beam Guard Fence." Timber Guard Posts shall consist of "Round Posts" only. Posts shall not be less than 7 inches in diameter at any point and shall be a minimum of 6 feet long. The bottom shall be sawed off square. All posts shall have two (2) strips of reflective sheeting as specified and shown on the plans.

B. Paint. All paint and painting if required shall conform to the requirements specified in Item 514, "Paint and Painting."

510.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

510.4. CONSTRUCTION: Posts shall be set in holes with 3 feet exposed above ground, as shown in the plans. The posts shall be set plumb and firm to the line and grade, shown on the plans. Backfilling shall be thoroughly tamped in 4 inch layers.

510.5. MEASUREMENT: "Timber Guard Posts" will be measured as each post, complete in place.

510.6. PAYMENT: The work performed and material as prescribed by this item, measured as provided under "Measurement" will be paid for at the contract unit price bid for "Timber Guard Posts," which price shall be full compensation for furnishing all materials, for all preparation, hauling and installation of same, and for all labor, tools, equipment and incidentals necessary to complete the work, including furnishing and applying all paint, excavation, backfilling and disposal of surplus material.

510.7. BID ITEM:

Item 510.1 - Timber Guard Posts - per each

ITEM

511 CUTTING AND REPLACING PAVEMENTS (TRENCH REPAIR)

511.1. DESCRIPTION: *Cut pavements, remove base, and replace base material and pavements on cuts up to six (6) feet in width.*

511.2. MATERIALS: Furnish materials conforming to the following:

A. Tack Coat. Item 203, "Tack Coat."

B. Surface Treatments. Item 204, "Surface Treatments."

C. Hot Mixed Asphaltic Concrete Pavement. Item 205, "Hot Mixed Asphaltic Concrete Pavement."

D. Asphalt Treated Base. Item 206, "Asphalt Treated Base."

E. Hydraulic Cement Concrete. Item 300, "Concrete."

F. Reinforcing Steel. Item 301, "Reinforcing Steel."

G. Membrane Curing Compound: Item 305, "Membrane Curing."

511.3. EQUIPMENT: Furnish equipment in accordance with the pertinent Items. Use of a motor grader will be permitted for placement of asphalt concrete pavement unless otherwise shown on the plans.

511.4. CONSTRUCTION: Repair using one or more of the following operations as shown on the plans. Cut neat vertical faces around the perimeter of the work area when removing pavement structure layers. Removed materials are the property of the Contractor unless otherwise shown on the plans. Dispose of removed material in accordance with federal, state, and local regulations. Provide a smooth line and grade conforming to the adjacent pavement.

A. Removing Upper Pavement Layers. All concrete and asphaltic concrete pavements shall be cut with a concrete saw or other approved equally capable equipment. If necessary, remove adjacent soil and vegetation to prevent contamination of the repair area, and place it in a windrow. Do not damage adjacent pavement structure during repair operations.

1. **Cutting Existing Asphaltic Concrete Layers.** The depth of the cut shall be such that upon removal of asphaltic concrete, the sides of the cut will be straight and square. Where existing base materials are to remain, pavements shall be removed to their full depth up to the top of the base material. Care shall be taken not to damage the existing base. If subgrade work is required, remove flexible pavement structure layers from work area.

2. **Cutting Existing Portland Cement Concrete Layers.** Remove areas identified by the Engineer. Saw-cut and remove existing asphalt concrete overlay over the repair area and at least 6 inches outside each end of the repair area. Saw-cut full depth through the concrete around the perimeter of the repair area before removal. Do not spall or fracture concrete adjacent to the repair area. Care shall be taken, when cutting concrete pavement, not to cut transverse reinforcing steel.

3. **Cutting Surface Treatments.** Asphalt surface treatments shall be cut by means of sharp axes or hand held pneumatic tools with wedge bits, or other approved equipment.

B. Removal of Underlying Layers (Bases).

1. **Concrete and Cement Stabilized Bases:** Remove by means of hand held pneumatic pavement breakers with approved cutting bits. It is the intent of this specification that the base shall be removed in a manner that will leave the sides of the cut straight and square.

   Where reinforcement is encountered in concrete bases, a minimum of 1 foot shall be cleaned of all old concrete and left in place to tie to new reinforcement in the new concrete base.

2. **Flexible Bases.** Remove by normal trenching operations.

C. Replacement of Underlying Layers (Bases).

1. **Concrete Base.** Replace concrete bases with Class "A" concrete conforming to the provisions of Item 300, "Concrete." If existing concrete is steel reinforced, the reinforcing steel shall be replaced in accordance with Item No. 301, "Reinforcing Steel." The concrete shall have a slump of not more than 3 inches and shall be spaded, tamped and finished to the satisfaction of the Engineer. Immediately following finishing operations, the surface shall be cured in accordance with the provisions of Item 305, "Membrane Curing." The concrete shall be protected from traffic for seventy-two (72) hours.

2. **Stabilized or Flexible Base.** Unless otherwise shown on the plans, replace cement stabilized, asphalt treated, asphaltic concrete, or flexible bases with Type B asphaltic concrete base in accordance with Item 205, "Hot Mix Asphaltic Concrete Pavement" or other materials approved by the Engineer.

D. Replacement of Upper Pavement Layers. Pavement layers shall be replaced under this item in the thickness and type shown on the plans or as directed by the Engineer.

1. **Asphaltic Concrete.** Hot mix asphaltic concrete shall be furnished and placed in accordance with Item 205, "Hot Mix Asphaltic Concrete Pavement." All concrete bases shall receive a tack coat of asphalt or emulsion in accordance with the provisions of Item 203, "Tack Coat" prior to placement of hot mix asphaltic concrete.

2. **Portland Cement Concrete.** When Portland cement concrete pavement is indicated on the plans as the replacement pavement, "Class A" concrete in accordance with Item 300, "Concrete," shall be placed conforming to the methods described in 511.4.C.1. "Concrete Bases." The concrete shall be placed, spaded, tamped and finished to the line, grade and texture of the surrounding concrete pavement.

3. **Surface Treatments.** Where the existing pavement is shown to be a single or double surface treatment on the plans, the replacement surface pavement will not be constructed under this item. Such surface treatments will be constructed to the widths and details shown on the plans and measured and paid under Item 204, "Surface Treatments" or other items as directed by the Engineer.

511.5. MEASUREMENT: Cutting and replacing pavements will be measured by the square yard of pavement so cut and replaced, of the type and depth indicated in the plans and bid proposal and of the limits shown in the plans. Materials used in replacing bases and pavements such as flexible base, cement stabilized base, concrete, reinforcing steel, prime coat, tack coat and asphaltic concrete pavement will not be measured directly for payment. Depth will be measured from the top of pavement to the bottom of new base material.

511.6. PAYMENT: Payment for cutting and replacing pavements will be made at the contract unit price bid per square yard for "Cutting and Replacing Pavements" of the type and depth classification shown on the plans. Where the depth of replaced base and pavement differs from that shown on the plans and bid proposal, the contract unit price bid per square yard shall be adjusted by the ratio of the actual depth of pavement and base replaced to the depth shown on the plans and in the bid proposal. Such variations in depth shall be subject to approval of the Engineer in writing.

The contract unit price bid for "Cutting and Replacing Pavements" shall be considered as full compensation for cutting pavements, removing bases, replacing bases and pavements, removing and disposing of all surplus materials, furnishing and placing all new materials, and for all manipulations, work, tools, equipment, labor and incidentals necessary to complete the work.

511.7. BID ITEMS:

Item 511.1 - Replacing with Flexible Base and Pavement - __inches compacted depth - per square yard

Item 511.2 - Replacing with Cement Stabilized Base and Pavement __inches depth - per square yard

Item 511.3 - Replacing with Hot Mix Asphaltic Concrete Pavement - Type B __inches compacted depth - per square yard

Item 511.4 - Replacing with Portland Cement Concrete Pavement - __inches depth - per square yard

Item 511.5 - Replacing with Flexible Base and Surface Treatment - __inches compacted depth - per square yard

ITEM

512 ADJUSTING EXISTING MANHOLES AND VALVE BOXES

512.1. DESCRIPTION: *Adjustment of all existing manholes and valve boxes by either lowering or raising the top elevation to match the final profile grade line and includes the reconstruction of existing manholes or valve boxes in conformity with the provisions of these specifications.*

512.2. MATERIALS: Provide materials as provided herein or as shown on the plans.

A. Concrete. Item No. 300, "Concrete (Class B)."

512.3. EQUIPMENT: Provide equipment necessary to conduct the work specified herein or as directed by the Engineer.

512.4. CONSTRUCTION:

A. Manholes. Perform all work in conformance with Sections 1. "Lowering Manholes", 2. "Raising Manholes" and 3. "Reconstructing Existing Manholes" unless otherwise shown on the plans. Existing manhole rings, risers, and covers which are determined by the Inspector to be in an unacceptable condition, will be removed and replaced with new rings, risers, and cover. Contractor shall take all necessary measures to prevent damage to existing or new rings, risers, covers, or cones from equipment and materials used in or taken through the work area. If an existing or new manhole cover, ring, riser, or cone is damaged by the Contractor, it shall be replaced, as directed by the Engineer, by the Contractor at his expense.

1. Lowering Manholes. Manholes shall be lowered below subgrade before placing base materials and openings shall be protected by hatch covers. Manholes shall be adjusted after the base material has been laid and before placing of the surface course. Material excavation from around the manholes shall be replaced with concrete in accordance with Standard Drawings, and select materials from the excavation as shown on the plans or specified by the Engineer. All excess materials shall be disposed of by the Contractor at his own expense and in an approved location.

All manholes shall be lowered a sufficient depth so as to be level with the finished surface course and shall not exceed ±½ inch deviation at any point between the top of manhole elevation and surface of pavement. Adjustment in height will be made by removal of "throat rings" above the manhole "cone" where feasible. A minimum of two and a maximum of six throat rings shall be used at each manhole. If the height of the manhole cannot be adjusted to meet the required number of throat rings, the manhole shall be reconstructed in accordance with Section 3, "Reconstructing Existing Manholes."

2. Raising Manholes. Manholes to be raised between ¾ inches to 5-¾ inches on an existing surface course not being replaced will be completed utilizing a pivoted turnbuckle manhole riser meeting the requirements shown in Figure 1. Installation of the riser begins by removal of the manhole lid and cleaning the manhole frame from roadway materials, dirt, and any other debris not part of the manhole frame. Insert appropriately sized riser (see Section a. "Measurement Dimensions Required for Obtaining Properly Sized Riser") and seat with a hammer. Expand turnbuckle mechanism to full circumferential engagement. Replace lid and ensure that lid seats fully on riser without rocking. If necessary, seating surfaces shall be machined. Apply solvent to the top of the lid just

prior to application of pavement overlay. Manufacturer's instructions shall be consulted to ensure proper installation of riser.

All manholes shall be raised a sufficient height so as to be level with the finished surface course and shall not exceed ±½ inch deviation at any point between the top of manhole elevation and surface of pavement.

a. **Measurement Dimensions Required for Obtaining Properly Sized Manhole Riser.** Measurement dimensions typically required to obtain a properly sized riser include the interior or bottom of hole dimension, the top of hole opening, the lid thickness, lid diameter, and riser height. Manufacturer's requirements shall be consulted to ensure that the proper dimensions for the riser are obtained.

3. **Reconstructing Existing Manholes.** Major adjustments will be made by reconstruction of the manhole below the "cone" where necessary. Material excavation from around the manholes shall be replaced with concrete meeting the requirements of Item No. 300, "Concrete (Class B)," and select materials from the excavation as shown on the plans or specified by the Engineer. All excess materials shall be disposed of by the Contractor.

B. Valve Boxes. Perform all work in conformance with this section unless otherwise shown on the plans. Adjust existing valve boxes in situations where the finished profile of the street or sidewalk will be changed from its existing elevation. Existing valve boxes and covers which are determined by the Inspector to be in an unacceptable condition, will be removed and replaced with new boxes and/or covers. Material excavation from around the valve boxes shall be replaced with concrete meeting the requirements of Item No. 300, "Concrete (Class B)," and select materials from the excavation as shown on the plans or specified by the Engineer. Contractor shall take all necessary measures to prevent damage to existing or new boxes and covers from equipment and materials used in or taken through the work area. If an existing or new box and/or cover is/are damaged by the Contractor, it shall be replaced, as directed by the Engineer, by the Contractor at his expense.

The valve box shall be repositioned in such a manner as to prevent shock or stress from being transmitted to the valve. It shall be centered and plumb over the operating nut of the valve. Valve boxes shall be located so that the valve operating nut is readily accessible for operation through the opening in the valve box.

All valve box covers shall be raised or lowered a sufficient distance so as to be level with the finished surface course and shall not exceed ±½ inch deviation at any point between the top of valve box elevation and surface of pavement or sidewalk.

512.5. MEASUREMENT: Manholes adjusted, as prescribed above, will be measured by the unit of each manhole adjusted. The excavation and the amount of concrete or reinforced concrete as necessary to fill the area excavated, if required, will not be measured for payment.

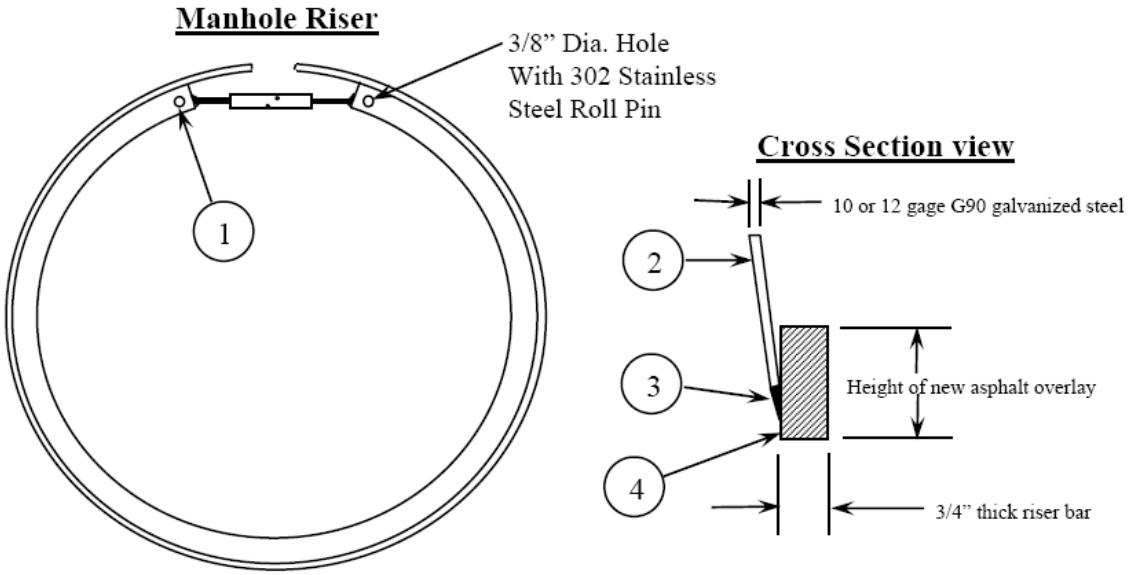
512.6. PAYMENT: The work performed as prescribed by this item will be paid for at the contract unit price bid per manhole for "Adjusting Existing Manholes" which price shall be full compensation for all excavation, including saw cutting of surfaces as required, reinforced concrete and disposal of material excavated; for furnishing and placing all materials and for all labor, tools, equipment and incidentals necessary to complete the work.

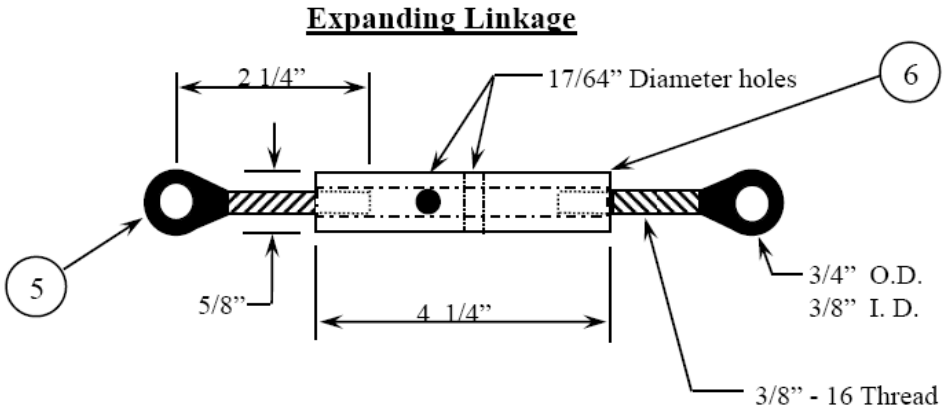
512.7. BID ITEM:

Item 512.1 - Adjusting Existing Manholes - per each

Item 512.2 - Reconstructing Existing Manholes - per each

Item 512.3 - Valve Box Adjustments - per each





Item Number	Item Description	Material Description	Tensile Yield	Tensile Ultimate
1	3/8" Roll Pins	302 Stainless Steel (14,000 LB Double Sheer Strength)		
2	Steel Skirt	12 or 10 gage A.I.S.I. 1020 Steel (A-36) G-90 Galvanized	33,000 P.S.I.	60,000 P.S.I.
3	Weld	65%-70% circumference welded	75,000 P.S.I.	85,000 P.S.I.
4	3/4" wide Riser Bar	Hot Rolled Steel A.I.S.I. 1020 (A-36)	33,000 P.S.I.	60,000 P.S.I.
5	Rod Ends	Forging A.I.S.I. C-1030 Steel Heat Treated BHN 240 Zinc Plated with Dichromate Finish	70,000 P.S.I.	92,000 P.S.I.
6	Turnbuckle	A.I.S.I. 1020 BHN 149 Zinc Plated dipped in Linebacker rust inhibitor	70,000 P.S.I.	80,000 P.S.I.

Figure 1
Manhole Riser Detail

ITEM

513 REMOVING AND RELOCATING MAILBOXES

513.1. DESCRIPTION: *This item shall govern for the removal, temporarily relocating, or replacing of mailbox assemblies of the type specified on the plans or as directed by the Engineer.*

513.2. MATERIALS: Provide materials to meet the requirements of section 513.4, "Construction."

513.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

513.4. CONSTRUCTION: Mail boxes and any supporting posts shall be removed from their present location, installed in a temporary, serviceable location or locations during construction and replaced in a permanent location as shown on the plans. Any supporting posts found to be set in concrete at the time of their removal shall be reset in the permanent location in concrete. As a minimum, each individual mailbox shall be set on a 4 inch x 4 inch wood post, equal or better than the original, at the location and to the height shown on the plans. Relocate mailbox assemblies to permanent locations upon completion of construction work.

Temporary community boxes may be required in lieu of temporarily relocating existing mail boxes. Community boxes will be installed by the U.S. Postal Service on concrete slabs installed as a part of this contract. Contractor shall install temporary concrete pads at locations and dimensions as shown on the plans, or as directed by the Inspector. Contractor shall remove concrete slabs upon completion of the project.

Mail boxes found to be set on ornamental iron, masonry or other special posts shall be relocated on such posts undamaged by the Contractor.

Maintain mailbox assemblies in a serviceable condition while in their temporary locations. The Contractor is not responsible for damage to the mailbox not of their causing while in the temporary locations. Any damage to the mail boxes, posts, supporting members, braces etc., caused by negligence of the Contractor shall be remedied by the Contractor at his expense. All such repairs shall be made in such a manner so as to insure the unit to be in as good as, or better condition than it was originally. Any such repairs shall be subject to approval by the Engineer.

513.5. MEASUREMENT:

A. Removing and Relocating Mail Boxes. "Removing and Relocating Mail Boxes" will be measured by the number of mail boxes so removed and relocated.

B. Community Mailbox Slabs. Concrete slabs for community mail boxes will be measured by the square yard, complete and in place, to include removal at job completion.

513.6. PAYMENT:

A. Removing and Relocating Mail Boxes. The work performed as prescribed by this item will be paid for at the contract unit price bid, per mail box, for "Removing and Relocating Mail Boxes" which price shall be full compensation for removing mail boxes from their present position, temporary relocation in a serviceable position, and relocation to permanent

designated location, for resetting in concrete if required, for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work.

B. Community Mailbox Slabs. Work performed as prescribed by this item will be paid for at the contract unit price bid per square yard, which price shall be full compensation for the construction and removal of concrete slab(s), materials including reinforcing, labor, tools, equipment and incidentals necessary to complete the work.

513.7. BID ITEM:

Item 513.1 - Removing and Relocating Mail Boxes - per each

Item 513.2 - Community Mail Box Slab - per square yard

ITEM

514 PAINT AND PAINTING

514.1. DESCRIPTION: *This item shall govern for type, quality, and testing of paints, their source, and for the application of paint to structures and appurtenances. The painting of structures and appurtenances shall include, unless otherwise provided in these specifications, or 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 of the painting operations.*

Notice of Intent. The intent of this specification is to procure the specified paints in place on structures and/or railings, so that the durability and protective value of these paints will 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 on the bare metal and between coats. This will require careful attention to preparation of surface, to prevention contamination and marring of coating during and after drying, and to uniform, skilled application.

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 Engineer.

514.2. MATERIALS: Provide the paint system (surface preparation, primer, intermediate, and appearance coats as required) shown on the plans. Provide System II with #742 Gray Appearance Coat if no system is specified. Provide a concrete gray appearance coat (Federal Standard 595B color 35630) if appearance coat is required unless otherwise shown on the plans.

If faying surfaces will be painted, provide a prime coat that is documented to have the required slip and creep characteristics (as determined by "Testing Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints" in the Research Council on Structural Connections' Specification for Structural Joints Using ASTM A 325 or A 490 Bolts) to meet the required mean slip coefficient shown on the plans. Perform all required testing at no expense to the City.

A. Paint Systems. Standard paint systems for painting new and existing steel include the following.

1. System I (Overcoating). Provide paint in accordance with Texas Department of Transportation (TxDOT) Departmental Material Specification DMS-8101, "Structural Steel Paints-Performance." Provide a penetrating sealer, intermediate prime coat on bare steel areas, and an appearance coat in accordance with manufacturer's specifications. This system is used for repainting existing steel and used only when specified on the plans.

2. System II. Provide #810 Prime Coat meeting TxDOT DMS-8100, "Structural Steel Paints-Formula." For appearance coat, provide either #742 Gray Appearance Coat meeting TxDOT DMS-8100 or acrylic latex meeting TxDOT DMS-8101, "Structural Steel Paints-Performance," as specified. This system is used for painting new steel and repainting existing steel.

3. **System III.** Provide paint in accordance with TxDOt DMS-8101, "Structural Steel Paints-Performance." Provide inorganic zinc (IOZ) prime coat, epoxy intermediate coat, and urethane appearance coat for all outer surfaces except those to be in contact with concrete. Provide epoxy zinc prime coat for areas to be in contact with concrete and for touchup of IOZ. This system is used for painting new steel.

4. **System IV.** Provide paint in accordance with TxDOT DMS-8101, "Structural Steel Paints-Performance." Provide IOZ prime coat and acrylic latex appearance coat for all outer surfaces except those to be in contact with concrete. Provide epoxy zinc prime coat for areas to be in contact with concrete and for touchup of IOZ. This system is used for painting new steel.

B. Paint Inside Tub Girders and Closed Boxes. Provide a white polyamide cured epoxy.

C. Paint over Galvanizing. Provide epoxy intermediate coat and urethane appearance coat in accordance with TxDOT DMS-8101, "Structural Steel Paints-Performance." Provide intermediate coating recommended by the manufacturer for use on galvanized steel.

D. Special Protection System. Provide the type of paint shown on the plans.

514.3. EQUIPMENT: Ensure that spray equipment:

- has adequate capacity and sufficient gauges, filters, agitators, regulators, and moisture separators to ensure delivery of clean dry air at the proper pressure and volume;
- is adequate for the type of paint being used;
- has spray heads that provide a smooth, uniform coat of paint;
- can separate moisture from air stream in contact with the paint; and
- has no dried coatings, solvents, or other foreign matter on surfaces that paint is likely to contact.

Maintain all equipment and accessories in good working order.

During painting operations, keep paint pots no more than 20 ft. above or below the level of spray application of paint. Do not allow fluid hoses to sag more than 10 ft. below the level of the bottom of the paint pot or actual spraying operations, whichever is the lowest point. Keep hoses serviceable with no cracks or deterioration. Equip paint pots (or other containers from which the paint is dispensed) with agitators that operate whenever paint is in the pot.

A. Airless Spray Equipment. Use regulator and air or fluid pressure gauges. Use fluid hoses with at least ¼ in. I.D. and a maximum length of 75 ft.

B. Conventional Spray Equipment. Use independent fluid pressure and atomization pressure regulators and gauges. Use fluid and air hoses with at least ½ in. I.D. and a maximum length of 75 ft.

514.4. CONSTRUCTION:

A. Qualification. Certification of the cleaning and painting contractor, subcontractor, or fabricator is required as follows.

1. **Shop Cleaning and Painting.** Follow all applicable provisions for qualification specified in the AASHTO/NSBA Steel Bridge Collaboration S8.1.

2. **Field Cleaning and Painting.** Maintain SSPC-QP 1 (for paint application and removal of coatings not containing hazardous materials) and SSPC-QP 2 (for removal of coatings containing hazardous materials) certification for the duration of the project when the following conditions exist:

   - total steel surface area to be cleaned and painted exceeds 15,000 sq. ft.,
   - existing coating to be removed from steel contains hazardous materials as specified on the plans, or
   - certification is required on the plans.

   Submit proof of certification before beginning work.

B. Responsibility for Hazards. Some paints and cleaning products are harmful to health. Handle all paints and cleaning products in accordance with the information on the manufacturer's safety data sheet and in accordance with all applicable federal and state regulations. Comply with all worker and public safety protection measures including 29 CFR 1926.62 when cleaning requires removing paint containing lead or chromium. Monitor permissible exposure limits (PEL) in accordance with OSHA requirements.

C. Access. Provide safe access to all parts of the work for proper inspection. Do not place rigging, scaffolds, etc., in contact with previously painted surfaces until the previously applied coating has had at least 48 hours of curing time. Protect previously painted and cured surfaces with an approved padding to minimize damage when rigging, scaffolds, etc., will be placed on or hung from those surfaces. Repair all coating damaged as a result of rigging or scaffolding as directed.

Remove tree limbs, bushes, grass, and other items that will interfere with the cleaning and painting operations as directed. Remove vertical clearance signs, and erect and maintain temporary ground-mounted signs matching the content and letter size on the existing sign unless otherwise directed. Re-attach permanent clearance signs as directed.

D. Steel to be Painted. Clean and paint all structural steel except weathering steel that is to remain unpainted, unless otherwise shown on the plans. Structural steel includes all main members, bearing apparatus, diaphragms, and lateral bracing where applicable. Unless otherwise shown on the plans or exempted in this Item, paint the rolling faces of rockers and base plates, all surfaces of bearing plates, and all surfaces of iron or steel castings, whether or not the surfaces are milled. Unless otherwise provided in the Contract or approved in writing, perform the initial cleaning and application of required prime and intermediate coatings on new steel before shipment of the steel to the job site.

E. Painting Galvanized Surfaces. Do not water-quench or chromate-quench galvanized surfaces to be painted. Wash the surface to be painted with a biodegradable alkaline detergent to remove oil, grease, flux, white rust, dirt, and any other contaminants. Thoroughly rinse the surface with potable water to remove remaining detergent. Remove remaining oily contamination with a clean solvent. Properly label and store. Recycle or dispose of spent solvents.

Lightly abrasive-blast the surface to be painted, or use another approved method to show an etched pattern on the entire surface without removing any of the zinc. Apply primer within 24 hours of cleaning. Reclean the surface if more than 24 hours elapse before painting.

Apply at least 2.0 mils dry film thickness (DFT) of intermediate coating and at least 2.0 mils DFT of appearance coating.

Ensure that the appearance coating dries to form a smooth, continuous, tightly adhering film of uniform thickness and appearance, free of sags, runs, pinholes, holidays, overspray, and any other discontinuities; and that it has a uniform appearance within all portions of the painted piece and all related pieces and components of a job.

F. Shop Cleaning and Painting. Unless otherwise approved, do not apply coatings until all fabrication work is completed and has been tentatively accepted.

Follow all applicable provisions of AASHTO/NSBA Steel Bridge Collaboration S8.1, for both organic and inorganic zinc-based primer systems, except as modified by this Item. Use the paint systems specified in this Item and on the plans and meet the dry film thickness (DFT) requirements of this Item instead of those of S8.1. The requirement to test for primer curing using ASTM D 4752 does not apply to organic zinc primer. Use TxDOT Standard Test Method Tex-728-I instead of SSPC-PA2 for measuring DFT.

Repair all runs, sags, and other defects in each coat before application of subsequent coats.

Clean and paint surfaces that will be in contact with concrete, such as the top surfaces of top flanges, in accordance with the specified system except as modified in this Section or otherwise shown on the plans. Designate no-paint areas on the shop drawings.

Paint erection marks for field identification of members upon previously painted surfaces. Do not load pieces for shipment until coatings are thoroughly dry. Except for small approved touchups, do not apply any paint after material is loaded for shipment.

1. Faying Surfaces.

a. Painted. When painting faying surfaces, ensure that the primer used is documented to have the required slip and creep characteristics. If no mean slip coefficient (or corresponding surface condition) is specified, do not paint faying surfaces without approval.

Apply no more than the maximum average film thickness used in the qualifying test to the faying surfaces. Before bolting, ensure that paint on faying surfaces has cured for the minimum time used in the qualifying test. Perform all required testing of the paint at no additional expense to the City.

b. Unpainted. If surfaces to be in contact after final bolting will be left unpainted, provide an SSPC-SP 10 blast-cleaning, and ensure that these areas are free of paint and overspray to within 1 in. or 1 bolt diameter, whichever is less, from the outside edges of the bolt holes. Do not power wire-brush uncoated faying surfaces. Roughen galvanized faying surfaces by hand wire-brushing. Remove tape from masked areas as soon as practical.

For unpainted top lateral bracing connections shown on the plans as designed to AASHTO Class A surface condition (slip coefficient of 0.33), an SSPC-SP 10 blast-cleaning is not required. Remove grease and loose mill scale from nonweathering steel, and remove grease and all mill scale from weathering steel. If no slip

coefficient or assumed surface condition is shown on the plans or if the connection is shown as Class B (slip coefficient 0.50), provide an SSPC-SP 10 blast.

2. **No-Paint Areas at Field-Welded Connections.** Do not paint surfaces within 4 in. of groove welds or within 2 in. of fillet welds. Do not apply intermediate coat within 4 in. of the edge of primer at these areas. Remove tape from masked areas as soon as practical after painting.

3. **Paint Application for Specified Systems.**

   a. **System II.**

      (1) **Prime Coat.** Apply a total of 3.5 to 10.0 mils DFT of primer in at least 2 coats to outer surfaces that will not be in contact with concrete. Extend the primer at least 1½ in. onto surfaces that will be in contact with concrete, such as top flanges (see Figure 1). Coat the remaining portion of the surfaces to be in contact with concrete with a film coat of tightly adhering primer.

      (2) **Appearance Coat.** If the appearance coat is shop-applied, apply at least 2.0 mils DFT of appearance coating to outer surfaces that will not be in contact with concrete. Do not extend the appearance coat onto surfaces that will be in contact with concrete.

   b. **System III.**

      (1) **Outer Surfaces Not in Contact with Concrete.** Extend prime and intermediate coatings at least 1½ in. onto surfaces that will be in contact with concrete, such as top flanges (see Figure 2).

         (a) **Prime Coat.** Apply at least 3.0 mils DFT of IOZ primer. Surfaces to be in contact with concrete may be covered with a film coat of IOZ primer. Thoroughly wet coated surfaces with a fine mist of potable water after the primer has set. Test the IOZ primer for cure in accordance with ASTM D 4752. If the IOZ primer meets a resistance rating of 4 or higher, apply the intermediate coat. If it does not meet this rating, reapply a fine mist of potable water until the coating is cured. Alternative cure tests may be used if recommended by the coating manufacturer.

         (b) **Intermediate Coat.** Apply at least 2.0 mils DFT of epoxy intermediate coating after primer (including epoxy zinc on top flange; see 514.4.F.3.b(2), “Surfaces to be in Contact with Concrete”) has met curing requirements.

         (c) **Appearance Coat.** If appearance coat is shop-applied, apply at least 2.0 mils DFT of appearance coating.

      (2) **Surfaces to be in Contact with Concrete.** See Figure 2. Before coating surfaces to be in contact with concrete, ensure that the IOZ prime coat has met curing requirements. Allow the surface to dry before evaluating the condition of the IOZ primer. If the surface to be in contact with concrete shows metal oxidation or if IOZ primer present on that surface is mud-cracked, reclean the surface to specified requirements. Do not damage the IOZ primer on other surfaces during recleaning. Paint on shear studs is not required. Apply 2 coats of 3 to 5 mils wet

film thickness (WFT) each of epoxy zinc primer to a clean, dry surface. Wait between 1 and 48 hours between coat applications.

c. System IV.

(1) Outer Surfaces Not in Contact With Concrete.

(a) Prime Coat. Apply at least 3.0 mils DFT of IOZ primer. Extend primer at least 1½ in. onto surfaces that will be in contact with concrete, such as top flanges (see Figure 3). Thoroughly wet all coated surfaces with a fine mist of potable water.

(b) Appearance Coat. If appearance coat is shop-applied, test the IOZ primer for cure in accordance with ASTM D 4752. If the IOZ primer meets a resistance rating of 4 or higher, apply the appearance coat. If it does not meet this rating, reapply potable water with a fine mist until the coating is cured. Alternative cure tests may be used if recommended by the coating manufacturer. Apply at least 2.0 mils DFT of appearance coating.

(2) Surfaces to be in Contact with Concrete. Coat surfaces to be in contact with concrete in accordance with Section 514.4.F.3.b(2), "Surfaces to be in Contact with Concrete."

d. Paint Inside Tub Girders and Closed Boxes. Provide an SSPC-SP 7 blast-cleaning to unpainted surfaces. Apply 2 to 3 mils DFT of paint over all inside surfaces that will be visible after final bolting including exposed surfaces of interior splice plates.

e. Special Protection System. Apply paint as shown on the plans.

4. Repairs. If repairs must be made after the IOZ primer has cured, use epoxy zinc primer to repair the IOZ primer. Brush application for touchup is acceptable as long as the paint is mixed in the appropriate proportions by weight and is agitated continuously during the painting operation.

G. Field Cleaning and Painting. Clean and paint only after erection or maintenance work including bolting, welding, straightening of material, etc. is complete; slab concrete has been placed; and the Engineer has examined and approved the work. Clean and paint unpainted areas including bolts, nuts, washers, and areas where the shop-applied paint has been damaged or fails to meet specification requirements, in accordance with the method required under the paint system specified. Prevent paint spatter and overspray from coming in contact with passing traffic, private and public property, and areas of the bridge not designated to be painted.

1. Containment. Submit a plan that details the procedures and type and size of equipment proposed to keep public property, private property, and the environment from being adversely affected by the cleaning and painting operations. Approval of the plan is required before cleaning and painting operations begin.

When required on the plans, submit an analysis showing the loads, including wind loads, added to the existing structure by the containment system and waste materials. Verify that the forces and stresses induced in the members from these loads do not cause them to be overstressed. Have a licensed professional engineer sign, seal, and date the submittal.

When abrasive-blasting is used to remove the existing coating, provide a containment system capable of containing all blast refuse. Unless otherwise shown on the plans, construct and maintain a structure meeting the following minimum requirements:

- rigid or flexible framing;
- ability to withstand winds up to 30 MPH;
- enclosure of all sides of area with air-penetrable or air-impenetrable walls;
- watertight floor;
- overlapping seams and entryways; and
- exhaust air filtration system capable of creating negative pressure inside the enclosure causing the sides of the containment to have a concave appearance.

In place of a full containment structure, a modified containment system may be proposed when using abrasive-blasting equipment equipped with negative pressure that will contain all blast refuse. Demonstrate for approval the equipment's ability to contain all blast refuse.

When using hand tools, provide a system that will contain all removed paint, rust, and other debris. Place an airtight membrane below the member being cleaned to collect all falling debris. When using power hand tools, equip them with high-efficiency particulate air (HEPA) filter vacuums or provide a full containment system as specified above.

When using water-blasting (low-pressure or high-pressure), provide a system capable of collecting all falling paint chips and other debris. Store, characterize, and dispose of all recovered debris in accordance with 30 TAC 335, "Industrial Solid Waste and Municipal Hazardous Waste." Discharge liquids in accordance with the TCEQ Texas Pollution Discharge Elimination Program (30 TAC 305, "Effluent Guidelines and Standards for TPDES Permits") and Texas Surface Water Quality Standards (30 TAC 307). Alternatively, liquids may be captured, stored and characterized for disposal at an authorized facility in accordance with 30 TAC 315, "Pretreatment Regulation for Existing and New Sources of Pollution," or 30 TAC 335, "Industrial Solid Waste and Municipal Hazardous Waste."

Remove all blast refuse from the floor and cleaned members before the Inspector enters the containment to inspect the cleaned surfaces. Remove all blast refuse from the containment before ending work for the day.

Provide containment during the priming operation to provide a wind-free environment and to keep the primer from entering the environment. Obtain approval of the containment system prior to beginning work.

Use a skimmer when cleaning and painting over bodies of water. If the skimmer collects any blast or paint material, remove the material the day the release occurs. Correct the containment problem that allowed the release before continuing work.

2. **Cleaning and Preparation of Surfaces.** Prepare surfaces prior to applying paint.

   a. **General Preparation.** Clean far enough into the shop-applied paint to ensure removal of all contaminants. Feather edges of sound paint around cleaned areas.

      Ensure that surfaces to be painted are completely free of oil, grease, moisture, dirt, sand, overspray, welding contamination (slag or acid residue); loose or flaking mill

scale, rust, or paint; weld spatter; and any other conditions that will prevent the paint from forming a continuous, uniform, tightly adhering film. Remove all steel splinters (hackles) raised or evident during cleaning. When abrasive blast-cleaning is required, reblast areas from which hackles are removed. Use the test described in Section 514.4.G.2.c, "Tape Test," on all surfaces to be painted to determine if they are contaminated with loose particles.

Before other cleaning operations, remove grease-like contaminants with clean petroleum solvents or other approved methods. Contain solvents and removed material as approved. Dispose of properly or reuse solvents as approved. This requirement applies to all coats.

When abrasive blast-cleaning is required, blast all flame-cut edges to produce a visible anchor pattern over the entire flame-cut surface.

Completely remove, as directed, the protective coating on machined surfaces and pins.

b. Classes of Cleaning. The requirements of Section 514.4.G.2.a, "General Preparation," apply whether or not a class of cleaning is specified. For blasting, use an approved abrasive as shown on the plans and potable water. Do not use steel shot. When abrasive blast-cleaning is used to remove existing paint containing lead or chromium, use an abrasive recycling system with an approved recyclable abrasive. Abrasive will be considered recyclable if it is separated from the dust and paint debris before being reused.

(1) Class A Blast-Cleaning. Remove all visible rust, paint, mill scale, and other forms of contamination, so that the blasted surface appears near white when viewed with the unaided eye (corrected to 20/20 vision). Slight staining is allowed provided it does not exceed 5% in any 9-sq. in. area. Staining includes light shadows, slight streaks, or minor discoloration caused by stains from rust, mill scale, or previously applied paint. Meet the surface preparation requirements of SSPC-SP 10 unless otherwise shown on the plans.

(2) Class B Blast-Cleaning. Remove all dirt, rust scale, loose mill scale, loose rust, and loose paint. Tight mill scale and tightly adhered rust and paint are permitted. Expose each square inch of surface area to be cleaned to the abrasive blast pattern long enough to expose several flecks of the underlying metal. Meet the surface preparation requirements of SSPC-SP 7. Use the test described in Section 514.4.G.2.c, "Tape Test," on the cleaned surface to determine if it is adequately cleaned.

(3) Class C Cleaning. Remove all exposed loose rust, loose mill scale, peeling or flaking paint, and oxidized paint. Clean these areas by hand-scraping, wire-brushing or other approved method. Feather all sound, tightly adhered coating edges surrounding cleaned areas.

(4) Class D Water-Blasting. Remove all dirt, loose rust, and loose paint using water-blasting equipment. Tight mill scale and tightly adhered rust and paint are permitted. Probe perimeter of peeled areas of paint with a putty knife to ensure remaining paint is tightly adhered.

System I requires Class D water-blasting to remove contaminants, followed by a Class C cleaning for defective areas. If prime coat is field-applied, System II requires Class A blast-cleaning. If prime coat is shop applied, Systems II, III, and IV require Class A spot cleaning of all damaged and unpainted areas.

c. Tape Test. Perform the tape test as follows:

- Press a strip of filament tape onto the surface by rubbing with moderate thumb pressure 4 times, leaving approximately 2 in. of one end of the tape free from the surface.
- Grasp the free end and remove the tape from the surface with a sharp pull.

The surface will be considered to be contaminated and not adequately cleaned if visible particles cling to the tape.

3. Painting.

a. Paint Condition. Thoroughly mix and strain paints to be applied. Mix by mechanical methods. Ensure that the paint is a completely homogeneous mixture free of lumps, skins, and agglomerates and that it contains all pigments, vehicle solids, and thinners required in the original formulation. Keep paint containers tightly covered and protected from weather when not in use.

b. Thinning. Adjust paint to the correct application consistency by using suitable thinners or by using properly applied heat up to 150°F. Using heat to thin epoxy paints may decrease their useful pot life.

c. Paint System Requirements. Ensure that all coatings in the paint system, including shop-applied coats, are from the same manufacturer.

(1) System I (Overcoating).

(a) Penetrating Sealer. Apply at least 1.0 mil DFT of penetrating sealer to all surfaces to be painted.

(b) Prime Coat. Apply at least 4.0 mils DFT of primer to areas that have received a Class C cleaning and to other areas where there is no existing primer.

(c) Appearance Coat. Apply at least 2.0 mils DFT of appearance coat.

(2) System II.

(a) Prime Coat. Apply 3.5 to10.0 mils DFT of primer in at least 2 coats.

(b) Appearance Coat. Apply at least 2.0 mils DFT of appearance coat.

(3) Systems III.

(a) Prime Coat. Spot-clean to Class A all damaged and unpainted areas. Apply at least 3.0 mils DFT of epoxy zinc primer to the cleaned areas.

(b) Intermediate Coat. If intermediate coat is not shop applied, apply at least 2.0 mils DFT of epoxy intermediate coating.

(c) Appearance Coat. Apply at least 2.0 mils DFT of appearance coat.

(4) System IV.

(a) Prime Coat. Spot-clean to Class A all damaged and unpainted areas. Apply at least 3.0 mils DFT of epoxy zinc primer to the cleaned areas.

(b) Appearance Coat. Apply at least 2.0 mils DFT of appearance coat.

(5) Special Protection System. Apply paint as shown on the plans.

d. Temperature. Do not apply #810 Prime Coat when the steel or air temperature is below 50°F or when the steel or air temperature is expected to drop below 50°F within 2 hr. after application. Do not apply #742 Appearance Coat when the steel or air temperature is below 40°F or when the steel or air temperature is expected to drop below 40°F within 2 hours after application. Follow product data sheets for temperature requirements for all other paints.

e. Application. Immediately before painting, clean steel surfaces or surfaces of previously applied coats of paint by blowing with clean compressed air, brushing, or both to remove traces of dust or other foreign particles. When directed, wash the surfaces of previously applied coatings either with clean, fresh water or with a mild detergent and water mixture followed by a complete and thorough rinse with clean, fresh water. Do not apply paint to any surface with discernible moisture.

Do not apply paint to any surface when the relative humidity is greater than 85% as determined by a sling psychrometer in accordance with ASTM E 337. Do not apply any paint when impending weather conditions might result in injury to fresh paint.

Do not apply paint to any surface when the relative humidity is greater than 85% as determined by a sling psychrometer in accordance with ASTM E 337.

Apply each coat of paint to clean, dry, firm surfaces complying with all specification requirements. Ensure that surfaces to be painted are free of all forms of contamination. Ensure that each coat dries to form a smooth, continuous, tightly adhering film of uniform thickness and appearance, free of sags, runs, pinholes, holidays, overspray, or other defects. Apply all coats by spray, except that any approved method of application may be used to paint inaccessible areas.

Repair all runs, sags, and other defects in each coat of paint before application of subsequent coats.

Measure the dry film thickness of coatings in accordance with TxDOT Standard Test Method Tex-728-I.

If, in the opinion of the Engineer, there is an objectionable amount of dust in the atmosphere, discontinue painting or take necessary precautions to prevent dust and dirt from coming in contact with freshly painted surfaces or with surfaces before the paint is applied.

Where there is potential for paint to be sprayed on traffic, provide a shield that will protect the traffic from paint.

When painting steel that is in contact with concrete, provide full coverage of the steel with a minimal amount of paint on the concrete surface. Do not extend the paint more than 4 in. onto the concrete surfaces or as directed. Ensure that when painting is complete, the only visible paint on concrete surface is the finish coat. Remove excessive or objectionable paint on concrete surfaces in an approved manner.

(1) Prime Coat. Paint cleaned areas with the specified prime coat. Overlap painting onto the surface of the shop applied paint enough to form a sealed edge.

When System III or IV is specified, paint spot-repair and unpainted areas with epoxy zinc primer. Cure the epoxy zinc primer in accordance with the manufacturer's product data sheet before applying appearance coat.

When System II is specified and the steel and the ambient temperature are both above 60°F, the second coat of primer may be applied before the first coat has cured but not within 2 hours after the application of the first coat. Cure the primer in accordance with Table 1 before applying appearance coat.

Table 1
System II Primer Cure Times

Temperature	Day Cure, Minimum
77°F and above	2
65 to 77°F	3
55 to 65°F	4
40 to 55°F	5

(2) Appearance Coat. After field-painting of the prime coat in accordance with Section 514.4.G.3.e(1), "Prime Coat," is completed and approved, apply the specified appearance coat.

Clean prime coat and intermediate coat surfaces by an approved method which does not damage the paint to remove all dirt, grease, concrete, overspray, and any other substance that may impair adhesion before the application of the appearance coat.

Provide an even and uniform appearance throughout the painted portion of the structure.

f. Workmanship. Perform all painting with skilled painters who can adjust equipment and application techniques as dictated by the type of paint, weather conditions, environment, and size and shape of the surface being painted. Painters who, in the opinion of the Engineer, do not adjust equipment to apply coatings in a uniform full wet coat free of runs, sags, holidays, and overspray will not be considered skilled painters.

Apply sprayed coatings essentially 90° to the surface and between 10 and 18 in. from the surface as necessary to apply a full wet coat of paint free of overspray, runs, sags, and holidays. Any spray painter who does not consistently spray in this manner or extends the spraying stroke so that paint is applied to the surface at an angle of less

than 80° will not be allowed to spray paint. Brush application for touchup is acceptable as long as the paint is mixed in the appropriate proportions by weight and is agitated continuously during the painting operation.

4. **Handling and Shipping.** Pad the blocks, chains, slings, braces, clamps, etc., used for handling, moving, storing, and shipping painted members so that the paint will not be damaged.

5. **Cleaning and Painting Existing Structures.** Unless otherwise shown on the plans, provide System II for existing steel structures to be cleaned and painted.

H. Paint Improperly Applied. To uncover evidence of improperly applied paint, the Engineer may at any time during construction explore underneath the surface of any paint coats already applied. Repair these areas of investigation at no additional expense to the City. Whenever unsatisfactory conditions are found, the Engineer may require remedial measures.

Repair or completely remove and replace all paint that has been applied improperly, has been applied to improperly cleaned surfaces, fails to dry and harden properly, fails to adhere tightly to underlying metal or other paint film, or does not have a normal, workmanlike appearance in conformance with this Item. When the final field coat does not have a uniform color and appearance throughout the structure, correct it by the use of whatever additional coats or other corrective measures are required. Remove freshly applied paint that has not yet set with the use of suitable solvents. Remove dried paint films with blast-cleaning, scraping, or flame torches, as approved.

I. Storage and Disposal. Collect all waste generated by cleaning and painting operations as necessary to prevent release into the environment. At a minimum, collect all waste before leaving the job site each day. Handle and store the waste as if it were hazardous until classification is made. Follow the requirements of 30 TAC 335 for onsite handling of the waste. Store waste collected in containers that comply with 49 CFR 178. Seal containers containing waste each day before leaving the job site.

Test each container of waste using EPA Test Method 1311, "Toxicity Characteristic Leaching Procedure (TCLP)," to determine existing metal and organic content. If testing shows that the waste is not hazardous, handle and dispose of the waste as a "Special Waste" as defined in 30 TAC 330.2 or as directed. Provide documentation showing that disposal of the waste was done in a suitable landfill holding permits to handle this type of material. If testing shows that the waste is hazardous, dispose of the waste in compliance with applicable hazardous waste rules and regulations. Transport hazardous waste using a permitted transporter and dispose of in an authorized hazardous waste facility.

When the plans specify that the existing coating to be removed contains hazardous materials and steel grit is used as the abrasive, the waste generated is classified as hazardous regardless of the results of the TCLP. Dispose of this waste in compliance with applicable hazardous waste rules and regulations as specified above and by the Contract.

Provide copies of all test reports and transportation manifests to the Engineer before shipping hazardous waste. Provide signed original manifests to the Engineer verifying that all steps of the handling and disposal process were correctly handled.

J. Miscellaneous. Notify the Engineer of any condition that may require the repair or replacement of any portion of the bridge.

Upon completion of the painting operations for each structure that will be considered by TxDOT as "On-System," stencil on the exterior face of the outside beam the control, section, and structure number, as directed. Stencil on the interior face of the outside beam the completion date of the painting operation. Do this work at each end of the structure where painting is specified.

514.5. MEASUREMENT: "Paint and Painting" will not be measured for payment.

514.6. PAYMENT: The work and materials prescribed herein will not be paid for directly, but shall be included in the unit bid price for the items of construction in which this work and materials are used.

514.7. BID ITEM:

N/A

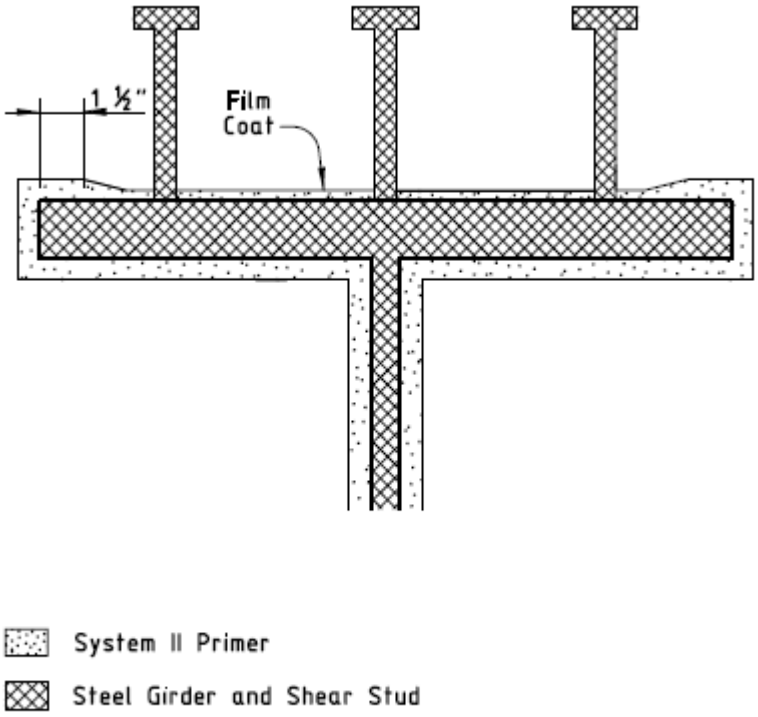


Figure 1
Application areas of System II paint (appearance coat not shown).

From Texas Department of Transportation

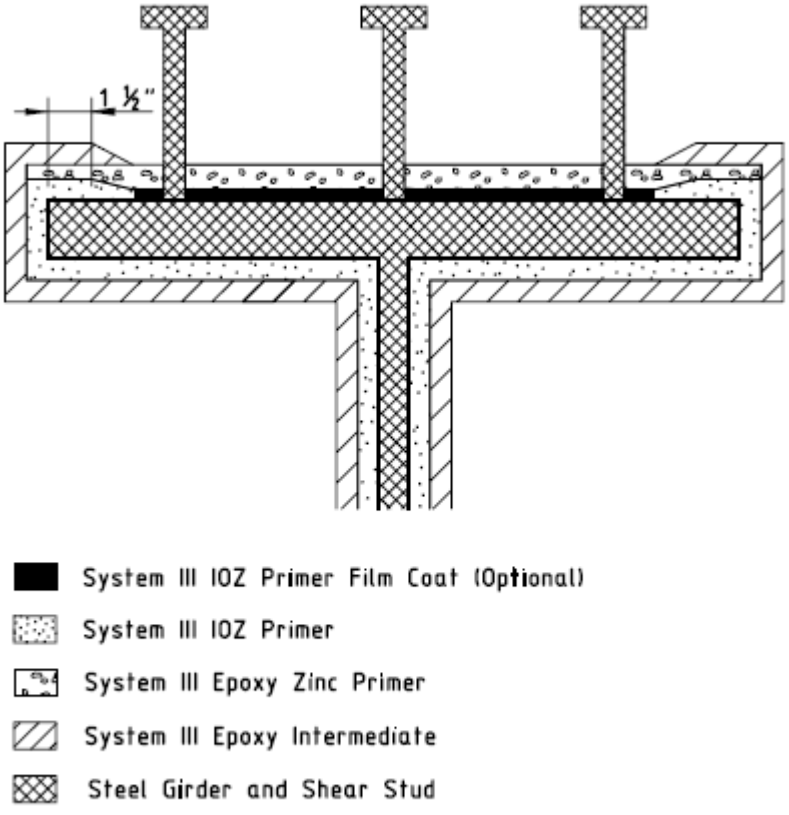


Figure 2
Application areas of System III paints (appearance coat not shown).

From Texas Department of Transportation

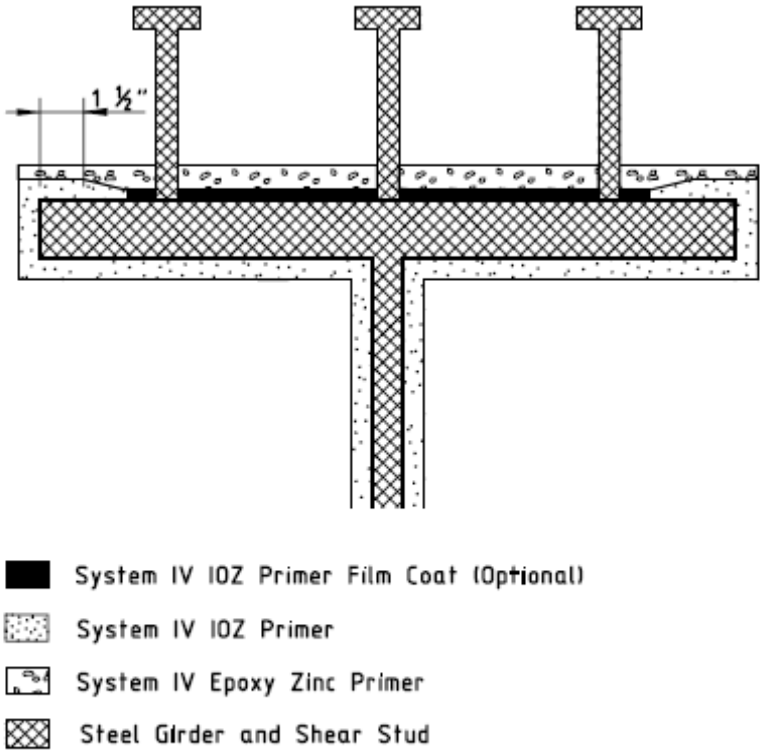


Figure 3
Application areas of System IV paints (appearance coat not shown).

From Texas Department of Transportation

ITEM

515 TOPSOIL

515.1. DESCRIPTION: *This item shall govern for the furnishing, placing and spreading of approved selected topsoil, to the lines and grades, at locations shown on the plans or as directed by the Inspector and in conformity with these specifications.*

515.2. MATERIALS: Use easily cultivated, fertile topsoil that is free from objectionable material, has a high resistance to erosion, and is able to support plant growth. Obtain topsoil from the right of way at sites of proposed excavation or embankment when specified on the plans, or as directed. Secure additional topsoil, if necessary, from approved sources outside the right of way in accordance with the requirements of TxDOT Standard Specification Item 7, Article 7.19, "Preservation of Cultural and Natural Resources and the Environment." Ensure that the topsoil obtained from sites outside the right of way has a pH of 5.5 to 8.5. Topsoil is subject to testing by the Engineer. Use water that is clean and free of industrial wastes and other substances harmful to the growth of vegetation.

515.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

515.4. CONSTRUCTION: Remove and dispose of objectionable material from the topsoil source before beginning the work. Stockpile topsoil, when necessary, in a windrow at designated locations along the right of way line or as directed by the Engineer. Keep source and stockpile areas drained during the period of topsoil removal and leave them in a neat condition when removal is complete. Before placing topsoil, cultivate the area to a depth of 4 in. Spread the topsoil on excavated areas to a uniform loose cover at a minimum thickness of 4 in. or at the thickness specified in the plans. Water and roll the topsoil with a light roller or other suitable equipment. If the topsoil settles below the established grade after the application of water and light rolling, additional topsoil shall be added and sprinkled with water and rolled as directed by the Engineer.

515.5. MEASUREMENT: Measurement of "Topsoil" shall be made by the cubic yard in place and only for those areas designated on the plans, or to areas as directed by the Engineer.

515.6. PAYMENT: Topsoil measured as specified above will be paid for at the contract unit price bid per cubic yard, which price shall be full compensation for all hauling, placing material, sprinkling the material with water, and for all labor, equipment, tools and incidentals necessary to complete the work.

515.7. BID ITEM:

Item 515.1 - Topsoil - per cubic yard

ITEM

516 SODDING

516.1. DESCRIPTION: *This item shall govern for the furnishing and planting of Bermuda, St. Augustine, Buffalo 609 or other acceptable grass sod on the areas designated on the plans or as directed by the Engineer. All planting shall be completed as soon as practical to avoid erosion of topsoil and graded areas in advance of acceptance of the work.*

516.2. MATERIALS: The sod shall consist of live, growing grass secured from sources where the soil is fertile. All grass sod shall have a healthy, virile root system of dense, thickly matted roots throughout the soil of the sod for a minimum thickness of 1 inch. The Contractor shall not use sod from areas where the grass is thinned out, or where the grass roots have been dried out by exposure to air and sun to such an extent as to damage its ability to grow when transplanted. The sod shall be free from noxious weeds or other grasses and shall not contain any matter deleterious to its growth or which might affect its subsistence or hardiness when transplanted. Sources from which sod is to be obtained shall be subject to approval by the Engineer.

A. Block Sod. Use block sod free from noxious weeds, Johnson grass, other grasses, or any matter deleterious to the growth and subsistence of the sod.

B. Fertilizer. A pelleted or granulated fertilizer shall be used with an analysis of 16-8-8. (The figures in the analysis represent the percent of nitrogen, phosphoric acid, and potash nutrients respectively.) At least 50% of the nitrogen component must be of a slow-release formulation such as urea-based and plastic resin-coated fertilizers. Ensure that fertilizer is in an acceptable condition for distribution in containers labeled with the analysis. Fertilizer is subject to testing by the Texas A&M Feed and Fertilizer Control Service in accordance with the Texas Fertilizer Law.

C. Water. Use water that is clean and free of industrial wastes and other substances harmful to the growth of vegetation.

D. Mulch. When mulch is specified below the sod, use straw mulch consisting of oat, wheat or rice straw or hay mulch of either Bermudagrass or prairie grasses. Use straw or hay mulch free of Johnson grass and other noxious and foreign materials. Keep the mulch dry and do not use molded or rotted material.

E. Tacking Methods. Use a tacking agent applied in accordance with the manufacturer's recommendations or a crimping method on all straw or hay mulch operations. Tacking agents must be approved before use, or may be specified on the plans.

516.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

516.4. CONSTRUCTION:

A. General. Cultivate the area to a depth of 4 in. before placing the sod. Plant the sod specified and mulch, if required, after the area has been completed to lines and grades as shown on the plans. Where rolling is specified by the following sub-articles, the roller shall be a light corrugated drum roller.

B. Planting Season. All planting shall be done between the average date of the last freeze in the spring and six weeks prior to the average date for the first freeze in the fall according to the U.S. Weather Bureau for the area.

C. Block Sodding. At locations shown on plans or where directed by the Engineer, sod blocks shall be carefully placed on the prepared areas. The fertilizer shall then be applied and thoroughly watered. When sufficiently dry, the sodded area shall be rolled or tamped to form a thoroughly compacted, solid mat. Any voids left in the block sodding shall be filled with additional sod and tamped.

D. Watering. Sod shall be thoroughly watered immediately after planting and subsequently at such intervals to promote growth or as directed by the Engineer. Furnish and operate equipment to distribute water at a uniform and controllable rate. Ensure that watering does not erode soil or plantings. Apply water in the required quantity where shown on the plans or as directed by the Engineer.

E. Fertilizing. The fertilizer shall be applied uniformly over the sodded areas and in the manner directed. The fertilizer shall be dry and in good physical condition. Fertilizer that is powdered or caked will be rejected. Distribution of fertilizer shall meet the approval of the Engineer. Unless otherwise indicated on the plans, fertilizer shall be applied uniformly at the average rate of 300 pounds per acre for all types of sod.

F. Finishing. Where applicable, the shoulders, slopes, and ditches 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 the planting operations shall be spread uniformly over adjacent areas or disposed of as directed by the Engineer so that the completed surfaces will present a sightly appearance. Keep sod along edges of curbs, driveways, walkways, etc., trimmed until acceptance.

G. Sequence of Sodding. It is the intent of this specification that all sodding be placed and watered twice a week, unless intervening rains make watering unnecessary. Watering shall be required for at least thirty (30) days after planting to establish growth or until acceptance of the work by the City. If the season is inappropriate, the Engineer may require that the sodding operations be advanced or retarded as may seem advisable. All areas shall be covered with live sod before final acceptance. Any blocks which show no signs of life shall be replaced with live sod before the work shall be measured for payment.

516.5. MEASUREMENT: Measurement of acceptable "Sodding," complete in place, will be by the square yard. Fertilizer, mulch, and water will not be measured for payment.

516.6. PAYMENT: "Sodding," measured as provided above, will be paid for at the contract unit price bid per square yard, which price shall be full compensation for furnishing, hauling and placing all materials, for all fertilizer and water required and for all labor, tools, equipment and incidentals necessary to complete the work.

516.7. BID ITEM:

Item 516.1 - Bermuda Sodding - per square yard

Item 516.2 - St. Augustine Sodding - per square yard

Item 516.3 - Buffalo 609 Sodding - per square yard

ITEM

517 BRIDGE RAILING

517.1. DESCRIPTION: *This item shall govern for the construction of railing comprised of concrete, steel, aluminum, or a combination of these materials, including necessary anchorage for the railing on bridges, culverts, walls, or other structures complete on the structures and in conformity with the lines, dimensions and details shown an the plans and with the provisions of these specifications.*

517.2. MATERIALS: This item shall include all posts, connections, parts and accessories, all required anchorage in the structures, headwalls, wingwalls, and parapet walls for proper anchorage of the post. Use materials that conform to requirements of the following Items:

A. Hydraulic Cement Concrete. Item 300, "Concrete."

B. Reinforcing Steel. Item 301, "Reinforcing Steel."

C. Structural Metal. Item 302, "Metal for Structures."

D. Railing. Item 509, "Metal Beam Guard Rail."

E. Paint. Item 514, "Paint and Painting."

F. Galvanizing. Texas Department of Transportation (TxDOT) Standard Specification Item 445, "Galvanizing."

517.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

517.4. CONSTRUCTION: Construct railing in accordance with details, alignment, and grade designated on the plans. Unless otherwise directed, do not place railing until falsework or formwork, if any, for the span has been released. During construction, ensure that expansion joints in the railing will function properly after the railing is installed. If the plans allow either steel or aluminum options for a particular railing type, furnish either steel or aluminum but not both for the entire Contract.

A. Metal Railing.

1. General. Furnish metal beam rail elements in accordance with Item 509, "Metal Beam Guard Rail."

Fabricate and erect metal railing according to the pertinent provisions of TxDOT Standard Specification Item 441, "Steel Structures," and the requirements of this Item.

When required by the plans, prepare and submit for approval the required shop or erection drawings in accordance with TxDOT Item 441. Show all splice locations and details on the shop or erection drawings. Splice members only as provided on the plans.

Field weld when required in accordance with TxDOT Standard Specification Item 448, "Structural Field Welding."

2. **Fabrication.** Fabricate metal railing and post panels in sections conforming to the details shown in the plans and field-verified lines and grades. Fabricate adjacent sections so that they will accurately engage each other in the field. Match mark each pair of sections so they can be erected in the same position in which they were fabricated.

   Fabricate metal rail elements included as part of the railing system to the dimensions and cross-sections shown on the plans and within a tolerance of ¼ in. per 10 ft. in the straightness of either edge. Joint and connect metal rail elements to the rail posts as shown on the plans, lapping metal rail elements in the direction of traffic in the adjacent lane. Unless otherwise shown on the plans, bolts and nuts for metal railing should meet requirements of ASTM A 307 and be galvanized in accordance with TxDOT Standard Specification Item 445, "Galvanizing."

   Fabricate aluminum in accordance with *AWS D1.2, Structural Welding Code - Aluminum*.

   To facilitate bending or straightening, aluminum materials other than castings may be heated to a temperature up to 400°F for no more than 30 min.

3. **Castings.** Provide permanent mold castings of the materials specified that are true to pattern in form and dimensions and of uniform quality and condition. Castings must be free from cracks and defects such as blowholes, porosity, hard-spots, or shrinkage that could affect their suitability for use. Repair minor defects in aluminum castings by an approved inert gas-welding process. Ensure that finished castings are free of burrs, fins, discoloration, and mold marks and that they have a uniform appearance and texture.

   Produce castings under radiographic control sufficient to establish and verify a product free from harmful internal defects. When heat-treating is required, heat-treat the entire lot of castings to the specified temper.

   Permanently mark the heat or lot number on the web or top of the base of all castings. Furnish mill test reports showing the heat or lot number, chemical composition, tensile strength, elongation, and number of pieces for each casting heat or lot. For aluminum castings, a heat or lot should consist of not more than 1,000 lb. of trimmed castings when produced from batch type furnaces, or 2,000 lb. when produced from a continuous furnace during a period of no more than 8 consecutive hours. Furnish the entire number of acceptable posts cast from each heat or lot except when a portion is required to complete a project.

4. **Corrosion Protection.** Provide protective coating for all metal railing unless otherwise noted on the plans. Galvanize all portions of steel railing after fabrication in accordance with TxDOT Standard Specification Item 445, "Galvanizing," unless otherwise noted on the plans. When painting is specified on the plans, provide the paint system shown on the plans. Apply paint in accordance with Item 514, "Paint and Painting." Repair any damaged galvanizing after erection in accordance with TxDOT Standard Specification Item 445, "Galvanizing."

   Aluminum railing and galvanized steel railing do not require field painting. Before final acceptance, clean extrusion marks, grease, and dirt from the railing.

5. **Storage.** Store railing materials above the ground on platforms, skids, or other supports, and keep them free from grease, dirt, and contact with dissimilar metals. Avoid scratching, marring, denting, discoloring, or otherwise damaging the railing.

B. Concrete Railing. Provide concrete portions of railing in accordance with the requirements of Item 307, "Concrete Structures," and requirements of this Item. Construct forms so that the railing line and grade can be checked after the concrete has been placed but before initial set. Do not disturb the form alignment during finish floating of the railing tops. Exercise particular care in other construction to avoid disturbing or vibrating the span with the newly placed railing.

Provide precast members conforming to TxDOT Standard Specification Item 424, "Precast Concrete Structures (Fabrication)."

Concrete railing may be constructed using approved slip-form equipment. Provide sensor control for both line and grade.

C. Tests. The Engineer will sample cast aluminum posts for testing in accordance with TxDOT Standard Test Method Tex-731-I to verify the material requirements of Item 302, "Metal for Structures." Metal beam rail elements may be sampled in accordance with TxDOT Standard Test Method Tex-713-I. The Engineer may sample bolts and nuts in accordance with TxDOT Standard Test Method Tex-708-I for galvanized coating testing.

517.5. MEASUREMENT: Railing of the classification and type designated will be measured by the linear foot, end to end of rail, complete in place in accordance with the dimensions and details governing the quantities as shown in the plans.

517.6. PAYMENT: Payment for railing will be made at the contract unit price bid per linear foot for "Bridge Railing" as shown on the plans, complete in place, measured as herein provided. This price will be full compensation for furnishing, preparing, and placing concrete, expansion joint material, reinforcing steel, structural steel, aluminum, cast steel, pipe, anchor bolts, tie-in anchorage to approach railing or guard fence, anchorage devices for attaching metal beam guard fence or end treatments, and all other materials required in the finished railing; removal and disposal of salvageable materials; and hardware, paint and painting of metal railing, galvanizing, equipment, labor, tools, and incidentals.

Concrete parapet walls, headwalls, etc., and the reinforcing steel thereof, (except rail anchorage) will not be considered as parts of the rail for payment, but shall be paid for at the contract unit price bid for their respective items.

517.7. BID ITEM:

Item 517.1 - Bridge Railing - per linear foot

ITEM

520 HYDROMULCHING

520.1. DESCRIPTION: *This item shall govern for preparing ground, providing for sowing of seeds, mulching with 70/30 wood/cellulous blend fiber mulch, and other management practices along and across such areas as are designated on the plans and in accordance with these specifications. All areas shall be covered with live grass before acceptance.*

520.2. MATERIALS:

A. Seeds. All seed must meet the requirements of the Texas Seed Law including the labeling requirements for showing purity, germination, name and type of seed. Seed furnished shall be of the previous season's crop for the date of the project. Each variety of seed shall be furnished and delivered in separate bags or containers. A sample of each variety shall be furnished for analysis and testing when directed by the Engineer. The amount of seed planted per acre shall be of the type specified below and shall equal or exceed the following percentages for purity and germination or an equivalent amount of pure live seed.

- Common Name: Bermuda and Giant Bermuda grass (hulled)
- Scientific Name: Cynodon Dactylon
- Purity: 95%
- Germination: 90%

Annual Rye grass will be free of Johnson grass, field bind weed, dodder seed, and free of other seed to the limits allowable under the Federal Seed Act and applicable State Seed Laws.

Annual Rye grass will be added into slurry between October 1 and March 15. No additional cost will be charged to the City.

B. 70/30 Wood/Cellulose Blend Fiber Mulch. Wood/Cellulose blend fiber mulch shall consist of 70% long wood grain fibers produced from grinding clean, whole wood chips and 30% cellulose fiber produced from ground newsprint. Mulch fibers shall be free of abrasive or hard contaminants which would inhibit hydraulic pumping. The mulch fibers must maintain uniform suspension in water under agitation and shall blend with grass seed, fertilizer, and other additives to form homogeneous slurry. Upon application, the mulch material shall form a blotter-like mat covering the ground. This mat shall have the characteristics of water absorption and percolation and shall cover and bond grass seed in contact with the soil. The wood fiber mulch shall be dyed green to aid visual metering during application. The dye shall be biodegradable and not inhibit plant growth. The wood fiber mulch shall also conform to the following specifications:

1. Percent moisture content (maximum) 12.5% ±3.0%

2. Percent organic matter

a. Wood fiber (minimum) 70% ±0.8% O.D. Basis[1]

[1] Oven Dry Basis

b.	Paper fiber (maximum)	30.0% ±0.8% O.D. Basis
3.	Percent ash content	1.0% +0.2% O.D. Basis
4.	Ph	4.8% ±0.5%
5.	Water holding capacity (minimum)	1,000 Grams of water per 100 grams of fiber

The wood fiber mulch shall be packaged in units' not exceeding 100 lbs. and shall be suitable for outdoors storage for up to six months. The package shall contain, on current labels, the manufacturer's name and address, net weight, and customer service telephone number.

C. Fertilizers. Fertilizer shall have a chemical analysis of 15-15-15 with micronutrients and shall be water soluble (The figures in the analysis represent the percent of nitrogen, phosphoric acid and potash nutrients, respectively). Fifty percent or greater of the Nitrogen required shall be in the form of Nitrate Nitrogen ($N0_3$). The remaining Nitrogen required may be in the form urea Nitrogen ($C0(NH_2)_2$).

In the event it is necessary to substitute a fertilizer of a different analysis, it shall be a pelleted or granulated fertilizer with a lower concentration, but the total amount of nutrients furnished and applied per acre shall equal or exceed that specified for each nutrient.

The fertilizer shall be dry and in good physical condition. Fertilizer that is powdered or caked will be rejected.

D. Tactifier and Binder. Natural vegetable gum containing gelling and hardening agents that when mixed with water and properly cured, shall form an insoluble network.

E. Water. Shall be furnished by the contractor and shall be clean and free of substances harmful to the growth of vegetation.

F. Herbicide. Herbicide used shall be an easy to apply, effective in a short term, chemical agent to inhibit or destroy weed growth, while being harmless to seed and grass being implanted.

G. Topsoil. Topsoil shall conform to the provisions of Item 515, "Topsoil."

520.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

520.4. CONSTRUCTION:

A. General. Security of stored hydromulch materials will be the sole responsibility of the Contractor at no additional expense to the City.

It is the contractor's responsibility to verify the location of all utility lines, electric cables, sprinkling systems and conduits so that the proper precautions must be taken not to disturb or damage any subsurface improvements. Should obstructions be found, the Contractor will promptly notify the City Inspector. Any damage caused by the contractor shall be repaired by himself at no cost to the City. Any such repairs shall be subject to approval by the Inspector.

B. Preparation of Subsoil. Inspect subsoil for the presence of objectionable materials, such as rocks (2 inches in diameter and larger), concrete waste, building debris, weeds, grass or other

material that would be detrimental to the growth of grasses. Protect existing underground improvements from damage.

Cultivate to a depth of 3 inches in areas to receive hydromulch. If compaction is due to equipment, traffic or storage, cultivate to a depth of 6 inches, and apply herbicide as directed by manufacturer.

Remove any foreign or objectionable materials collected during cultivation.

Grade placement area to eliminate rough spots and low areas where ponding may occur. Assure positive drainage away from all buildings. Maintain smooth, uniform grades.

Hydromuch area and weed control shall consist of killing all weeds and maintaining a weed-free condition until completion of the project by applying herbicide as directed by the manufacturer.

C. Seeded Lawns. The following construction sequences and procedures shall be observed:

1. The contractor shall notify the Inspector not less than 48 hours in advance of any seeding operation and shall not begin the work until areas prepared or designated for seeding have been approved.

2. Before placement of hydromulch, all areas shall be cultivated to a depth of 3 inches unless otherwise specified or ordered by the Engineer. Cultivation of the soil may be done by disc, spring tooth harrow, roto-tiler, or similar equipment. This operation shall be done at right angles to the natural flow of water on the slopes.

3. The area shall then be rolled in two directions; the second shall be done at right angles to the first rolling.

4. Rake the area to make it smooth and level. Add soil where necessary or as directed by the Inspector.

5. The finished grade shall be 1 inch below all curbs, sidewalks, and/or other appurtenances.

6. Apply the fertilizer at the rate and mixture specified. The fertilizer shall be applied by an approved hand or mechanical method.

7. Roll the area in one direction.

8. Slurry to be sprayed evenly in two intersecting directions with a hydraulic seeder.

9. Erect a barrier of stakes and strings, and post warning signs where necessary, or as directed by the Inspector.

10. Apply water as required to keep the mulch damp at all times throughout germination and initial growth period as determined by the Inspector.

11. Upon completion, all excess material shall be removed and disposed of off the project site at contractor's expense.

D. Slurry. The slurry will be mixed and spread uniformly over the area at the following rate for both residential and commercial areas:

- 70/30 Wood/Cellulose Blend Fiber Mulch 2,000 lb/acre
- Fertilizer 400 lb/acre
- Bermuda 1.5 lb/1,000 sq ft
- Annual Ryegrass (Oct. through March 15) 20 lbs per 1,000 sq ft
- Water and binder shall be added according to manufacturer's recommendations.

E. Guarantee and Lawn Established Period. The guarantee and lawn established period shall begin immediately after the completion of the planting and shall start with the Provisional Acceptance and end with the Final Acceptance.

1. **Provisional Acceptance.** Upon completion of hydromulching and written request of Contractor, the Inspector will inspect all the work for Provisional Acceptance.

2. **Guarantee Period.** The guarantee period shall begin upon completion of the provisional acceptance. All plant materials shall be guaranteed by the Contractor for a period of thirty days (30) from the date of provisional acceptance, to be in good, healthy, and nourished condition. The exceptions are damages resulting from neglect by the property owner, abuse or damage by others, or unusual phenomena or incidents which are beyond the Contractor's control.

   During the lawn establishment period, it shall be the contractor's responsibility to ensure the continuing healthy growth. This care shall include labor, water and material necessary to keep the project in a presentable condition, including but not limit to removal of litter, mowing, trimming, removal of grass clippings, edging, fertilization, insecticide and fungicide applications, weed control, and repair and reseeding any and all damaged areas.

   Water application shall be accomplished each week from March through October. An even application of one inch minimum of water shall be required over all lawn areas weekly. The rate and frequency of water application may be changed, as directed by the Inspector, depending on weather, and soil conditions.

3. **Replacement.** The Contractor shall replace, without cost to the City, and as soon as weather conditions permit, all dead grassed areas not in a vigorous, thriving condition, as determined by the Inspector during and at the end of the guarantee period. Replacements shall be subject to all requirements stated in this specification. The Contractor shall make all necessary repairs to grades, grassed areas, and terrace paving required because of grass replacement at no cost to the City.

4. **Final Inspection and Acceptance.** At the end of the guarantee period and upon written request of the contractor, the Inspector will inspect all guaranteed work for final acceptance. The written request shall be submitted to the City ten (10) days prior to the anticipated date of inspection.

   Acceptance of hydromulching lawn as herein specified shall be based on a uniform stand of grass and a uniform grade at the time of final inspection. Area of two square feet or more that are bare or have a poor stand of grass and area not having a uniform grade for any cause before final inspection shall be regraded, rehydromulched and reseeded as specified at the Contractor's expense.

Upon completion by the Contractor of all repairs or renewals which may appear at that time to be necessary in the judgment of the City or its authorized representative, the final acceptance of the hydromulching will be issued.

520.5. MEASUREMENT: Measurement of acceptable "Hydromulching," complete in place, shall be made by the square yard and only for those areas designated on the plans, or for other areas directed by the Inspector. Fertilizers, wood cellulose fibers, seeds, herbicide and water will not be measured for payment.

520.6. PAYMENT: "Hydromulching," measured as provided above, will be paid for at the contract unit price bid per square yard, which price shall be full compensation for furnishing, hauling and placing all materials, for all fertilizer and water required and for all labor, tools, equipment and incidentals necessary to complete the work.

520.7. BID ITEM:

Item 520.1 - Hydromulching (Residential or Commercial) - per square yard

ITEM

522 SIDEWALK PIPE RAILING

522.1. DESCRIPTION: *This item shall govern for furnishing and installation of railings for structures, in conformity with the lines, dimensions and details shown on the plans, and with the conditions of these specifications. This item shall include all connections, parts, and accessories, all required anchorage in the structures, headwalls, and wingwalls for proper anchorage of the post.*

522.2. MATERIALS:

A. Sidewalk Pipe Railing. Sidewalk pipe railing shall consist of two (2) horizontal steel pipe rails and vertical posts furnished and installed, complete on structures in conformity with the lines, diameters, dimensions and details shown on the plans and with the conditions of these specifications. This item shall include all connections, parts and accessories, all required anchorage in the structure concrete required for proper anchorage of the post. The pipe shall be of structural steel conforming to the requirements of the Standard Specifications for Steel for Bridges and Buildings, ASTM A 36, or approved equal.

B. Paint. Sidewalk pipe railing shall be painted with one (1) shop coat of primer, and two (2) field coats of aluminum paint. All paints and painting done under this item shall comply with the requirements as set forth under Item 514, "Paint and Painting."

522.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

522.4. CONSTRUCTION: Railing shall be constructed of the type specified, in accordance with details shown on the plans, and in conformance with the requirements herein specified. 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 the falsework for the span has been released. The finished railing shall be rigidly fixed in position and true to line and free of scratches and other defects which would mar the appearance.

522.5. MEASUREMENT: "Sidewalk Pipe Railing," including all painting, anchorage, parts, and connections, in place in accordance with the plans and specifications, complete and accepted will be measured upon the face of the rail in place, from center to center of end post.

522.6. PAYMENT: Payment for railing, measured as prescribed above, will be made at the contract unit price bid per linear foot for "Sidewalk Pipe Railing," which price shall be full compensation for the furnishing of all labor, material, tools, equipment, and incidentals necessary to complete the work in accordance with the plans and specifications.

522.7. BID ITEM:

Item 522.1 - Sidewalk Pipe Railing - per linear foot

ITEM

523 ADJUSTING OF VEHICULAR & PEDESTRIAN GATES

523.1. DESCRIPTION: *This item shall govern for the adjustment of manual Vehicular & Pedestrian Gates made necessary by the construction of new driveways or sidewalk entrances. This item does not apply to gates that operate automatically.*

523.2. MATERIALS: All additional materials needed to perform the gate adjustment shall conform to those specified in Item 507, "Chain Link Wire Fence."

523.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

523.4. CONSTRUCTION: Approval from the property owner shall be obtained by the Engineer, in order to perform the necessary work required. The Contractor shall remove the existing gate from the gate posts, relocate and/or replace (if necessary) the existing hinges at a level such that the gate will provide the necessary clearance to properly operate. In addition, the center rest shall be lowered, if necessary. Then the gate shall be reinstalled and shall be operative.

523.5. MEASUREMENT: Vehicular and pedestrian gates will be measured for each driveway or sidewalk entrance and/or exit of each type that is adjusted.

523.6. PAYMENT: The work performed and the materials furnished as prescribed by this item will be paid for at the bid price per gate for "Adjusting of Vehicular & Pedestrian Gates," which price shall be full compensation for removing and reinstalling the existing gate and for furnishing all additional materials, all labor, tools, equipment and incidentals necessary to complete the work.

523.7. BID ITEM:

Item 523.1 - Adjusting Vehicular Gates - per opening

Item 523.2 - Adjusting Pedestrian Gates - per each

ITEM

524 CONCRETE STEPS

524.1. DESCRIPTION: *This item shall govern the installation of concrete steps composed of Portland Cement concrete, constructed as herein specified on an approved subgrade, in conformity to the lines, grades and details shown on the plans or as established by the Engineer.*

524.2. MATERIALS: Materials shall conform to the provisions of the following Items:

A. Concrete. Item 300, "Concrete," Class "A" or shall be of the class as noted on the plans.

B. Reinforcing Steel. Item 301, "Reinforcing Steel"

C. Welded Wire-Flat Sheets. Item 303, "Welded Wire Flat Sheets"

D. Expansion Joint Materials. Item 307.2.E, "Expansion Joint Materials"

E. Membrane Curing Compound. Item 307.2.H, "Curing Materials"

524.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

524.4. CONSTRUCTION:

A. Subgrade Preparation. The subgrade shall be excavated and shaped to the lines, grades and cross section shown on the plans, or as directed by the Engineer, and shall be sprinkled and thoroughly compacted.

B. Subbase Placement. A cushion, 2 inches minimum thickness, of crusher screenings, gravel, crushed rock or flex base material shall be spread, thoroughly, tamped and leveled. The cushion shall be moist at the time the concrete is placed. Where the subgrade is rock or gravel, 70% percent of which rock, the 2 inch cushion need not be used. The Inspector will determine if the subgrade meets the above requirement.

If the subgrade is undercut, or the natural ground is below "top of subgrade," then necessary backfill shall be made with an approved material and compacted with a mechanical tamper. Hand tamping will not be permitted.

The foundation shall be level and uniformly compacted to prevent future settlement.

C. Concrete Forms. Forms shall be of metal or well-seasoned wood of a section satisfactory to the Inspector; clean, straight, free from warp, and of a depth equal to the thickness of the finished work. All forms shall be securely staked to line and grade and maintained in a true position during the depositing of concrete. Before concrete is placed, forms shall be thoroughly oiled with a light form oil.

D. Expansion Joints. Expansion joint material, ½ inch thick, shall be provided where the new construction abuts the existing sidewalks if the Engineer deems it necessary or if shown on the plans. The expansion joint material shall be placed vertically and shall extend the full

depth of the concrete. Similar expansion material shall be placed around all obstructions protruding through the steps.

E. Reinforcement. Concrete steps shall be reinforced as shown on the plans. Care shall be exercised to keep all steel in its proper position during the depositing of concrete. Splices in the No. 3 bars shall have a minimum lap of 12 inches.

F. Concrete Placement and Finishing. Concrete shall be placed in the forms and spaded, tamped and thoroughly compacted until mortar entirely covers the surface and has a monolithic finish. The top surface shall be floated and troweled to a uniform smooth surface, then finished with a camel hair brush or wood float to a gritty texture. The outer edges and joints shall be rounded with approved tools to the radii shown on the plans.

G. Curing. Immediately after finishing, the surface shall be protected by a membrane-compound curing agent, or by wetted cotton or burlap mats. Either method shall be subject to approval by the Inspector.

H. Filling and Grading. Complete all necessary excavation, filling and grading of the slopes, adjacent to the completed concrete steps. The adjacent excavation and grading of the slopes shall be done in a manner acceptable to the Engineer.

524.5. MEASUREMENT: Accepted work as performed as prescribed by this item will be measured by the cubic yard of concrete complete in place.

524.6. PAYMENT: The work performed as prescribed by this item will be paid for at the contract unit price bid per cubic yard for "Concrete Steps" which price shall be full compensation for preparing the subgrade; for furnishing and placing all materials including all reinforcing steel and expansion joint materials and for any other materials, manipulation, labor, tools, equipment and incidentals necessary to complete the work. Excavation, filling and grading of the slopes, adjacent to the completed concrete steps will be considered incidental work pertaining to this item and will not be paid for directly.

524.7. BID ITEM:

Item 524.1 - Concrete Steps - per cubic yard

ITEM

525 CONCRETE TRAFFIC BARRIERS (PORTABLE)

525.1. DESCRIPTION: *This item shall govern for furnishing and placing precast concrete traffic barrier at the locations designated in the plans.*

525.2. MATERIALS: All materials used in the construction of precast concrete traffic barrier shall conform to the requirements of Item 307, "Concrete Structures."

When temporary barrier is to be furnished and retained by the Contractor, products from non-approved sources or previously used product may be provided if the Contractor submits written certification that the barrier sections and materials substantially conform to the requirements of this Item. The Engineer may approve the use of the product if:

- the barrier sections substantially meet typical cross-sectional dimension requirements,
- there is no evidence of structural damage such as major spalling or cracking, and
- the general condition of both the barrier sections and their connectors is acceptable.

Barrier sections to be furnished by the City will be at a stockpile location or existing concrete traffic barrier installation shown on the plans.

525.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

525.4. CONSTRUCTION:

A. General. Precast barrier furnished by the Contractor shall be constructed in accordance with this item and as discussed below the most current standards of the Texas State Department of Transportation (TxDOT), as may be amended from time to time.

B. Fabrication. Notify the Engineer of the location of the casting site and the date on which the work will begin. Multi-project fabrication plants (as defined in TxDOT Standard Specification Item 424, "Precast Concrete Structures (Fabrication)") that produce concrete traffic barrier must be approved in accordance with TxDOT DMS-7350, "Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Traffic Barrier." The TxDOT Construction Division maintains a list of approved multi-project plants. Construct barrier in accordance with Item 307, "Concrete Structures," to the dimensions and cross-sections shown on the plans. Provide forms and cure concrete in accordance with TxDOT Item 424, "Precast Concrete Structures (Fabrication)."

Provide a rough texture to the bottom surface of Single Slope, F Shape, or Safety Shape barriers and to the top of Low Profile barriers similar to a wood float finish.

Remove formwork after the concrete has reached sufficient strength to prevent physical damage to the member. When the barrier sections have attained sufficient strength to permit handling without causing visible damage, move the barrier sections to a storage area and place them on blocking to prevent damage.

Produce precast barrier to the tolerances given in Table 1 unless otherwise shown on the plans.

Table 1
Precast Barrier Tolerances

Dimension	Tolerance
Length	±1"
Insert Placement	±½"
Horizontal Alignment	±⅛" per 10 ft. of length
Deviation of Ends:	
Horizontal Skew	±¼"
Vertical Batter	±⅛" per foot of depth

C. Installation. When shown on the plans, install the barrier sections in accordance with the details shown otherwise concrete traffic barriers shall be installed at the edge of the roadway where the drop off to excavation exceeds a three feet differential from top of roadway surface. The interface between adjacent barriers shall be interlocking. Installation shall be performed such that an impact by a vehicle typically traversing that stretch of roadway shall not cause the barrier to be moved. The ends of the concrete barrier system must be flared or for no direct payment approved guardrail terminal section or crash cushions may be used. No action associated with the concrete traffic barriers shall violate any portion of the *Texas Manual on Uniform Traffic Control Devices*.

D. Removal and Storage. Stockpile portable barriers no longer required on the project and to be retained by the City, not designated for permanent use, at a site shown on the plans or as directed by the Engineer. Haul City-owned connection hardware after use to the location directed by the Engineer unless otherwise shown on the plans.

E. Defects and Breakage. Concrete traffic barrier, including any required hardware, damaged or lost in the process of fabricating, curing, handling, or placing shall be repaired or replaced as directed by the Traffic Engineer. All replacements and repairs shall be made at the Contractor's expense.

525.5. MEASUREMENT: Measurement of the concrete traffic will be by the linear foot, based on the nominal lengths of the barrier segments as shown in the plans. Barriers shall remain the property of the contractor after usage.

525.6. PAYMENT: The work performed and materials furnished and measured as provided above will be paid for at the Unit price bid for "Concrete Traffic Barrier (Portable)," which price shall be full compensation for furnishing, installing the barrier, including the furnishing of all materials, and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work. Additionally, included under this item shall be for any reuse, relocating, or removing the barriers as directed by the Traffic Engineer for the duration of the project.

525.7. BID ITEM:

Item 525.1 - Concrete Traffic Barrier (Portable) - per linear foot

ITEM

526 FIELD OFFICE

526.1. DESCRIPTION: *This item shall govern the erection or furnishing of a building to be used by the inspection force as a Field Office where the contract amount is one million dollars or greater.*

526.2. EQUIPMENT:

A. General. Furnish facilities after the receipt of the work order to begin work and before beginning physical work on the project. Provide field offices of the type and number specified near the worksite at a location acceptable to the Engineer. The Contractor may make use of permanent buildings or rental space meeting the requirements for field offices instead of portable buildings if approved. Maintain the field office until the City accepts the project. Furnish other equipment as required.

B. Damage. Immediately repair or replace the facility if it is damaged in any manner. Payment for repair will not be made unless it is the result of negligence by the City. Reimburse the City for equipment damaged by the Contractor's operations.

C. Right-Of-Way. When facilities are allowed in the right of way, remove buildings and other facilities and restore the right of way before project acceptance.

D. Parking and Fencing. Unless otherwise shown on the plans, provide an all-weather parking area for the sole use of at least 2 City-owned vehicles. Situate the area near the field office or laboratory at a location acceptable to the Engineer. Maintain the parking area until the project is completed and restore the area to a condition acceptable to the Engineer upon project completion. When shown on the plans, enclose the field office or laboratory and the parking area with a 6-ft. chain-link fence, a top-mounted 3-strand barbed wire, and a 12-ft. gate.

E. Buildings.

1. Field Office. Provide field offices with roofs, floors, doors, and screened windows. The building shall be a minimum of 10 feet by 16 feet by 8 feet high with not less than three glass windows and one door. Ensure the floor is of sufficient strength to support testing equipment and has an impervious floor covering.

If the Contractor uses part of the structure, do not interconnect the field office with Contractor-used rooms.

Ensure that the field office is weatherproof, piped for water and fuel, and electrically wired by certified personnel with the power requirements shown on the plans or directed by the Engineer. Furnish and install adequate equipment, outlets, lighting, air conditioning, heating, and ventilation.

Provide a partitioned rest room furnished with rest room supplies, a lavatory and a flush toilet connected to a sewer or septic tank. A portable toilet may be used when approved by the Engineer.

When directed by the Engineer, provide secured and controlled access to the field office or laboratory through the use of security measures such as bars, alarms, or security fencing. Furnish steps to the building if deemed necessary by the Engineer.

2. **Laboratory.** Provide laboratories with all of the requirements described in Section 526.2.E.1, "Field Office." In addition, provide the following items unless otherwise directed:

   a. laboratory equipment necessary for testing when shown on the plans;

   b. water (for testing purposes) from an approved source;

   c. an exhaust fan for concrete curing, asphalt, or other operations to meet OSHA requirements (Vent all exhaust to the outside of the structure.);

   d. a work platform at least 18 in. long and 12 in. wide, mounted on a lumber post at least 6 in. by 6 in. extending through the floor and firmly fixed in the ground (The work platform support can be provided by other methods as shown on the plans or as directed.);

   e. a minimum of 20 ft. of total work counter length at least 3 ft. wide and 3 ft. above the floor and of sufficient strength to support required testing equipment;

   f. and a laboratory sink measuring 24 in. by 30 in. and 12 in. in depth.

F. Field Office and Laboratory Appurtenances. Provide workbenches and tables at least 3 ft. wide and 6 ft. long, chairs, and filing cabinets in the quantity acceptable to the Engineer. Provide solar screens, blinds, or shades if deemed necessary by the Engineer. Provide potable water, electricity, collection and disposal of trash, and janitorial services acceptable to the Engineer.

Provide a telephone and service unless otherwise directed. A cell phone may be provided to meet this requirement. Provide a paper copier and facsimile when required by the plans.

For Contracts that require a nuclear gauge for moisture or density determination, provide a closet within the facility or a separate structure for storage of the gauge as far as possible from the normal office work. For all doors allowing access to the nuclear gauge, provide internal keyed deadbolt locks and hinges with pins on the inside of the storage area.

When shown on the plans provide any or all of the following in accordance with the requirements therein:

- computers (laptop or desktop) meeting the minimum requirements of Item 1000, "Web Portal" or as designated on the plans,
- printers, and
- Internet service. The Internet service must be a provided on a line separate from required phone service.

526.3. MEASUREMENT: No measurement will be made under this item.

526.4. PAYMENT: No payment will be made under this item. The Field Office is not a pay item and shall remain the property of the contractor after completion of this project.

526.5. BID ITEM:

N/A

ITEM

530 BARRICADES, SIGNS, AND TRAFFIC HANDLING

530.1. DESCRIPTION: *This item shall govern for providing, installing, moving, repairing, maintaining, cleaning and removing upon completion of work, all barricades, signs, cones, lights and other such type devices and of handling traffic as indicated on the plans or as directed by the Engineer.*

530.2. GUIDELINES FOR BARRICADING ON CITY RIGHT-OF-WAY: The barricade contractor must locally maintain sufficient materials in stock to accommodate three or more construction phases per project. These will include all applicable traffic control sign types, trucks, trailers, arrow boards, and all other traffic control devices assigned to the Contractor's barricading operation.

The *Texas Manual on Uniform Traffic Control Devices (TMUTCD)*, Section 6A-6, requires the appropriate training for all personnel who are involved in the selection, placement, and maintenance of traffic control devices on construction projects. The City of San Antonio requires that all personnel associated with barricading operations and traffic handling possess certificates from either of the two groups listed in Table 1 below. Each certificate will be valid for four years.

Table 1
Barricading Training

Texas Engineering Extension Service	American Traffic Safety Service Association
Work Zone Traffic Control	Training Course for Worksite Traffic Supervisors

The Contractor shall have a minimum of one barricade supervisor and three persons who are responsible for construction work zone traffic control. These persons shall be based in the San Antonio metropolitan area and their sole tasks shall be implementing and maintaining construction work zone traffic control devices.

The Contractor shall have a commercial telephone answering service during non-working hours. The Contractor shall provide the City during working hours with an office telephone number, pager number, and cellular telephone number to contact the barricading supervisor. The contractor must be able to respond to any call within two hours. The barricading contractor or General Contractor must possess liability insurance in the minimum amount of one million dollars. A copy of the liability policy must be sent to the City Traffic Engineer for approval 48 hours prior to starting barricading operations.

The contractor shall comply with all standards set forth in the plan barricade detail sheets. One noncompliance letter issued by the City to the Contractor in regard to construction work zone traffic control, and not corrected within 48 hours, will be cause for delay of payment for this item.

If the general contractor elects to do his own barricading, he must comply with all the foregoing requirements. Additionally, a general contractor will be required to submit a traffic control plan (TCP) at least 72 hours in advance (excluding weekends and holidays) of starting work in each construction phase. Upon satisfactory evidence of competent barricading expertise, this requirement for a traffic control plan may be waived by the City Traffic Engineer.

530.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

530.4. CONSTRUCTION: All barricades, signs, and other types of devices listed above shall conform to the requirements of the TMUTCD. It is the contractor's responsibility to see that all traffic control devices are properly installed and maintained at the job site. If it is determined by the Traffic Engineering Representative that the traffic control devices do not conform to the established standards, or are incorrectly placed to protect the general public, the Traffic Engineer shall have the option to stop the work, at no expense to the City, until the situation is corrected by the Contractor. If it is determined that additional temporary traffic control devices, special directional devices, and/or business name signs are required, they will be provided by the contractor at no additional cost. As work progresses, the location of temporary traffic control devices will be adjusted and modified as necessary by the Contractor.

All retro reflective traffic control devices such as barricades, vertical panels, signs, etc., shall be maintained by cleaning, replacing or a combination thereof such that during darkness and rain, the retro reflective characteristics shall equal or exceed the retro reflective characteristics of the standard reflective panels in the Inspector's possession.

The contractor shall contact the City of San Antonio Traffic Operations Section prior to removing any traffic signs or traffic signals. Prior to completion of the contract and removal of barricades, all applicable permanent traffic signs and signals must be in place and functioning properly. All permanent signs or traffic control devices missing or damaged during construction shall be replaced at the contractor's expense. Permanent pavement marking shall be applied prior to the opening of any street to traffic. Temporary short-term expendable pavement markings may be provided prior to application of permanent markings.

The contractor must maintain all streets open to through traffic by repairing trenches, potholes, etc., at no direct payment. The contractor shall provide reasonable access to residences and all businesses within all phases of the work, as well as providing suitable access accommodations for school children, pedestrians, garbage pick-up and mail delivery by the US Postal Service. Temporary pedestrian crossing will be determined in the field by the Police Department School Services Unit. Temporary pedestrian crossings shall be 4 feet wide by 4 inches thick asphalt treated base or asphaltic concrete and will be paid for under Item 206, "Asphalt Treated Base" or Item 205, "Hot Mix Asphaltic Concrete Pavement," respectively.

When flagging is required by the plans or Traffic Control Plan, provide a Contractor representative who has been certified as a flagging instructor through courses offered by the Texas Engineering Extension Service, the American Traffic Safety Services Association, the National Safety Council, or other approved organizations. Provide the certificate indicating course completion when requested. This representative is responsible for training and assuring that all flaggers are qualified to perform flagging duties. A qualified flagger must be independently certified by one of the organizations listed above or trained by the Contractor's certified flagging instructor. Provide the Engineer with a current list of qualified flaggers before beginning flagging activities. Use only flaggers on the qualified list.

Flaggers must be courteous and able to effectively communicate with the public. When directing traffic, flaggers must use standard attire, flags, signs, and signals and follow the flagging procedures set forth in the TMUTCD.

530.5. MEASUREMENT: This item will be measured by "Lump Sum" as indicated on the plans.

530.6. PAYMENT: This item will be paid for at the contract lump sum price bid for "barricades, signs, and traffic handling". This price shall be full compensation for furnishing all labor, materials, supplies, equipment and incidentals necessary. To complete the work as specified. The lump sump price will be pro-rated based on the number of workdays in the project contract. Failure to complete the work within time allowed in the project contract due to approving designs, testing, material shortages, closed construction season, curing periods, and testing periods will not qualify for additional compensation. When additional work is added by an approved field alteration or when work is suspended for the convenience of the City, through no fault of the contractor, additional compensation may be paid to the Contractors.

530.7. BID ITEM:

Item 530.1 - Barricades, Signs and Traffic Handling - lump sum

ITEM

531 SIGNS

531.1. DESCRIPTION: *Furnish retroreflective and nonretroreflective signs constructed of aluminum substrate to the dimensions specified and install signs of varying sizes and legends as shown on the plans or as specified by the Engineer.*

531.2. MATERIALS: The following ASTM Standards and documents, of the issue in effect on the date of Invitation for Bid, form a part of this specification to the extent herein.

A. ASTM B 209 Specification for Aluminum and Aluminum Alloy Sheet and Plate

B. ASTM D 523 Standard Method for Test for Specular Gloss

C. ASTM D 4956 Standard Specification for Retroreflective Sheeting for Traffic Control

D. ASTM E 284 Standard Definition of Terms Relating to Appearance of Materials

E. ASTM E 308 Computing the Colors of Objects by Using the CIE System

F. ASTM E 810 Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting

G. ASTM E 1164 Standard Practice for Obtaining Spectrophotometric Data for Object-Color Evaluation

H. CIE Publication Number 39-2, Recommendation for Surface Colors for Visual Signaling

I. FP-92 Standard Specifications for Construction of Roads and Bridges on Federal Highway Project

J. Substrate. This shall be aluminum alloy 5052-H38 and otherwise in conformance with ASTM B-209 and have gold chromate finish. The size, shape and thickness of the sign blanks are as indicated on the standard detail sheet in the plans or as specified by the Engineer.

1. **Metal working.** The aluminum shall be free of burrs and pits on both sides, including edges and holes, and shall be made ready for applications of the sheeting.

2. **Surface Preparation.** The aluminum shall be thoroughly cleaned and degreased with solvent and alkaline emulsions cleaner by immersion, spray, or vapor degreasing and dried prior to application of the gold chromate sheeting coat.

   The aluminum shall be new and corrosion-free with holes drilled or punched, corners rounded to the radii shown in the standard detail sheet, and all edges smoothed prior to application of sheeting. The heavy or medium chromate coating shall conform in color and corrosion resistance to that imparted by the Alodine 1200F treatment.

3. **Size.** The dimensions of substrate applications for regulatory, warning, and guide signs shall be as specified by the Engineer and as shown on the plans.

K. Background, Legends, Symbols, and Colors. These shall be in accordance with the Standard Highway Sign Designs (SHSD) for Texas and with the Texas Manual of Uniform Traffic Control Devices (TMUTCD).

1. **Retroreflective Materials.** Retroreflective materials shall comply with "Standard Specifications for construction of Roads and Bridges on Federal Highway Projects", FP-85 and Federal Specifications L-S-300C. The Contractor shall furnish a certification that the materials comply with the requirements of FP- 85 and L-S-300C.

   a. **Retroreflective Sheeting.** Type III (High Intensity): The materials as listed in these specifications shall comply with FP-85, Section 718 and L-S-300C. Colors shall be as specified in specifications for Standard Highway Sign Colors (FHWA, HTO-21).

   b. **Retroreflective Sheeting.** Type IX (Diamond Grade Fluorescent yellow green, VIP Reflective Sheeting): The materials shall comply with ASTM 4956. Designed to provide higher nighttime sign brightness in the legibility distance and brightness at high entrance angles. The minimum fluorescence luminance factor (YF) for new sheeting shall be 35%.

2. **Electronically Cuttable Film.** Electronically cuttable film shall consist of flexible, transparent, durable acrylic colored films coated with a transparent pressure sensitive adhesive protected by a clear removable liner. These films are designed to be applied to retroreflective materials for the creation of traffic control signs and devices by either cutting by knife over roll (sprocket fed or friction fed) and flat bed electronic cutting machines. The films shall be available in standard traffic colors, be dimensionally stable, and be designed to optimally cut, weed, lift, and transfer. Use of electronic cuttable films will not require the release of any volatile organic compounds.

   When electronic cuttable film is applied to retroreflective sheeting, the resulting color of the composite sheeting will conform to Federal Specification FP-92, Section 718.01 and ASTM D 4956 or to the using agency specification for the appropriate retroreflective sheeting to which it is applied.

   Only signage utilizing electronically cuttable film will be allowed. Silk screened sign faces will not be accepted.

   a. **Color Test.** Conformance to color requirements shall be determined by instrumental method in accordance with ASTM E 1164 on sheeting applied to aluminum test panels. The values shall be determined on a HunterLab Labscan 6000 0/45 Spectrocolorimeter with option CMR 559 [or approved equal 0/45 (45/0) instrument with circumferential viewing (illumination)].

      Computations shall be done in accordance with ASTM E 308 for the 2° observer.

   b. **Coefficient of Retroreflection R^.** When electronic cuttable film is applied to retroreflective sheeting, the composite will conform to the percentage retained of the minimum coefficient of retroreflection specified by the using agency and the manufacturer for the retroreflective sheeting when the retroreflective sheeting is screen processed. The coefficient of retroreflection shall be determined in accordance with ASTM E 810. Coefficients of retroreflection R^ shall be specified in units of candelas as per foot candle per square foot (candelas per lux per square meter). The observation angles shall be 0.2 and 0.5 degrees unless otherwise specified. The

entrance angles shall be –4 and 30 degrees unless otherwise specified. The electronic cuttable film shall have and 85° specular gloss of not less than 50 when tested in accordance with ASTM D 523.

c. Processing and Cuttability. The electronic cuttable film shall permit cutting, weeding, masking with transfer tape, lifting, and application to retroreflective sheeting when used in accordance with manufacturer's recommendations at temperatures between 65° and 95° F and relative humidifies between 30% and 70%. The film shall lay flat with minimal edge curl and be dimensionally stable.

d. Adhesive Liner. The protective liner attached to the adhesive shall be removable by peeling without soaking in water or other solutions, without breaking, tearing, or removing any adhesive from the electronic cuttable film. The liner shall have a controlled release from the adhesive coated film sufficient to allow cutting without the film popping off from the liner while still allowing the liner to easily be peeled from the film.

e. Film. Film with punched edges for use on sprocket fed knife over roll cutters shall be edge scored and weeded to remove film in the punched area as a means of eliminating adhesive build up on the sprockets.

f. Resistance to Accelerated Outdoor Weathering. When electronic cuttable film is applied to retroreflective sheeting, the surface of the film shall be weather resistant and show no appreciable cracking, blistering, crazing, or dimensional change after 2 years unprotected outdoor exposure, facing the equator and inclined 45° from the vertical. Following weather exposure, panels shall be washed in a 5% HCI solution for 45 seconds, rinsed thoroughly with clean water, blotted dry with a soft cloth and brought to equilibrium at standard conditions.

After cleaning, the coefficient of retroreflection shall not be less than the value specified by the using agency for the retroreflective sheeting when the retroreflective sheeting is screen processed. Show no appreciable evidence of cracking, scaling, pitting, blistering, edge lifting or curling or more than 1/32 inch shrinkage or expansion. Show good color fastness or better when tested. The electronic cuttable film shall not be removable from the retroreflective sheeting without damage.

g. Sign Face. The sign face, made of electronic film and retroreflective sheeting shall comply with the appearance, specification, and good workmanship designated by the using agency for sign faces constructed of screen processed retroreflective sheeting of the same type.

3. Non-Retroreflective Sheeting. All letters, numerals, and symbols shall be as prescribed in this specification.

4. Application Methods. The method of application of sheeting, letters, numbers, and symbols shall be precisely as prescribed in writing by the manufacturer.

a. Legend Spacing and Layout. Spacing and layout for all traffic control signs shall conform to the SHSD.

b. Tolerance for Horizontal Alignment. Letters, numerals, and symbols shall be horizontally aligned to a tolerance of 1/16 inch. Test of each sign board shall be as follows:

(1) Place a metal straight edge along the bottom of a series of letters forming each line of the sign. In each line, letters shall not vary more than 1/16 inch from that line.

c. Tolerance for Vertical Alignment. Letters, numerals, and symbols shall be vertically aligned to a tolerance of 1/16 on each letter in each line:

(1) Place a metal straight edge along the bottom edge of a series of letters forming each line of the sign. Place a square along the straight edge and test the trueness of the vertical faces of individual letters. Letters shall be normal to the square within 1/16 inch.

L. Sign Posts. Steel post shall conform to the standard specification for hot rolled carbon sheet steel, structural quality, ASTM designation A570, Grade 50. Average minimum yield strength after cold forming is 60,000 psi. The cross section of the post shall be square tube formed steel, carefully rolled to size and shall be welded directly in the corner by high frequency resistance welding or equivalent process and externally scarified to agree with corner radii. Sign posts shall be hot dipped galvanized conforming to ASTM A653, G90.

1. Sizes. Perforated sign posts, anchors and sleeves shall be of the following size:

Size	USS Gauge	Weight
1½" X 1½"	14	1.71
1¾" X 1¾"	14	1.71
2" X 2"	12	2.42
2¼" X 2¼"	12	2.77

Holes shall be 7/16 ± 1/64 inches in diameter on one inch centers on all four sides down the entire length of the post. On square tubing, holes shall be on centerline of each side in true alignment and opposite each other directly and diagonally. The length of each post shall have a permissible length tolerance of ± ¼".

The finished posts shall be straight and have a smooth, uniform finish. It shall be possible to telescope all consecutive sizes of square tubes freely and for not less than ten feet of their length without the necessity of matching any particular face to any other face. All holes and ends shall be free from burrs and ends shall be cut square.

a. Tolerance on Outside Sizes.

Nominal Outside Dimension	Outside Tolerances at Corners
1½" X 1½"	±0.006"
1¾" X 1¾"	±0.008"
2" x 2"	±0.008"
2¼" X 2¼"	±0.010"

Note: Measurement from outside dimensions shall be made at least 2 inches from the end of the tube.

Permissible variation in wall thickness is +0.011", -0.005".

Convexity and concavity shall be measured in the center of the flat sides, tolerance in ±0.010", determined at the corner.

b. Squareness of Sides and Twist Permissible in 3" Length.

Nominal Outside Dimension	Squareness Tolerance	Twist
1½" x 1½"	±0.009"	0.050"
1¾" x 1¾"	±0.010"	0.062"
2" X 2"	±0.012"	0.062"
2¼" X 2¼"	±0.014"	0.062"

Permissible variation in straightness is 1/16 of an inch in 3 feet. The standard outside corner radius shall be 5/32 of an inch ±1/64 inch.

2. Installation. The square end of the post shall not be modified or pointed.

a. Flange. When sign post installation is required over building basements, bridges and cavities, a galvanized cast iron pipe flange shall be used. The base shall be 8 inches in diameter with six 5/16 inch holes drilled equidistant around the circumference, ⅝ inch from the outer edge. The neck of the flange shall be 3inches in diameter, drilled and threaded to receive a 2 inch diameter galvanized post.

b. Hardware. All ground mounted signs shall be attached to posts using ⅜" aluminum drive rivets. Stainless steel banding material, brackets and clips will be used for signs installed on light standards or mast arms.

c. Construction. Anchors shall be anchored in a minimum of one cubic foot of class "C" concrete, 28 inches deep, with a 6 inch long, ⅜ inch diameter pin inserted through the pre-drilled hole 3 inches from the bottom of the pole. Where the pole installation requires surface mounting, an 8 inch flange with a 2 inch threaded collar shall be used. The pole shall be galvanized, two inches in diameter and threaded to fit the flange. Sign placement and orientation shall be as specified in the construction plans.

M. Anti-Vandalism and Maker's Mark Decals. The anti-vandalism decal shall be installed on the back bottom left corner of the sign. Decals will be supplied by the Traffic Operations Section (207-7765). Each sign shall be permanently marked on the lower right corner of the back side with the month and year of installation, and name of manufacturer.

N. Warranty. The Contractor shall warrant the materials and workmanship of each sign in accordance with the maximum limits of material warranties extended by manufacturers of raw materials, subject to the conditions they specify. Type III and Type IX, Fluorescent Yellow Green, sheeting processed and applied to sign blank materials in accordance with sheeting manufacturer's recommendations, shall perform effectively for the number of years stated in Tables 1 and 2 of this specification. The retroreflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions; or (2) the coefficient of retroreflection is less than the minimum specified for that sheeting during that period listed in Tables 1 and 2. When sign failure occurs prior to the minimum years indicated and an inspection demonstrates that the failure is

caused by materials warranted to contractor to endure at least that long, the sign will be replaced or repaired free of materials charges. When failure occurs and inspection demonstrates that such failure is due to poor workmanship, the sign will be replaced or repaired at Contractor's expense, including shipping charges.

Table 1
Minimum Coefficient of Retroreflection
[0.2° observation angle and -4° entrance angle]

Type III Sheeting: 10 Year Life Span	
Sheeting Color	**Candelas per Foot - Candle per Sq. Ft.**
White	250
Yellow	170
Green	45
Red	45
Blue	20
Brown	12

Table 2
Minimum Coefficient of Retroreflection
[0.2° observation angle and -4° entrance angle]

Type IX Sheeting: 7 Year Life Span	
Sheeting Color	**Candelas per Foot - Candle per Sq. Ft.**
Floresent Yellow Green	300

531.3. EQUIPMENT: Provide machinery, tools, and equipment necessary for proper execution of the work.

531.4. CONSTRUCTION: Construction shall be high quality with no visible defects in the finished product. Fabrication shall be in accordance with these specifications. Street name signs shall always be supplied and installed at each project intersection whether signs previously existed at the location or not.

A. Unsignalized Intersection. At unsignalized intersections, ground-mounted street name signs of 9 inch heights with 6 inch letters and 1-½ inch block numbers are required.

B. Signalized Intersection.

1. Ground Mounted Street Signs. If a signalized intersection has either mast arms or span-wire on which overhead street name signs can be attached, no ground mounted streets name signs are required at that intersection.

2. Overhead Street Signs. Signs shall be bolted or strapped to the mast arm or span wire. Attachments to mast arms shall be by means of a ⅝ inch stainless steel strap and a stainless steel flared strap bracket.

a. Signs Outside Central Business District. Overhead street name signs installed outside of the Central Business District shall be 15 inches high with 6½ inch letters and 4½ inch block numbers.

b. Signs Within Central Business District. Overhead street name signs installed inside the Central Business District shall be 18 inches high with 8 inch letters and 4 ½ inch block numbers. Overhead street name signs shall be installed on all approaches.

C. Existing Signs. The removal of existing signs shall be coordinated with the Traffic Division to assure required signage is in place during all construction phases. When existing signs are to be removed, they will be unbolted from their post by hand and delivered to the Traffic Operations Section (207-7765).

531.5. MEASUREMENT: Measurement shall be based on the number of satisfactorily installed signs.

531.6. PAYMENT: The accepted quantities shall be paid at the contract unit price for the sign type applicable in the bid list which shall be full compensation, furnishing of all materials, labor, tools, equipment, and supplies to construct signs of varying sizes and legends as shown on the plans or as specified by the Traffic Design Engineer.

531.7. BID ITEM:

Item 531.1 - Metro Street Name, Block Numbers* (Varies x 15”)

Item 531.2 - Metro Street Name, Block Numbers* (Varies x 18”)

Item 531.3 - R1-1 STOP* (30”)

Item 531.4 - R1-2 YIELD* (36”)

Item 531.5 - R1-4 ALL WAY plate* (18” x 6”)

Item 531.6 - R2-1 Speed Limit* (24” x 30”)

Item 531.7 - R3-1 No Right Turn* (24” x 24”)

Item 531.8 - R3-2 No Left Turn* (24” x 24”)

Item 531.9 - R3-3 NO TURNS* (24” x 24”)

Item 531.10 - R3-4 No U-Turns*(24” x 24”)

Item 531.11 - R3-5 Left or Right Only* (30” x 36”)

Item 531.12 - R3-6 Lane-Use Control* (30” x 36”)

Item 531.13 - R3-7 LEFT LANE MUST TURN LEFT or RIGHT LANE MUST TURN RIGHT* (30” x 30”)

Item 531.14 - R3-8 Lane-Use Control* (30” x 30”)

Item 531.15 - R3-8 U-Turn Only* (24” x 30”)

Item 531.16 - R3-9 Two Way Left Turn Only* (30” x 36”)

Item 531.17 - R4-7 Keep Right* (24” x 30”)

Item 531.18 - R5-1 DO NOT ENTER* (30” x 30”)

Item 531.19 - R6-1 ONE WAY* (36” x 12”)

Item 531.20 - R6-2 ONE WAY* (18” x 24”)

Item 531.21 - R7-1 NO PARKING ANYTIME* (18” x 24”)

Item 531.22 - R7-18 NO PARKING THIS SIDE THIS BLOCK*(18” x 24”)

Item 531.23 - R1-1 (STOP)* (18” X 18”)

Item 531.24 - R9-3a Pedestrian Crossing Prohibited*(18” X 18”)

Item 531.25 - R10-11 NO TURN ON RED 7-9 AM AND 2-4 PM, SCHOOL DAYS ONLY*

Item 531.26 - R10-11a NO TURN ON RIGHT*(24” x 30”)

Item 531.27 - R10-12 LEFT TURN YIELD ON “Green Ball”*(30” x 36”)

Item 531.28 - R10-5 LEFT ON ARROW ONLY*(24” x 30”)

Item 531.29 - R10-6 STOP HERE ON RED* (24” x 36”)

Item 531.30 - R10-7 DO NOT BLOCK INTERSECTION*(24” x 30”)

Item 531.31 - S-25 NO PARKING 7-9 AM AND2-4 PM SCHOOL DAYS ONLY*(18” x 24”)

Item 531.32 - S-26 NO PARKING 7-9 AM AND2-4 PM STUDENT LOADING, SCHOOL DAYS ONLY*(18” x 24”)

Item 531.33 - S-27 NO PARKING 7-9 AM AND 2-4 PM SCHOOL BUS ZONE, SCHOOL DAYS ONLY*(18” x 24”)

Item 531.34 - S1-1 Advance School Crossing and School Crossing**(36” x 36”)

Item 531.35 - W16-7 Diagonal Arrow sign**(30” x 18”)

Item 531.36 - S4-1 1\20 MPH School Sign***(24” x 48”)

Item 531.37 - W1-1 Turn*(30” x 30”)

Item 531.38 - W1-2 Curve*(30” x 30”)

Item 531.39 - W1-3 Reverse Turn*(30” x 30”)

Item 531.40 - W1-4 Reverse Curve*(30” x 30”)

Item 531.41 - W1-5 Winding Road*(30” x 30”)

Item 531.42 - W1-6 Large Arrow* (48” X 24”)

Item 531.43 - W1-7 Large Arrow* (48” X 24”)

Item 531.44 - W16-7 Diagonal Arrow sign* (30” x 18”)

Item 531.45 - W1-8 Chevron Alignment* (18” x 24”)

Item 531.46 - W3-3 Signal Ahead* (36” x 36”)

Item 531.47 - W8-1 BUMP* (30” x 30”)

Item 531.48 - W8-2 DIP* (30” x 30”)

Item 531.49 - W9-2 Lane Ends Merge Left* (30” x 30”)

Item 531.50 - W10-1 Railroad Advance Warning* (36” Dia.)

Item 531.51 - W11-2 Ped Crossing* (30” x 30”)

Item 531.52 - W13-1 Advisory Speed* (18” x 18”)

Item 531.53 - W14-1 DEAD END* (30” x 30”)

Item 531.54 - W14-2 NO OUTLET* (30” x 30”)

Item 531.55 - OM-3 Type 3 Object Marker* (12” x 36”)

Item 531.56 - OM-4P End of Road Marker* (18” x 18”)

Item 531.57 - 9 inch Street Name, Block Numbers* (Varies x 9”)

Item 531.58 - W14-1P Dead End Street Marker* (36” x 9”)

Item 531.59 - Special Sign*

Item 531.60 - W14-2P No Outlet Street Marker* (36” x 9”)

Item 531.61 - S5-1 School Speed Limit When Flashing*** (24” x 48”)

Item 531.62 - W16-9p Ahead** (36” x 20”)

Item 531.63 - W16-2 XXX FT** (30”x 18”)

Item 531.64 - W13-1 30MPH Advisory** (18” x 18”)

Item 531.65 - S4-3A School Zone Arrows* (24” x 18”)

Item 531.66 - S5-2A, End School Zone* (24” x 9”)

Item 531.67 - R9-6 (YIELD TO PEDS)* (12” X 18”)

Item 531.68 - R3-17 (BIKE LANE)* (30” X 24”)

Item 531.69 - R3-17a (AHEAD)* (30” X 12”)

Item 531.70 - R3-17b (ENDS)* (30” X 12”)

Item 531.71 - R4-4 (BEGIN RIGHT TURN LANE YIELD TO BIKES)* (36” X 30”)

Item 531.72 - R1-2 (YIELD)* (18” X 18” X 18”)

Item 531.73 - W11-1 (Bicycle Warning)* (30” X 30”)

Item 531.74 - R5-3 (NO MOTOR VEHICLES)* (24” X 24”)

Item 531.75 - D11-1 (Bike Route)* (24” X 18”)

Item 531.76 - M4-11 (BEGIN)* (Bicycle Route Supplemental Plaques) (12” X 4”)

Item 531.77 - M4-12 (END)* (Bicycle Route Supplemental Plaques) (12” X 4”)

Item 531.78 - M4-13 (TO)* (Bicycle Route Supplemental Plaques) (12” X 4”)

Item 531.79 - M7-1 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)

Item 531.80 - M7-2 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)

Item 531.81 - M7-3 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)

Item 531.82 - M7-3 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)

Item 531.83 - M7-3 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)

Item 531.84 - M7-3 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)

Item 531.85 - M7-3 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)

* High Intensity

** Diamond Grade (Fluorescent Yellow Green)

*** Diamond Grade (Fluorescent Yellow Green) with High Intensity White Background

NOTE: All overhead mounted signs shall be Diamond Grade

ITEM

533 CLEANING AND REMOVAL OF PAVEMENT MARKINGS AND MARKERS

533.1. DESCRIPTION: *Clean both concrete and asphaltic surfaces prior to the placement of pavement markings/markers and/or for removal of existing pavement markings and raised pavement markers.*

533.2. MATERIALS: The blasting medium shall be a quality commercial product capable of producing the specified surface cleanliness without the deposition of deleterious materials on the cleaned surface.

533.3. EQUIPMENT: All equipment shall be of sufficient capacity to efficiently and economically clean the roadway surface to the specified cleanliness. Equipment shall be power driven and in good operating condition. Equipment shall utilize moisture and oil traps, in working order, of sufficient capacity to remove contaminants from the air and prevent deposition of moisture, oil or other contaminants on the roadway surface.

533.4. CONSTRUCTION: Unless otherwise shown on the plans, acceptable methods of removal for asphaltic pavements include heat scarification, blasting, and mechanical methods. Grinding is not an acceptable mechanical method unless otherwise approved by the Engineer. Blasting is the only acceptable method for removal or cleaning of a portland cement concrete surfaced pavement.

A. Removal of Existing Pavement Markings/Markers.

1. Existing markings or markers to be removed shall be removed to the extent that the pavement marking or marker and its adhesive compound is/are either completely removed or obliterated.

2. Widths, lengths, and shapes of the cleaned surface shall be of sufficient size to include the full area of the specified pavement marking to be placed or removed.

3. Avoid damage to the pavement surface during the removal of markings or markers. Repair damaged areas on asphaltic surfaces in excess of ¼ inch in depth using approved patching materials.

4. Blasting on portland cement concrete surfaces shall be sufficient to remove old pavement markings and all other contaminants. Over-blasting to the extent of damage to the roadway surface shall be avoided.

5. Very small particles of tightly adhering existing markings may remain in place if complete removal of the small particles will result in pavement damage.

B. Cleaning.

1. Pavement surfaces where existing pavement markings will remain in place shall be cleaned with high pressure air or water to remove dust, sand, and other objectionable material prior to application of new markings. If water is used, the area to be cleaned shall be sufficiently dry, as defined in Item 535.4.A.1, for application of the marking material.

2. All surfaces other than portland cement concrete surfaces required to be cleaned shall be cleaned sufficiently to remove loose and flaking conditions or markings of the road surface. Surface cleaning shall be completed on all existing pavements where the inlaid plastic material or raised pavement marker is not being used with new pavement.

3. Where blasting is used for the removal of pavement markings, adhesives, or for removal of objectionable material, remove the residue, including dust and water, immediately after contact with the surface being treated. Remove by a vacuum attachment operating concurrently with the blasting operation.

4. Where grinding is allowed by the Engineer to remove pavement markings on asphaltic concrete pavements, remove the residue by means of a vacuum attachment to the grinding machine. Do not allow the residue to flow across or be left on the pavement.

533.5. MEASUREMENT AND PAYMENT: Cleaning or removal of existing or incorrectly installed pavement markings and/or markers shall not be paid for directly, but shall be considered subsidiary to the pavement marking or marker items or Mobilization if no pavement marking pay items are used.

533.6. BID ITEM: This specification is included solely as a technical guide as to how cleaning or removal of markings and/or markers shall be performed and does not constitute a separate bid item.

ITEM

535 HOT APPLIED THERMOPLASTIC PAVEMENT MARKINGS

535.1. DESCRIPTION: *Apply thermoplastic pavement markings, in conformance with the minimum optical and physical properties required for a thermoplastic road marking compound described herein, in a molten state, onto a pavement surface.*

535.2. MATERIALS: All materials shall conform to the requirements of TxDOT DMS-8220 "Hot Applied Thermoplastic." Thermoplastic materials shall be stored in a dry environment to minimize the amount of moisture retained during storage.

535.3. EQUIPMENT: Provide the necessary equipment to conduct the work specified herein. All equipment shall be maintained in good working order such that neat and clean thermoplastic markings are applied at the proper thicknesses and glass beads are placed at the correct rate. Equipment that is deemed deficient by the Engineer shall be replaced immediately.

535.4. CONSTRUCTION: The appearance of the finished markings shall have a uniform surface, crisp edges with a minimum over-spray, clean cut-off, meet straightness requirements and conform to the design drawings and/or engineer instructions.

The contractor shall provide the Engineer with certification from the marking manufacturer that contractor has been adequately trained and certified to apply the manufacturer's material. This certification shall be considered current if the certification date provided by the manufacturer is within two years of the date of marking application.

All striping and pavement markings shall be placed in accordance with the requirements of this specification, the detailed plans, and the current edition of the *Texas Manual on Uniform Traffic Control Devices* (TMUTCD). The Contractor shall provide all other engineering services necessary for pre-marking of all proposed stripe within the limits of the designated work.

Unless authorized otherwise in writing by the Engineer, striping shall be accomplished during daylight hours. Approved lighting arrangements will be required for night time operations when allowed.

The Contractor may be required to place markings over existing markings, as determined by the Engineer. The contractor shall adjust the operation of the thermoplastic screed shoe to match the previous lengths of stripes and skips, when necessary.

Failure of the striping material to adhere to the pavement surface during the life of the contract shall be prima facie evidence that the materials, even though complying with these specifications, or the application thereof, was inconsistent with the intent of the requirements for the work under the latest City specifications and shall be cause for ordering corrective action or replacement of the marking without additional cost to the City.

Unless otherwise approved by the Engineer, permanent pavement markings on newly constructed pavements surfaced with asphaltic concrete or bituminous seals shall not be applied for a minimum of 14 days or a maximum 35 days. Temporary pavement marking shall be provided during the 14 to 35 day period.

A. Surface Preparation.

1. **Moisture.** All surfaces shall be inspected for moisture content prior to application of thermoplastic. Approximately two square feet of a clear plastic or tar paper shall be laid on the road surface and held in place for 15 to 20 minutes. The underside of the plastic or tar paper shall then be inspected for a buildup of condensed moisture from the road surface. Pavement is considered dry if there is no condensation on the underside of the plastic or tarpaper. In the event of moisture, this test shall be repeated until there is no moisture on the underside of the plastic or tar paper.

2. **Cleaning.** All surfaces shall be clean and dry, as defined in Section 535.4.A.1, before thermoplastic can be applied. Loose dirt and debris shall be removed by thoroughly blowing compressed air over the area to be striped. If the thermoplastic is to be applied over existing paint lines, the paint line shall be swept with a mechanical sweeper or wire brush to remove poorly adhered paint and dirt that would interfere with the proper bonding or the thermoplastic. Additional cleaning through the use of compressed air may be required to remove embedded dirt and debris after sweeping. Latence and curing compound shall be removed from all new portland cement concrete surfaces in accordance with Item 533, "Removal of Pavement Markings and Markers."

3. **Layout.** The pavement markings shall be placed in proper alignment with guidelines established on the roadway. Deviation from the alignment established shall not exceed 2 inches and, in addition, the deviation in alignment of the marking being placed shall not exceed 1 inch per 200 feet of roadway nor shall any deviation be abrupt.

   No striping material shall be applied over a guide cord; only longitudinal joints, existing stripes, primer, or other approved type guides will be permitted. In the absence of a longitudinal joint or existing stripe, the Contractor shall mark the points necessary for the placing of the proposed stripe. Edge striping shall be adjusted as necessary so that the edge stripe will be parallel to the centerline and shall not be placed off the edge of the pavement.

   Longitudinal markings shall be offset at least 2-inches from construction joints of portland cement concrete surfaces and joints and shoulder breaks of asphalt surfaces.

4. **Primer Sealer.** Primer sealer shall be used on all portland cement concrete surfaces. A primer sealer shall be used on asphalt surfaces that are over two years old and/or on asphalt surfaces that are worn or oxidized to a condition where 50 percent or more of the wearing surface is exposed aggregate. Existing pavement markings may act as the primer sealer if, after cleaning, more than 70 percent of the existing pavement marking is still properly bonded to the asphalt surface (see coverage check procedure in Appendix A to estimate percent of marking remaining).

5. **Primer Sealer Application.** When required as described, the primer-sealer shall be applied to the road surface in a continuous film at a minimum thickness of 3 to 5 mils. Before the Thermoplastic is applied, the primer-sealer shall be allowed to dry to a tacky state. The thermoplastic shall be applied within 4 hours after the primer application.

B. Temperature Requirements.

1. **Ambient Conditions.** The ambient air and road surface shall be 55ºF and rising before application of thermoplastic can begin.

2. **Material Requirements.** Unless otherwise specified by the material manufacturer, the thermoplastic compound shall be heated from 400ºF to 450ºF and shall be a minimum of 400ºF as it makes contact with road surface during application. An infrared temperature gun shall be used to determine the temperature of the thermoplastic as it is being applied to the road surface.

C. Drop-on Glass Sphere Application.

1. **Application Rate.** Retro-reflective glass spheres shall be applied at the rate of 10 pounds per 100 square feet of applied markings. This application rate shall be determined by confirming the following consumption rates:

   a. 200 pounds of drop on glass spheres per ton of applied thermoplastic when the thermoplastic is being applied at 0.090 inch film thickness.

   b. 150 pounds of drop on glass spheres per ton of applied thermoplastic when the thermoplastic is being applied at 0.125 inch thickness.

2. **Application Method.** Retro-reflective glass spheres shall be applied by a mechanical dispenser property calibrated and adjusted to provide proper application rates and uniform distribution of the spheres across the cross section of the entire width of the line. To enable the spheres to embed themselves into the hot thermoplastic, the sphere dispenser shall be positioned immediately behind the thermoplastic application device. This insures that the spheres are applied to the thermoplastic material while it is still in the molten state.

D. Application Thickness.

1. **Longitudinal and Transverse Markings.** On previously unmarked pavements or pavements where markings have been effectively removed, all lane lines, center lines, transverse markings and pavement markings in traffic areas with ≤1,000 vehicles per day per lane shall have a minimum film thickness of 0.090 inch at the edges and a maximum of 0.145 inch at the center. A minimum average film thickness of 0.090 inch shall be maintained. On pavements with existing markings, meeting the traffic requirements stated above, all lane lines, center lines, transverse markings and pavement markings shall have a minimum film thickness of 0.060 inch for re-application over existing strip line.

2. **High Wear Longitudinal and Transverse Marking.** On previously unmarked pavements or pavements where markings have been effectively removed, all lane lines, center lines, transverse markings and pavement markings in high traffic areas (>1,000 vehicles per day per lane) shall have a minimum film thickness of 0.125 inch at the edges and a maximum of 0.188 inch at the center. A minimum average film thickness of 0.125 inch shall be maintained. On pavements with existing markings, meeting the traffic requirements stated above, all lane lines, center lines, transverse markings and pavement markings shall have a minimum film thickness of 0.090 inch for re-application over existing strip line.

E. Packaging.

1. **Containers.** The thermoplastic material shall be delivered in 50 pound containers or bags of sufficient strength to permit normal handling during shipment and handling on the job without loss of material.

2. **Labeling.** Each container shall be clearly marked to indicate the color of the material, the process batch number and/or manufacturer's formulation number, the manufacturer's name and address and the date of manufacture.

F. Acceptance.

1. **Sampling Procedure.** Random samples may be taken at the job site at the discretion of the City Engineer for quality assurance. The City reserves the right to conduct the tests deemed necessary to identify component materials and verify results of specific tests indicated in conjunction with the specification requirements.

   The sample(s) shall be labeled as to the shipment number, lot number, date, quantity, and any other pertinent information. At least three randomly selected bags shall be obtained from each lot. A 10 pound) sample from the three bags shall be submitted for testing and acceptance. The lot size shall be approximately 44,000 pounds unless the total order is less than this amount.

2. **Manufacturer's Responsibility.**

   a. **Sampling and Testing.** The manufacturer shall submit test results from an approved independent laboratory. All material samples shall be obtained 20 days in advance of the pavement marking operations. The cost of testing shall be included in the price of thermoplastic material. The approved independent laboratory's test results shall be submitted to the City Traffic Engineer in the form of a certified test report.

   b. **Bill of Lading.** The manufacturer shall furnish the Material and Tests Laboratory with copies of Bills of Lading for all materials inspected. Bill of lading shall indicate the consignee and the destination, date of shipment, lot numbers, quantity, type of material, and location of source.

   c. **Material Acceptance.** Final acceptance of a particular lot of thermoplastic will be based on the following.

      (1) Compliance with the specification for material composition requirements verified by approved independent laboratory with tests results.

      (2) Compliance with the specification for the physical properties required and verified by an approved independent laboratory with test results.

      (3) Manufacturer's test results for each lot thermoplastic have been received.

      (4) Identification requirements are satisfactory.

3. **Contractor's Responsibility.**

   a. **Notification.** The contractor shall notify the Construction Inspector 72 hours prior to the placement of the thermoplastic markings to enable the inspector to be present during the application operation. At the time of notification, the Contractor shall indicate the manufacturer and the lot numbers of the thermoplastic that will be used.

A check should be made by the contractor to insure that the approved lot numbers appear on the material package. Failure to do so is cause for rejection.

b. Warranty or Guarantee. If the normal trade practice for manufacturers is to furnish warranties or guarantees for the materials and equipment specified herein, the Contractor shall turn the guarantees and warranties over to the Engineer for potential dealing with the manufactures. The extent of such warranties or guarantees will not be a factor in selecting the successful bidder.

535.5. MEASUREMENT: Measurement shall be based on the length of satisfactorily installed line, in feet, or as appropriate, the number of symbols or words which are satisfactorily installed on the roadway surface by the contractor.

535.6. PAYMENT: Payment shall be according to the quantities measured for each bid item.

535.7. BID ITEM:

Item 535.1 - 4 inch wide yellow line

Item 535.2 - 4 inch wide white line

Item 535.3 - 8 inch wide yellow line

Item 535.4 - 8 inch wide white line

Item 535.5 - 12 inch wide white line

Item 535.6 - 16 inch wide white line

Item 535.7 - 24 inch wide white line

Item 535.8 - Right White Arrow (per each)

Item 535.9 - Left White Arrow (per each)

Item 535.10 - Combination Thru/Right White Arrow (per each)

Item 535.11 - Combination Thru/Left White Arrow (per each)

Item 535.12 - Word “ONLY” (per word)

Item 535.13 - Straight White Arrow (per each)

Item 535.14 - Railroad Crossing Symbol, including two R's, crossbuck and 3 transverse bars (per each)

Item 535.15 - White Diamond (per each)

Item 535.16 - Straight White Arrow Bicycle Facility (per each)

Item 535.17 - Bicycle Rider Symbol (per each)

Item 535.18 - Solid White Yield Lines (6” x 9”) (per each)

Item 535.19 - Word “STOP” (per word)

Item 535.20 - Word “YIELD” (per word)

Item 535.21 - Word “BUS) (per word)

APPENDIX A: Method for Estimating Amount of Marking Bonded to Pavement

This inspection will ensure uniformity of coverage of the entire line, such as paint cracking, peeling, and whether or not the marking has adequate coverage. One-square-inch sections of transparent material inscribed within a grid of 100 equal squares shall be used as a tool for quantitative measure of specified percentage of coverage. The grid concept was taken from the Air Force who used it for measuring rubber coverage on pavement. For a 4-inch line, it is suggested that a grid of 4 x 25 inches be used, and for a 12-inch (or larger) line, a grid of 10 x 10 inches. Count the squares that have no paint, e.g., 3 out of 100 squares equal 3% of the paint gone or 97% coverage.

Follow the steps below to take the readings of the pavement markings:

1. Using either the 10- x 10-inch grid or the 4- x 25-inch grid, place the grid on the line to be evaluated.

2. Count the squares that have no paint.

3. The number of squares without paint will be the percentage of paint gone. In other words, if there are 30 out of 100 squares that have no paint, then 30% of the paint is gone.



Cyrus, Holly M., "Development of Methods for Determining Airport Pavement Marking Effectiveness," DOT/FAA/AR-TN03/22, Federal Aviation Administration, March 2003.

ITEM

536 PREFORMED PAVEMENT MARKINGS

536.1. DESCRIPTION: *Provide a long-term tape and sheeting pavement marking material to be used for permanent type longitudinal or transverse lines and word/symbol legends.*

536.2. MATERIALS: All materials shall conform to the requirements of TxDOT DMS-8240 "Permanent Prefabricated Pavement Markings" as shown on the plans. Type A, B, or C prefabricated markings shall be indicated on the plans based upon the traffic conditions of the roadway and the placement method indicated.

536.3. EQUIPMENT: Provide the necessary equipment to conduct the work specified herein.

536.4. CONSTRUCTION: All markings shall be located as shown in the plans.

The contractor shall install the preformed plastic pavement markings to newly paved hot-mix asphaltic concrete pavements by the in-laid method unless the temperature of the pavement has reached or fallen below the minimum allowable pavement temperature shown in Table 1.

Table 1
Acceptable Pavement Temperatures for Application of Pavement Markings.

<table>
<tr><th>Hot Mix Asphalt Mixture Type Upon Which the Preformed Pavement Marking is to be Applied</th><th>Surface Temperature Range for Inlaid Method, ºF</th><th>Minimum Allowable Pavement Temperature for Inlaid Method, ºF</th><th>Surface Temperature Range for Cold-Laid Method, ºF</th></tr>
<tr><td>Open-Graded Friction Course (OGFC)</td><td rowspan="3">160 ºF to 180 ºF</td><td rowspan="3">160 ºF</td><td rowspan="3">60 ºF to 120 ºF</td></tr>
<tr><td>Stone Matrix Asphalt (SMA)</td></tr>
<tr><td>Dense Graded Hot Mixed Asphalt w/PG 76- or 82-XX Asphalt Cement</td></tr>
<tr><td>Dense Graded Hot Mixed Asphalt w/PG 70-, 64-, or 58-XX Asphalt Cement</td><td>120 ºF to 155 ºF</td><td>120 ºF</td></tr>
</table>

All material shall be placed according to the manufacturer's instructions, and in accordance with the surface condition, moisture and temperature requirements listed below:

A. Inlaid Preformed Pavement Markings.

This installation procedure shall apply to streets with newly paved asphaltic concrete surfaces that have attained the temperature ranges shown in Table 1 from initial placement. If at any time after initial placement the pavement cools to below the minimum allowable temperature as shown in Table 1, the markings shall be installed as Hot Applied Thermoplastic Pavement Marking per Item 535 requirements. For portland cement concrete streets, see Cold-Laid Preformed Pavement Markings (next section) below.

The contractor shall place and inlay all pavement markings on the newly placed asphaltic concrete pavement prior to the final rolling of the asphalt.

The preformed pavement markings shall be applied after the newly placed asphaltic concrete pavement has been adequately compacted and within the temperature range specified in Table 1. The Contractor will be required to install temporary pavement markings at no additional cost to the City if the cold-laid method is used. Preformed pavement line markings shall be installed with a mechanical applicator which shall be capable of placing pavement lines in a neat, accurate and uniform manner. The mechanical applicator shall be equipped with a film cut-off device. Word legends and arrows shall be installed by hand and result in neat, accurate and uniform words and arrows.

The preformed pavement markings shall be inlaid into the asphaltic concrete surface by means of a mechanical roller. The roller shall be of sufficient weight capacity to inlay the pavement marking to a minimum depth of 65% of the material thickness, and to not more than 80% of the material thickness while the temperature range of the pavement surface is within the ranges specified in Table 1. In the event the inlaid markings are distorted or discolored to the point that cleaning does not restore its initial appearance by the contractor's operations, fail to provide a uniform appearance, or are installed improperly, such markings shall be removed and replaced in the finished surface of the pavement as Hot Applied Thermoplastic Pavement Marking per Item 535 requirements at no additional expense to the City.

B. Cold-Laid Preformed Pavement Markings.

This installation procedure applies to all portland cement concrete pavements, existing asphaltic concrete pavement, and newly placed asphaltic concrete that at any time has fallen below the minimum allowable temperature specified in Table 1 after initial placement.

Pavement on which pavement markings are to be placed shall be cleaned and prepared prior to placement of markings. Cleaning shall be in conformance with Item 533, “Cleaning and Removal of Pavement Markings and Markers” such that contaminants, loose materials, and conditions deleterious to proper adhesion are removed. When blast cleaning is required, it shall be done to the extent that a sound pavement surface is exposed. Surfaces shall be further prepared after cleaning by sealing or priming, as recommended by the manufacturer.

Pavement to which materials to be applied shall be completely dry. Materials shall not be applied until concrete pavement has appeared to be dry for a minimum of four hours and until asphaltic concrete pavement has appeared to be dry for a minimum of two hours.

Pavement and ambient air temperature requirements recommended by the manufacturer shall be observed. If no temperature requirements are established by the manufacturer, material shall not be placed if the surface temperature is outside the acceptable range shown in Table 1 (see column 4 of this table).

536.5. MEASUREMENT: Measurement shall be made by the length of satisfactorily installed line, in feet, the number of and types of symbols and other pavement legends in accordance with the plans and specifications.

536.6. PAYMENT: The accepted quantities shall be paid at the contract unit price for the type of line or legend applicable in the bid list which shall be full compensation for materials, surface preparation, labor and incidentals.

536.7. BID ITEM:

Item 536.1 - 4 inch Wide Yellow Line

Item 536.2 - 4 inch Wide White Line

Item 536.3 - 8 inch Wide Yellow Line

Item 536.4 - 8 inch Wide White Line

Item 536.5 - 12 inch Wide White Line

Item 536.6 - 16 inch Wide White Line

Item 536.7 - 24 inch Wide White Line

Item 536.8 - Right White Arrow (per each)

Item 536.9 - Left White Arrow (per each)

Item 536.10 - Combination Thru/Right White Arrow (per each)

Item 536.11 - Combination Thru/Left White Arrow (per each)

Item 536.12 - Word "ONLY" (per word)

Item 536.13 - Straight White Arrow (per each)

Item 536.14 - Railroad Crossing Symbol, including two R's, crossbuck and 3 transverse bars (per each)

Item 536.15 - White Diamond (per each)

Item 536.16 - Straight White Arrow Bicycle Facility (per each)

Item 536.17 - Solid White Yield Lines (6" x 9") per each)

Item 536.18 - Word "STOP" (per word)

Item 536.19 - Word "YIELD" (per word)

Item 536.20 - Word "BUS" (per word)

ITEM

537 RAISED PAVEMENT MARKERS

537.1. DESCRIPTION: *Provide raised pavement markers which include reflectorized and non-reflectorized traffic buttons, pavement markers and jiggle bars all of which are capable of being attached to a roadway surface by an adhesive.*

537.2. MATERIALS: Materials shall conform to the following requirements:

A. Jiggle Bar Tiles. TxDOT DMS-4100, "Jiggle Bar Tiles."

B. Raised Pavement Markers. TxDOT DMS-4200, "Pavement Markers (Reflectorized)."

C. Traffic Buttons. TxDOT DMS-4300, "Traffic Buttons."

D. Testing. The Engineer reserves the right to perform any or all tests required by this item as a check on the tests reported by the manufacturer. Upon request, the Contractor shall furnish, free of charge, samples of the material of the size and in the amount determined by the Engineer for test purposes. In case of any variance, the Engineer's tests will govern.

537.3. EQUIPMENT: Provide all equipment necessary to perform the work specified herein.

537.4. CONSTRUCTION: The Contractor shall establish guides to mark the lateral location of pavement markings as shown on the plans or as directed by the Engineer. The Engineer shall approve locations of these markings and may authorize necessary adjustments from the plans.

The reflective faces of all Type II markers shall be positioned so that the direction of reflection of one (1) face shall be directly opposite to the direction of reflection of the other face.

Raised Pavement markers Type I-C shall have clear reflector face towards traffic. Raised pavement markers Type II C-R, shall have the clear face toward the normal traffic flow and the red face toward wrong-way traffic.

Unless otherwise shown on the plans or specified by the Engineer, all raised pavement markers placed in broken lines shall be placed in line with and midway between the stripes. The first and last raised pavement marker in a no-passing line shall be a reflective marker. Buttons used to simulate a 10 feet skip lane lines shall be spaced at 40 inches.

The pavement markers not placed in accordance with the plans or as directed by the Engineer shall be removed by the Contractor at the Contractor's expense.

Removal of existing pavement markers or residual adhesive from a missing pavement marker prior to placement of new or replacement marker(s) shall be in conformance with Item 533, "Cleaning or Removal of Pavement Markings or Markers." The portion of the highway surface to which the raised pavement marker is attached by the adhesive shall be clean and free of dirt, grease, oil, and moisture at the time of installation. Surface preparation for installation of raised pavement markers will not be paid for directly, but shall be considered subsidiary to this item. Unsound pavement or other materials that would adversely affect the bond of the adhesive shall not be an acceptable surface.

The hot epoxy adhesive shall be applied so that 100 percent of the bonding area of the raised pavement marker will be in contact and shall be of sufficient thickness so that excess adhesive shall be forced out around the perimeter of the raised pavement marker but without impairing the functional capability of the reflectivity of the pavement marker. When the project is complete, the raised pavement marker shall be firmly bonded to the pavement; lines formed by the raised pavement markers shall be true, and the entire installation shall present a neat appearance.

Where required by the Engineer, pavement markings outside the limits of this project will be removed or adjusted to provide for a proper tie into this project. The old markings shall be removed or defaced in such a manner that they do not give the appearance of traffic pavement markings.

537.5. MEASUREMENT: Measurement will be based on the number of satisfactorily installed pavement markers.

537.6. PAYMENT: Pavement markers will be paid for at the contract unit bid price per each type of marker. The price shall be full compensation for furnishing the raised pavement marker, epoxy adhesive and all other materials, surface preparation, installation, labor, equipment, tools and incidentals necessary to complete the work.

537.7. BID ITEM:

Item 537.1 - Traffic Button (Type W) per each

Item 537.2 - Traffic Button (Type Y) per each

Item 537.3 - Jiggle Bar (Type W) per each

Item 537.4 - Jiggle Bar (Type Y) per each

Item 537.5 - Pavement Marker (Type I-A) per each

Item 537.6 - Pavement Marker (Type I-C) per each

Item 537.7 - Pavement Marker (Type I-R) per each

Item 537.8 - Pavement Marker (Type II-A-A) per each

Item 537.9 - Pavement Marker (Type II C-R) per each

ITEM

539 INTERSECTION GRADE PAVEMENT TAPE

539.1. DESCRIPTION: *Provide pavement tape specially formulated for use at intersections where excessive pavement wear and shoving tends to wear pavement markings prematurely. Tape is to be used for longitudinal or transverse lines, words, and symbol legends.*

539.2. MATERIALS: The preformed markings shall consist of white or yellow films with pigments selected and blended to conform to standard highway colors. Glass beads shall be incorporated to provide immediate and continuing retro-reflection.

Unless otherwise shown on the plans, preformed words and symbols shall conform to the applicable shapes and sizes as outlined in the "Texas Manual on Uniform Traffic Control Devices" (current edition).

The preformed markings shall be capable of being adhered to asphaltic concrete or portland cement concrete (PCC) pavement surfaces with the appropriate adhesive as specified by the manufacturer. Following proper application and tamping, the intersection markings shall be immediately ready for traffic. The contractor shall identify proper solvents, primers, and/or adhesives (where necessary) to be applied at the time of application, all equipment necessary for proper application, and any recommendations for application that will assure effective product performance.

The markings shall be highly durable retro-reflective pliant polymer materials designed for use as symbols, legends and intersection markings, such as crosswalks and stop bars, in areas of high wear.

The retro-reflective pavement marking film shall consist of a mixture of high quality polymeric materials, pigments and glass beads distributed throughout its base cross-sectional area, with a reflective layer of beads bonded to the top urethane wear surface. The edges of the preformed tape shall be clean cut and true.

The white and yellow films shall have the following initial minimum reflective values as measured in accordance with ASTM D 4061 (Table 1). The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot-candle. The metric equivalent shall be expressed as millicandelas per square meter per lux. The test distance shall be 50 feet and the sample size shall be a 24 inch x 30 inch rectangle.

Table 1
Initial Minimum Reflective Values

	White				Yellow		
Entrance Angle (degrees)	86.0	86.0	86.5		86.0	86.0	86.5
Observation Angle (degrees)	0.2	0.5	1.0		0.2	0.5	1.0
Specific Luminance (sq meters per lux)	550	380	300		410	250	175

The surface of the retro-reflective film shall provide an initial average skid resistance value of 45 BPN when tested in accordance with ASTM 303.

The pavement marking film shall be capable of use for patching worn areas of the same type of film in accordance with the manufacturer's instructions.

The film shall have a minimum tensile strength of 350 pounds per square inch of cross-section when measured in the direction of the length of roll and tested in accordance with ASTM D 638-76, except that a sample 6 inch x 1 inch shall be tested at a temperature between 70°F and 80 °F using a jaw speed of 10 to 12 inches per minute. The sample shall have a minimum elongation of 50% at break when tested by this method.

To ensure an effective performance life, the glass beads must be strongly bonded and not easily removed by traffic wear.

The following test shall be employed to measure reflectivity retention:

Taber Abraser Simulation Test

Using Taber Abraser with an H-18 wheel and a 125 gram load, the sample shall be inspected at 200 cycles, under a microscope, to observe the extent and type of bead failure.

No more than 15% of the beads shall be lost due to popout and the predominant mode of failure shall be "wear down" of the beads.

The size, quality and refractive index of the glass beads shall be such that the performance requirements for the markings shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.

The film shall have glass bead retention qualities such that when a 2 inch x 6 inch is bent over a ½ inch diameter mandrel, with the 2 inch dimension perpendicular to the mandrel axis, microscopic examination of the area on the mandrel shall show no more than 10% of the beads with entrapment by the binder of less than 40%.

The film, without adhesive, shall have a minimum thickness of 0.060 inch.

The film, when applied according to the manufacturer's instructions, shall provide a neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. The film shall be weather resistant and, through normal traffic wear, shall show no facing, lifting, or shrinkage which will significantly impair the intended usage of the marking throughout its useful life and shall show no significant tearing, roll back or other signs or poor adhesion.

The contractor shall be responsible for supplying and installing at no expense to the City replacement material for any markings which exhibit loss of adhesion or wear through to bare pavement due to traffic wear for a period of two years.

539.3. EQUIPMENT: Provide all necessary equipment required to perform the work specified herein.

539.4. CONSTRUCTION: The markings shall be applied and tamped in accordance with Item 536, "Preformed Pavement Markings" as described for Cold-Laid markings.

539.5. MEASUREMENT: Measurement shall be made by the length of satisfactorily installed line, in feet, the number and types of symbols and other pavement legends in accordance with the plans and specifications.

539.6. PAYMENT: The accepted quantities shall be paid at the contract unit price for the type of line or legend applicable in the bid list which shall be full compensation for materials, surface preparation, labor, and incidentals.

539.7. BID ITEM:

Item 539.1 - 4 inch wide yellow line

Item 539.2 - 4 inch wide white line

Item 539.3 - 8 inch wide yellow line

Item 539.4 - 8 inch wide white line

Item 539.5 - 12 inch wide white line

Item 539.6 - 16 inch wide white line

Item 539.7 - 24 inch wide white line

Item 539.8 - Right White Arrow (per each)

Item 539.9 - Left White Arrow (per each)

Item 539.10 - Combination Thru/Right White Arrow (per each)

Item 539.11 - Combination Thru/Left White Arrow (per each)

Item 539.12 - Word “ONLY” (per word)

Item 539.13 - Straight White Arrow (per word)

Item 539.14 - Railroad Crossing Symbol, including. two R's, crossbuck and 3 transverse bars (per each)

Item 539.15 - White Diamond (per each)

Item 539.16 - Straight White Arrow Bicycle Facility (per each)

Item 539.17 - Bicycle Rider Symbol (per each)

Item 539.18 - Solid White Yield Lines (6” x 9”) (per each)

Item 539.19 - Word “STOP” (per word)

Item 539.20 - Word “YIELD” (per word)

Item 539.21 - Word “BUS” (per word)

ITEM

540 TEMPORARY EROSION, SEDIMENTATION AND WATER POLLUTION PREVENTION AND CONTROL

540.1. 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, tidal water, groundwater and wetlands.*

Note: The control measures contained herein shall be installed and maintained throughout the construction contract and coordinated with the permanent or existing 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 period. These control measures shall not be used as a substitute for the permanent pollution control measures unless otherwise directed by the Engineer in writing. The controls may include sediment control fences, inlet protection, baled hay, rock filter dams, dikes, swales, sediment traps and basins, pipe slope drains, paved flumes, construction exits, temporary seeding, sodding, mulching, soil retention blankets or other structural or non-structural water pollution controls. This item does not apply to commercial operations.

540.2. MATERIALS: The items, estimated quantities and locations of the control measures are shown on the plans; however, the Engineer may increase or decrease the quantity of these items as the need arises. The materials will be shown on the plans and in this specification. The Engineer may allow other materials and work as the need arises and as approved in writing. Pollution control measures may be applicable to contractor operations outside the right of way where such work is necessary as a result of roadway related construction such as construction and haul roads, field offices, equipment and supply areas, and materials sources.

Unless otherwise shown on the plans, provide materials that meet the following requirements:

A. Rock Filter Dams.

1. **Aggregate.** Furnish aggregate with hardness, durability, cleanliness, and resistance to crumbling, flaking, and eroding acceptable to the Engineer. Provide the following:

   - **Types 1, 2, and 4 Rock Filter Dams.** Use 3 to 6 in. aggregate.

   - **Type 3 Rock Filter Dams.** Use 4 to 8 in. aggregate.

2. **Wire.** Provide minimum 20 gauge galvanized wire for the steel wire mesh and tie wires for Types 2 and 3 rock filter dams. Type 4 dams require:

   - a double-twisted, hexagonal weave with a nominal mesh opening of 2½ in. x 3¼ in.;
   - minimum 0.0866 in. steel wire for netting;
   - minimum 0.1063 in. steel wire for selvages and corners; and
   - minimum 0.0866 in. for binding or tie wire.

3. **Sandbag Material.** Furnish sandbags meeting Section 540.2.I, "Sandbags," except that any gradation of aggregate may be used to fill the sandbags.

B. Temporary Pipe Slope Drains. Provide corrugated metal pipe, polyvinyl chloride (PVC) pipe, flexible tubing, watertight connection bands, grommet materials, prefabricated fittings, and flared entrance sections that conform to the plans. Recycled and other materials meeting these requirements are allowed if approved. Furnish concrete in accordance with Item 505, "Concrete Riprap."

C. Baled Hay. Provide hay bales weighing at least 50 lb., composed entirely of vegetable matter, measuring 30 in. or longer, and bound with wire, nylon, or polypropylene string.

D. Temporary Paved Flumes. Furnish asphalt concrete, hydraulic cement concrete, or other comparable non-erodible material that conforms to the plans. Provide rock or rubble with a minimum diameter of 6 in. and a maximum volume of ½ cu. ft. for the construction of energy dissipaters.

E. Construction Exits. Provide materials that meet the details shown on the plans and this Section.

1. **Rock Construction Exit.** Provide crushed aggregate for long and short-term construction exits. Furnish aggregates that are clean, hard, durable, and free from adherent coatings such as salt, alkali, dirt, clay, loam, shale, soft, or flaky materials and organic and injurious matter. Use 4- to 8- in. rock for Type 1 and 2- to 4- in. rock for Type 3. Unless otherwise shown on the plans, provide a light weight (4 oz.) non-woven filter fabric below the ballast to prevent mud and sediment migration.

2. **Timber Construction Exit.** Furnish No. 2 quality or better railroad ties and timbers for long-term construction exits, free of large and loose knots and treated to control rot. Fasten timbers with nuts and bolts or lag bolts, of at least ½ in. diameter, unless otherwise shown on the plans or allowed. For short-term exits, provide plywood or pressed wafer board at least ½ in. thick.

3. **Foundation Course.** Provide a foundation course consisting of flexible base, bituminous concrete, hydraulic cement concrete, or other materials as shown on the plans or directed.

F. Embankment for Erosion Control. Provide rock, loam, clay, topsoil, or other earth materials that will form a stable embankment to meet the intended use.

G. Pipe. Provide pipe outlet material in accordance with TxDOT Standard Specification Item 556, "Pipe Underdrains," and details shown on the plans.

H. Construction Perimeter Fence.

1. **Posts.** Provide essentially straight wood or steel posts that are at least 60 in. long. Furnish soft wood posts with a minimum diameter of 3 in. or use 2 x 4 boards. Furnish hardwood posts with a minimum cross-section of 1½ x 1-1/5 in. Furnish T- or L-shaped steel posts with a minimum weight of 0.95 lb. per foot.

2. **Fence.** Provide orange construction fencing as approved by the Engineer.

3. **Fence Wire.** Provide 14 gauge or larger galvanized smooth or twisted wire. Provide16 gauge or larger tie wire.

4. **Flagging.** Provide brightly-colored flagging that is fade-resistant and at least ¾ in. wide to provide maximum visibility both day and night.

5. **Staples.** Provide staples with a crown at least ½ in. wide and legs at least ½ in. long.

6. **Used Materials.** Previously used materials meeting the applicable requirements may be used if accepted by the Engineer.

I. Sandbags. Provide sandbag material of polypropylene, polyethylene, or polyamide woven fabric with a minimum unit weight of 4 oz. per square yard, a Mullen burst-strength exceeding 300 psi, and an ultraviolet stability exceeding 70%. Use natural coarse sand or manufactured sand meeting the gradation given in Table 1 to fill sandbags. Filled sandbags must be 24 to 30 in. long, 16 to 18 in. wide, and 6 to 8 in. thick.

Table 1
Sand Gradation

Sieve #	Maximum Retained (% by Weight)
4	3%
100	80%
200	95%

J. Temporary Sediment Control Fence. Provide a net-reinforced fence using woven geo-textile fabric. Logos visible to the traveling public will not be allowed.

1. **Fabric.** Provide fabric materials in accordance with TxDOT DMS-6230, "Temporary Sediment Control Fence Fabric."

2. **Posts.** Provide essentially straight wood or steel posts with a minimum length of 48 in., unless otherwise shown on the plans. Soft wood posts must be at least 3 in. in diameter or nominal 2 x 4 in. Hardwood posts must have a minimum cross-section of 1½ x 1½ in. T- or L-shaped steel posts must have a minimum weight of 0.95 lb. per foot.

3. **Net Reinforcement.** Provide net reinforcement of at least 14 gauge galvanized welded wire mesh, with a maximum opening size of 2 x 4 in., at least 24 in. wide, unless otherwise shown on the plans.

4. **Staples.** Provide staples with a crown at least ¾ in. wide and legs ½ in. long.

5. **Used Materials.** Use recycled material meeting the applicable requirements if accepted by the Engineer.

K. Curb Inlet Gravel Filters.

1. **Gravel Filter Bags.** Furnish gravel filter bags meeting Section 540.2.I, "Sandbags." Gravel bags shall be filled with ¾ inch gravel.

2. **Concrete Masonry Units.** Hollow, Non-Load-Bearing Concrete blocks of 1500-2000 psi, 28-day compressive strength concrete shall be used with dimensions of 8" x 6" x6" width, height, and length, respectively.

3. **Wood Blocks.** Wolmanized treated 2" x 4" lumber with the length as per inlet size.

540.3. EQUIPMENT. Provide a backhoe, front end loader, blade, scraper, bulldozer, or other equipment as required when "Earthwork for Erosion Control" is specified on the plans as a bid item.

540.4. CONSTRUCTION: 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 Engineer in writing.

A. Contractor Responsibilities.

1. SW3P. Implement the City's Storm Water Pollution Prevention Plan (SWP3) for the project site in accordance with the specific or general storm water permit requirements. Prevent water pollution from storm water associated with construction activity from entering any surface water or private property on or adjacent to the project site. 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.

2. Preconstruction Submittals.

a. Operations on Right of Way. Prior to the start of construction, the Contractor shall submit to the Engineer, for approval, schedules for accomplishment of the pollution control measures in accordance with the Storm Water Pollution Prevention Plan (SW3P). A plan for the disposal of waste materials generated on the project site must be submitted for approval, also. The Contractor shall submit to the Engineer, for approval, the proposed SW3P for the industrial activities (such as hot mix plants, concrete batch plants, or material handling areas) on the right of way.

b. Operations off Right of Way. The Contractor shall provide the Engineer, for information purposes only, proposed methods of 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 areas, and material sources).

Pollution control measures for the Contractor's facilities off the right of way are not covered by the City's Environmental Protection Agency (EPA) NPDES general permit. The Contractor shall obtain his own Notice of Intent for the off-site operations. These pollution controls will not be measured for payment but shall be performed at the Contractor's expense.

B. General.

1. Phasing. Implement control measures in the area to be disturbed before beginning construction, or as directed. Limit the disturbance to the area shown on the plans or as directed. If, in the opinion of the Engineer, the Contractor cannot control soil erosion and sedimentation resulting from construction operations, the Engineer will limit the disturbed area to that which the Contractor is able to control. Minimize disturbance to vegetation.

2. Rainfall Events. A rain gauge shall be provided by the Contractor and located at the project site. Within 24 hours of a rainfall event of ½ inch or more as measured by the project rain gauge, the Contractor and Inspector will inspect the entire project to

determine the condition of the control measures. Maintain control measures in accordance with Item 540.4.B.3, "Maintenance."

3. **Maintenance.** Correct ineffective control measures in accordance with this section. Implement additional controls as directed. Remove excavated material within the time requirements specified in the applicable storm water permit.

   Following a rain event as described in Item 540.4.B.2, Rainfall Event," 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 needed for repair of control measures.

   In the event of continuous rainfall over a 24-hour period, or other circumstances that preclude equipment operation in the area, the Contractor will hand carry and install additional backup devices as determined by the Engineer. The Contractor will remove silt accumulations and deposit the spoils in an area approved by the Engineer as soon as practical. Any corrective action needed for the control measures will be accomplished in the sequence directed by the Engineer; however, areas adjacent to waterbodies shall generally have priority followed by devices protecting storm sewer inlets.

4. **Stabilization.** Stabilize disturbed areas where construction activities will be temporarily stopped, or construction becomes inactive, in accordance with the applicable storm water permit. Inactive construction areas are defined as areas in which no construction activity will occur for a period of 30 days or longer. Inactive construction areas which have been disturbed will require stabilization through the use of vegetation, mulch, erosion control matting or structural methods within 7 calendar days from the last construction activity in the area. At all times prior to stabilization, inactive construction areas shall be considered as active, disturbed construction area, contributing to the sediment loading at the site control systems. After stabilization, inactive construction areas will be considered undisturbed areas, eliminating the contribution of sediment to the erosion control devices.

5. **Finished Work.** Upon acceptance of vegetative cover, remove and dispose of all temporary control measures, temporary embankments, bridges, matting, falsework, piling, debris, or other obstructions placed during construction that are not a part of the finished work, or as directed. Soil retention blankets shall be removed only when, in the opinion of the Engineer, final permanent perennial seeding would be adversely affected by the presence of an existing soil retention blanket.

   The project will not be accepted until a 70% density of existing adjacent undisturbed areas is obtained, unless otherwise shown on the plans. When shown on the plans, the Engineer may accept the project when adequate controls are in place that will control erosion, sedimentation, and water pollution until sufficient vegetative cover can be established.

6. **Restricted Activities.** Do not locate disposal areas, stockpiles, or haul roads in any wetland, water body, or streambed. Do not install temporary construction crossings in or across any water body without the prior approval of the appropriate resource agency and the Engineer. Restrict construction operations in any water body to the necessary areas as shown on the plans or applicable permit, or as directed. Use temporary bridges, timber mats, or other structurally sound and non-eroding material for stream crossings.

Provide protected storage area for paints, chemicals, solvents, and fertilizers at an approved location. Keep paints, chemicals, solvents, and fertilizers off bare ground and provide shelter for stored chemicals.

C. Installation, Maintenance, and Removal Work. Perform work in accordance with the specific or general storm water permit. Install and maintain the integrity of temporary erosion and sedimentation control devices to accumulate silt and debris until earthwork construction and permanent erosion control features are in place or the disturbed area has been adequately stabilized as determined by the Engineer. If a device ceases to function as intended, repair or replace the device or portions thereof as necessary. Remove sediment, debris, and litter. When approved, sediments may be disposed of within embankments, or in the right of way in areas where the material will not contribute to further siltation. Dispose of removed material in accordance with federal, state, and local regulations. Remove devices upon approval or when directed. Upon removal, finish-grade and dress the area. Stabilize disturbed areas in accordance with the permit, and as shown on the plans or directed. The Contractor retains ownership of stockpiled material and must remove it from the project when new installations or replacements are no longer required.

1. Rock Filter Dams for Erosion Control. Remove trees, brush, stumps, and other objectionable material that may interfere with the construction of rock filter dams. Place sandbags as a foundation when required or at the Contractor's option. For Types 1, 2, 3, and 5, place the aggregate to the lines, height, and slopes specified, without undue voids. For Types 2 and 3, place the aggregate on the mesh and then fold the mesh at the upstream side over the aggregate and secure it to itself on the downstream side with wire ties, or hog rings, or as directed. Place rock filter dams perpendicular to the flow of the stream or channel unless otherwise directed. Construct filter dams according to the following criteria, unless otherwise shown on the plans:

a. Type 1 (Non-reinforced).

(1) Height. At least 18 in. measured vertically from existing ground to top of filter dam.

(2) Top Width. At least 2 ft.

(3) Slopes. At most 2:1.

b. Type 2 (Reinforced).

(1) Height. At least 18 in. measured vertically from existing ground to top of filter dam.

(2) Top Width. At least 2 ft.

(3) Slopes. At most 2:1.

c. Type 3 (Reinforced).

(1) Height. At least 36 in. measured vertically from existing ground to top of filter dam.

(2) Top Width. At least 2 ft.

(3) Slopes. At most 2:1.

d. Type 4 (Sack Gabions). Unfold sack gabions and smooth out kinks and bends. For vertical filling, connect the sides by lacing in a single loop–double loop pattern on 4- to 5-in. spacing. At one end, pull the end lacing rod until tight, wrap around the end, and twist 4 times. At the filling end, fill with stone, pull the rod tight, cut the wire with approximately 6 in. remaining, and twist wires 4 times. For horizontal filling, place sack flat in a filling trough, fill with stone, and connect sides and secure ends as described above. Lift and place without damaging the gabion. Shape sack gabions to existing contours.

e. Type 5. Provide rock filter dams as shown on the plans.

2. Temporary Pipe Slope Drains. Install pipe with a slope as shown on the plans or as directed. Construct embankment for the drainage system in 8-in. lifts to the required elevations. Hand-tamp the soil around and under the entrance section to the top of the embankment as shown on the plans or as directed. Form the top of the embankment or earth dike over the pipe slope drain at least 1 ft. higher than the top of the inlet pipe at all points. Secure the pipe with hold-downs or hold-down grommets spaced a maximum of 10 ft. on center. Construct the energy dissipaters or sediment traps as shown on the plans or as directed. Construct the sediment trap using concrete in accordance with Item 505, "Concrete Riprap," when designated on the plans. Rubble riprap in accordance with TxDOT Standard Specification Item 432, "Riprap" may also be used when designated on the plans or as directed by the Engineer.

3. Baled Hay for Erosion and Sedimentation Control. Install hay bales at locations shown on the plans by embedding in the soil at least 4 in. and, where possible, approximately ½ the height of the bale, or as directed. Fill gaps between bales with hay.

4. Temporary Paved Flumes. Construct paved flumes as shown on the plans or as directed. Provide excavation and embankment (including compaction of the subgrade) of material to the dimensions shown on the plans, unless otherwise indicated. Install a rock or rubble riprap energy dissipater, constructed from the materials specified above to a minimum depth of 9 in. at the flume outlet to the limits shown on the plans or as directed.

5. Construction Exits. When tracking conditions exist, prevent traffic from crossing or exiting the construction site or moving directly onto a public roadway, alley, sidewalk, parking area, or other right of way areas other than at the location of construction exits. Construct exits for either long or short-term use.

a. Long-Term. Place the exit over a foundation course, if necessary. Grade the foundation course or compacted subgrade to direct runoff from the construction exits to a sediment trap as shown on the plans or as directed. Construct exits with a width of at least 14 ft. for one-way and 20 ft. for two-way traffic for the full width of the exit, or as directed.

(1) Type 1. Construct to a depth of at least 8 in. using crushed aggregate as shown on the plans or as directed.

(2) Type 2. Construct using railroad ties and timbers as shown on the plans or as directed.

b. Short-Term.

(1) Type 3. Construct using crushed aggregate, plywood, or wafer board. This type of exit may be used for daily operations where long-term exits are not practical.

(2) Type 4. Construct as shown on the plans or as directed.

6. Earthwork for Erosion and Sediment Control. Perform excavation and embankment operations to minimize erosion and to remove collected sediments from other erosion control devices.

a. Excavation and Embankment for Erosion Control Features. Place earth dikes, swales or combinations of both along the low crown of daily lift placement, or as directed, to prevent runoff spillover. Place swales and dikes at other locations as shown on the plans or as directed to prevent runoff spillover or to divert runoff. Construct cuts with the low end blocked with undisturbed earth to prevent erosion of hillsides. Construct sediment traps at drainage structures in conjunction with other erosion control measures as shown on the plans or as directed. Where required, create a sediment basin providing 3,600 cu. ft. of storage per acre drained, or equivalent control measures for drainage locations that serve an area with 10 or more disturbed acres at one time, not including offsite areas.

b. Excavation of Sediment and Debris. Remove sediment and debris when accumulation affects the performance of the devices, after a rain, and when directed.

7. Construction Perimeter Fence. Construct, align, and locate fencing as shown on the plans or as directed.

a. Installation of Posts. Embed posts 18 in. deep or adequately anchor in rock, with a spacing of 8 to 10 ft.

b. Wire Attachment. Attach the top wire to the posts at least 3 ft. from the ground. Attach the lower wire midway between the ground and the top wire.

c. Flag Attachment. Attach flagging to both wire strands midway between each post. Use flagging at least 18 in. long. Tie flagging to the wire using a square knot.

8. Sandbags for Erosion Control. Construct a berm or dam of sandbags that will intercept sediment-laden storm water runoff from disturbed areas, create a retention pond, detain sediment, and release water in sheet flow. Fill each bag with sand so that at least the top 6 in. of the bag is unfilled to allow for proper tying of the open end. Place the sandbags with their tied ends in the same direction. Offset subsequent rows of sandbags ½ the length of the preceding row. Place a single layer of sandbags downstream as a secondary debris trap. Place additional sandbags as necessary or as directed for supplementary support to berms or dams of sandbags or earth.

9. Temporary Sediment-Control Fence. Provide temporary sediment-control fence near the downstream perimeter of a disturbed area to intercept sediment from sheet flow. Incorporate the fence into erosion-control measures used to control sediment in areas of higher flow. Install the fence as shown on the plans, as specified in this Section, or as directed.

a. Installation of Posts. Embed posts at least 18 in. deep, or adequately anchor, if in rock, with a spacing of 6 to 8 ft. and install on a slight angle toward the run-off source.

b. Fabric Anchoring. Dig trenches along the uphill side of the fence to anchor 6 to 8 in. of fabric. Provide a minimum trench cross-section of 6 x 6 in. Place the fabric against the side of the trench and align approximately 2 in of fabric along the bottom in the upstream direction. Backfill the trench, then hand-tamp.

c. Fabric and Net Reinforcement Attachment. Unless otherwise shown under the plans, attach the reinforcement to wooden posts with staples, or to steel posts with T-clips, in at least 4 places equally spaced. Sewn vertical pockets may be used to attach reinforcement to end posts. Fasten the fabric to the top strand of reinforcement by hog rings or cord every 15 in. or less.

d. Fabric and Net Splices. Locate splices at a fence post with a minimum lap of 6 in. attached in at least 6 places equally spaced, unless otherwise shown under the plans. Do not locate splices in concentrated flow areas. Requirements for installation of used temporary sediment control fence include the following:

- fabric with minimal or no visible signs of biodegradation (weak fibers),
- fabric without excessive patching (more than 1 patch every 15 to 20 ft.),
- posts without bends, and
- backing without holes.

10. Curb Inlet Gravel Filter.

a. Installation. Install the curb inlet gravel filters in the following manner:

(1) Place the 2” x 4” treated lumber in front of and parallel with the opening of the inlet.

(2) Place the Concrete Masonry Units (CMUs) around the inlet, to be protected, in front of the 2” x 4” lumber, with the openings of the CMUs facing the inlet.

(3) Surround the CMUs with gravel bags, making certain that there are no gaps are evident between the gravel bags.

b. Sediment Control. When the accumulated sediment deposit reaches a depth of approximately 6 inches, it shall be removed and disposed of at approved sites in a manner that will not contribute to additional siltation. If the structure ceases to function as intended, the Engineer may direct that the Filter bag be replaced. Such replacement will not be measured for payment. Torn or punctured bags shall be replaced with a new Filter bag.

540.5. MEASUREMENT: 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 as scheduled, and measures are ordered in writing by the Engineer, such work shall not be measured for payment, but shall be performed at the Contractor's expense.

In case of failure on the part of the Contractor to prevent and control soil erosion, sedimentation and water pollution which may degrade receiving water, the Engineer reserves the right to employ outside assistance or to use City forces to provide the necessary corrective measures. All costs including engineering costs will be deducted from any moneys due or to become due to the Contractor.

When the need for control measures can not 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 Engineer, these measures shall be measured and paid for in accordance with contract bid items shown under this section.

A. Rock Filter Dams. Installation or removal of rock filter dams will be measured by the foot or by the cubic yard. The measured volume will include sandbags, when used.

1. **Linear Measurement.** When rock filter dams are measured by the foot, measurement will be along the centerline of the top of the dam.

2. **Volume Measurement.** When rock filter dams are measured by the cubic yard, measurement will be based on the volume of rock computed by the method of average end areas.

    a. **Installation.** Measurement will be made in final position.

    b. **Removal.** Measurement will be made at the point of removal.

B. Temporary Pipe Slope Drains. Temporary pipe slope drains will be measured by the foot.

C. Baled Hay. Baled hay will be measured by each bale.

D. Temporary Paved Flumes. Temporary paved flumes will be measured by the square yard of surface area. The measured area will include the energy dissipater at the flume outlet.

E. Construction Exits. Construction exits will be measured by the square yard of surface area.

F. Earthwork for Erosion and Sediment Control. Earthwork for erosion and sediment control will not be measured directly but will be considered subsidiary to this or other pertinent items.

G. Construction Perimeter Fence. Construction perimeter fence will be measured by the foot.

H. Sandbags for Erosion Control. Sandbags will be measured as each sandbag or by the foot along the top of sandbag berms or dams.

I. Temporary Sediment-Control Fence. Temporary sediment-control fence will be measured by the foot.

J. Curb Inlet Gravel Filter. Curb inlet gravel filter will be measured by the linear foot, as measured on the centerline of the gravel bags installed.

540.6. PAYMENT: The following will not be paid for directly but are subsidiary to pertinent Items:

- erosion-control measures for Contractor project-specific locations (PSLs) inside and outside the right of way (such as construction and haul roads, field offices, equipment and supply areas, plants, and material sources);
- removal of litter;
- repair to devices and features damaged by Contractor operations;
- added measures and maintenance needed due to negligence, carelessness, lack of maintenance, and failure to install permanent controls;
- removal and reinstallation of devices and features needed for the convenience of the Contractor;
- finish grading and dressing upon removal of the device; and
- minor adjustments including but not limited to plumbing posts, reattaching fabric, minor grading to maintain slopes on an erosion embankment feature, or moving small numbers of sandbags.

The Contractor will be reimbursed for maintenance, repair, or reinstallation of devices and features when the need for additional control measures cannot be attributed to the above, as determined by the Engineer. Stabilization of disturbed areas will be paid for under pertinent Items. Furnishing and installing pipe for outfalls associated with sediment traps and ponds will not be paid for directly but is subsidiary to the excavation and embankment under this Item.

Pollution control measures outside the right of way will not be measured for payment but shall be performed at the Contractor's expense.

Control measures as shown on the plans will be paid for in accordance with applicable bid items as shown below:

A. Rock Filter Dams. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid as follows:

1. Installation. Installation will be paid for as "Rock Filter Dams (Install)" of the type specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals.

2. Removal. Removal will be paid for as "Rock Filter Dams (Remove)." This price is full compensation for furnishing and operating equipment, proper disposal, labor, materials, tools, and incidentals.

When the Engineer directs that the rock filter dam installation or portions thereof be replaced, payment will be made at the unit price bid for "Rock Filter Dams (Remove)" and for "Rock Filter Dams (Install)" of the type specified. This price is full compensation for furnishing and operating equipment, finish backfill and grading, lacing, proper disposal, labor, materials, tools, and incidentals

B. Temporary Pipe Slope Drains. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Pipe Slope Drains" of the size specified. This price is full

compensation for furnishing materials, removal and disposal, furnishing and operating equipment, labor, tools, and incidentals.

Removal of temporary pipe slope drains will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the pipe slope drain installation or portions thereof be replaced, payment will be made at the unit price bid for "Temporary Pipe Slope Drains" of the size specified, which is full compensation for the removal and reinstallation of the pipe drain.

Earthwork required for the pipe slope drain installation, including construction of the sediment trap, will be measured and paid for under Section 540.5.F, "Earthwork for Erosion and Sediment Control." Riprap concrete or stone, when used as an energy dissipater or as a stabilized sediment trap, will be measured and paid for in accordance with Item 505, "Concrete Riprap" or TxDOT Item 432, "Riprap," respectively.

C. Baled Hay. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Baled Hay." This price is full compensation for furnishing and placing bales, excavating trenches, removal and disposal, equipment, labor, tools, and incidentals.

When the Engineer directs that the baled hay installation (or portions thereof) be replaced, payment will be made at the unit price bid for "Baled Hay," which is full compensation for removal and reinstallation of the baled hay.

D. Temporary Paved Flumes. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Paved Flume (Install)" or "Temporary Paved Flume (Remove)." This price is full compensation for furnishing and placing materials, removal and disposal, equipment, labor, tools, and incidentals.

When the Engineer directs that the paved flume installation or portions thereof be replaced, payment will be made at the unit prices bid for "Temporary Paved Flume (Remove)" and "Temporary Paved Flume (Install)." These prices are full compensation for the removal and replacement of the paved flume and for equipment, labor, tools, and incidentals.

Earthwork required for the paved flume installation, including construction of a sediment trap will be considered subsidiary to this item and will not be measured or paid for directly.

E. Construction Exits. Contractor-required construction exits from off right-of-way locations or on-right of way PSLs will not be paid for directly but are subsidiary to pertinent Items.

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" for construction exits needed on right-of-way access to work areas required by the Department will be paid for at the unit price bid for "Construction Exits (Install)" of the type specified or "Construction Exits (Remove)." This price is full compensation for furnishing and placing materials, excavating, removal and disposal, cleaning vehicles, labor, tools, and incidentals.

When the Engineer directs that a construction exit or portion thereof be removed and replaced, payment will be made at the unit prices bid for "Construction Exit (Remove)" and "Construction Exit (Install)" of the type specified. These prices are full compensation for the

removal and replacement of the construction exit and for equipment, labor, tools, and incidentals.

Construction of sediment traps used in conjunction with the construction exit will be considered subsidiary to this item and will not be measured or paid for directly.

F. Earthwork for Erosion and Sediment Control. The work performed and materials furnished in accordance with this Item will not be paid for directly but is subsidiary to pertinent Items unless otherwise shown on the plans.

Sprinkling and rolling required by this Item will not be paid for directly, but will be subsidiary to this Item.

G. Construction Perimeter Fence. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Construction Perimeter Fence." This price is full compensation for furnishing and placing the fence; digging, fence posts, wire, and flagging; removal and disposal; and materials, equipment, labor, tools, and incidentals.

Removal of construction perimeter fence will be not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the perimeter fence installation or portions thereof be removed and replaced, payment will be made at the unit price bid for "Construction Perimeter Fence," which is full compensation for the removal and reinstallation of the construction perimeter fence.

H. Sandbags for Erosion Control. Sandbags will be paid for at the unit price bid for "Sandbags for Erosion Control" (of the height specified when measurement is by the foot). This price is full compensation for materials, placing sandbags, removal and disposal, equipment, labor, tools, and incidentals.

Removal of sandbags will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the sandbag installation or portions thereof be replaced, payment will be made at the unit price bid for "Sandbags for Erosion Control," which is full compensation for the reinstallation of the sandbags.

I. Temporary Sediment-Control Fence. The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Sediment-Control Fence." This price is full compensation for furnishing and placing the fence; trenching, fence posts, fabric and backfill; removal and disposal; and equipment, labor, tools, and incidentals.

Removal of temporary sediment-control fence will not be paid for directly but is subsidiary to the installation Item. When the Engineer directs that the temporary sedimentation control fence installation or portions thereof be replaced, payment will be made at the unit price bid for "Temporary Sediment-Control Fence," which is full compensation for the removal and reinstallation of the temporary sediment-control fence.

J. Curb Inlet Gravel Filter. The work performed and the materials furnished as specified herein, measured as provided under "Measurement" will be paid for at the unit price bid per linear foot for "Curb Inlet Gravel Filter," which payment shall be full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work as specified, including maintaining and replacing the gravel bags as required by these

specifications, removal of accumulated silt, and removal and proper disposal of the "Curb Inlet Gravel Filter" upon completion of site stabilization.

540.7. BID ITEM:

Item 540.1 - Rock Filter Dams (Install/Remove) - per linear foot (Type _)

Item 540.2 - Rock Filter Dams (Install/Remove) - per cubic yard (Type _)

Item 540.3 - Temporary Pipe Slope Drains - per foot (_ inches in diameter)

Item 540.4 - Baled Hay - per bale

Item 540.5 - Temporary Paved Flume (Install/Remove) - per square yard

Item 540.6 - Construction Exits (Install/Remove) - per square yard

Item 540.7 - Construction Perimeter Fence - per foot

Item 540.8 - Sandbags for Erosion Control - per foot (_ inches high)

Item 540.9 - Temporary Sediment-Control Fence - per foot

Item 540.10 - Curb Inlet Gravel Filters - per linear foot

ITEM

550 TRENCH EXCAVATION SAFETY PROTECTION

550.1. DESCRIPTION: *Provide trench excavation safety protection required for the construction of all trench excavation in the project and including all additional excavation and backfill necessitated by the protection system.*

550.2. CONSTRUCTION: Provide vertical or sloped cuts, benches, shields, support systems, or other systems providing the necessary protection in accordance with the most recent provisions of OSHA Standards and Interpretations, 29 CFR 1926, Subpart P, "Excavations."

Utilize Subpart P, Appendix F, "Selection of Protective Systems" to make decisions regarding whether trench excavation protective systems are to be used for certain trench depths and soil conditions.

550.3. MEASUREMENT: This Item will be measured by the linear foot along the long axis of a trench that requires safety excavation per OSHA and will be entered by personnel. This measurement includes all required trench protection, including trench ends.

550.4. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Trench Excavation Safety Protection."

This price is full compensation for excavation and backfill required for excavation protection; for any retention by contractor of structural design/geotechnical/safety/ equipment consultant; furnishing, placing, and removing shoring, sheeting, or bracing; dewatering or diversion of water; jacking and jack removal; and equipment, labor, materials, tools, and incidentals.

550.5. BID ITEM:

Item 550.1 - Trench Excavation Safety Protection – per linear foot

ITEM

551 TEMPORARY SPECIAL SHORING

551.1. DESCRIPTION: *Furnish and install temporary shoring to hold the surrounding earth, water, or both out of the work area.*

551.2. MATERIALS: Furnish new or used materials that will meet the requirements of this specification. Materials that do not meet the requirements of this specification as determined by the Engineer shall be replaced at no expense to the City.

551.3. EQUIPMENT: Provide equipment necessary to install temporary special shoring. Maintain equipment in good repair and operating condition.

551.4. CONSTRUCTION: All Special Shoring shall generally conform to the established alignment and cross sections or other limits for certain designated areas of the excavation indicated in the plans.

Unless complete details are included in the plans, the Contractor is responsible for the temporary special shoring design. Submit details and design calculations bearing the seal of a licensed professional engineer before constructing the shoring. The City reserves the right to reject designs. Design the shoring to comply with OSHA Standards and Interpretations, 29 CFR 1926, Subpart P, "Excavations." Design structural systems to comply with *AASHTO Standard Specifications for Highway Bridges* or *AASHTO LRFD Bridge Design Specifications*. Design shoring subject to railroad loading to comply with the *AREMA Manual for Railway Engineering* and any additional requirements of the railway being supported.

Provide vertical or sloped cuts, benches, shields, support systems, or other systems to provide the necessary protection in accordance with the approved design. Construct temporary MSE walls, when used, in accordance with the requirements of TxDOT Item 423, "Retaining Walls."

When providing Temporary Special Shoring designs, the contractor shall consider that the existing surface treatment and soil outside of the construction limits may, in conjunction with the implementation of Temporary Special Shoring materials and construction techniques, support concrete traffic control barriers conforming to the *Texas Manual on Uniform Traffic Control Devices* and vehicular traffic.

551.5. MEASUREMENT: This Item will be measured by the square foot of surface area of a vertical plane at the face of the shoring between the top of the ground being supported and the minimum protection grade line shown on the plans. If no minimum protection grade is shown on the plans, the lowest required excavated elevation will be used. Shoring projecting above the level of the ground being supported will not be measured. When excavation techniques (e.g., sloped cuts or benching) are used to provide the necessary protection, the surface area for payment will be calculated based on the area described by a vertical plane adjacent to the structure. Temporary Special Shoring shall remain the property of the contractor and shall be removed after usage.

551.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Special Shoring." This price is full compensation for the furnishing of all structural design/geotechnical/equipment consultant services, excavation and backfill; furnishing, placing and removing shoring, sheeting, or bracing; dewatering or diversion of water; jacking and jack

removal; and equipment, labor, materials, tools, and incidentals. In the event that Special Shoring is specified in the area of a "trench" excavation as defined in Part 1926, Subpart P, "Excavations" of OSHA, recovery of safety related costs shall be only under contractor's bid for Item 550, "Trench Excavation Safety Protection."

No payment will be made for special shoring made necessary by the selection of an optional design or sequence of work that creates the need for shoring.

551.7. BID ITEM:

Item 551.1 - Temporary Special Shoring - per square foot

ITEM

552 REMOVING AND RELOCATING IRRIGATION SYSTEMS

552.1. DESCRIPTION: *This item shall govern for removing and relocating portions of existing sprinkler systems within the City's right-of-way, which interfere with the proposed construction. Materials shall include PVC of various size, valves, sprinkler heads, specialties, controls, fittings, backflow preventers and wiring for automatic control irrigation system. The piping and sprinklers shall be installed in accordance with the plans and specifications or as directed by the Engineer. The installation of pipe shall include all joints or connections to existing pipes, valves or other appurtenances as may be required to complete the work.*

552.2. MATERIALS: Materials shall conform to the following provisions:

A. PVC Pipe. Pipe shall conform to the requirements of ASTM D1785, PVC 1120 Schedule 40; or ASTM D2241, PVC 1120 SDR 21, class 200.

B. PVC Fittings. Solvent welded socket type fittings shall conform to requirements of ASTM D2466, Schedule 40. Threaded type fittings shall conform to requirements of ASTM D 2464, Schedule 80.

C. Solvent Cement. Solvent cement shall conform to the requirements of ASTM D 2564.

D. Backflow Preventers. Backflow preventers with intermediate atmospheric vent shall be in accordance with ASSE 1012. Reduced pressure principle backflow preventers shall be in accordance with ASSE 1013.

E. Accessories and Appurtenances. Pop-up spray heads, gear driven rotary heads, remote control valves, and valve boxes shall match existing equipment in brand model number and nozzles.

552.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

552.4. CONSTRUCTION: Remove portions of sprinkler systems that conflict with the proposed new construction. Re-install sprinkler system after the required site grading has been completed. Perform irrigation system work under the supervision of a person possessing an irrigator's license issued by the TCEQ. Provide documentation of this license. Follow the codes of the controlling utility authority for water and electrical connection and service. If at all possible, coordinate irrigation system installation with plant installation, when plant installation is specified, to ensure that watering requirements are met. Prevent damage to vegetation, slopes, utilities, structures, and other amenities. Repair any damage within the right of way caused by the Contractor.

A. Excavation and Trenching. Excavate and trench to a sufficient depth to provide for a minimum of 12 in. soil cover for all lines or as shown on the plans. Use common trenches for irrigation lines and wire runs where feasible. Protect trenches and boring pits less than 5 ft. deep using approved methods. Protect trenches and boring pits 5 ft. deep or deeper in accordance with Item 550, "Trench Excavation Safety Protection," and Item 551, "Temporary Special Shoring." Trenching around roots shall be hand excavated to pipe grade when roots of 2 inches diameter or greater are encountered. Trench width shall be 4 inches

minimum or 1½ times diameter of pipe, whichever is wider. Backfill shall be hand tamped over excavation.

B. Pipe and Valve Assembly. Assemble pipe and fittings as recommended by the manufacturers. Clean pipe and fittings of dust, dirt, and moisture before assembly. Make connections between plastic pipe and metal valves with threaded fittings and plastic adapters. Install backflow preventers as required by ordinances of the controlling water utility authority. Install pipe, valves, and valve boxes a minimum of 12 in. from sidewalks, buildings, walls, and other objects, or as directed.

C. Sprinkler Heads and Drip Tubing. Install sprinkler heads and drip tubing in accordance with the manufacturer's recommendations at locations shown on the plans or as directed.

D. Controller. Install controllers in accordance with the manufacturer's recommendations at locations shown on the plans or as directed.

E. Closing and Flushing of PVC Pipe. Cap or plug pipe after installation to prevent entry of foreign materials that would obstruct the flow of water. Leave caps or plugs in place until removal is necessary for completion of the installation. Thoroughly flush all water lines.

F. Hydrostatic Tests. Notify the Engineer in writing at least 48 hr. before testing. Center load all pipe with sufficient backfill to prevent arching or slipping while under pressure. After all welded joints have cured for at least 24 hr., test the main lines from the meter to the valves, with all valves closed, for at least 2 consecutive hours by applying a continuous and static minimum 80-psi water pressure. Repair leaks if necessary and retest. Before final approval, maintain the lines under static pressure for 24 hr. without leaks.

G. Backfill and Compaction. After the irrigation system is fully operational, and all tests and inspections have been performed and the results approved, backfill trenches and other excavations with soil free of objectionable material. Backfill and compact in 8-in. layers. Smooth and shape disturbed soil to final grade or as directed.

552.5. MEASUREMENT: Irrigation systems will be measured per linear foot completed in place.

552.6. PAYMENT: The work performed as prescribed by this item will be paid for at the contract unit price bid, per linear foot for "removing and relocating irrigation systems" which price shall be full compensation for removing irrigation systems from their present location and relocation to permanent location as shown on plans or as directed by the Engineer, for furnishing all materials, labor, tools, equipment and incidentals necessary to complete the work.

552.7. BID ITEM:

Item 552.1 - Removing and Relocating Irrigation Systems - per linear foot

ITEM

554 EROSION CONTROL MATTING

554.1. DESCRIPTION: *This item shall govern for the furnishing and placing of erosion control mat (ECM) of the size and quantity designated to prevent soil erosion in channels and on steep slopes as shown on the plans and in accordance with these specifications.*

NOTE: An erosion control mat (ECM) is defined as either a degradable erosion control blanket (ECB), a turf reinforcement mat (TRM), or a high performance turf reinforcement mat (HPTRM). ECB should be used in applications where degradable mats are acceptable and calculated shear stresses are less than or equal to 1½ lbs/ft^2. TRM or HPTRM should be used when calculated shear stresses are greater than 1½ lbs/ft^2.

A. ECB. An erosion control mat manufactured from biodegradable materials designed to hold seed and soil in place until vegetation is established in disturbed areas and promote vegetation.

B. TRM. An erosion control mat manufactured from 100% synthetic non degradable materials with a minimum 10 year design life. TRM's are designed to reinforce the root system of vegetation, and form a high-strength system that helps prevent soil erosion in high velocity channels and on steep slopes.

C. HPTRM. A high survivability turf reinforcement mat manufactured from 100% continuously woven synthetic material with a minimum 25 year design life. HPTRM's are designed to reinforce the root system of vegetation, and form a high-strength system for applications with high loading and/or high survivability requirements. These applications may include the need for maintenance vehicles within channels, high bed loading, protection of critical structures and/or utility cuts, and projects requiring higher factors of safety.

554.2. MATERIALS: The ECB, TRM or HPTRM supplied shall meet the requirements of Texas Department of Transportation (TxDOT) Standard Specifications For Construction Item 169, "Soil Retention Blankets," of the Class and Type as specified on the plans and are on the approved product lists for TxDOT. Further definition of the Erosion Control Matting, beyond "Class and Type" shall be at the discretion of the Engineer, and may include but not limited to the requirements for performance properties such as maximum shear stress, velocity, functional longevity, design life, UV resistance, tensile strength, and manufacturing process. Materials manufactured of biodegradable components shall be classified as ECB's. Materials manufactured from 100% synthetic components shall be classified as TRM's. Materials manufactured from 100% continuously woven synthetic components shall be classified as HPTRM's.

A. Material Submittals. The submittal requirements for this specification item shall include:

1. The erosion control matting type.

2. The certified Minimum Average Roll Values (MARV) for physical properties, as derived from quality control testing performed by a Geosynthetic Accreditation Institute - Laboratory Accreditation Program (GAI-LAP) accredited laboratory.

3. Documentation of certifiable, independent large-scale testing which support's Manufacturer's reported product performance properties.

4. One full set of the Manufacturer's literature and installation recommendations as well as any special details necessary for the proposed application.

5. A sample will be required.

B. Material Acceptance. The acceptance of the materials shall be at the discretion of the Engineer. Acceptance shall be based upon conformance with this specification and the additional material properties added by the Engineer and included in the Project Documents. Acceptance of materials must be received in writing from the Engineer prior to construction proceeding.

554.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

554.4. CONSTRUCTION:

A. General.

1. **Schedule.** Prior to start of construction, submit schedules to the Engineer for accomplishment of temporary and permanent erosion control work included in the construction drawings, as are applicable for clearing and grubbing, grading, and installation of erosion control mat. Also submit a proposed method of erosion and dust control on haul roads and a plan for disposal of waste materials.

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

B. Site Preparation.

1. **ECB.** Prepare subgrade by removing large rocks, soil clods, vegetation, and other sharp objects (larger than 2" in diameter) that could keep the ECB from intimate contact with subgrade.

2. **TRM/HPTRM.**

a. Grade and compact areas to be treated with TRM/HPTRM and compact. The top 8" of subgrade must be free of rock, debris and consist of a cohesive live soil that meets the requirements of Item 515, "Topsoil.". The Engineer has final determination of whether or not the soil is "live." If the existing subgrade does not meet these standards, the contractor is responsible for the import of acceptable material.

b. Remove large rocks, soil clods, vegetation, and other sharp objects (larger than 2" in diameter) that could keep the TRM/HPTRM from intimate contact with subgrade.

c. Prepare the 8" compacted seedbed by loosening the top ½" of soil above final subgrade.

d. Construct, as a minimum, 12 in x 12 in anchor trenches at upstream and downstream ends of the installation to inhibit undermining from stray surface water. (Anchor trenches should be excavated to a depth that matches design scour depth.) Excavate 6 in x 6 in check slots at 25 to 30 feet intervals along length of channel. Cut

longitudinal anchor slots 6 in x 6 in at top of each side slope. The aforementioned dimensions are minimums and the dimensions detailed on the drawings will control.

C. Installation.

1. ECB. Install ECB such that they are shingled downstream. The end of each ECB shall overlap the next downstream ECB by a minimum of 12 inches. Leading edges shall be placed in a trench that is 4 inches wide to a minimum depth of 8 inches. The fabric shall line the trench and then filled with available substrate. Install 2 staples per square yard of ECB using 6 in (depth) x 1 in (width) metal sod staples.

2. TRM/HPTRM.

a. A mandatory pre-construction conference with an Engineer representing the TRM/HPTRM manufacturer, contractor, and inspector must be completed. The conference is to be scheduled by the contractor with at least one week's notice to all parties involved. Representatives may be required to be on site for installation assistance. The Contractor is to schedule the Engineer representing the TRM/HPTRM to inspect the site preparation prior to installation and the completed installation and provide a certified letter stating the site meets the manufacture's recommendations. All permanent TRM/HPTRM's shall be installed so as to produce root reinforcement of the vegetation. Stem reinforcement of the vegetation will not be accepted.

b. Install the TRM/HPTRM at elevation and alignment indicated.

c. The TRM/HPTRM, is to be soiled filled with ½" of top soil, and vegetated by applying the right mixture of seed and soil amendments with a Flexible Growth Medium, protected by a light weight erosion control blanket, or by applying the right mixture of seed and soil amendments with a wood blend fiber mulch, protected by a light weight erosion control blanket, or by placing sod directly on top and secure sod with 8" staples.

d. Beginning at downstream end in center of channel, place initial end of first roll of TRM/HPTRM in anchor trench and secure with ground anchor devices at 12 in intervals.

e. Position adjacent rolls in anchor trench in same manner, overlapping proceeding roll minimum 3 in.

f. Secure the TRM/HPTRM at 12 in intervals along the trench, backfill and compact with specified soil or as directed by the Engineer.

g. Unroll center strip of TRM/HPTRM upstream over compacted trench. Stop at next check slot or terminal anchor trench. Unroll adjacent rolls of TRM/HPTRM upstream in similar fashion, maintaining 3 in overlap.

h. Fold and secure the TRM/HPTRM snugly into transverse check slots. Lay material in bottom of slot, and then fold it back against itself as indicated. Anchor through both layers of TRM/HPTRM at 12 in intervals. Backfill with soil and compact. Continue unrolling the TRM/HPTRM widths upstream over compacted slot to next check slot or terminal anchor trench.

i. Secure TRM/HPTRM to channel bottom with ground anchoring devices at a frequency of 2 ½ anchors per square yard. Anchors should be a minimum of 8 gauge and 8" in length or so that they have sufficient ground penetration to resist pullout in a saturated condition. Increased anchoring frequency may be required if site conditions are such that the Engineer determines it necessary.

j. At the Engineers discretion a manufacturer's designated representative shall be on site for installation assistance.

k. Any installation of angular placement, overlapping around curves, or modified placement methods must be detailed on the construction drawings.

l. The Engineer must approve alternate installation methods prior to execution.

D. Irrigation, Mowing, and Project Acceptance. Prior to project acceptance by the Engineer, it shall be the responsibility of the contractor to establish a minimum of 70% of the area seeded shall be covered with the specified vegetation with no bare or dead spots greater than 10 square feet. The contractor shall be responsible to set up and maintain temporary irrigation, as required, to assist in establishment of vegetation. All areas that erode prior to project acceptance shall be repaired at the expense of the contractor including necessary reseeding, watering, and repair of the TRM/HPTRM. Vegetated areas shall not be mowed prior to establishment of 70% vegetative density and a minimum grass growth of 3 inches. Mower height shall not be set lower than 3 inches. Throughout the duration of the project, the contractor shall be responsible for mowing to facilitate growth and shall not let the vegetation in the seeded areas exceed 18 inches. In addition, the Contractor shall water all grassed areas as often as necessary to establish satisfactory growth and to maintain its growth throughout the duration of the project.

554.5. MEASUREMENT: Measurement of erosion control matting will be made by the square yard of surface area covered, complete in place, and ready for use as an erosion control surface treatment. (Erosion Control Matting necessary for anchorage trenches, overlaps and waste is subsidiary to the design surface area).

554.6. PAYMENT: Erosion control matting, measured as herein specified, will be paid for at the unit Price bid per square yard, which payment shall include furnishing all materials (including topsoil amendment, fertilizer, seed, and material for anchorage trenches, overlaps and waste), labor, and equipment necessary to provide a complete and finished installation as specified.

554.7. BID ITEM:

Item 554.1 - Erosion Control Matting - per square yard

ITEM

556 CAST IN PLACE DETECTABLE WARNING SURFACE TILES

556.1. DESCRIPTION: *This item shall govern the furnishing and installation of Cast In Place Detectable Warning Surface Tiles as shown on the plans and in accordance with these specifications. The work shall include all materials, equipment, surface preparation, labor, and other incidentals.*

556.2. MATERIALS:

A. Cast In Place Detectable Warning Surface Tiles. The Cast In Place Detectable Warning Surface Tiles shall comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (Title III Regulations, 28 CFR Part 36, Appendix A, "ADA Accessibility Guidelines for Buildings and Facilities", Section 4.29.2, "Detectable Warnings on Walking Surfaces").

The Cast In Place Detectable Warning Surface Tile shall be an epoxy polymer or a homogenous glass and carbon reinforced composite which is colorfast and ultra-violet stable. The tile shall incorporate an in-line pattern of truncated domes measuring nominal 0.2 inch height, 0.9 inch base diameter, and 0.45 inch top diameter with a center-to-center spacing of 1.67 inches minimum and 2.35 inches maximum as measured between the most adjacent domes. For wheelchair safety the field area shall consist of a non-slip surface with a minimum of 36 - 90° raised points, 0.045 inch high, per square inch.

B. Color. The color of the tile shall be uniform throughout and shall not use any type of paint coating to achieve color stability. The tiles shall contrast visually with adjoining surfaces by using brick red on light surfaces and yellow on dark surfaces.

C. Packaging. Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy plastic wrappings to protect tile from concrete residue during installation and tile type shall be identified by part number.

D. Certification. All material shall conform to Table 1 below. A written certification shall be supplied to the City verifying that the proposed materials meet these specifications.

E. Warranty. All materials, workmanship, and labor shall be covered by a manufacturer's guarantee and/or warranty for a period of five (5) years from the date of field application. If failures such as defective work, breakage, deformation, fading, and loosening of the tiles occur during this 5 year period, the Contractor shall bear the cost of removal and reinstallation of said materials to the satisfaction of the City.

556.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

556.4. CONSTRUCTION: All material shall be placed according to the manufacturer's instructions, and in accordance with the surface condition requirements.

A. Temperature. The Contractor shall maintain a minimum temperature of 40°F in spaces to receive tiles for at least 24 hours prior to installation, during installation, and for not less than 24 hours after installation.

B. Water. The use of water for work, cleaning or dust control, etc. shall be contained and controlled and shall not be allowed to come into contact with the general public. Provide barricades or screens to protect the general public

C. Installation. Prior to placement of the Cast In Place Detectable Warning Surface Tile system, the Contractor shall review the manufacturer and contract drawings and refer any and all discrepancies to the Engineer.

1. **Safety.** During Cast In Place Detectable Warning Surface Tile installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.

2. **Flange System.** The specifications of the structural embedment flange system and related materials shall be in strict accordance with the guidelines set by the manufacturer.

3. **Concrete and Placement of Tile System.** The physical characteristics of the concrete shall be consistent with the contract specifications while maintaining a slump range of 4 - 7 to permit solid placement of the Cast In Place Detectable Warning Surface Tile system. An overly wet mix will cause the tile to float. Under these conditions, suitable weights such as 2 concrete blocks or sandbags (25 lb) shall be placed on each tile.

   The concrete pouring and finishing operations require typical mason's tools, however, a 4' long level with electronic slope readout, 25 lb. weights, and a large non-marring rubber mallet are specific to the installation of the Cast In Place Detectable Warning Surface Tile system. If desired, a vibrating mechanism can be employed. The vibrating unit should be fixed to a soft base such as wood, at least 1 foot square.

   The factory installed plastic sheeting must remain in place during the entire installation process to prevent the splashing of concrete onto the finished surface of the tile.

   When preparing to set the tile, it is important that no concrete be removed in the area to accept the tile. It is imperative that the installation technique eliminates any air voids under the tile. Holes in the tile perimeter allow air to escape during the installation process. Concrete will flow through the large holes in each embedment flange on the underside of the tile. This will lock the tile solidly into the cured concrete.

   The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement. Immediately after finishing concrete, an electronic level shall be used to check that the required slope is achieved. The tile shall be placed true and square to the curb edge in accordance with the contract drawings. The Cast In Place Detectable Warning Surface Tiles shall be tamped (or vibrated) into the fresh concrete to ensure that the field level of the tile is flush to the adjacent concrete surface. The embedment process should not be accomplished by stepping on the tile as this may cause uneven setting which can result in air voids under the tile surface. The tile field level (base of truncated dome) shall be flush to the adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

   Immediately after placement, the tile elevation shall be checked in relation to the adjacent concrete. The elevation and slope should be set consistent with contract drawings to permit water to drain into the street gutter or as the design dictates. Ensure that the field surface of the tile is flush with the surrounding concrete and back of curb so that no ponding is possible on the tile at the back side of curb.

While concrete is workable, a 3/8 inch radius edging tool shall be used to create a finished edge of concrete, then a steel trowel shall be used to finish the concrete around the tile's perimeter, flush to the field level of the tile.

During and after the tile installation and the concrete curing stage, there shall be no walking, leaning or exerting any other force on the tile that may rock the tile and create a void between the underside of tile and concrete.

D. Placement Tolerances. Following tile placement, the Contractor shall compare installation tolerances to these specifications and adjust the tile before the concrete sets. Two suitable weights of 25 lb each may be required to be placed on each tile as necessary to ensure solid contact of the underside of tile to concrete.

E. Removal of Plastic Sheeting. Following the concrete curing stage, the protective plastic wrap shall be removed from the tile surface by cutting the plastic with a sharp knife, tight to the concrete/tile interface. If concrete has bled under the plastic, a soft brass wire brush shall be used to clean the residue without damage to the tile surface.

F. Bolting. If more than one tile is required, individual tiles can be bolted together using ¼ inch or equivalent hardware. This can help to ensure that adjacent tiles are flush to each other during the installation process. Tape or caulking can be placed on the underside of the bolted butt joint to ensure that concrete does not rise up between the tiles during installation. Any protective plastic wrap which was peeled back to facilitate bolting or cutting, should be replaced and taped to ensure that the tile surface remains free of concrete during the installation process.

G. Cutting/Trimming. If required, tiles can be cut to custom sizes or radial shapes using a continuous rim diamond blade in a circular saw or mini-grinder. Use of a straightedge to guide the cut is advisable where appropriate.

H. Sound Plates. Any sound-amplifying plates on the underside of the tile, which are dislodged during handling or cutting, should be replaced and secured with construction adhesive. The air gap created between these plates and the bottom of the tile is important in preserving the sound-on-cane audible properties of the tile.

556.5. MEASUREMENT: Cast In Place Detectable Warning Surfaces will not be measured for payment.

556.6. PAYMENT: The work prescribed herein will not be paid for directly but shall be included in the unit price bid for the item of construction in which the operation occurs.

556.7. BID ITEM:

N/A

Table 1
Material Properties

PROPERTY	TEST METHOD	VALUE
Width		24 inch at street access ramp or landing and 36 inch at signalized driveways.
Length		Full width of the street access ramp, landing, or sidewalk.
Depth		1.375 inch (+/-) 5% max.
Face Thickness		0.1875 inch (+/-) 5% max.
Warpage of Edge		0.5% max.
Embedment Flange Spacing		≤ 3.1 inch
Water Absorption	ASTM D 570-98	≤ 0.05%
Slip Resistance - Combined wet and dry static coefficients of friction on top of domes and field area.	ASTM C 1028-96	≥ 0.80
Compressive Strength	ASTM D 695-02a	≥ 28,000 psi
Tensile Strength	ASTM D 638-03	≥ 19,000 psi
Flexural Strength	ASTM D 790-03	≥ 25,000 psi
Chemical Stain Resistance - To withstand without discoloration or staining.	ASTM D 543-95	1% soap solution, turpentine, Urea 5% diesel fuel and motor oil 10% other chemicals
Abrasive Wear: BYK - Gardner Tester	ASTM D 2486-00 With reciprocating linear motion of 37± cycles per minute over a 10 inch travel. The 40 grit sand paper shall be fixed and leveled to a holder. The combined mass of the sled, weight and wood block shall be 3.2 lb.	Average wear depth ≤ 0.060 after 1000 abrasion cycles when measured on the top surface of the dome representing the average of three measurement locations per sample
Fire Resistance	ASTM E 84-05	flame spread < 15
Gardner Impact to Geometry "GE" of the standard - A failure is noted when a crack is visible on either surface or when any brittle splitting is observed on the bottom plaque in the specimen.	ASTM D 5420-04	mean failure energy expressed as a function of specimen thickness ≥ 550 inch lbf/inch
Accelerated Weathering	ASTM G 155-05a for 3000 hours	ΔE <4.5 as well as no deterioration, fading or chalking of the tile surface
Single wheel HS20-44 loading corresponding to an 8000 lb individual wheel load and a 30% impact factor	AASHTO HB-17 The tile shall be mounted on a concrete platform with a ½ inch airspace at the underside of the tile top plate then subjected to the specified maximum load of 10,400 lbs.	The tile shall exhibit no visible damage at the maximum load of 10,400 lbs.

DIVISION VI - TRAFFIC SIGNALS

ITEM

600 TRAFFIC SIGNAL GENERAL CONDITIONS

600.1. DESCRIPTION: *The purpose of this specification is to describe the necessary definitions, regulations, procedures, work zone control, and maintenance for traffic signal construction for the City of San Antonio. These specifications pertain to all phases of construction and modifications of new and/or existing traffic signals as shown on the project plans. The requirements of this specification shall be enforced on all contracts which include signalized intersections, even if no traffic signal work is part of the Contract.*

600.2. DEFINITIONS: The words defined in the following section shall for the purpose of these specifications have the meanings ascribed to them pertaining to traffic signals.

- **ASA.** American Standards Association.
- **ASTM.** American Society of Testing Materials.
- **AWS.** American Welding Society.
- **AWG.** American Wire Gauge.
- **Backplate.** A thin strip extending outward parallel to the signal face on all sides of a signal housing to provide suitable background for the signal indications.
- **City Traffic Engineer.** Contact the Transportation Group under the Public Works Department at 311.
- **Construction Traffic Coordinator.** The person in charge of construction barricading and barricade inspections.
- **Controller Assembly.** The complete assembly for controlling the operation of a traffic signal consisting of a traffic signal controller unit and all auxiliary and external equipment housed in a weatherproof cabinet.
- **Controller.** That part of the controller assembly which performs the basic timing and logic functions for the operation of the traffic signal.
- **CPS.** City Public Service. CPS Energy is a municipally-owned energy company providing both natural gas and electric service.
- **Detector.** A device for indicating, when attached to a loop or pushbutton, the passage or presence of vehicles or pedestrians.
- **FHWA.** Federal Highway Administration.
- **Flasher.** A device used to open and close signal circuits at a repetitive rate.

- **Flash Operation.** This feature discontinues normal signal operation and causes a predetermined combination of flashing signal circuits.

- **IMSA.** International Municipal Signal Association.

- **Inspector.** The Inspector referred to is the person appointed by the City in responsible charge of inspection of the traffic signal elements of a project. On a privately funded project, this person may be an Engineer representing the owner under the guidance of the Traffic Design Engineer.

- **ITE.** Institute of Transportation Engineers.

- **Luminaire.** The assembly which houses the light source and controls the light emitted from the light source for roadway illumination. Luminaires consist of a housing, lamp socket, reflector, and glass globe or refractor.

- **Manual Operation.** The operation of a signal controller unit by means of a hand operated switch.

- **Mounting Assembly.** The framework and hardware required to mount the signal face(s) and pedestrian signal(s) to the pole.

- **MUTCD.** Manual on Uniform Traffic Control Devices.

- **NEC.** National Electrical Code.

- **NESC.** National Electrical Safety Code.

- **NEMA.** National Electrical Manufacturer's Association.

- **Pedestrian Signal.** A traffic control signal for the exclusive purpose of directing pedestrian traffic at signalized locations.

- **Punch List.** The list compiled by the City for the Contractor noting deficiencies needing attention prior to final acceptance of the traffic signal system.

- **Phase.** A part of the time cycle allotted to any traffic movement or combination of movements receiving the right-of-way during one or more intervals.

- **TxDOT.** Texas Department of Transportation.

- **Signal Face.** An assembly controlling traffic in a single direction and consisting of one or more signal sections. Circular and arrow indications may be included in a signal assembly. The signal face assembly, also called a signal head, shall include the visors and backplates where specified or shown on the plans.

- **Signal Indication.** The illumination of a signal section or other device, or of a combination of sections of other devices at the same time.

- **Signal Section.** A complete unit for providing a signal indication consisting of housing, lens, reflector, lamp receptacle, and lamp.

- **Signal Systems Engineer.** Person in charge of the Signal Systems Section, responsible for system timing.
- **TMUTCD.** Texas Manual on Uniform Traffic Control Devices.
- **Traffic Design Engineer.** Person in charge of Traffic Engineering Design section for the City of San Antonio.
- **Traffic Operations Engineer.** Person in charge of the City Traffic Signal and Sign Maintenance Shop.
- **UL.** Underwriters Laboratories.
- **Vehicle.** Any motor vehicle normally licensed for roadway use.

600.3. REGULATIONS AND CODES:

A. Electrical Equipment. All electrical equipment shall conform to the standards of the National Electrical Manufacturer's Association (NEMA), the National Electric Safety Council (NESC), Underwriter's Laboratories (UL), or the Electronic Industries Association (EIA) where applicable.

B. Standards. All materials and workmanship shall conform to the requirements of the latest revision of the National Electric Code (NEC), Illumination Engineer's Society (IES), standards of the American Society for Testing and Materials (ASTM), American Association of State Highway and Transportation Officials (AASHTO), requirements of the plans, Traffic Signal Special Specifications, Special Provisions, and to any other codes, standards, or local ordinances which may apply. Whenever reference is made to any of these standards, the reference shall be considered to mean the code, ordinance, or standard that is in effect at the time of construction.

600.4. INSPECTION PROCEDURES:

A. Notification. Prior to beginning any work on any City traffic signal facility, the Contractor shall notify the Traffic Operations Engineer one week in advance. Under no circumstances will the City accept work done without this prior contact being made.

B. Inspection. The Construction Inspector shall be responsible for coordination and inspection of all elements of the traffic signal system. The only persons authorized to modify that Inspector's directions are the Traffic Design Engineer or City Traffic Engineer.

C. Acceptance. Final inspection on City as well as privately administered projects, for the purpose of generation of the Punch List, shall be conducted by the Traffic Design Engineer or his designated agent as well as the Contractor and City Construction Inspector. The Contractor shall notify the Traffic Design Engineer 48 hours in advance of a desire for final inspection. It will be the Contractor’s responsibility to have a bucket truck available at the Final Inspection for inspection of any overhead signal resources. After the Punch List items are completed the signal may be put into Flash Operations for a period of time described by the Engineer. A Final Letter of Acceptance of the traffic signal will be initiated by the Traffic Design Engineer to the Construction Inspection Section, after the signal has functioned properly for a period of time.

600.5. EQUIPMENT SUBMITTALS:

A. Approval. The Contractor shall note that the approval by the Traffic Design Engineer is required prior to installation of any equipment that is to be used.

B. Material List. The Contractor shall submit two copies of a complete material list for approval which shall conform to these specifications. The list shall state all relevant information regarding materials and equipment to allow the City to procure exact replacements of any items supplied on the project. The submittals must be complete enough to be able to judge if items comply with the features specified and shall be evaluated by the Contractor prior to submittal to eliminate rejection of obviously wrong items.

The materials on the list shall be identified by the contract project name or number, bid item number, catalog part numbers, catalog cuts, shop drawings, trade names, and schedules of other pertinent information. The materials from catalog cuts shall be clearly indicated by the Contractor. Any material designation used in the contract documents shall be so noted on the material list. If requested, the Contractor shall submit shop drawings for review and approval.

C. Pre-Approved Materials. It is the City's intent to keep a "pre-approved" list of equipment for traffic signal projects. The intent is to streamline the approval process by making information available to the Contractor of items that have been previously approved under these specifications. This list is in no way to be construed as an endorsement of any brand or product. This list is available from the Traffic Design Engineer, and use of the list does not relieve the Contractor from responsibility to comply with the specifications of a particular project. The maintenance of this list is at the discretion of the Traffic Design Engineer, and the Contractor should be prepared to provide submittals of all equipment as required herein.

The Contractor shall be allowed to substitute a reference to an item in the "pre-approved" list in lieu of a catalog data sheet, if he desires, and if the Traffic Design Engineer has provided such a list. Such reference shall be sufficiently complete for the City to judge which item is being proposed. The Contractor may also be asked to submit additional documentation from an independent testing lab attesting that the material submitted meets or exceeds the required specifications.

D. Changes to Approved Materials. There shall be no substitutions for any of the materials on the submittal without the prior written approval of the Traffic Design Engineer. Proposed changes to the approved materials submittal shall be submitted in writing. If requested, the Contractor shall submit samples of proposed materials for testing and evaluation by the City.

E. Rejection of Material. The City reserves the right to reject an incomplete or unclear material list or submittal. Installation of equipment not corresponding to the submittal shall be grounds for rejection of the equipment and replacement with approved materials at no cost to the City, even if the non-approved material might otherwise have been approved had it been properly submitted.

F. Submittals. Submittals shall be delivered to the Traffic Design Engineer as soon as possible after signing of the contract. Payments to the Contractor may be held if the submittal process is not completed in a timely fashion, considering no equipment can be installed without all submittals being approved.

Submittals shall be provided for the following equipment:

- Traffic Paint
- Preformed Plastic Markings
- Pull Boxes & Lids
- Pedestrian Signals
- Signal Heads
- Lamps
- Backplates
- Signal Mountings
- Detector Modules
- Conflict Monitors
- Load Switches
- Controller and Cabinet
- Wood Poles
- Span Wire
- Pedestrian Pushbuttons and Signs
- Loop Wire
- Loop Sealant
- Wire and Cable
- Conduit and Fittings
- Warning Tape
- Metal Splice Boxes
- Service Pedestal
- Service Box
- Surge Arrestors
- Breakers
- Steel Poles
- Anchor Bolts
- Sign Materials
- Sign Mounting Brackets

600.6. BARRICADING:

A. General. Barricading shall be provided by the Contractor as provided for in the plans and requested by the Traffic Design Engineer, Inspector, and Construction Traffic Coordinator. The Contractor shall supply his own barricades or employ a legitimate barricading company for this purpose, supplying the Inspector with the responsible party's 24-hour telephone number for emergencies.

B. Contractor's Responsibilities. It is the Contractor's responsibility to see that all traffic control devices are properly installed and maintained. All locations and distances shall be in conformance with the barricading details supplied by the Traffic Design Engineer, the Construction Traffic Coordinator and the *Texas Manual On Uniform Traffic Control Devices*.

Any time a Contractor's vehicle occupies a street open to vehicular traffic, or during the work in the street for the purpose of hanging heads, erection of poles, cutting and installation of loops, or any other such work, adequate advance warning signs and barricades or cones shall be used as required by the Texas MUTCD. Additionally, all locations not in a road project

shall have the SIGNAL CONSTRUCTION AHEAD signs and END CONSTRUCTION signs on all approaches of the intersection having the new signals or modification installed.

Any trenches left overnight as well as any foundations that do not have poles sitting on them or any other such hazard to the public shall be adequately covered and barricaded with reflective standard barricades equipped with warning flashers or as directed by the Engineer.

C. Contractor Supplied Barricading. If the Contractor elects to do his own barricading, a traffic control plan is required 48 hours (excluding weekends) in advance for approval. Contractor shall adhere to the appropriate requirements of Item 530, "Barricades, Signs and Traffic Handling."

D. Lane Closures. Any lane closures or total closures of streets or existing sidewalks must be approved in advance. A 72-hour notice is required on all lane closures and/or total closures.

No closures or partial closures shall occur during the peak hours of 7:00 am to 9:00 am and 4:00 pm to 6:00 pm, weekdays.

E. Sidewalks. No sidewalks in the downtown area shall be closed.

F. Materials for Temporary Traffic Control Devices. Reflectorized signs shall be constructed of retro-reflective sheeting and shall be maintained to meet the appearance, color and reflectivity requirements. Paints and coloration of signs shall be equal to the TxDOT's standards. All traffic control devices shall conform to the *Texas Manual on Uniform Traffic Control Devices for Streets and Highways*. Contractors shall furnish copies of certifications from manufacturers of the lights that the warning lights meet the requirements of the ITE Standard for Flashing and Steady Burn Warning Lights, if requested.

G. Temporary Signage for Traffic Signal Construction. Signs erected on portable supports normally mean signs which are used during the day to warn or guide traffic through and/or around the actual construction area, but at the end of the day such signs are either removed or turned away from the view of traffic. Portable supports shall be as shown in the detail. Signs required for nighttime usage should not normally be mounted on temporary supports, except when approved by the Inspector. Signs erected on fixed supports for use on construction projects normally mean signs that are to remain in place for both day and night usage to regulate, warn and guide traffic in advance of and within the limits of the project including the crossroad approaches. However, under certain conditions, such as where a sign may be required for a few days duration and then is no longer needed or where a sign is moved from location to location every few days or where it is not practical or desirable to provide a fixed mounting, such signs may be erected on a temporary support. Signs erected on temporary supports should be at a minimum height of 3 feet. Signs erected on fixed supports should be at a minimum height of 7 feet. All regulatory signs shall be erected at least 7 feet above the ground. Posts for fixed supports should be set in the ground without concrete footings.

Where portable or temporary supports require the use of weights to keep the sign or barricade from turning over, the use of some type of sandbag is recommended. The use of pieces of concrete, rocks, iron, steel or other solid objects will not be permitted.

Signing shown on the details is typical and may be adjusted to fit field conditions.

No more than 2 signs shall be placed on a barricade.

H. Visibility of Signals. The Contractor shall be responsible for maintaining appropriate visibility of new or existing signals. The contractor will be responsible for temporary signals or signal relocations necessary to meet the visibility requirements in the Texas MUTCD when traffic is detoured to another part of the roadway even if no other signal work is part of the Contract.

600.7. SIGNAL SHUTDOWNS:

A. At any location where an existing signal is to be temporarily shut down for the sake of changing from the old controller or service to the new controller or service, the Contractor shall be responsible for arranging and bearing the cost of duly-constituted peace officers in their jurisdiction for directing traffic. Security guards are not considered as police officers and shall not be used for this purpose.

B. Signal shutdowns shall not begin prior to 9:00 am on weekdays (holidays excluded) and shall be avoided from 4:00 to 6:00 pm weekdays (holidays excluded).

C. Additionally, the City shall not allow an existing traffic signal or flasher system to be turned off and STOP signs used to control traffic. The Contractor shall plan ahead and consider this when planning his project strategy. It is suggested that the new poles be installed as soon as possible and possibly temporarily wired overhead to avoid this problem. Except in highly unusual circumstances, the City will require the Contractor to place the new signals in operation before the old signals are removed. If temporary signals cannot be avoided, the Contractor will be responsible for all temporary signals.

600.8. CITY SUPPLIED MATERIALS: The City shall not supply nor lend out equipment on a contract-deduction basis or any other basis unless such arrangement is so stated in the plans or approved by the Traffic Design Engineer.

600.9. UTILITY LOCATIONS: The locations of utilities shown on the plans are approximate. All involved utilities, tunnels, and storm drains may not be complete on the plans, and the Contractor shall be responsible for obtaining any additional information from the applicable sources prior to construction, and determining the accuracy and adequacy of such information necessary for his performance of the work. Damage to any utility or existing facilities (including detector loops not involved in the project) shall be repaired or replaced at the Contractor's expense.

Existing loop detectors damaged or broken by the Contractor shall be replaced by him at no expense to the City, unless other arrangements have been made in writing with the City.

600.10. MAINTENANCE DURING CONSTRUCTION:

A. General. Any and all maintenance, reattachments to CPS poles or City poles, temporary signals, relocation of signals over lanes, or pole relocations or removals shall be by the Contractor. The City shall have no maintenance or construction responsibilities during construction except for the timing in the controller cabinet itself.

B. Detours. During detours, traffic signal heads must be repositioned by the Contractor to the minimum requirements of the Texas Manual on Uniform Traffic Control Devices and to the directions of the Traffic Design Engineer and/or Inspector.

C. Left Turns. Where left turn arrows presently exist and a one-lane detour road will be built as a temporary construction detour, the Inspector, Traffic Operations Engineer, or Traffic

Design Engineer may require the arrow(s) be eliminated temporarily by the Contractor to facilitate traffic movement.

D. Damage to Signals by Contractor. In the event that the Contractor or his sub-contractor damages any traffic signal facilities to the point that the signal installation is inoperative it shall be the Contractor's responsibility to set temporary Stop signs as soon as possible. It will also be the Contractor's responsibility to have an off-duty police officer on the site within two hours of the non-functioning signal, if the signal is not repaired to the Engineer's satisfaction within the first hour. In the event that the Contractor is unable to accomplish the above, the City of San Antonio shall at it's option send an on-duty police officer to the site and have either the City's Traffic Signal Maintenance Section or another independent private traffic signal Contractor to facilitate the repairs. Any and all cost incurred by the City of San Antonio to repair the damaged signal facilities shall be the responsibility of the General Contractor for the project.

600.11. SIGNAL TURN-ONS:

A. City Approval. Signals shall be turned on when the City has determined that the location is in adequate condition (wiring, signals, service, etc.) to be turned on safely. The Traffic Design Engineer shall make this determination.

B. Manual Flash Mode. Unless otherwise shown on the plans, it is the City's policy for new traffic signals to turn on the new system and let it remain in the Manual Flash mode for approximately one week before the system is switched on to cycling mode.

C. Placing Signals in Service. The Contractor shall ensure that service has been provided and that all wires are terminated in the cabinet. At that point he shall arrange with the Inspector for the Traffic Design Engineer to conduct an inspection to verify that there are no other circumstances that would delay the turn-on. The Traffic Design Engineer shall coordinate turning the signal on to the flash mode through the Inspector. The Contractor shall have personnel and a bucket truck at the site on the day the Traffic Design Engineer turns the signal on to flashing operation for the purpose of uncovering the signals and any necessary overhead work or inspections.

The Contractor shall not place any signal in operation, either cycling or flashing, under any circumstances!

600.12. PRESERVATION OF SOD, SHRUBBERY AND TREES: The Contractor shall assume full responsibility for the preservation of all sod, shrubbery, and trees at the site during the installation. When it becomes necessary to remove any sod, shrubbery, or tree branches, the Contractor shall obtain permission from the owner.

All sod and shrubbery that are removed shall be carefully preserved and replaced in their original position. Damaged sod or shrubbery shall be replaced by the Contractor at his expense.

600.13. LOCATING OF FACILITIES: The Contractor shall locate poles, controllers, etc., as shown in plans. Slight (less than three feet) deviation to avoid existing utilities is permissible, unless the new location would move the pole too close to the roadway, obstruct the view of another traffic control device, or otherwise not conform to the intent of the plans. Large deviations must be approved by the Traffic Design Engineer. The Contractor shall bear in mind that electrical plans are somewhat diagrammatic in nature when it comes to conduit routing and adjustments which may be necessary in the field.

600.14. REMOVAL AND REPLACEMENT OF CURBS AND WALKS: The Contractor shall secure permission from the Inspector before cutting into any curbs and sidewalks. Sidewalk slabs that require conduit or other facilities to be placed in or beneath them shall be neatly sawcut at the closest expansion or cold joint and the entire slab removed and replaced. Sawcutting slots through slabs is considered unsightly and will not be tolerated. Exceptions to this may be approved by the Traffic Design Engineer only on conduit runs in excess of 50 feet that are not bored.

After the work is complete, the Contractor shall restore facilities which have been removed to the equivalent of their original condition or better.

600.15. PERMITS: The Contractor shall obtain all permits and inspections as required. Cost of these permits is the responsibility of the Contractor and is subsidiary to the various items in the project.

600.16. SALVAGED EQUIPMENT:

A. Salvaged Equipment. Equipment not reused in the new signal system shall be removed by the Contractor. Salvaged poles, signals, cabinets and contents, signal wire, pedestrian signals, signs, and pedestrian buttons shall be transported and unloaded at the City Traffic Design Shop.

B. Notification. The Contractor shall notify the City 48 hours prior to the proposed delivery date/time to arrange for the receipt of the salvaged equipment by the City. The Contractor shall make a complete listing of the items salvaged and present it upon delivery of the items.

C. Damaged Equipment. All equipment damaged or destroyed by improper care, handling, or transport shall be replaced with new equipment. The Contractor shall remove from the jobsite and dispose of any non-salvaged items and old wire. Holes resulting from the removal of pull boxes, foundations, and other materials shall be backfilled and compacted with material equivalent to the surrounding material and the surface made to match the surrounding surface in accordance with the appropriate specification.

600.17. CLEANUP: The Contractor shall leave the intersection area, right-of-way, and any work or storage areas in broom clean condition. Dirt areas shall be raked clean. No scraps or debris of any kind shall be left at the site.

600.18. WARRANTY: Unless otherwise noted on the plans or superseded by the requirements of other Items, the Contractor shall guarantee all items of workmanship and materials to be free from defects for a period of one year from the date of acceptance.

600.19. AS-BUILT PLANS: The Contractor shall supply the Traffic Design Engineer with redlined blueprints of any and all field changes and alterations for a file copy on all projects with traffic signals for the City. This set of As-Builts is in addition to and separate from any other As-Built requirements in that contract.

600.20. MEASUREMENT AND PAYMENT: Requirements of this Item shall not be measured or paid for directly and are considered subsidiary to the other governing items specified for the project.

600.21. BID ITEM:

N/A

ITEM

609 PROGRAMMABLE SIGNAL HEADS

609.1. DESCRIPTION: *This Item shall govern for furnishing and installing 12 inch vehicle signal heads with programmable visibility of signal faces as shown on the plans.*

609.2. GENERAL: The intent of this specification is to describe a 12 inch traffic signal head (comprised of one or more signal sections) which shall permit the optical adjustment of the indication's visibility zone.

The signal section shall employ no louvers or hoods to obtain its programmable limitations, however if required, hoods shall be provided to eliminate extraneous light falling on the lens.

The indication shall be visible at all locations within 15 degrees of the optical axis. The signal section shall be programmable to veil any portion of the visibility zone.

All materials furnished by the Contractor shall be new.

All heads shall be in compliance with the Texas MUTCD.

609.3. EQUIPMENT: Provide equipment as required by the following.

A. Optical System. The optical system shall consist of the following basic components:

- Lamp.
- Lamp Collar.
- Optical Limiter-Diffuser.
- Objective Lens.

All other components necessary to fully utilize the programmable signal section shall be provided by the Contractor.

1. **Lamp.** The lamp shall be a nominal 150 watt, 120 volt AC, three prong, sealed beam with an integral reflector. The lamp shall have an average rated life of at least 6000 hours.

2. **Optical Limiter.** The optical limiter shall provide an accessible imaging surface which focuses on the optical axis for objects at a distance of 900 to 1200 feet. A veiling mask shall be applied to the optical limiter to limit the area in the visibility zone which can view the signal.

3. **Objective Lens.** The objective lens shall be a high resolution planar incremental lens. The lens shall be symmetrical so that it may be rotated to any angle a multiple of 90 degrees from its base orientation about its optical axis without effecting its operation.

4. **Project Indication.** The projected indication shall conform to ITE transmittance and chromaticity standards.

B. Design.

1. **Signal Housing.** The signal housing shall be die-cast aluminum conforming to the latest ITE specification alloy and tensile requirements.

2. **Hinges and Latch Pins.** Hinges and latch pins shall be stainless steel.

3. **Access Openings.** All access openings not otherwise utilized for mounting hardware or other purposes shall be sealed with weather resistant rubber gaskets so the resulting housing shall be moisture and dust-proof.

4. **Signal Head Components.** The complete head shall consist of three (3) or more individual sections as shown on the plans. The lens colors shall be as shown on the plans. Heat resistant tape or other masking material shall be provided in sufficient quantity to adequately tape or mask all signal sections as specified herein. Lamps shall be provided by the Contractor for each signal section.

5. **Lamp Intensity.** When shown on the plans, each section shall be equipped with a photo-electric cell for night time dimming of the signal indications. Lamp intensity with the photo-electric cell installed shall not be less than 97 percent of the uncontrolled intensity at 1000 foot candles ambient light into the photo-electric cell. The lamp intensity shall reduce to 85 percent +/- 2 percent of maximum at less than 1 foot candle ambient light into the photo-electric cell. The photo-electric cell shall be responsive within the range of 105 to 135 volt, single phase, 60 Hz AC.

6. **Lamp Fixture.** Lamp fixture shall be comprised of a separately accessible housing and integral lamp support, ceramic socket and self-aligning, quick release lamp retainer. Each section shall include a terminal block for screw- type attachment of signal wires. Internal No. 18 stranded and color coded copper wire shall interconnect all sections to permit field connections within any section.

7. **Signal Head Finishes.** Unless otherwise shown on the plans, signal sections shall be Federal Yellow No. 13538 of Federal Standard 595. Back plates, louvers and the inside of visors shall be flat black. All exposed metal surfaces, except for the back plates, louvers and the inside of visors, shall be given two (2) separately baked on coats of high grade enamel. The back plates, louvers and the inside of the visors shall be provided with two (2) coats of high grade flat black finish paint.

609.4. CONSTRUCTION: The head shall mount to standard 1½ inch fittings as a single section, multiple sections or in combination with other faces. The fittings shall be provided with the head and shall be mounted as shown on the plans. The head shall be mountable with ordinary tools and capable of being serviced with no tools.

609.5. MEASUREMENT: This Item will be measured by each vehicle signal section complete in place.

609.6. PAYMENT: The work performed and materials furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit price bid for "Programmable Signal Section." This price shall be full compensation for furnishing, assembling and installing the signal section; for all mounting attachments; and for all labor, tools, equipment and incidentals necessary to complete the work.

609.7. BID ITEM:

Item 609.1 - Optic Programmable Head Type 1 - per each

Item 609.2 - Optic Programmable Head Type 2 - per each

Item 609.3 - Optic Programmable Head Type 3 - per each

Item 609.4 - Optic Programmable Head Type 5 - per each

Item 609.5 - Optic Programmable Head Type 6 - per each

Item 609.6 - Optic Programmable Head Type 8 - per each

Item 609.7 - Optic Programmable Head Type 9 - per each

ITEM

615 TRAFFIC SIGNAL CONTROLLER CABINET

615.1. DESCRIPTION: *The purpose of this specification is to describe a traffic signal controller cabinet for use with various types of controllers. The work shall consist of furnishing the controller cabinet, associated equipment described herein, mounting equipment, and auxiliary load rack if specified, and mounting in the field. The Contractor will make all field wire terminations inside the cabinet unless otherwise specified. Contractor shall supply the cabinet as specified on the plans.*

615.2. MATERIALS: The Contractor shall include all warranties and/or guarantees with respect to materials, parts, workmanship and performance of the product he proposes to supply. A warranty period of twenty-four (24) months from date of installation shall apply to the cabinet and associated parts. The warranty shall cover all units, defects, parts, labor, and shipping costs.

Each cabinet shall be supplied with a cabinet drawing and wiring diagram.

The equipment supplied under these specifications from any manufacturer shall not be construed as endorsement of this equipment by the City of San Antonio. No reference to this purchase will be permitted.

The Contractor will bear all expenses connected with the return of any equipment which the City deems necessary to have returned to the factory for repair during the guarantee period.

The Contractor shall, at the option of the City, supply the City with a standard production model for evaluation by the City prior to approval.

Such requested sample unit shall be provided within two weeks of the written request from the City. The Contractor shall arrange to have the unit transported back to the original sender at no expense to the City.

All equipment, including cabinet and all internal components shall conform to the Federal Highway Administration Publication FHWA-IP-78-16, December 1978, and Caltrans' Traffic Signal Control Equipment Specifications, dated January 1989, with Addendum 5, dated November, 1992, and with the changes as noted within these specifications. In case of conflicting requirements, the Project Plans or Invitation to Bid shall prevail over these specifications, which shall prevail over the Caltrans specifications, which shall prevail over the FHWA specifications.

All cabinet output file back panels shall be hard-wired with individual copper conductors. Printed circuit boards shall not be used for output file back panels.

615.3. CONTROLLER CABINETS - GENERAL: This specification defines the cabinets to be used with the Model 170E controller units. This specification replaces Chapter 11 of Federal Highway Administration Publication FHWA-IP-78-16, Type 170 Traffic Signal Controller System, hereafter referred to as TSCES.

Details of alternative designs must be submitted to the Traffic Signal Engineer for approval prior to fabrication.

A. General Cabinet Construction.

All cabinets shall be rainproof. The cabinet top shall be "crowned" or slanted to prevent standing water.

The cabinet and doors shall be fabricated of 0.125-inch minimum thickness aluminum. All exterior seams for cabinet and doors shall be continuously welded. All exterior welds shall be smooth. All edges shall be filed to a radius of 0.03125 inch minimum.

Cabinets shall conform to the requirements of ASTM Designation B 209 for 5052-H32 aluminum sheet.

Welding shall be done by the gas metal arc (Mig) or gas tungsten arc (Tig) process using bare aluminum welding electrodes. Electrodes shall conform to the requirements of the American Welding Society (AWS) A5.10 for ER5356 aluminum alloy bare welding electrodes.

Procedures, welders and welding operators for welding on aluminum shall be qualified in accordance with the requirements of AWS B3.0, "Welding Procedure and Performance Qualification," and to the practices recommended in AWS C5.6.

The surfaces of each aluminum cabinet shall be the original cast-like finish or fabricated finish. Any variations of finish shall be pre-approved in writing by the City. Each cabinet shall be equipped with an electric fan with ball or roller bearings and a capacity of at least 100 cubic feet of free air delivery per minute.

The fan shall be mounted within the cabinet and vented out between the top of the cabinet and the front door.

The fan shall be thermostatically controlled and shall be manually adjustable to turn on between 33C and 65C with a differential of not more than 6C between automatic turn on and turn off. The cabinet fan circuit shall be protected at 125 percent of the ampacity of the fan motor.

Intake (including filter) and exhaust areas shall pass a minimum of 60 cubic feet of air per minute.

Each cabinet shall be provided with louvered vents in the front door with a removable and reusable metal air filter. The filter shall cover the vents and shall be held firmly in place with bottom and side brackets and a spring-loaded upper clamp.

The bottom filter bracket shall be formed into a waterproof sump with drain holes to the outside. The louvered vents shall be designed and constructed such that a stream of water from a pressure head, such as a Rainbird sprinkler or other type sprinkler, will not enter the cabinet.

All cabinets shall have a police panel. The police door shall provide access to the "Auto-Flash" and "Signals Off" switches. Police Access shall be limited to these two switches. The police panel door shall be equipped with a lock keyed for a master police key.

One key shall be furnished with each cabinet for the police lock. Each police key shall have a shaft at least 1.75 inches in length.

Type 332, 336, and 337 cabinets shall have single front and rear doors, each equipped with a lock. When each door is closed and latched, the door shall be locked. The latching handles shall have provision for padlocking in the closed position. The operating handle shall be stainless steel with a 7.5-inch handle and a minimum 0.50 inch stainless steel shank. The cabinet door frame shall be double flanged out on all four sides and shall be provided with strikers to hold tension on and form a firm seal between door gasketing and cabinet door frame.

The flange width shall be a minimum of one inch, measured from front edge to flange to cabinet outside surface.

Each cabinet will be supplied with locks keyed alike to the standard Corbin #2 core combination. Two keys shall be supplied with each cabinet.

The locks shall have rectangular, spring-loaded bolts. The bolts shall have a 0.281-inch throw and shall be 0.75 inch wide by 0.375 inch thick dimension tolerance is +0.035 inch. The locks shall be left hand on the front door and right hand on the rear door. Keys shall be removable in the locked position only. Locks shall be rigidly mounted with two stainless steel machine screws. In the locked position, the throw shall extend a minimum of 0.25 (+ 0.03) inch. The front portion of the lock shall neither be recessed nor shall it extend more than 0.1875 inch from the face of the door. The locks shall be mounted on the door in such a position that the tumblers are in the upper quadrant.

The latching mechanism shall be a three-point draw roller type. The center catch and pushrods shall be plated. Pushrods shall be turned edgewise at the outward supports and cross section shall be 0.25 inch by 0.75 inch, minimum.

Supports shall be 0.105 inch steel, minimum. Rollers shall have a minimum diameter of 0.875 inch and shall be equipped with ball bearings and nylon wheels. The center catch shall be fabricated of 0.1875-inch plated steel, minimum.

Each door shall be equipped with two bolt hinges, minimum 3.5 inches long. Each hinge shall have a fixed pin. All doors shall be provided with catches to hold the door open at both 90 degrees and 180 degrees, plus or minus ten degrees. The catches shall be 0.375 inch diameter minimum, plated steel rods. Door latches, in latched position, shall not come in contact with cabinet surface or flange lip. The catches shall be capable of holding the door open at 90 degrees in a 60 MPH wind at an angle perpendicular to the plane of the door.

On all cabinets, door hinge pins and bolts shall be made of stainless steel. Door hinges shall be made of aluminum. The hinges shall be bolted to the cabinet and may be welded to the door. The hinge pins and bolts shall be covered by the door edge and shall not be accessible when door is closed. Hinge pins will be welded at each end to form a cap and welds filed or ground smooth.

Type 332 cabinets shall be provided with two lifting eyes to be used when placing the cabinet on the foundation. Each eye attached to the cabinet shall have a minimum diameter of 0.75 inch and shall be capable of supporting the cabinet.

Gasketing shall be provided on all door openings and shall be dust-tight. Gaskets shall be 0.25 inch minimum thickness closed cell neoprene and shall be permanently bonded to the metal. The mating surface of the gasketing shall be covered with a silicone lubricant to prevent sticking to the mating surface.

B. Power Supply.

A power supply shall be provided in the cabinet for all equipment installed in the cabinet except the 170 Controller unit, the Model 210 Monitor and the Models 242 and 252 Isolators.

All Power Supply Assemblies (PDA) for 8-phase cabinets shall meet Caltrans' Traffic Singal Control Equipment Specifications for PDA #2, dated January 1989 or latest revision.

The power supply shall be ferro-resonant design having no active components and shall conform to the following requirements:

- Line Regulation: Two percent from 95 to 135 VAC at 60 Hz, plus an additional 1.6 percent for each additional one percent frequency change.
- Load Regulation: Five percent from one ampere to five amperes with a maximum temperature rise of 30°C above ambient.
- Design Voltage: +24 (+0.5) VDC at full load and 30C with 115 VAC input line after 0.5 hour warm-up.
- Full Load Current: Five amperes, minimum.
- Ripple Noise: Two volts peak-to-peak and 500 millivolts rms at full load.
- Line Voltage: 95 to 135 VAC.
- Efficiency: 60 percent, minimum.
- Minimum Voltage: 22.8 VDC.

The power supply front panel shall include:

- All fuses or circuit breakers.
- Pilot lamp.
- Test points or meter for monitoring output voltage.

The power supply, including terminals, shall be protected to prevent accidental contact with energized parts.

Wiring for 120 VAC power input to power supply shall be terminated on terminal strips or soldered. AC plugs will not be acceptable.

The power supply cage and transformer shall be securely braced with nylon strapping to minimize damage in transit.

C. Flash Transfer Relay.

The Flash Relays shall conform to the requirements of these specifications.

A leakage resistor, which will permit 3 to 8 volts to be applied to the relay coil, shall be installed across the terminals of each relay socket to overcome the residual magnetism.

The flash transfer relay shall transfer field outputs from switchpack output to flash control. Transfer of the flash transfer relay circuit to flash control shall not interrupt the operation of the controller unit.

The coils of the flash transfer relays shall be energized only when the signals are in flashing operation and the police panel "ON/OFF" switch is in the "ON" position.

D. Equipment Removal.

The following equipment shall be completely removable from the cabinet without removing any other equipment and using only a screwdriver:

1. Power Supply

2. Power Distribution Assembly

3. Input File

4. Output File

E. Miscellaneous.

All fuses, circuit breakers, switches, (except police panel switches and fan fuse) and indicators shall be readily visible and accessible when the front door is open.

All equipment in the cabinet shall be clearly and permanently labeled. The marker strips shall be made of a material that can be easily and legibly written on using a pencil or ball-point pen. Marker strips shall be located immediately below the item they are to identify and must be clearly visible with the items installed. Glossy marker strips are not acceptable because ink tends to bubble and smear. Resistor/Capacitor transient suppression shall be provided at the relay socket (across relay coils) and in the fan circuit.

F. Cabinet Wiring Diagram.

One set of nonfading (comparable to Xerox 2080) readable cabinet wiring diagrams shall be supplied with each cabinet. The diagram shall be nonproprietary. They shall identify all circuits in such a manner as to be readily interpreted. The cabinet drawing shall show the component layout in an elevation view as viewed from the rear of the cabinet with the left and right cabinet walls shown in their relative positions. The diagrams shall be placed in a heavy duty side opening clear plastic pouch and attached to the front cabinet door. The pouch shall be of such design and material that it provides adequate storage and access to the wiring diagram, and shall be constructed of a material which will not react with or stick to xerographic plastic toners used in copy machines.

Detailed equipment layout scale drawings and wiring diagrams of all equipment installed in the cabinet shall be submitted to the Traffic Engineer for approval prior to production. Review by the City does not lessen the contractor's responsibility to meet the specifications.

G. Cabinet Light.

Each cabinet shall be equipped with a fluorescent lighting fixture mounted inside the top front of the cabinet. The fixture shall have an 8 watt lamp AT5-CW, operated from a normal power factor, U.L. listed ballast. The lamp shall be shaded to diffuse the light. A door switch shall be installed to turn the cabinet light on when the front door is opened. The door switch shall be on a separate circuit by itself, and used only to turn on the light and operate the door alarm.

On the Type 332 and 336 cabinets, additional wiring shall be provided from the load (normally open) side of the light switch to Input File location I11D, and run AC- to Input File location I11E for the door alarm circuit.

H. Conductors.

Conductors used in cabinet wiring shall terminate with properly sized spring-spade type terminals or shall be soldered to a through-panel solder lug on the rear side of the terminal block. All crimp-style connectors shall be applied with a power tool which prevents opening of the handles until the crimp is completed.

Conductors in the controller cabinet between the service terminals and the signal bus breakers including the chassis ground conductor to Power Distribution Assembly shall be No. 8, or larger.

All conductors used in controller cabinet wiring shall be No. 22, or larger, with a minimum of 19 copper strands. Conductors shall conform to Military Specification: MIL-W-16878D, Type B or better. The insulation shall have a minimum thickness of 10 mils and shall be nylon jacketed polyvinyl chloride except that Conductors No. 14 and larger may have Type THHN insulation, and shall be stranded with a minimum of seven copper strands.

All conductors, except those which can be readily traced, shall be labeled. Labels attached to each of the conductors shall identify the destination of the other end of the conductor.

All conductors used in controller cabinet wiring shall conform to the following color-code requirements:

1. The grounded conductors of AC circuits shall be identified by a continuous white or gray color.

2. The equipment grounding conductors shall be identified by a solid green color or by a continuous green color with one or more yellow stripes.

3. The DC logic ground conductors shall be identified by a solid white color with a colored (except green) stripe.

4. The ungrounded conductors shall be identified by any color not specified above.

All cabinet wiring harnesses shall be neat, firm and routed to minimize crosstalk and electrical interference. Printed circuit motherboards may be used to eliminate or reduce cabinet wiring.

1. Wiring containing AC shall be routed and bundled separately or shielded separately from all logic voltage control circuits.

2. Cabling shall be routed to prevent conductors from being in contact with metal edges.

All conductors, terminals or parts, which could be hazardous to maintenance personnel, shall be protected with suitable insulating material.

Within the cabinet wiring, the DC logic ground and equipment ground shall be electrically isolated from the AC grounded conductor and each other by 500 megohms when tested at 250 VDC, with the power line surge protector disconnected.

Conductors from Connector C to the input file shall be of sufficient length to allow any conductor to be connected to any detector output terminal (Positions S, F, W). The AC-copper terminal bus shall not be grounded to the cabinet or connected to the logic ground and

shall provide a minimum of 10 terminals for connection to field conductors. Nylon screws with a minimum diameter of 0.25 inches shall be used for securing the bus to the service panel.

An equipment grounding (earth ground) bus shall be provided in each cabinet. The bus shall be copper and grounded to the cabinet.

The output common of the cabinet power supply shall be connected to the DC logic ground bus using a No. 14, or larger, stranded copper wire.

The DC ground bus shall be located on the input panel.

A No. 8, or larger, copper conductor shall be connected between equipment ground bus and rack rails.

Terminals for the signal wires shall be fitted with 90 degree lugs for #14 AWG wire. Lugs shall be the type that the end of the field wire slips into and is held in place with a compression screw on the wire. (Blackburn #L35 or equivalent)

Each loop detector lead-in, from the field terminals in the cabinet to the sensor unit rack connector shall be a cable UL Type 2092 or better. The stranded tinned copper drain wire shall be connected to a terminal on the input file terminal block. This input terminal shall be connected to the equipment grounding bus through a single conductor.

Each cabinet shall be provided with one harness, terminated at one end with standard C-2 connector plugs, at the other end to a terminal strip, and four feet in length. The harness for the C-2 connector shall contain conductors for the AUDIO IN and AUDIO OUT pairs. Harness shall be terminated at a terminal strip placed near the bottom of the cabinet, and each AUDIO IN and AUDIO OUT position on the terminal strip shall be protected with an EDCO Model SRA-64C (18 VAC) or approved equal. Harness conductors shall be clearly labeled at the terminal strip.

I. Surge Protection.

All cabinets shall be provided with an EDCO Model # SHA-1210 or approved equal. Cabinet shall be wired so filtered AC+ shall be supplied to the 170 unit receptacles (2), cabinet power supply, and conflict monitor only.

Surge protection shall be provided for all cabinet power.

All signal output lines shall be protected by a MOV installed at the field wiring terminal block, between the terminal and earth ground. The MOV shall be Type V150LA20.

J. Conflict Monitor.

The Contractor shall supply a conflict monitor that conforms to the TEES specification for the Model 2070L controller. The conflict monitor shall be EDI, Model 2018 KCLiP, or approved equivalent. The Contractor shall supply fifteen (15) CMU Data Key Programming Tool (datakey programming device).

K. Heavy Duty Relays.

This specification defines the Model 430 heavy duty relays to be used with the Model 170E controller unit.

This specification replaces chapter 17 of Federal Highway Administration Publication FHWA-IP-78-16, Type 170 Traffic Signal Controller System:

1. Heavy duty relays shall be the electromechanical type and shall be designed for continuous duty at 95 to 135 VAC.

2. Each relay shall mate with the eight-pin Jones-type socket as shown on the plans and shall be enclosed in a removable, clear plastic cover.

3. The manufacturer's name and part number, and electrical rating, shall be provided on the cover. They shall be permanent, durable and readily visible when the relay is mounted in its socket.

4. Each relay shall be provided with double-pole, double-throw contacts. Contact points shall be of fine silver, silver alloy or superior alternative material. Contact points and contact arms shall be capable of switching at 20 amperes tungsten load per contact, and 120 VAC once every two seconds with a 50 percent duty cycle, for at least 250,000 operations, without contact welding or excessive burning, pitting or cavitation.

5. The relay coil shall have a power consumption of 10 volt-amperes or less.

6. Each relay shall withstand a potential of 1,500 volts at 60 hertz between insulated parts, and between current carrying parts and non-current carrying parts.

7. Each relay shall have a one-cycle surge rating of 175 amperes RMS.

L. Supply Quantity.

All cabinets shall be supplied with all necessary equipment for proper operation, including the plug-in items listed in the following table, in all cases, regardless of the intended operation.

CABINET TYPE	303	332	336	337
Load Switches	6	12	12	6
DC Isolators	2	3	3	2
Detectors	4	14	12	4
Conflict Monitors	1	2	2	1
AC Isolators	1	1	1	1

M. Output Files.

There shall be eight capacitive dummy loads mounted to a terminal block on the rear of the swing-down back panel. One side of each dummy load shall be tied to AC-. Four of the dummy loads shall be connected at the factory to the center (yellow) output of the load switches assigned to ped signals for Phases 2, 4, 6, and 8.

The P20 connector and cable assembly for monitoring the red outputs of all load switches shall be provided and mounted to the swing-down back panel, for future use.

Auxiliary output files shall be provided in each Type 332 cabinet. Auxiliary output files shall be supplied in Type 336 cabinets if specified (adequate rack length shall be provided in all 336 cabinets for an aux file in case the City retrofits one at a later date). The file shall accommodate six load switches and two flash relays. The file shall be connected via a cable to the C6 connector on the rear of the standard 12-position output file. Four dummy capacitive loads shall be provided on a terminal block for selective jumping to the outputs of the load switches. The red and yellow signal circuits of switch packs 13, 14, 16, and 17 shall be available at a Molex type 1375 receptacle which shall intermate with a Molex type 1375 plug to allow flash programming. A plug connector, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Plugs shall be readily accessible without the removal of any other equipment. Plug pins shall be crimped and soldered.

615.4. TYPE 332 CABINET:

A. Rack Assembly.

A standard EIA 19-inch rack cage shall be installed inside the cabinet for mounting the controller unit, input file power supply, output file and power distribution assembly. The EIA rack portion of the cage shall consist of two pairs of 53-inch minimum usable, continuous, adjustable equipment mounting angles of 0.1345 inch nominal thickness plated steel tapped with 10-32 threads with EIA universal spacing. The angles shall comply with Standard EIA RS-310-B and shall be supported top and bottom by welded support angles to form a cage. Clearance between rails for mounting assemblies must be 17.75 inches.

Two plated supporting angles extending from the front to the back rails shall be supplied to support the controller unit. The angles shall be designed to support a minimum of 50 pounds each. The horizontal side of each angle shall be mounted 17.5 inches from the top of the rack and shall be adjustable vertically.

The cabinet shall have supporting angles (railing) on either side level with the bottom edge of the door opening to provide horizontal support for the cage. The cage shall be vertically attached to each side of the cabinet at four points, two at the top and two at the bottom of the rails.

A minimum of 10.5 inches of EIA rack height and 20 inches of depth (18 inches behind and two inches in front of the mounting ears) shall be provided for the Model 170E controller unit.

A 2-inch tall drawer shall be rack-mounted in each Type 332 cabinet. The drawer shall be provided with a hinged top cover and shall be capable of supporting 50 pounds in the extended position.

B. Input File.

The input file shall utilize 5.25 inches of rack height. The input file shall intermate with and support 14 two-channel loop detector units.

The input file shall provide card guides (top and bottom) and a 22-pin single-readout, edge connector centered vertically for each detector. The input file shall allow air circulation through the top and bottom.

Pins D, E, F, J, K, L, and W on each edge connector slot shall be terminated on their associated terminal block mounted on the rear of their input file. Pins F and W for each slot shall terminate on the terminal blocks mounted on the rear of the input file and will connect to the proper controller unit inputs in the Connector C1S wiring harness. Common grounding of output emitters will be permitted and common grounding conductor brought out to TB15, Terminal 4 (CTR DC GND).

The edge connectors shall be double-sided connectors with the numbered side of each pin shorted to its respective lettered side internally.

The card guide shall begin 1.0 (+0.5) inch back from the front face of the file.

The input file shall be provided with marker strips to identify isolators and detectors in the file as described in Section VI E.

C. Power Distribution Assembly.

The power distribution assembly shall be furnished and mounted on the EIA 19-inch rack utilizing no more than seven inches of rack height. All equipment shall be readily accessible for ease of replacement. The depth of the assembly shall not exceed 10 inches from the front cabinet rails including terminal blocks.

The following equipment shall be provided with the power distribution assembly:

- 2 - Equipment duplex receptacles (one on the front panel, and another on the back panel readily accessible from back door)
- 1 - Controller unit duplex receptacle
- 1 - Main circuit breaker
- 1 - Four-pole single bus circuit breaker
- 1 - Two-pole flash bus circuit breaker
- 1 - Equipment circuit breaker
- 1 - Mercury Contactor
- 1 - Auto/Flash Switch
- 1 - Flash Relay and socket
- 2 - Flasher Unit sockets
- 2 - Model 204 Flasher Units
- 1 - Flash Indicator light
- Terminal Blocks

The main circuit breaker shall be rated for 50 amperes at 120 VAC. The circuit breakers for the equipment receptacles and signal bus shall be rated for 15 amperes at 120 VAC. The flash bus circuit shall be rated for 20 amperes at 120 VAC. Rating of breakers shall be shown on face of breaker or handle. Breaker function shall be labeled below breakers on front panel.

Equipment Receptacles shall be NEMA 5-15R duplex type. The Equipment Receptacles shall have ground-fault circuit interruption as defined in the National Electrical Code. Circuit

interruption shall occur on six milliamperes of ground-fault current and shall not occur on less than four milliamperes of ground-fault current.

An "Auto/Flash" switch shall be provided which, when placed in "Flash" position (down), shall energize the Mercury Contactor (MC) Coil. When the switch is placed in the "Auto" position (up) the switch packs shall control the signal indications. The switch shall be a single-pole single-throw toggle switch rated for 15 amperes at 120 VAC.

A lamp labeled "Flash Operation" shall be provided on the front panel of the assembly. The lamp shall be driven by the Flasher Unit Output through Transfer Relay Circuit No. 1.

The Controller Unit Receptacle shall be a hospital grade NEMA 5-15R mounted on the back panel of the assembly. AC+ to the 170 unit receptacle shall be from the filtered outputs of the SHA-1210 surge protector.

Terminal Blocks shall be provided and mounted on the back panel of the assembly. The blocks shall be of type specified for signal field wire terminal blocks. All conductors from the power distribution assembly routed to the cabinet wiring shall be connected to the terminal block on the common side, except for the AC power conductor between the service terminal block and main circuit breaker.

All internal conductors terminating at the blocks shall be connected to the other side of the blocks. Terminal position assignments shall be as shown on Plan Sheet No. SA170-4, Model 332 T1 and T2 Terminal Block Assignment Detail, modified as follows:

> "Add two No. 14 conductors between the back equipment duplex receptacle and the PDA Terminal Blocks (AC+ to T1, Terminal 10; AC- to T2 Terminal 1.)"

The Flash Relays shall conform to the provisions for "Heavy Duty Relays, Model 430."

A leakage resistor, which will permit three to eight volts to be applied to the relay coil, shall be installed across the terminals of each relay socket to overcome the residual magnetism.

D. Output File.

Card guides shall be provided to support the switch packs and the monitor unit.

The output file shall utilize 10.5 inches of rack height and shall be supplied with 12 Model 200 Switch Packs. Four Model 430 Flash Transfer Relays and one Model 210 Monitor Unit shall be furnished with each output file. The depth of the assembly including terminal blocks and relays shall not exceed 14.5 inches from the front cabinet rails.

The output file shall be provided with marker strips to identify switch packs when mounted in the file, as specified in Section VI.

Switch pack connectors, monitor unit connectors, flash transfer relay sockets and flash programming connectors shall be accessible from the back of the output file without the use of tools.

Three field wire terminal blocks shall be mounted vertically on the back of the assembly. The terminal blocks shall be the 12-terminal type.

The controller unit outputs to the output file shall be connected through Connector C4.

The red and yellow signal circuits of all switch packs assigned to vehicle signals for phases 1 through 8 shall be available at a Molex Type 1375 Receptacle which shall intermate with a Molex Type 1375 plug to allow flash programming. A plug connector, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Connectors shall be readily accessible without the removal of any other equipment. Plug pins shall be crimped and soldered.

The monitor connector shall be rigidly supported printed circuit board edge connector, having two rows of 28/56 independent double readout bifurcated contacts on 0.156 inch centers. The connector shall terminate with the Model 210 Monitor Unit.

It shall be possible to remove the monitoring device without causing the intersection to go into flashing operation. The cabinet shall be wired so that with front cabinet door closed and with the monitor unit removed, the intersection shall go into flashing operation. The cabinet shall contain a conspicuous warning against operation with the monitor unit removed.

The monitor unit connector shall be wired in accordance with the pin assignment shown on the plans.

Output File Option: The monitor unit compartment including the housed Model 210 Monitor Unit, exclusive of handle, shall extend no farther than 1.25 inches in front of the 19-inch rack front surface. The switch pack socket connector front surface shall be no more than 8.5 inches in depth from the front surface of the output file. (This option allows use of a common motherboard for switch packs and monitor unit).

E. Side Panels.

Two panels shall be provided and mounted on the EIA rack parallel to the cabinet sides.

In viewing from the back door, the left side panel shall be designated as the "Input Panel" and the right side panel shall be designated as the “Service Panel.”

All input field terminal blocks for detector field cables and other input conductors, except service conductors, shall be mounted on the “input panel.” The “input panel” shall be wired per CALTRANS's August 1983 specification.

F. Terminal Blocks.

Terminal blocks shall be provided for terminating field conductors. They shall be readily accessible through the cabinet rear door and shall be rated for 20 amperes at 600 volts RMS, minimum.

The terminal blocks for detector field conductors, auxiliary field wires and control wires shall be the barrier type and shall be provided with 8-32 by 5/16 inch minimum nickel plated brass binder head screws and nickel plated brass inserts.

The terminal blocks for field wires to the signal indications, power distribution assembly and the required unused position shall be the barrier type and shall be provided with 10-32 by 5/16 inch nickel plated brass binder head screws and nickel plated brass inserts.

The terminal blocks for the input file and power supply shall be the barrier type and shall be provided with 8-32 by 5/16 inch nickel plated brass binder head screws and nickel plated brass inserts.

The terminals of the power line service terminal block shall be labeled "L1" and "AC-", and shall be covered with a clear insulating material to prevent inadvertent contact. Terminating lugs large enough to accommodate No. 2 conductors shall be furnished for the service terminal block. The terminal block shall be rated for 50 amperes at 600 volts, minimum.

G. Connectors.

Connector C1P shall contain 104 pin contacts and shall intermate with connector C1S mounted on the controller unit chassis. Corner guide pins for connector C1P shall be stainless steel and shall be 0.097 inches in length. Corner guide socket assemblies shall be stainless steel and shall be 0.625 inches in length.

Connector C4 shall contain 37 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The Plug Connector C4P shall be mounted on the output file.

Connector C5 shall contain 24 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The Plug Connector C5P shall be mounted on the input file.

Connector blocks for Connector C1 pin and socket connectors shall be constructed of diallylphathalate or better. Contacts shall be secured in the blocks with springs of stainless steel.

615.5. TYPE 337 CABINET: This section defines the minimum detailed requirements for a four-phase post-mounted controller cabinet assembly. The cabinet shall be a weatherproof outdoor type with approximate dimensions of 35 inches x 20 inches x 17 inches.

The controller cabinet assembly Model 337 post-top mounted unit shall include all specified wiring, auxiliary devices, slipfitter conforming to the pole size the cabinet is to be mounted to (or with bottom hole and bolt circle conforming to the mounting pedestal specified) and any other necessary mounting hardware.

Cabinets for post-top mounting shall be adequately reinforced in the bottom of the fully-equipped cabinet to withstand a 100 mph wind, and shall have less than 2 inches of deflection at the top when a 100 pound force is applied horizontally at the top of the cabinet on any of the four planes of cabinet faces. Adaptors will be allowed if they meet the above requirements for strength and stiffness and if they effectively seal the floor of the cabinet against dust and moisture. Reinforcing which consists of two 4.5 inch x 3/4 inch support channels, opened face down, welded across the bottom front and rear of the cabinet, and extending from side to side, in addition to a square slipfitter mounting support bracket which is installed and welded to the two support channels, will be considered to meet these requirements. Any other bottom support configuration must be approved by the City.

Rail shall be provided, both front and rear, as an integral part of the cabinet. Rails shall extend the full height of the cabinet and shall conform to dimensional requirements of Standard EIA RS-310-C, except equipment mounting holes shall be provided with 10-32 threads and shall be located to secure equipment provided.

Two plated supporting angles shall be supplied to support the controller unit. The angle shall be designed to support a minimum of 50 pounds each. The horizontal side of each angle shall be a minimum of 3 inches and the length a minimum of 11 inches.

A. Rack Assembly.

The rack assembly shall be self-supporting and shall allow a free space beneath the lowest horizontal surface and between the side panels of 17 inches wide by 16 inches deep by 9 inches high with both cabinet doors closed.

The assembly shall be equipped with mounting "ears" to allow mounting in standard EIA rails. Overall width of the assembly shall conform to Standard EIA RS-310-C.

The rack assembly shall be fabricated and mounted according to the dimensions shown on the plans.

The rack assembly shall provide a space which shall intermate with and support a Model 204 flasher. The flasher shall be wired so as to have its load balanced among switch packs 1 through 4.

An Auto-Flash switch shall be provided for the use of Maintenance Personnel.

A Maintenance Interlock Switch (MIS), MFG. Cherry P/N-50KX Series E-23, shall be provided to supply emergency power to the flasher and flash transfer relays in the event that the Power Distribution Assembly is removed. This shall be accomplished in a manner which prevents the application of emergency power unless the maintenance Auto-Flash switch is in the Flash position. Emergency power to the flasher and transfer relays shall be independently fused.

The rack assembly shall provide a receptacle which shall intermate with and support the Power Distribution Assembly (PDA). The receptacle shall be equipped with a connector (BEAU SG 5413 ABT or equal). Dimensions for the receptacle and location and pin assignments for the connector shall be as shown on the plans.

Means shall be provided to secure the PDA.

The front face of all plug-in assemblies shall be flush with the front face of the rack assembly. The sole exception shall be the Flash Relay, which may be mounted with its socket on the same plane as the flash transfer relay sockets.

The front face of the rack assembly may be inset from the EIA rails a maximum of l/2-inch.

The rack assembly depth shall not exceed 13 inches from the front surface of the front EIA rails.

The assembly shall allow air circulation from bottom to top.

Field wire terminal blocks and bus bars shall be mounted on the back panel of the assembly. The three signal output terminal blocks shall be mounted vertically and shall be the six position type.

The rear panel shall be hinged to allow it to swing down and provide access to terminals, relays and connections as detailed elsewhere in these specifications.

The rack assembly shall provide for an Input File subassembly and an Output File subassembly, both of which shall be integral to the Rack Assembly.

B. Input File.

The Input File shall intermate with and support 4 two-channel loop detector units.

The input file shall provide card guides (top and bottom) and a 22-pin single-readout edge-connector centered vertically for each detector unit. Pins D, E, J and K on each edge connector shall be wired to the field terminals to provide for two loop detector channels or one magnetometer channel.

Loops #1 and #2 output collectors and emitters (pins F, H, W and X) for each slot shall terminate on a terminal block mounted on the rear of the input file and shall connect to the proper controller unit inputs in the Connector C1S wiring harness. Common grounding of output emitters will be permitted.

The edge connectors shall be double sided connectors with the numbered side shorted to its respective lettered side internally.

The input shall be provided with marker strips to identify items in the file. Marker strips shall be located immediately above and below the item they are to identify.

C. Power Distribution Assembly.

The power distribution assembly shall be furnished and mounted on the EIA 19 inch rack Assembly. Maximum dimensions are 12.05 inches wide by 3.90 inches high by 7.375 inches deep.

The PDA shall be equipped with a connector to intermate with its associated connector in the Rack Assembly.

The following equipment shall be provided with the power distribution assembly:

- 1 - Main circuit breaker
- 1 - Signal circuit breaker
- 1 - Flash circuit breaker
- 1 - Equipment circuit breaker
- 1 - 24VDC Power Supply
- 1 - Power relay and socket
- 1 - Auto/Flash switch (Police)
- 1 - Signals-Off switch
- 1 - Power indicator labeled “24VDC PWR”
- 1 - Flash indicator units
- 2 - Test points
- 2 - Power Supply fuses (AC and DC)

All circuit breakers shall be rated for 120 volts AC with the following ratings:

Main and Signals	30 amperes
Flasher	20 amperes

Equipment 15 amperes

D. Output File.

Card guides shall be provided to support the switch packs and monitor unit.

The Output file shall be capable of containing six Model 200 switch packs, three Model 430 flash transfer relays, one Model 210 monitor unit and one Flash Relay.

The Output File shall be provided with marker strips to identify items in the file. Marker strips shall be located immediately below the item they are to identify, as described in Section VI E.

Switch pack, flash transfer relay and monitor unit sockets shall be accessible from the back of the file without the use of tools.

The controller unit outputs to the Output File shall be connected through Connector C4.

The red and yellow signal circuits of all switch packs shall be available at a Molex Type 1375 receptacle which shall intermate with a Molex Type 1375 plug to allow flash programming. Plug connectors, with programming jumpers, shall be furnished for each circuit to allow red, yellow or pedestrian flash programming. Requirements are: 4 red, 3 yellow and 3 pedestrian. Connectors shall be readily accessible without the removal of any other equipment. The monitor unit connector shall be a rigidly supported printed circuit board edge connector, having two rows of 28/56 independent double readout bifurcated contacts on 0.156 inch centers. The connector shall intermate with the monitor unit.

It shall be possible to remove the monitor unit without causing the intersection to go in flashing operation. The cabinet shall be wired so that with the front door closed and the monitor removed, the intersection shall go into flashing operation. The cabinet shall contain a conspicuous warning against operation with the monitor unit removed.

E. Outlet Panel.

An Outlet Panel shall be provided at a convenient location. It shall contain the following:

1 - Equipment Receptacle

1 - Controller Receptacle

1 - Terminal Block (TB1)

Equipment Receptacles shall be NEMA 5-15R duplex type. The Equipment Receptacles shall have ground-fault circuit interruption as defined in the National Electrical Code. Circuit interruption shall occur on six milliamperes of ground-fault current and shall not occur on less than four milliamperes of ground-fault current. The Controller Unit Receptacle shall be a hospital grade NEMA 5-15R mounted on the back panel of the assembly.

TB1 shall be a 6-position double-row terminal block.

F. Connectors.

Connector C1P shall contain 104 pin contacts and shall intermate with Connector C1S mounted on the controller unit chassis. Corner guide pins for Connector C1P shall be stainless steel and shall be 1.097 inches in length. Corner guide socket assemblies shall be stainless steel and shall be 0.625 inch in length.

Connector C4 shall contain 24 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The Plug Connector C4P shall be mounted on the Rack Assembly.

Connector blocks for Connector C1 pin and socket connectors shall be constructed of diallylphathalate or better. Contacts shall be secured in the blocks with springs of stainless steel.

615.6. TYPE 303 CABINET: This specification defines the minimum detailed requirements applicable to cabinets and harnesses. The intent of this specification is to set forth the minimum acceptable electrical and mechanical design and requirements within which all equipment must operate satisfactorily and reliably, and the means by which the equipment shall be tested to determine whether it shall so operate.

All equipment shall be housed within a rain-proof pole, or post-top mounted cabinet. The cabinet shall be clean-cut in design and appearance and have nominal interior dimensions as follows:

DEPTH: 17 inches

WIDTH: 20 inches

HEIGHT: 36 inches

There shall be minimum clearance of 1 1/2 inches between the inside surface of the front door and the front panel of the Model 170E microcomputer as well as the front panel of modules plugged into the input rack.

The housing shall have a door, opening 33 inches high x 20 inches wide with a 2.5 inches space between bottom of opening and bottom of cabinet.

All Type 303 cabinets shall be supplied for both pole and pedestal mountings.

Cabinets shall have bolt holes drilled in the back for mating with pole mounting hardware, and shall be supplied with all necessary mounting hardware. Mounts to wood poles shall be accomplished by means of stainless steel straps. Stainless steel plugs for the mounting holes shall be provided.

Cabinets shall be adequately reinforced in the bottom of the fully-equipped cabinet to withstand a 100 mph wind, and shall have less than 2 inches of deflection at the top when a 100 pound force is applied horizontally at the top of the cabinet on any of the four planes of cabinet faces. Cabinets shall be drilled for a standard 4 inches slipfitter. The slipfitter and any hardware necessary for pole-mounting shall be provided.

Cabinets shall be supplied with an aluminum electrical box, 8 inches long by 8 inches wide by 6 inches deep drilled to match slipfitter mounting holes in cabinet floor. The box shall be equipped with access cover facing downward. The access cover shall be designed so that when opened, the bottom and one side of the box is accessible, and the cover should hang in the open position. The

access cover shall be attached with a full-length piano hinge on one edge and secured with two stainless steel #10 round-head machine screws, with matching threaded holes in the box. The box shall be constructed of 0.125-inch thick aluminum. All corners shall be continuously welded or press-broken, and the door shall be gasketed against dust. A 0.125 inch drain hole shall be provided at the appropriate location.

A. Rack Assembly.

The cabinet shall be constructed with metal mounting rails running the depth of the cabinet along the lower left and right hand bottom of the cabinet. These rails shall be constructed at a height such that the cabinet rack shall rest on the rail when in its normal position, and shall slide along the rail when being installed or removed.

A rack with standard EIA spacing shall be inside the cabinet for mounting the processor unit and the rack assembly which will contain the rack, switch pack rack, power supply/power distribution panel. The rack shall consist of two pair of full length, 0.1875 inch nominal thickness aluminum angles tapped with 10-32 threads where required a shown in the cabinet drawing, at the end of this specification. Chassis supporting angles extending behind the front rails shall be part of the rack and support the weight of the processor unit. Each chassis supporting angle shall be 10 inches deep and 3 inches deep.

The rack assembly shall be easily removable from the cabinet without use of special tools. By unplugging connector P1, removing the screws securing the rack assembly to the rails, and disconnecting the field wiring, it shall be possible to remove the rack assembly from the cabinet.

B. Input File.

Each detector rack shall utilize 5.25 inches of rack-mounting height.

The detector rack shall provide card guides (top and bottom) and a 22-pin edge-connector on 0.156 inch centers, mounted vertically for each detector. The detector rack shall allow air circulation rough the top and bottom.

Four pins (D, E, J, K) on each detector module edge-connector shall be wired to four field terminals to provide for two loop detector channels.

Loop 1 and 2 output collectors and emitters (pin F, H, W and X) for each slot shall connect to the proper processor unit inputs in the connector C1S wiring harness.

Wiring between the rack and field terminals shall be twisted pair not tightly bundled.

The edge connectors shall be double sided connectors with the numbered side of each pin shorted to its respective lettered side internally.

Output circuit emitters shall have a common junction and be grounded only by connection to C1P, pin 104, DC Input Ground.

A Flasher Assembly Panel shall be located in the left end of the Detector Rack and shall contain the flasher relay.

C. Flasher Relay.

A Type 204 solid state flasher relay to be used for alternate opening and closing connections between the applied power and the lamps required for flashing operation.

The following Table shall determine the inter-connection between the Solid State Flasher and the switchpacks.

Each switchpack shall be assigned to the two Solid State Flasher load circuits as follows:

LOAD CIRCUIT #1	LOAD CIRCUIT #2
S.P. 1	S.P. 4
S.P. 2	S.P. 5
S.P. 3	S.P. 6

D. Maintenance Assembly.

A “Flash” switch, so labeled, shall be provided. This switch when placed in the “On” position shall energize the mercury contactor coil. When this switch is placed in the "Off" position the processor unit shall resume control via the switch pack outputs to the field. The Flash switch shall be accessible from the Police Panel Door opening.

A “Signal” switch, so labeled shall be provided. This switch, when placed in the “Off” position, shall energize the mercury contactor coil and prevent the flash relay from energizing the flash transfer relays, thereby disconnecting AC to the field terminals. The “Signals” switch shall be accessible from the Police Panel Door opening.

Two 24VDC test points for the cabinet power supply shall be provided.

The 2l0 conflict monitor shall be readily serviceable without special tools.

Card guides shall be provided to guide and support the printed circuit board of the monitor module.

A rigidly supported printed circuit board edge connector, having two rows of 28/56 interdependent bifurcated contacts on 0.156 inch centers, shall be provided. The connector shall intermate with the 210 conflict monitor unit.

A 24VDC relay shall be provided to reverse the relay logic of the monitor module. The output of this relay shall be wired in series with a door switch. The relay shall be mounted in the PDA and be readily serviceable. Servicing shall not require any special tools other than a screwdriver. The relay shall be normally open. Monitor pin 25 shall be wired to DC ground and pin 24 shall be wired to one side of this relay with the other side of the relay going to the ferro-resonant supply.

A 110 VAC relay shall be supplied for the activation of the flash relays in the event of loss of AC+ to the load switches.

A spring-loaded door switch shall be wired in series with the output of the relay described in section and in parallel with the CMU interlock.

Closing of the front cabinet door with the monitor unit removed shall cause the intersection to go into flashing operation. The cabinet shall contain a conspicuous warning against operation with the monitor unit removed.

The stop timing output of the monitor shall go to C1-82 of the processor.

E. Output File.

The load rack shall intermate with Type 200 solid state switch packs. The rack shall be capable of containing six (6) solid state switch packs.

F. Relay Panel.

Relays used for this purpose shall have a clear plastic cover.

All contact points which make, break and carry current to the signal lamps shall be of silver-cadmium, coin silver or superior alternative material. Contacts shall be capable of making, breaking, and carrying a current of 20 amperes 120 volts, without undue pitting. 120 volt AC relay coils shall be used and shall have a power consumption of 10 volt amperes or less and shall be designed for continuous duty.

The transfer relay shall withstand potential of 1500 volts at 60 hertz between insulated parts and between current carrying parts and grounded and non-current carrying parts.

Each flash transfer relay shall have a one cycle surge rating of 175 amperes RMS (247.5 amperes peak).

Each transfer relay shall be unaffected by electrical noise, having a rise time of up to 200 volts per microsecond. Each relay shall be unaffected by the 500 volt power noise transient test when the dv/dt herein specified is not exceeded.

The flash transfer relays shall transfer field signal light circuits (for switch packs 1 thru 6), from the processor unit to flasher and shall permit flashing lights as programmed on the main street or highway and on the cross street or streets. Operation of the flash transfer relay circuit shall not prohibit the operation of the processor, but shall prohibit operation of the field signal light circuits by the processor. The line to the coils of the FTR's shall have a RC suppression device.

The flash transfer relay shall be Midtex, 187-02701A or equal, and shall be provided with a connector (Cinch Jones, type #P-408-53 or equal) and intermate with Cinch Jones, type #S-408-53 or equal, using the following pin definitions:

PIN NUMBER	CIRCUIT
1	Coil
2	Coil
3	NC Ckt #2
4	NC Ckt #2
5	Common Ckt #1
6	Common Ckt #2

A minimum of 4 program block positions shall be provided for flashing operation. The programming plugs shall be provided to alter whether flashing yellow, flashing red, or absence of flash (white) appears on the output field terminals to the signal heads.

Flasher programming shall be provided by the use of a Molex type 1375 receptacle and intermate with a Molex type 1375 plug. Two (2) red, one (1) yellow, and two (2) white programming plugs shall be provided. Flash programming shall be in compliance with the following:

- Red programming plugs shall contain three red jumper wires connecting pins 9 and 15, and 3, 7 and 13.
- Yellow programming plugs shall contain three yellow jumper wires connecting pins 1 and 7, 3 and 9, 13 and 15.
- White programming plugs shall contain two white jumper wires connecting pins 1, and 3, 13 and 15.

G. Power Distribution Assembly.

The main circuit breaker, labeled (Main C.B.) shall be a magnetic breaker, single pole, automatic trip, and trip indicating, rated at 40 amperes at 125VAC.

The auxiliary circuit breaker, labeled (AUX EQ C.B.) shall be a magnetic breaker, signal pole, automatic trip, and trip indicating, rated at 15 amperes at 125 VAC.

The flasher circuit breaker, labeled (FL C.B.), shall be a magnetic breaker, single pole, automatic trip, and trip indicating, rated at 15 amperes at 125 VAC.

The load switch circuit breaker, leveled (LS C.B.), shall be a magnetic breaker, single pole, automatic trip, and trip indicating, rated at 30 amperes at 125 VAC.

A 3 ampere fuse, labeled (24 VDC), shall fuse the 24 VDC output of the ferro-resonant power supply.

A 1 ampere fuse, labeled (24VPS 110VAC), shall fuse the AC input of the ferro-resonant power supply.

Four Molex type 1375 receptacles shall be provided and must intermate with a Molex type 1375 plug. The receptacles shall be color coded.

Aux. 1 shall contain all wiring to the maintenance panel switches.

P1 shall contain all wiring that is external to the rack assembly. By removal of the connector the rack assembly may be removed without disconnecting the wiring from terminals with the exception of the field terminals.

P2 shall contain all DC power connections to the rack assembly.

P3 shall contain all AC and power control wiring to the rack assembly components.

A mercury contactor shall be provided and shall be capable of switching a minimum of 30 amperes at 120VAC.

A phone jack, which shall mate with a Switchcraft Model 190 plug, shall be provided for automatic cabinet diagnostic testing. When the plug is inserted, a reset signal will be supplied to the conflict monitor. The source of the reset signal shall be C1-97.

A ground fault interrupter shall be installed and shall be a NEMA 5-15R duplex type. Circuit interruption shall occur between 4 and 6 milliamperes of ground fault current. The ground fault receptacle shall be of the feed-through type.

Terminal blocks shall be so arranged that they shall not upset the entrance and connections of incoming field conductors. There shall be 5 blocks, each having 12 positions with 10-32 screws. Magnum Electric Corp. 481312-04 or equal.

The AC+ service connection shall be made directly to the main C.B. in the PDA from the power line service terminal. The terminals of the power line service terminal block shall be labeled "L1" and "AC-", and shall be covered with a clear insulating material to prevent inadvertent contact. Terminating lugs large enough to accommodate No. 2 conductors shall be furnished for the service terminal block. The terminal block shall be rated for 50 amperes at 1000 volts, minimum.

615.7. TYPE 336 CABINET:

This section defines the detailed requirements for an eight-phase controller cabinet to be mounted on a post-top or foundation mount.

The cabinet shall be designed for either post-top or foundation mount. The design must be flexible enough to allow choosing the mounting type at time of installation, and to allow changing the mounting type at any time in the future. For foundation mounting, the cabinet shall be designed with a square opening in the floor of the cabinet as large as possible and still allow easy access to anchor bolts and a good seal with the foundation. For post-top mounting, an adapter shall be used which mates with the anchor bolt holes, in such a way as to provide a dust-proof attachment. The adaptor shall mate with a standard 4 inch slipfitter, and shall be strong enough to meet the stiffness requirements defined below. All cabinets shall be supplied with an adaptor and a 4 inch slipfitter, regardless of the stated application of the cabinet.

All Type 336 cabinets shall be capable of housing an auxiliary output file ("stretch" version), and one shall be supplied and installed when specified.

All Model 336 cabinets shall both a front and a rear door, keyed with a Corbin #2 lock as described previously in the general cabinet specifications.

Cabinets assembled for post-top mounting shall be adequately reinforced in the bottom of the fully-equipped cabinet to withstand a 100 mph wind, and shall have less than 2 inches of deflection at the top when a 100 pound force is applied horizontally at the top of the cabinet on any of the four planes of cabinet faces.

The input file shall have 14 slots, and an input panel used, as described for the Type 332 cabinet in this specification.

The output file shall have 12 output slots.

The red and yellow signal circuits of all switch packs assigned to vehicle signals for phases 1 through 8 shall be available at a Molex Type 1375 Receptacle which shall intermate with a Molex

Type 1375 plug to allow flash programming. A plug connector, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Connectors shall be readily accessible without the removal of any other equipment. Plug pins shall be crimped and soldered.

The cabinet shall also include 4 flash relays, and two flashers.

615.8. CONSTRUCTION: The Contractor shall have all cabinet equipment (cabinet, controller, load switches, detectors, isolators, etc.) shipped to the Contractor for assembly. Once all devices have been received and assembled by the Contractor, he shall install a copy of the plan sheets relating to that particular intersection, reduced to fit inside the documentation pouch on the door. Once accomplished and the complete assembly is ready for testing, the Contractor shall contact the City Signal Shop at 207-7765 and arrange to schedule for testing and configuration by the City. The City will direct the Contractor as to which day the controller unit(s) can be delivered. When testing is completed, the City will notify the Contractor to pick up the cabinet(s). Upon notification, the Contractor must pick up the cabinet(s) within 2 working days. Any cabinets that are delivered to the City without all the proper devices or documentation within the cabinet, or devices not plugged into the appropriate slots (still boxed, with the exception of the extra conflict monitors) will be rejected until they are corrected. At the option of the City, the Contractor may be required to remove the cabinet(s) from the City Signal Shop. All testing will be scheduled on a first-come-first-served basis, for complete units in compliance with these specifications.

All cabinets shall have a tag wired to the handle indicating the location for which it is intended, and the Contractor's name. Tags shall be of adequate size for lettering to be read easily.

The Contractor shall be responsible for connecting all field wires inside the cabinet according to the project plans, cabinet prints, and the directions of the City. All wires to be terminated in a neat fashion and bundled for a clean appearance. Loop cable wires to have spade connectors.

Once installed on the foundation, the base of the cabinet shall be sealed against water seepage. (Foundation-mounted only)

The door of the cabinet on the controller face side shall be positioned such that the technicians can easily view the signal displays of the intersection.

615.9. MEASUREMENT: Controllers and cabinets shall be measured for payment as combined units, including software and auxiliary items, per each controller cabinet unit, in accordance with the project plans and specifications.

615.10. PAYMENT: The accepted number of units shall be paid for at the contract unit price which shall be full compensation for the items, including installation and transport to and from the City Signal Shop.

615.11. BID ITEM:

Item 615.1 - Traffic Signal Controller Assembly (Type 332 Cabinet) - per each

Item 615.2 - Traffic Signal Controller Assembly (Type 303 Cabinet) - per each

Item 615.3 - Traffic Signal Controller Assembly (Type 337 Cabinet) - per each

Item 615.4 - Traffic Signal Controller Assembly (Type 336 Cabinet) - per each

ITEM

618 CONDUIT

618.1. DESCRIPTION: *Furnish and place conduit.*

618.2. MATERIALS: Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of Item 622, "Duct Cable."

When specified on the plans, provide:

- rigid metal (RM) conduit that is hot-dip galvanized inside and outside with a minimum of 1.5 oz. per square foot of a zinc coating in accordance with Texas Department of Transportation (TxDOT) Standard Specification Item 445, "Galvanizing;"
- electrical metallic tubing (EMT) and intermediate metal conduit (IMC) that is steel, galvanized on the outside, and protected on the inside with a suitable corrosion-resistant material;
- polyvinyl chloride (PVC) conduit that meets the requirements of NEMA Standard TC-2, UL 651, and the NEC;
- high-density polyethylene (HDPE) conduit without factory-installed conductors that meets the requirements of Item 622, "Duct Cable"; or
- flexible conduit that is liquid-tight.

Furnish conduit from new materials that comply with TxDOT DMS-11030, "Conduit."

Provide conduit from manufacturers prequalified by the Texas Department of Transportation. The TxDOT Traffic Operations Division maintains a list of prequalified electrical conduit manufacturers.

Unless otherwise shown on the plans, fabricate fittings such as junction boxes and expansion joints from a material similar to the connecting conduit. Use watertight fittings. Do not use set screw and pressure-cast fittings. Steel compression fittings are permissible. When using HDPE conduit, provide fittings that are UL-listed as electrical conduit connectors or thermally fused using an electrically heated wound wire resistance welding method.

Use red 3-in. 4-mil polyethylene underground warning tape that continuously states "Caution Buried Electrical Line Below."

618.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

618.4. CONSTRUCTION: Place conduit in accordance with the lines, grades, details, and dimensions shown on the plans or as directed. Install conduit a minimum of 18 in. deep underground unless otherwise shown on the plans.

Meet the requirements of the NEC when installing conduit. Secure and support conduit placed for concrete encasement in such a manner that the alignment will not be disturbed during placement of the concrete. Cap ends of conduit and close box openings before concrete is placed.

Ream conduit to remove burrs and sharp edges. Use a standard conduit cutting die with a 3/4-in. taper per foot when conduit is threaded in the field. Fasten conduit placed on structures with conduit straps or hangers as shown on the plans or as directed. Fasten conduit within 3 ft. of each box or fitting and at other locations shown on the plans or as directed. Use metal conduit clamps that are galvanized malleable or stainless steel unless otherwise shown on the plans. Use 2-hole type clamps for 2-in. diameter or larger conduit.

Fit PVC and HDPE conduit terminations with bushings or bell ends. Fit metal conduit terminations with a grounding type bushing, except conduit used for duct cable casing that does not terminate in a ground box and is not exposed at any point. Conduit terminating in threaded bossed fittings does not need a bushing. Prior to installation of conductors or final acceptance, pull a spherical template having a diameter of at least 75% of the inside diameter of the conduit through the conduit to ensure that the conduit is free from obstruction. Cap or plug empty conduit placed for future use.

Perform trench excavation and backfilling as shown on the plans or as directed and in accordance with Item 400, "Excavation, Trenching and Backfilling." Excavation and backfilling will be subsidiary to the installation of the conduit.

Jack and bore as shown on the plans or as directed, and in accordance with Item 406, "Jacking, Boring, or Tunneling."

Place warning tape approximately 10 in. above trenched conduit. Where existing surfacing is removed for placing conduit, repair by backfilling with material equal in composition and density to the surrounding areas and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition. Mark conduit locations as directed.

618.5. MEASUREMENT: Conduit will be measured by the foot of conduit.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Change Order. Additional measurements or calculations will be made if adjustments of quantities are required.

Boring through soil or rock will be measured in accordance with Item 406, "Jacking, Boring, or Tunneling."

618.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Conduit" of the type and size specified and the installation method specified as applicable. This price is full compensation for furnishing and installing conduit; hanging, strapping, jacking, boring, tunneling, excavating, and furnishing and placing backfill; replacing pavement structure, sod, riprap, curbs, or other surface; marking location of conduit (when required); furnishing and installing fittings, junction boxes, and expansion joints; and equipment, labor, tools and incidentals.

Flexible conduit will not be paid for directly but will be subsidiary to pertinent Items. Unless otherwise shown on the plans, no payment will be allowed under this Item for conduit used on electrical services or in foundations.

618.7. BID ITEM:

Item 618.1 - Conduit (2 inch/PVC Schedule 40) - per foot

Item 618.2 - Conduit (3 inch/PVC Schedule 40) - per foot

Item 618.3 - Conduit (4 inch/PVC Schedule 40) - per foot

Item 618.4 - Conduit (2 inch/PVC Schedule 40) (Bore) - per foot

Item 618.5 - Conduit (3 inch/PVC Schedule 40) (Bore) - per foot

Item 618.6 - Conduit (4 inch/PVC Schedule 40) (Bore) - per foot

Item 618.7 - Conduit (2 inch/PVC Schedule 40) (Bore Rock) - per foot

Item 618.8 - Conduit (3 inch/PVC Schedule 40) (Bore Rock) - per foot

Item 618.9 - Conduit (4 inch/PVC Schedule 40) (Bore Rock) - per foot

ITEM

620 ELECTRICAL CONDUCTORS

620.1. DESCRIPTION: *Furnish and place electrical conductors, except conductors specifically covered by other Items.*

620.2. MATERIALS: Provide new materials that comply with the details shown on the plans and the requirements of this Item. Use solid insulated conductors that are rated for 600 volts; approved for wet locations; and marked in accordance with UL, NEC, and CSA requirements.

A. Electrical Conductors. Furnish electrical conductors in accordance with Texas Department of Transportation DMS-11040, "Electrical Conductors."

B. Suppliers. Provide electrical conductors from manufacturers prequalified by the Texas Department of Transportation (TxDOT). The TxDOT Traffic Operations Division maintains a list of prequalified electrical conductor manufacturers.

C. Grounding Conductors. Ensure that all grounding conductors size AWG No. 8 and larger are stranded, except for the grounding electrode conductor, which will be a solid conductor.

D. Wire Colors. Use white insulation for grounded (neutral) conductors, except that grounded conductors AWG No. 8 and larger may be black with white tape marking at every accessible location. Do not use white insulation or marking for any other conductor except control wiring specifically shown on the plans.

Ensure that insulated grounding conductors are green except that insulated grounding conductors AWG No. 8 and larger may be black with green tape marking at every accessible location. Do not use green insulation or marking for any other conductor except control wiring specifically shown on the plans.

620.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

620.4. CONSTRUCTION: Splice conductors only in junction boxes, ground boxes, and transformer bases, and in poles and structures at the hand holes. Splice as shown on the plans. Do not exceed the manufacturer's recommended pulling tension. Use lubricant as recommended by the manufacturer. Install conductors in accordance with the NEC.

Make insulation resistance tests on the conductors prior to making final connections, and ensure that each continuous run of insulated conductor has a minimum DC resistance of 5 megohms when tested at 1,000 volts DC. The Engineer may require verification testing of all or part of the conductor system. The Engineer will witness these verification tests. Replace conductors exhibiting an insulation resistance of less than 5 megohms.

620.5. MEASUREMENT: This Item will be measured by the foot of each single conductor.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Change Order. Additional measurements or calculations will be made if adjustments of quantities are required.

620.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Electrical Conductors" of the types and sizes specified. This price is full compensation for furnishing, installing, and testing electrical conductors and for equipment, labor, tools, and incidentals, except that:

- conductors used in connecting the components of electrical services will be paid for under Item 628, "Electrical Services";
- conductors used for internal wiring of equipment will not be paid for directly but will be subsidiary to pertinent Items.

620.7. BID ITEM:

Item 620.1 - Electrical Conductors (No. 6) (Bare) - per foot of each single conductor

Item 620.2 - Electrical Conductors (No. 8) (Bare) - per foot of each single conductor

Item 620.3 - Electrical Conductors (No. 6) (Insulated) - per foot of each single conductor

ITEM

622 DUCT CABLE

622.1. DESCRIPTION: *Furnish and install duct cable consisting of a complete assembly of conductors enclosed in a high-density polyethylene duct.*

622.2. MATERIALS: Provide new materials that comply with the details shown on the plans, with conductors that meet the material requirements of Item 620, "Electrical Conductors."

A. Duct Cable. Furnish duct cable from new materials that comply with DMS-11060, "Duct Cable."

B. Suppliers. Provide duct cable from manufacturers prequalified by the Department. The Traffic Operations Division maintains a list of prequalified duct cable manufacturers.

C. Markings. Furnish duct that is clearly and durably marked at maximum 10-ft. intervals with the material designation including nominal size of the duct and either the name or the trademark of the manufacturer. Mark the duct at 2-ft. intervals with sequential numbers indicating length of cable, in feet, on reel, with zero mark at the inner end.

D. Assemblies and Reels. Assemblies exhibiting evidence of conductors pulled into the duct after the duct is manufactured are not acceptable. Duct cable testing less than 50 megohms insulation resistance at 1,000 volts while still on the reel is not acceptable.

Ensure that the complete assembly is packaged on reels having sufficient diameter to prevent permanent set or damage to the duct cable. Ensure that each reel is clearly and durably marked to show the voltage rating, type of insulation, number of conductors, conductor size, length, duct size, and either the name or the trademark of the manufacturer.

Before installation, furnish written certification that all duct cable complies with the requirements of this Item and as shown on the plans.

622.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

622.4. CONSTRUCTION: Install duct cable by open trench methods in accordance with the NEC, except at locations where installing duct cable in conduit. Backfill the trench in accordance with Item 400, "Excavation, Trenching and Backfilling," except for measurement and payment. When removal of existing pavement or concrete surface is allowed, backfill with material equal in composition and density to the surrounding area and replace removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition or as shown on plans.

Splicing the duct is not allowed. Make all connections in ground boxes or pole bases. Form bends with large radii to provide free movement of conductors. After installation, demonstrate that the conductors can move freely. Duct cable that has been kinked or in which the conductors cannot move freely is not acceptable. Splice conductors and test insulation in accordance with Item 620, "Electrical Conductors," except for measurement and payment.

622.5. MEASUREMENT: This Item will be measured by the foot of duct cable.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Change Order. Additional measurements or calculations will be made if adjustments of quantities are required.

622.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Duct Cable" of the types and sizes specified. This price is full compensation for furnishing and installing all duct cable; pulling through conduit; excavating and backfilling the trenches; replacing riprap, pavement structure, topsoil, sod, or other surface; testing insulation resistance; and equipment, labor, tools, and incidentals.

622.7. BID ITEM:

Item 622.1 - Duct Cable [Type/Size] - per foot

ITEM

624 GROUND BOXES

624.1. DESCRIPTION: *Construct, furnish, and install ground boxes complete with lids.*

624.2. MATERIALS: Provide new materials that comply with the details shown on the plans and meet the following requirements:

A. Cast-In-Place Concrete Ground Boxes. Construct cast-in-place concrete ground boxes and aprons in accordance with Item 300, "Concrete," and Item 301, "Reinforcing Steel."

B. Precast Polymer Concrete Ground Boxes. Provide fabricated precast polymer concrete ground boxes, and precast concrete ground boxes that comply with Texas Department of Transportation DMS-11070, "Ground Boxes."

C. Concrete Apron. Construct a concrete apron, when shown on the plans, in accordance with Item 300, "Concrete," and Item 301, "Reinforcing Steel."

D. Suppliers. Provide ground boxes from manufacturers prequalified by the Texas Department of Transportation (TxDOT). The TxDOT Traffic Operations Division maintains a list of prequalified ground box manufacturers.

624.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

624.4. CONSTRUCTION: Construct and/or place ground boxes in accordance with the appropriate requirements of the Items shown in Section 624.2 "Materials."

624.5. MEASUREMENT: This Item will be measured by each ground box complete in place.

624.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Ground Boxes" of the types and sizes specified. This price is full compensation for excavating and backfilling; constructing, furnishing, and installing the ground boxes and concrete aprons when required; and equipment, labor, materials, tools, and incidentals.

624.7. BID ITEM:

Item 624.1 - Ground Boxes Type A (122311) - per each

Item 624.2 - Ground Boxes Type B (122322) - per each

Item 624.3 - Ground Boxes Type C (162911) - per each

Item 624.4 - Ground Boxes Type D (162922) - per each

Item 624.5 - Ground Boxes Type A (122311) with Apron - per each

Item 624.6 - Ground Boxes Type B (122322) with Apron - per each

Item 624.7 - Ground Boxes Type C (162911) with Apron - per each

Item 624.8 - Ground Boxes Type D (162922) with Apron - per each

ITEM

625 ZINC-COATED STEEL WIRE STRAND

625.1. DESCRIPTION: *Furnish and install zinc-coated steel wire strand.*

625.2. MATERIALS: Conform to the requirements of ASTM A 475, Utilities Grade or better, Class A coating. These requirements include, but are not limited to, the properties given in Table 1. Furnish 7 wires per strand.

Table 1
Dimensions and Properties

Nominal Diameter of Strand (in.)	Nominal Diameter of Coated Wires (in.)	Approximate Weight per 1,000 ft. (lb.)	Minimum Breaking Strength (lb.)	Minimum Zinc Coating Wt. Class A (oz./sq. ft.)
3/16	0.065	80	2,400	0.50
¼	0.080	121	4,750	0.60
9/32	0.093	164	4,600	0.70
5/16	0.109	225	6,000	0.80
3/8	0.120	273	11,500	0.85
7/16	0.145	399	18,000	0.90
1/2	0.165	517	25,000	0.90

Supply new material. Remove drips, runs, sharp points, voids, and damage from the zinc coating. Samples from each roll of each diameter of strand will be taken. Replace strands failing to meet the requirements of this Item.

625.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

625.4. CONSTRUCTION: Install strands as shown on the plans. Splicing is not permitted.

When the strand is used as a messenger cable or span wire, ground it to the grounding conductor at each pole. Metal poles may be used as the grounding conductor. Ensure a resistance less than 1 ohm from the strand to the ground rod.

625.5. MEASUREMENT: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured directly but will be subsidiary to pertinent Items.

625.6. PAYMENT: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly but will be subsidiary to pertinent Items.

625.7. BID ITEM:

N/A

ITEM

627 TREATED TIMBER POLES

627.1. DESCRIPTION: *Furnish and install treated timber poles.*

627.2. MATERIALS: Use new treated southern pine timber poles in accordance with ANSI O5.1, "Specifications and Dimensions for Wood Poles," and the additional requirements of this Item. Use ANSI Class 5 treated timber poles for electrical services and ANSI Class 2 for all other applications, unless otherwise shown on the plans.

Ensure poles are free from pith holes at the tops and butts. Do not use poles that have a trimmed scar with a depth greater than 2 in., if the diameter is 10 in. or less, or 1/5 the pole diameter at the scar location, if the diameter is more than 10 in. Provide poles that do not deviate from straightness by more than 1 in. for each 10 ft. of length. A pole may only have sweep in 1 plane and 1 direction (single sweep), provided a straight line joining the midpoint of the pole at the butt and the midpoint of the pole at the top does not at any intermediate point pass through the external surface of the pole. Timber poles with more than 1 complete twist of spiral grain are not acceptable.

Butt slivering due to felling is permitted if the distance from the outside circumference is not less than 1/4 of the butt diameter and the height is not more than 1 ft. Use preservative treatment in accordance with AWPA C4. Furnish poles with a minimum net retention of preservative treatment in accordance with Table 1.

Mark all poles by branding in accordance with Table 2.

Table 1
Retention of Preservative Treatment

Treatment	Minimum Retention, lb/ft^3
Creosote	9.0
Pentachlorophenol	0.45
ACA/CCA	0.60

Table 2
Timber Pole Markings

Marking	Description of Marking
PTC	Supplier's code or trademark (for example, Pole Treating Company).
F-01	Plant location and year of treatment (for example, Forestville, 2001).
SPC	Species and preservative code (for example, southern pine, creosote).
535	Class-length (for example, Class 5, 35-ft. pole).

Place the bottom of the brand squarely on the face of the pole 10 ft. (plus or minus 2 in.) from the butt.

Furnish a treatment certification with every shipment of treated timber poles that includes:

- name of treating company,
- location of treating plant,

- applicable product standard (AWPA C4),
- charge number,
- date of treatment,
- contents of charge (poles),
- preservative treatment, and
- actual preservative retention values.

627.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

627.4. CONSTRUCTION: Use established industry and utility safety practices while installing poles located near overhead or underground utilities. Consult with the appropriate utility company prior to beginning such work.

Unless otherwise shown on the plans, set the pole a minimum depth in accordance with Table 3.

Table 3
Pole Setting Depth

Pole Length (ft.)	Minimum Setting Depth (ft.)
25 or less	4.5
26 - 30	5.0
31 - 35	5.5
36 - 40	6.0
41 - 45	6.5
46 - 50	7.0

Locate timber poles as shown on the plans or as directed. Drill holes for setting poles a minimum of 1.5 diameters of the pole butt. Unless otherwise shown on the plans, set the poles plumb. Backfill the holes thoroughly by tamping in 6-in. lifts. After tamping to grade, place additional backfill material in a 6-in.-high cone around the pole to allow for settling. Use material equal in composition and density to the surrounding area. Repair surface where existing surfacing material is removed, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

627.5. MEASUREMENT: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured directly, but will be subsidiary to pertinent Items.

627.6. PAYMENT: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly, but will be subsidiary to pertinent Items.

627.7. BID ITEM:

N/A

ITEM

628 ELECTRICAL SERVICES

628.1. DESCRIPTION: *When installing, furnish and install complete and independent points of electrical service. When removing, remove electrical services.*

628.2. MATERIALS: Provide materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items:

A. Steel Structures. Texas Department of Transportation (TxDOT) Standard Specification Item 441, "Steel Structures"

B. Galvanizing. TxDOT Standard Specification Item 445, "Galvanizing"

C. Anchor Bolts. TxDOT Standard Specification Item 449, "Anchor Bolts"

D. Conduit. Item 618, "Conduit"

E. Electrical Conductors. Item 620, "Electrical Conductors"

F. Treated Timber Poles. Item 627, "Treated Timber Poles"

G. Foundations. Item 656, "Foundations for Traffic Control Devices."

H. Electrical Services. For the installation of electrical services, use new materials that meet the requirements of the NEC, UL, CSA, and NEMA, and that comply with TxDOT DMS-11080, "Electrical Services."

I. Suppliers. Furnish electrical services from manufacturers prequalified by the Texas Department of Transportation. The TxDOT Traffic Operations Division maintains a list of prequalified electrical service manufacturers.

628.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

628.4. CONSTRUCTION: Perform work in accordance with the details shown on the plans and the requirements of this Item.

A. Installation. Ensure components of the electrical service meet the requirements of the Electrical Detail Standards. Follow NEC and local utility company requirements when installing the electrical equipment. Coordinate the utility companies' work for providing service.

B. Removal. Coordinate removal with the appropriate utility company before beginning work. Before the removal of the electrical service, disconnect and isolate any existing electrical service equipment in accordance with the utility company's requirements.

Use established industry and utility safety practices while removing electrical service equipment near any overhead utilities.

Remove existing electrical service support a minimum of 2 ft. below finish grade unless otherwise shown on the plans. Repair the remaining hole by backfilling with material equal in composition and density to the surrounding area. Replace any surfacing such as asphalt pavement or concrete riprap with like material to equivalent condition.

Disconnect conductors and remove them from the conduit or duct. Cut off all protruding conduit or duct 6 in. below finish grade. Abandoned conduit or duct need not be removed unless shown on the plans.

Reconnect duct cable, conductors, and conduit to be reused when shown on the plans. Make all splices in ground boxes unless otherwise shown on the plans.

Accept ownership of unsalvageable materials, and dispose of them in accordance with federal, state, and local regulations.

628.5. MEASUREMENT: This Item will be measured by each electrical service installed or removed.

628.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Electrical Services" of the types specified or "Remove Electrical Services."

A. Installation. This price is full compensation for paying all fees, permits, and other costs; making arrangements with the utility company for all work and materials provided by the utility company; furnishing, installing, and connecting all components including poles, service supports, foundations, anchor bolts, riprap, enclosures, switches, breakers, conduit (from the service equipment including the elbow below ground), fittings, conductors (from the service equipment including the elbow below ground), brackets, bolts, hangers, and hardware; and equipment, labor, tools, and incidentals.

Costs for utility-owned power line extensions, connection charges, meter charges, and other charges will be paid for by the City. The City will reimburse the contractor only the amount billed by the utility. No additional amount for supervision of the utility's work will be paid.

B. Removal. This price is full compensation for coordinating with the utility company to disconnect and isolate the electrical service; removing the service supports; backfilling holes; and equipment, labor, tools, and incidentals.

628.7. BID ITEM:

Item 628.1 - Electrical Services - per installation

Item 628.2 - Remove Electrical Services - per removal

ITEM

633 BATTERY BACKUP SYSTEM FOR TRAFFIC SIGNAL

633.1. DESCRIPTION:

Battery Backup System. *Furnish, fabricate, assemble or install a Battery Backup System (BBS) for traffic signal including rack mounted power inverters, battery charger, electronic controls, bypass switch, battery cables and connectors; and all wiring, hardware and incidentals necessary to form a complete battery backup system except for batteries and battery case (bell jar).*

Battery. *Furnish and install individual 12V battery and battery case (bell jar).*

633.2. MATERIALS: Furnish new materials in accordance with the NEC, these specifications, and the details shown on the plans.

A. General.

1. Provide a BBS that operates normally in the standby mode (utility line mode) shifting to battery-inverter (backup mode) operation only as follows:

a. Upon failure of the normal power supply, or

b. In manual test.

2. Provide a BBS that consists of three major components

a. Electronic controller, battery charger, and inverter;

b. Transfer relay and manual bypass switch; and

c. A battery bank system (battery string).

3. Provide BBS with controller, battery charger, inverter, transfer relay, and manual bypass switch from the same original equipment manufacturer (OEM) or OEM approved compatible components.

4. Provide a BBS that is compatible with Model 332 signal cabinets, Model 170E controllers, and Model 2070 controllers.

a. Rack mount electronic controller, inverters, and battery charger securely and neatly.

b. Rack or rail mount transfer relay and manual bypass switch securely and neatly.

c. Locate batteries outside of the signal cabinet.

d. Submit equipment dimensions, mounting arrangement, hardware, and wiring details for approval.

5. Provide power conditioning only to the extent of lightning and surge protection. Meet at least ANSI/IEEE C.62.41/C62.42 Cat A&B. Additional isolation or regulation

transformers, buck-boost auto-transformers, dual conversion components, and other power conditioning components will not be allowed.

6. Meet the requirements of Electronic Industries Standards EIA-310-B, Racks, Panels, and Associated Equipment, with 10-32 Universal Spacing threaded holes.

7. Switch from failed utility power (utility line mode) to stable BBS inverter power (backup mode) or from backup mode to utility mode in less than 65 milliseconds.

a. Failed utility power is defined as available utility line voltage at the controller cabinet outside the range of 100 VAC to 130 VAC ± 2 VAC.

b. Switch the BBS from battery backup mode to utility line mode upon restoration of a utility power low voltage failure when utility power has been restored to within the range 100 VAC to 130 VAC ± 2 VAC, and has been above 105 VAC ± 2 VAC for at least 30 seconds.

c. Switch the BBS from battery backup mode to utility line mode upon restoration of a utility power high voltage failure when utility power has been restored to within the range 100 VAC to 130 VAC ± 2 VAC, and has been below 125 VAC ± 2 VAC for at least 30 seconds.

8. Connect signal system to utility power through a de-energized normally closed contact of the power transfer relay under any condition of BBS failure or upon programmed complete discharge state of the batteries. Equip the BBS to prevent a malfunction feedback to the traffic signal cabinet or to the utility line.

9. Provide a user programmable controller.

a. Provide for programming through a panel mounted display and selection buttons.

b. Provide for programming by a user furnished laptop PC through an RS232 connection.

c. Provide any required software needed to program or monitor BBS.

10. Provide at least three user accessible single pole double throw (NO/NC) dry relay contacts on a panel mounted terminal block rated for at least 120 VAC, 1 amp. Provide labels for each contact.

a. Energize the first relay set of NO and NC contact closures whenever the unit switches to battery power. Label this contact “On Battery.”

b. Energize the second relay set of NO and NC contact closures whenever the battery approaches 40% of remaining useful capacity.

(1) Label this contact “Low Battery.”

(2) Low battery voltage setpoint is user programmable.

c. Energize the third relay set of NO and NC contact closures as programmed by the user.

11. Provide all interconnect wiring as necessary for a complete installation. Provide copper conductors. Meet UL 508, NEC, or other industry standard ampacity, insulation, and stranding requirements. Meet all NEC requirements.

a. Provide Anderson quick disconnect battery connectors.

b. Provide at least 20 feet of conductor to connect battery string in ground box to inverter input in traffic signal cabinet.

c. Provide proper size battery circuit breakers, fuses, and fuse blocks.

d. Provide waterproof connections between bell jar bubble protected battery terminal area and signal controller cabinet. Battery terminal connections need not be waterproof.

e. Provide battery to battery conductors as necessary to accommodate batteries in a ground box and covered with bell jar battery enclosures as shown on ED (13)-03.

f. Derate battery and inter-battery conductors by 50% of rated ampacity and do not exceed 2% voltage drop at anticipated load level.

12. Provide all hardware, brackets, connectors, and miscellaneous components necessary for a complete installation in a model 332 signal cabinet. Meet the following requirements:

a. Stainless steel screws, bolts, nuts, washers and lock washers.

b. All other metal parts are corrosion resistant.

B. Electronic Components. Provide electronic controller, battery charger, and inverter that meet the following requirements, ratings, and characteristics.

1. Listed under UL 1778.

2. Rated for enclosure mounting in an outdoor environment with operating temperature range from -37°C to 74°C.

3. Low voltage disconnect prevents battery discharge below 20% capacity.

a. Set to 1.70 to 1.75 Volts per cell, or,

b. 10.20 to 10.50 Volts per battery.

4. Inverter output using battery power.

a. Microprocessor controlled high frequency pulse width modulated (PWM) pure sine wave output with less than 3% total harmonic distortion (THD) under 500 Watt load comprising signal controller and LED signal heads.

b. RMS Voltage 110 VAC to 125 VAC.

c. 60 Hz ± 5%.

d. Capable of supplying load power factor between 0.7 leading to 0.7 lagging.

e. Continuous rated output

(1) At least 800 Watts, 1100 VA at 25°C

(2) At least 500 Watts, 750 VA at 74°C

f. Inverter efficiency rating

(1) At least 80% at 500 Watts at 25°C

(2) At least 80% at 500 Watts at 74°C

g. Provide inverter DC input voltage of 12V, 24V, or 48V as shown in the descriptive code or on the purchase order.

h. Supply a battery wiring diagram for up to four batteries.

5. Charger

a. Types of acceptable chargers

(1) Current limited constant float voltage charger designed specifically for AGM VRLA batteries.

(a) Set float voltage at 13.65 Volts per 12 volt battery (2.275 Volts per cell)

(b) Thermally compensated

(2) 3 stage temperature corrected constant voltage with current limiting designed specifically for AGM VRLA batteries.

(a) Bulk rate stage. Charge at constant current of 0.4 times C10 rating of the battery or battery string until each battery voltage comes up to 14.7 Volts (correct for temperature).

(b) Absorption stage. Charge at a constant voltage of 14.7 Volts per battery for a maximum of 8 hours or until charge current reduces to 0.1 times C10 rating.

(c) Float state. Set float voltage at 13.65 Volts per 12 volt battery (2.275 Volts per cell).

(d) Thermally compensated

b. Battery temperature sensor as follows:

(1) Accurate to ±3°C

(2) Sensor head integrally molded to at least 20 feet of connection cable

(3) Connection cable rated for at least 300 VAC and 150 VDC

(4) Connection cable rated for high temperature and waterproof.

(5) Manufactured such that the entire assembly is waterproof.

(6) Panel alarm for temperature probe malfunction.

c. Designed for use with the same battery bank voltage as inverter and controller.

d. Thermal compensation coefficient is negative at the rate of ± 4mV per cell per °C (reducing voltage with increasing temperature) (± 0.024 mVolt per 12 Volt battery).

e. Stop all charging if battery temperature is more than 50°C ± 3°C.

f. Charge battery bank (string) in 24 hours or less.

6. Transfer relay and manual bypass switch.

a. Switch positions as follows:

(1) BBS in standby operation, utility line connected as primary supply.

(2) BBS removed from operation, utility line supplying load. Allows removal of BBS rack mount module or batteries for maintenance or replacement without interrupting power to signal controller.

(3) Other switch positions as necessary.

b. Provide terminal board for wiring connections.

c. Rated at least 240 VAC and 30 amps.

d. Annunciate relay contact activation on front panel via a visual indication.

7. Minimum Displays and Controls.

a. Battery.

(1) Indicate current battery charge status in percent or other method approved by the Engineer.

(2) Battery voltage at the inverter.

(3) Battery temperature in °C.

(4) Voltmeter probes input-jacks to read battery voltage at the inverter input.

b. Supply line.

(1) Voltage AC.

(2) Frequency in Hz.

(3) Current in amps.

c. Event log.

d. Run timer.

C. Battery.

1. Provide nominal 12 VDC Absorbed Glass Mat (AGM) Valve Regulated Lead Acid (VRLA) battery with Thin Plate Pure Lead-tin (TPPL) design.

2. Provide a battery that meets the following requirements, features, construction techniques, ratings, and characteristics.

a. At least 70 Amp-Hour (Ah) but not more than 80 Ah rated capacity at the 10 Hour rate to 10.02 Volts at 25°C.

b. Rated for operation at -40° C to +80° C.

c. M6 female no-maintenance terminals with "L" style heavy duty copper alloy blade terminals installed.

d. Supply stainless steel or silicon bronze nuts, bolts, lock washers, and flat washers for terminal connections.

e. Supply insulating covers for battery terminals.

f. Gas recombination efficiency at least 99%.

g. Lifting handles.

h. Metal jacket construction.

i. Dimensions 13"x 6.5 " x 7 " (LxWxH, ± 0.5 inches) including metal jacket.

j. Weight 60 lb ± 5 lb.

k. non-spillable construction that won't leak when inverted.

l. rated to operate when positioned on its side.

m. suitable for use with the temperature compensation float and charge parameters shown for the BBS equipment above.

n. Designed for high vent pressure.

o. Maintains at least 70% of discharge capacity at -10°C.

p. Short circuit current less than 5000 amps.

q. 12 month warranty from installation date.

3. Provide a battery that passes the following tests.

a. UL1989.

b. UL 94 V-0 flame retardant case and cover.

c. International Electrotechnical Commission (IEC) Standard 952-1 Short Circuit Test.

d. IEC Standard 60952-1 to demonstrate safe cell temperatures.

e. IEC Standard 6096-21/22.2003 or IEEE - 485 capacity rating.

f. DOT 49 CFR Sec.173.159.

4. Battery box. Supply a non-metallic battery box enclosure (bell jar) as shown on the plans that is large enough for battery supplied and small enough to fit 4 cases with batteries and wiring into ground box.

5. Testing and Documentation.

a. Supply manufacturer test reports showing how the battery meets these specifications.

b. Supply the following battery test graphs.

(1) State of Charge (SOC) versus open circuit cell voltage (or battery voltage) at various temperatures throughout the operating range.

(2) State of Charge (SOC) versus loaded cell voltage (or battery voltage) at the C10 rate at 25°C and -10°C (or other temperatures approved by the Engineer).

(3) Discharge time versus temperature at the C10 rate.

(4) Discharge time versus cell voltage at the C10 rate for various temperatures throughout the operating range.

c. Supply battery maintenance guidelines.

D. Mechanical Components. Provide stainless steel screws, nuts and locking washer. Do not use self-taping screws unless approved. Provide corrosion resistant materials and materials resistant to fungus growth and moisture deterioration.

633.3. CONSTRUCTION:

A. Install BBS in accordance with the National Electrical Code (NEC).

B. Install warning sign at electrical service and on the inside door of the traffic signal cabinet that meets the requirements of the NEC stating,

"A battery backup system (BBS) power supply is connected to this traffic signal equipment. BBS controls are located in the traffic signal cabinet. Batteries are located in a ground box. Turning off circuit breaker will not de-energize traffic signal equipment,"

or other wording approved by the Engineer.

1. Install batteries in a battery ground box as shown on the plans.

2. Clean all electrical connection parts before assembly. Coat battery terminals with NO-OXID or similar material. Torque connections to 53 in-lbs.

3. Make waterproof wiring connections in battery box.

4. Strap battery and inverted case (bell jar) to ground box struts.

5. Install battery fuse blocks in traffic signal cabinet.

6. Maintain space between installed batteries for air flow, minimum 0.5 inches.

7. Locate temperature sensor in battery ground box between two batteries.

8. Set all user adjustable BBS settings to meet this specification.

C. Testing. Field test, demonstrate, and document the following BBS features.

1. Operational test. Schedule and perform an operational test. Provide test plan, recording log sheets, and schedule to the Engineer for approval. Conduct the BBS operational test prior to placing the signal system under traffic if possible. Make observation notes on recording sheets during test. Obtain the following information in the test log. Include legibly written name and signature of person conducting test and any witnesses.

2. Modify this test procedure for signal locations already operating and open to traffic. Submit modified procedures to the Engineer for approval.

3. Automatic testing provided by the BBS may be used in lieu of these requirements, or some of these requirements, when approved by the Engineer.

a. Ensure batteries are fully charged and signal is in normal operation. 12.48 Volts per battery or higher indicates fully charged batteries.

b. Operate signal system in battery backup mode by turning off circuit breaker feeding traffic signal at the electrical service.

c. Record the following:

(1) Beginning time (contractor supplied clock).

(2) Beginning temperature (log all temperatures in °C).

(a) Inside controller cabinet (contractor supplied thermometer),

(b) Ambient surrounding, and

(c) In battery box (from BBS panel).

(3) Log the following at the beginning of test and every 15 minutes throughout test:

(a) Battery bank voltage at inverter input (from BBS panel and also from test point on front of BBS panel with contractor supplied voltmeter).

(b) Battery amps at fuse block (from BBS panel).

(c) AC voltage, power factor, and current to controller cabinet (inverter output)(contractor supplied test equipment).

(d) Actual time.

(e) Battery temperature.

(f) Calculate Watts, Volt-Amps at signal controller input/inverter output.

(g) Calculate Watts at inverter input.

(h) Calculate inverter efficiency.

(i) Battery bank voltage and time when system shifts to flash.

(j) Battery bank voltage and time when low voltage protection drops battery out.

(k) Verify that transfer relay returns to utility supply mode when batteries drop out.

(l) Turn utility power back on. Verify that signal system returns to operation.

(m) Log charge voltage and current.

(n) Calculate and log expected charge voltage from parameters of this specification (charge voltage with temperature correction factor).

(4) Log charge voltage and current every 4 hours until batteries reach full charge and voltage drops to float voltage. Log float voltage.

(5) Provide calibrated test equipment.

4. Supply test results to the Engineer.

633.4. Training. Conduct on-site training for City of San Antonio personnel during the BBS testing.

633.5. Warranty. When BBS is procured through purchase specifications, provide 2 year full replacement warranty on all components except batteries. Provide 1 year non-prorated replacement warranty on batteries.

For construction projects, provide a warranty in accordance with Article 6, Special Specification, "Testing, Training, Documentation, Final Acceptance, and Warranty."

633.6. MEASUREMENT: This Item will be measured as each Battery Backup System furnished, installed, and tested, including the (4) battery (bell jar) boxes, battery ground box with apron, cabinet mounted BBS components, four (4) batteries, and cabling between cabinet and battery ground box. All components will be furnished, installed, and tested. Additional ground boxes will be paid for under City of San Antonio Item 603, "Ground Boxes."

Spare components such as BBS components and batteries will be measured per each unit. Spare BBS components will include the BBS components and 20 feet of BBS cabling to connect the BBS components mounted in the cabinet to the batteries. Spare battery ground boxes and battery (bell jars) boxes will be measured as each unit furnished.

633.7. PAYMENT: The work performed and materials furnished in accordance with this Item, and measured as provided under "Measurement" will be paid for at the unit price bid for "Battery Backup System" as specified. This price is full compensation for all equipment, cables and

connectors, documentation, and testing; and for all labor, materials, training, warranties, and incidentals necessary to complete the work.

Spare batteries will be paid for as each battery furnished and accepted by the City to the specified delivery location. Spare BBS components will be paid for as each set of BBS electronics for the cabinet furnished and accepted by the City to the specified delivery location. Spare battery ground boxes and battery (bell jar) boxes will be paid for as each unit furnished and accepted by the City to the specified delivery location.

633.8. BID ITEM:

Item 633.1 - Battery Backup System - per each

ITEM

636 ALUMINUM SIGNS

636.1. DESCRIPTION: *When installing, furnish, fabricate, and erect aluminum signs. Sign supports are provided for under other Items. When replacing, replace existing signs on existing sign supports. When refurbishing, refurbish existing aluminum signs on existing sign supports.*

636.2. MATERIALS:

A. Sign Blanks. Furnish sign blank substrates in accordance with Texas Department of Transportation (TxDOT) DMS-7110, "Aluminum Sign Blanks," and in accordance with the types shown on the plans. Use single-piece sheet-aluminum substrates for Type A (small) signs and extruded aluminum substrates for Type G (ground-mounted) or Type O (overhead-mounted) signs.

B. Sign Face Reflectorization. Reflectorize the sign faces with flat surface reflective sheeting. Furnish sheeting that meets TxDOT DMS-8300, "Sign Face Materials." Use reflective sheeting from the same manufacturer for the entire face of a sign.

C. Sign Messages. Fabricate sign messages to the sizes, types, and colors shown on the plans. Use sign message material from the same manufacturer for the entire message of a sign.

- Ensure that the screened messages have clean, sharp edges and exhibit uniform color and reflectivity. Prevent runs, sags, and voids. Furnish screen inks in accordance with TxDOT DMS-8300.
- Fabricate colored, transparent film legend and reflectorized sheeting legend from materials that meet TxDOT DMS-8300.
- Fabricate nonreflectorized-sheeting legend from materials that meet TxDOT DMS-8300.
- Furnish Type A aluminum signs required as part of a message in conformance with the plans and in accordance with this Item.

D. Hardware. Use galvanized steel, stainless steel, or dichromate-sealed aluminum for bolts, nuts, washers, lock washers, screws, and other sign assembly hardware. Use plastic or nylon washers to avoid tearing the reflective sheeting. Furnish steel or aluminum products in accordance with TxDOT DMS-7120, "Sign Hardware." When dissimilar metals are used, select or insulate metals to prevent corrosion.

E. Sampling. The Engineer will sample in accordance with TxDOT Standard Test Method Tex-726-I.

636.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

636.4. CONSTRUCTION:

A. Fabrication.

1. **Sign Blanks.** Furnish sign blanks to the sizes and shapes shown on the plans and that are free of buckles, warps, burrs, dents, cockles, or other defects. Do not splice individual extruded aluminum panel.

   Complete the fabrication of sign blanks, including the cutting and drilling or punching of holes, before cleaning and degreasing. After cleaning and degreasing, ensure that the substrate does not come into contact with grease, oils, or other contaminants before the application of the reflective sheeting.

2. **Sheeting Application.** Apply sheeting to sign blanks in conformance with the recommended procedures of the sheeting manufacturer. Clean and prepare the outside surface of extruded aluminum flanges in the same manner as the sign panel face.

   Minimize the number of splices in the sheeting. Overlap the lapsplices by at least 1/4 in. Use butt splices for Type D and Type E reflective sheeting. Provide a 1-ft. minimum dimension for any piece of sheeting. Do not splice sheeting for signs fabricated with transparent screen inks or colored transparent films.

3. **Sign Assembly.** Assemble extruded aluminum signs in accordance with the details shown on the plans. Sign face surface variation must not exceed 1/8 in. per foot. Surface misalignment between panels in multi-panel signs must not exceed 1/16 in. at any point.

4. **Decals.** If shown on the plans, code and apply sign identification decals in accordance with TxDOT Item 643, "Sign Identification Decals."

B. Storage and Handling.

Ship, handle, and store completed sign blanks and completed signs so that corners, edges, and faces are not damaged. Damage to the sign face that is not visible when viewed at a distance of 50 ft., night or day, will be acceptable. Replace unacceptable signs. Store all finished signs off the ground and in a vertical position until erected. Store finished signs 60 in. by 60 in. or smaller in a weatherproof building. Larger signs may be stored outside.

C. Cleaning.

Before shop inspection, wash completed signs with a biodegradable cleaning solution acceptable to the manufacturers of the sheeting, colored transparent film, and screen ink to remove grease, oil, dirt, smears, streaks, finger marks, and other foreign material. Wash again before final inspection after erection.

D. Installation.

Install signs as shown on the plans or as directed.

E. Replacement.

Remove the existing signs from the existing supports and replace with new signs, including mounting hardware, as shown on the plans.

F. Refurbishing.

Refurbish existing signs by providing and installing new messages and mounting hardware. Install new reflectorized legend and supplemental signs as shown on the plans.

G. Unsalvageable Material. Accept ownership of unsalvageable materials and dispose of in accordance with federal, state, and local regulations.

636.5. MEASUREMENT: Signs installed or replaced will be measured by the square foot of the sign face. Signs refurbished will be measured by each sign. This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Change Order. Additional measurements or calculations will be made if adjustments of quantities are required.

636.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Aluminum Signs," "Replacing Existing Aluminum Signs," or "Refurbishing Aluminum Signs," of the type specified.

A. Installation. This price is full compensation for furnishing and installing new signs and hardware; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams, stiffeners, or required joint backing strips; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; and equipment, materials, labor, tools, and incidentals.

B. Replacement. This price is full compensation for furnishing and installing new aluminum signs and hardware; removal of existing signs; fabrication of sign panels; treatment of sign panels required before application of the background materials; application of the background materials and messages to the sign panels; furnishing and fabricating frames, wind beams, stiffeners, or required joint backing strips; furnishing bolts, rivets, screws, fasteners, clamps, brackets, and sign support connections; assembling and erecting the signs; preparing and cleaning the signs; salvaging and disposing of unsalvageable material; and equipment, materials, labor, tools, and incidentals.

C. Refurbishing. This price is full compensation for modifying existing sign messages; removing and replacing existing route markers, reflectorized legend, or supplemental signs attached to the parent sign; preparing and cleaning the signs; furnishing sheeting and hardware; salvaging and disposing of unsalvageable material; and equipment, materials, labor, tools, and incidentals.

636.7. BID ITEM:

Item 636.1 - Aluminum Signs [Type] - per square foot of sign face

Item 636.2 - Replacing Existing Aluminum Signs [Type] - per square foot of sign face

Item 636.3 - Refurbishing Aluminum Signs [Type] - per each

ITEM

655 CONTROLLER FOUNDATION AND PEDESTAL POSTS

655.1. DESCRIPTION: *The purpose of this specification is to describe a controller foundation for various types of controller cabinets or a pedestal post with foundation for a Type 2070 controller mounted in a Type 303, 336, or 337 cabinet.*

The work shall include furnishing and installing anchor bolts, concrete, reinforcing materials, excavation, post with fittings, ground rod, pull box, conduit, and other incidentals required for a complete foundation as shown on the detail.

655.2. MATERIALS:

A. Concrete. Item 300, "Concrete." Concrete shall be 3,000 psi strength at 28 days.

B. Anchor Bolts. Anchor bolts shall be completely galvanized and of the dimensions shown on the Standard Detail.

C. Ground Box. One Type C Ground Box, unless otherwise shown on the plans.

D. Pedestal Post. The post shall consist of fully galvanized 4 inch, Schedule 40 pipe threaded on one end only to fit the coupling shown in the Standard Detail.

E. Other. All other materials shall be as shown on the Standard Detail.

655.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

655.4. CONSTRUCTION:

A. Controller Foundation.

1. Placement of anchor bolts shall be as shown on the plans. Failure to properly locate the bolts may be cause for the Contractor to demolish the improper foundation and reconstruct to the proper dimensions.

2. Concrete slab and concrete block on which the cabinet will sit shall be poured as one monolithic unit.

3. Concrete shall have a smooth finish free of brush marks or other mars.

4. Cabinets may be set on foundations after they have set a minimum of 72 hours. Cabinets scratched, dented or otherwise damaged prior to final acceptance shall be repaired to the City's satisfaction at no cost to the City.

5. Standard foundations shall contain two 3 inch conduits to the pull box in the slab, a 1 inch conduit drain that is cut flush with the concrete surface inside the cabinet, and fitted with a screen on the outside end, and two 1 inch conduits stubbed out and capped from the base of the slab approximately 12 inches. The slab shall be scored with a "Y" where the stubbed out conduits pass under.

6. The slab around the block shall sit above the surrounding grade two to four inches and shall be sloped slightly for drainage.

7. A 5/8 inch x 8-foot copper weld ground rod shall be installed in the pull box as shown in the detail.

B. Controller Pedestal Post.

1. Foundation shall be located as shown on the plans or as directed by the Engineer.

2. Foundation tops shall have a smooth finish. Foundations placed in sidewalks shall be finished to a level 0.25 inch above the sidewalk, and with a 0.25 inch chamfer. Foundations finished too low or too high either will not drain or will create a tripping hazard, and will be cause for the Contractor to completely replace the foundation at no expense to the City.

3. Cabinets may be set on the posts after the foundation concrete has cured a minimum of 72 hours. Cabinets scratched, dented, or otherwise damaged prior to the final acceptance by the City shall be repaired to the City's satisfaction at no expense to the City.

4. A 5/8 inch x 8-foot copper weld ground rod shall be installed in the adjacent pull box as shown in the detail.

655.5. MEASUREMENT:

A. Controller Foundation. Controller foundations shall be measured for payment by the number of units each, in accordance with the plans and specifications.

B. Controller Pedestal Posts. Controller pedestal posts shall be measured for payment by the number of units each, in accordance with the plans and specifications.

655.6. PAYMENT:

A. Controller Foundation. The accepted number of controller foundations will be paid for at the contract unit price which shall be full compensation for the controller foundation, installation, and incidentals.

B. Controller Pedestal Posts. The accepted number of controller pedestal posts will be paid for at the contract unit price which shall be full compensation for the pedestal post, pipe, rod, incidentals, and labor.

655.7. BID ITEM:

Item 655.1 - Type 332 Controller Foundation - per each

Item 655.2 - Controller Pedestal Post - per each

ITEM

656 FOUNDATIONS FOR TRAFFIC CONTROL DEVICES

656.1. DESCRIPTION: *Construct concrete foundations for small roadside signs, pedestal poles, flashing beacon assemblies, and other small traffic control devices.*

656.2. MATERIALS: Ensure materials and construction methods conform to the requirements of this Item and the pertinent requirements of the following Items:

A. Concrete. Item 300, "Concrete"

B. Reinforcing Steel. Item 301, "Reinforcing Steel"

C. Metal. Item 302, "Metal for Structures"

D. Concrete Structures. Item 307, "Concrete Structures"

E. Drilled Shafts. Item 308, "Drilled Shafts and Under-Reamed Foundations"

F. Excavation. Item 400, "Excavation, Trenching and Backfilling"

G. Riprap. Item 505, "Concrete Riprap"

H. Conduit. Item 618, "Conduit"

I. Steel Structures. Texas Department of Transportation (TxDOT) Standard Specification Item 441, "Steel Structures"

J. Galvanizing. TxDOT Standard Specification Item 445, "Galvanizing"

K. Structural Bolting. TxDOT Standard Specification Item 447, "Structural Bolting"

L. Anchor Bolts. TxDOT Standard Specification Item 449, "Anchor Bolts"

Use Class A concrete for non-reinforced drilled shafts. Use Class C concrete for reinforced drilled shafts. Use drilled shaft or galvanized steel screw-in type foundations for flashing beacon assemblies.

Use reinforcing steel when required.

656.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

656.4. CONSTRUCTION: Stake and install foundations as shown on the plans. The City may shift the foundation locations within design guidelines where necessary to secure a more desirable location or to avoid conflict with utilities. Use established industry and utility safety practices when working near underground or overhead utilities. Consult the appropriate utility prior to beginning work.

Hold anchor bolts in place with templates during concrete placement. Hold embedded items such as conduit or other hardware in place during concrete placement with templates or other approved

means. Cap conduits before placing concrete. Ream conduit to remove burrs and sharp edges. Install bell ends or bushings on the conduit.

Carefully align foundation, posts, and anchor bolts. Do not spring or rake posts or anchor bolts.

Remove the top template after concrete has achieved initial set. Keep forms and other bracing intact until the concrete has cured at least one curing day.

Allow concrete for pedestal poles and flashing beacon assemblies to cure at least 7 days before placing bases and poles on the foundation unless otherwise permitted in writing.

Allow concrete for traffic signal controller foundations and small roadside signs to cure at least 4 days before placing cabinets and posts on the foundation unless otherwise permitted.

Provide an ordinary surface finish to the concrete foundation extending above ground in accordance with Section 307.4.M, "Ordinary Surface Finish."

Place concrete riprap around the foundation in accordance with the plans.

Backfill disturbed surface with material equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

656.5. MEASUREMENT: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured directly, but will be subsidiary to pertinent Items.

656.6. PAYMENT: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be paid for directly, but will be subsidiary to pertinent Items.

656.7. BID ITEM:

N/A

ITEM

680 INSTALLATION OF HIGHWAY TRAFFIC SIGNALS

680.1. DESCRIPTION: *Install highway traffic signals.*

680.2. MATERIALS: Ensure electrical materials and construction methods conform to the current NEC and additional local utility requirements. Furnish new materials. Ensure all materials and construction methods conform to the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items:

A. Roadway Illumination Assemblies. Texas Department of Transportation (TxDOT) Standard Specification Item 610, "Roadway Illumination Assemblies"

B. Zinc-Coated Steel Wire Strand. Item 625, "Zinc-Coated Steel Wire Strand"

C. Treated Timber Poles. Item 627, "Treated Timber Poles"

D. Plywood Signs. Item 634, "Plywood Signs"

E. Aluminum Signs. Item 636, "Aluminum Signs"

F. Foundations for Traffic Control Devices. Item 656, "Foundations for Traffic Control Devices"

G. Controller Assemblies. Provide controller assemblies that meet the requirements of TxDOT DMS-11170, "Traffic Signal Controller Assembly," and the details shown on the plans.

H. Flasher Assemblies. Item 685, "Flashing Beacon Assemblies"

I. Suppliers. Provide control and flasher assemblies from manufacturers prequalified by the Texas Department of Transportation. The TxDOT Traffic Operations Division maintains a list of prequalified control and flasher assembly manufacturers.

J. Sampling and Testing. Sampling and testing of traffic signal controller assemblies will be done in accordance with TxDOT Standard Test Method Tex-1170-T.

680.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

680.4. CONSTRUCTION: Install traffic signal controller foundations in accordance with Item 655, "Controller Foundation and Pedestal Posts."

A. Electrical Requirements.

1. Electrical Services. Make arrangements for electrical services and install and supply materials not provided by the utility company as shown on the plans. Unless otherwise shown on the plans, install 120-volt, single-phase, 60-Hz AC electrical service.

2. Conduit. Install conduit and fittings of the sizes and types shown on the plans. Conduit of larger size than that shown on the plans may be used with no additional compensation,

providing that the same size is used for the entire length of the conduit run. Extend conduit in concrete foundations 2 to 3 in. above the concrete. Seal the ends of each conduit with silicone caulking or other approved sealant after all cables and conductors are installed.

3. **Wiring.** Unless otherwise shown on the plans, furnish solid No. 14 AWG conductors. Install above-ground cables and conductors in rigid metal conduit, except for span wire suspended cables and conductors, drip loops, and electrical wiring inside signal poles. Make power entrances to ground-mounted controllers through underground conduit. Wire each signal installation to operate as shown on the plans.

   Attach ends of wires to properly sized self-insulated solderless terminals. Attach terminals to the wires with a ratchet-type compression crimping tool properly sized to the wire. Place prenumbered identification tags of plastic or tape around each wire adjacent to wire ends in the controller and signal pole terminal blocks.

   Splices will not be permitted except as shown on the plans, unless the Engineer approves each individual splice in writing. Make all allowed splices watertight.

4. **Grounding and Bonding.** Ground and bond conductors in accordance with the NEC. Ensure the resistance from the grounded point of any equipment to the nearest ground rod is less than 1 ohm.

   Install a continuous bare or green insulated copper wire (equipment ground) throughout the electrical system that is the same size as the neutral conductor, but a minimum No. 8 AWG. Connect the equipment ground to all metal conduit, signal poles, controller housing, electrical service ground, ground rods, and all other metal enclosures and raceways.

   Provide copper wire bonding jumpers that are a minimum No. 8 AWG.

B. Controller Assemblies. Construct controller foundations in accordance with Item 655, "Controller Foundation and Pedestal Posts." Immediately before mounting the controller assembly on the foundation, apply a bead of silicone caulk to seal the cabinet base. Seal any space between conduit entering the controller and the foundation with silicone caulk.

Deliver the keys for the controller cabinets to the Engineer when the contract is complete.

Place the instruction manual and wiring diagrams for all equipment in the controller cabinet, inside the controller cabinet.

C. Timber Poles. Furnish ANSI Class 2 timber poles other than for electrical services in accordance with details shown on the plans.

D. Preservation of Sod, Shrubbery, and Trees. Replace sod, shrubbery, and trees damaged during the Contract.

E. Removal and Replacement of Curbs and Walks. Obtain approval from the Engineer before cutting into or removing walks or curbs not shown on the plans to be removed or replaced. Restore any curbs or walks removed equivalent to original condition after work is completed, to the satisfaction of the Engineer.

F. Sign Lighting. Attach sign lighting to traffic signal equipment as shown on the plans.

G. Intersection Illumination. Construct luminaires on signal poles as shown on the plans.

H. Test Period. Operate completed traffic signal installations continuously for at least 30-days in a satisfactory manner. If any Contractor-furnished equipment fails during the 30-day test period, repair or replace that equipment. This repair or replacement, except lamp replacement, will start a new 30-day test period.

Replace materials that are damaged or have failed prior to acceptance. Replace failed or damaged existing signal system components when caused by the Contractor. The City will relieve the Contractor of maintenance responsibilities upon passing a 30-day performance test of the signal system and acceptance of the contract.

680.5. MEASUREMENT: This Item will be measured as each signalized intersection controlled by a single traffic signal controller.

680.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Installation of Highway Traffic Signals" of the type (isolated, system, or flashing beacon) specified. This price is full compensation for furnishing, installing, and testing the completed installation, controller and associated equipment, luminaires, signs and sign lights mounted on signal equipment, timber poles, mounting hardware and steel wire strand; preservation and replacement of damaged sod, shrubbery and trees; removal and replacement of curbs and walks; and equipment, labor, tools, and incidentals. The City will pay for electrical energy consumed by the traffic signal.

New drilled shaft foundations for traffic signal poles will be paid for under Item 308, "Drilled Shafts And Under-Reamed Foundations." Controller foundations will be paid for under Item 655, "Traffic Signal Controller Foundation." New conduit will be paid for under Item 618, "Conduit." New electrical conductors will be paid for under Item 620, "Electrical Conductors." New ground boxes will be paid for under Item 624, "Ground Boxes." New electrical services will be paid for under Item 628, "Electrical Services." New vehicle and pedestrian signal heads will be paid for under Item 682, "Vehicle and Pedestrian Signal Heads." New traffic signal cables will be paid for under Item 684, "Traffic Signal Cables." New traffic signal pole assemblies will be paid for under Item 686, "Traffic Signal Pole Assemblies (Steel)." New traffic signal detectors will be paid for under Item 688, "Pedestrian Detectors and Vehicle Loop Detectors."

680.7. BID ITEM:

Item 680.1 - Installation of Highway Traffic Signals [Isolated] - per each

Item 680.2 - Installation of Highway Traffic Signals [System] - per each

ITEM

681 TEMPORARY TRAFFIC SIGNALS

681.1. DESCRIPTION: *Furnish, install, operate, maintain, reconfigure, and remove temporary traffic signals.*

681.2. WORK METHODS: Install materials in accordance with Item 680, "Installation of Highway Traffic Signals." If signal equipment is furnished by the City, obtain the equipment at locations shown on the plans. Provide electrical services in accordance with Item 628, "Electrical Services" (except for measurement and payment).

A. Operation and Maintenance. Maintain and operate the temporary traffic signals for the duration of the contract. Set signal timing as shown on the plans or as directed.

1. Designate in writing a sufficiently skilled individual responsible for maintenance and operation of the temporary traffic signals who is available to respond within a reasonable time, 24 hr. each day, unless otherwise shown on the plans.

2. Provide backup power, when shown on the plans, for each location at all times.

B. Reconfiguration. Reconfigure temporary traffic signals in accordance with the plans, as directed, and within the requirements of this Item. Reconfiguration is any change made to an installed intersection, including relocation of poles, controller, or signal heads.

C. Removal. Remove all equipment installed for temporary traffic signals, as shown on the plans or as directed in writing.

1. Completely remove poles or other supports used for temporary traffic signals. When approved, a concrete foundation may remain 2 ft. or more below finish grade. Backfill the remaining hole with material equal in composition and density to the surrounding area. Replace any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

2. Retain all removed temporary signal components, except for those furnished by the City, unless otherwise shown on the plans.

681.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

681.4. MEASUREMENT: This Item will be measured by each temporary signalized intersection. A signalized intersection is a group of signals operated by a single controller.

681.5. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Temporary Traffic Signals." This price is full compensation for picking up and returning materials furnished by the City; installation, operation, maintenance, reconfiguration, and removal of the temporary traffic signal, foundations, electrical services, electrical energy consumed; and materials, equipment, labor, tools, and incidentals.

Electrical energy consumed by the Contractor on an existing City electrical service will be paid for by the City.

Costs for utility-owned power line extensions, connection charges, meter charges, and other charges will be paid for by the City. The City will reimburse the contractor only the amount billed by the utility. No additional amount for supervision of the utility's work will be paid.

681.6. BID ITEM:

Item 681.1 - Temporary Traffic Signals - per each intersection

ITEM

682 VEHICLE AND PEDESTRIAN SIGNAL HEADS

682.1. DESCRIPTION: *Furnish and install vehicle and pedestrian signal heads.*

682.2. MATERIALS: Furnish only new materials.

A. Definitions.

1. **Back Plate.** A thin strip of material extending outward from all sides of a signal head.

2. **Incandescent Optical Unit.** The lens, reflector, lamp, lamp receptacle, and associated supporting parts in a signal section.

3. **LED Optical Unit.** The LED lens and associated supporting parts in a signal section.

4. **Louver.** A device mounted to the visor restricting signal face visibility.

5. **Signal Section.** One housing case, housing door, visor, and optical unit.

6. **Signal Face.** One section or an assembly of 2 or more sections facing one direction.

7. **Signal Head.** A unidirectional face or a multidirectional assembly of faces, including back plates and louvers when required, attached at a common location on a support.

B. General. Provide vehicle signal heads in accordance with Texas Department of Transportation (TxDOT) DMS-11120, "Vehicle Signal Heads." Provide vehicle signal heads from manufacturers prequalified by the Texas Department of Transportation. The TxDOT Traffic Operations Division maintains a list of prequalified vehicle signal head manufacturers.

Provide pedestrian signal heads in accordance with TxDOT DMS-11130, "Pedestrian Signal Heads" and Item 683, "LED Countdown Pedestrian Signal Module." Provide pedestrian signal heads from manufacturers prequalified by the Department. The Traffic Operations Division maintains a list of prequalified pedestrian signal head manufacturers.

Supply either aluminum or polycarbonate signal head components that are of the same material and manufacturer for any one project. Use galvanized steel, stainless steel, or dichromate sealed aluminum bolts, nuts, washers, lock washers, screws, and other assembly hardware. When dissimilar metals are used, ensure the metals are selected or insulated to prevent corrosion.

Use closed-cell silicone or closed-cell neoprene gaskets.

682.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

682.4. CONSTRUCTION:

A. Assembly. Assemble individual signal sections in multi-section faces in accordance with the manufacturer's recommendations to form a rigid signal face. Assemble and mount signal heads as shown on the plans. Install louvers and back plates in accordance with the manufacturer's recommendations. Close any openings in an assembled signal head with a plug of the same material and color as the head.

When installing a retrofit replacement LED traffic signal or pedestrian signal lamp unit into an existing signal housing, only remove the existing lens, reflector, and incandescent lamp; fit the new unit securely in the housing door; and connect the new housing unit to the existing electrical wiring or terminal block by means of simple connectors.

B. Wiring. Wire each optical unit to the terminal block located in that signal section by means of solderless wire connectors or binding screws and spade lugs. Wire all sections of a multi-section signal face to the section terminal blocks in which the traffic signal cable is terminated. Maintain the color coding on leads from the individual optical units throughout the signal head, except for the traffic signal cable. Use solderless wire connectors or binding screws and spade lugs for connections to terminal blocks. Use binding screws and spade lugs for field wiring.

682.5. MEASUREMENT: This Item will be measured by each vehicle signal section, pedestrian signal section, back plate, or louver.

682.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pedestrian Signal Section," "Vehicle Signal Section with Back Plate," or "Louver," of the types and sizes specified. This price is full compensation for furnishing, assembling, and installing the signal sections, back plates and louvers, LED countdown modules, and lenses and optics; mounting attachments; and equipment, labor, tools, and incidentals.

682.7. BID ITEM:

Item 682.1 - Install Vehicle Signal Section with Back Plate (3 second) - per each

Item 682.2 - Install Vehicle Signal Section with Back Plate (4 second) - per each

Item 682.3 - Install Vehicle Signal Section with Back Plate (5 second) - per each

Item 682.4 - Install Pedestrian Signal Section (12 inch) LED (2 Ind) - per each

Item 682.5 - Louver (12 inch) (Adjustable) - per each

ITEM

683 LED COUNTDOWN PEDESTRIAN SIGNAL MODULE

683.1. DESCRIPTION: *This Item will govern for the furnishing LED "walking person" and "hand" icon pedestrian signal modules with countdown (hereafter called module or modules).*

683.2. MATERIALS: Ensure electrical materials and construction methods conform to the current National Electric Code (NEC) and additional local utility requirements. Materials used for the lens and LED module construction shall conform to ASTM specifications where applicable. Enclosures containing the power supply and electronic components of the LED module shall be made of UL94VO flame retardant materials. The lens of the LED module is excluded from this requirement.

Furnish new materials. Ensure all materials and construction methods conform to the requirements of this Item and the following pertinent requirements:

A. Signal Heads. Item 682, "Vehicle and Pedestrian Signal Heads"

B. Controller. "Traffic Signal Control Equipment Specifications" published by the State of California, Business, Transportation & Housing Agency; Department of Transportation (CALTRANS), dated January, 1989, and all current addenda and Revisions. In case of conflict, TxDOT specifications will govern over the CALTRANS specifications.

C. Signal Indications. "Pedestrian Traffic Control Signal Indications" published in the Equipment and Materials Standards of the Institute of Transportation Engineers, (referred to in this document as "PTCSI").

D. National Electric Code (NEC);

E. American Society for Testing and Materials (ASTM).

683.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

683.4. CONSTRUCTION:

A. General.

1. Modules designed as retrofit replacements for existing pedestrian signal indication lamps shall not require special tools for installation. Retrofit replacement modules shall fit into existing pedestrian signal housings built for the PTCSI sizes stated in Section 1 of the "walking person" and "hand" icon pedestrian signal indication Standard without modification to the housing. See PTCSI 4.2.1 for housing sizes.

2. All LED's used shall be rated for 100,000 hours of continuous operation over a temperature range of -40°C to +74°C. The modules shall be rated for a minimum life of 72 months. Modules shall meet all parameters of this specification throughout this 72-month period. Installation of a retrofit replacement module into an existing pedestrian signal housing shall only require the removal of the existing optical unit components, i.e.,

lens, lamp module, gaskets, and reflector; shall be weather tight and fit securely in the housing; and shall connect directly to existing electrical wiring.

B. The Module.

1. The retrofit module shall be capable of replacing the optical unit. The module lens may be a replaceable part without the need to replace the complete module. The walking person and hand icons (16"x18" size only) shall be full (not outlines). The countdown digits shall be made up of two rows of LEDs. Each digit shall be a minimum of seven inches in height.

2. For each nominal message bearing surface (module) size, use the corresponding H (height) and W (width):

Bearing Surface	Module Size	Icon Height	Icon Width	Countdown Height	Countdown Width
H	(16 x 18 in)	Min 7 in	7 in	Min 9 in	6.5 in

3. The units shall not have any attachments or options that will allow the mode to be changed from counting the clearance cycle, to the full walk/don't walk cycle.

4. The module shall be a single, self-contained device, not requiring on-site assembly for installation into existing traffic signal housing. The power supply shall be designed to fit and mount inside the pedestrian signal module. The assembly and manufacturing process for the module shall be designed to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

C. Environmental Requirements. The module shall be rated for use in the ambient operating temperature range, measured at the exposed rear of the module, of -40 to +165°F. The pedestrian module shall be designed to meet NEMA 250 Hose down Test. The test is to be conducted on a stand-alone unit. No protective housing shall be used. The module lens shall be UV stabilized.

D. Signal LENS.

1. The lens of the LED pedestrian and countdown signal modules shall be polycarbonate UV stabilized and a minimum of ¼" thick.

2. The exterior of the lens of the LED pedestrian and countdown signal module shall be smooth and frosted to prevent sun phantom.

E. Module Identification. Each module shall be identified on the backside with the manufacturer's name, model numbers and serial number. The following operating characteristics shall be identified: nominal voltage, power consumption, wattage and Volt-Ampere.

F. Photometric Requirements.

1. Luminance, Uniformity & Distribution. For a minimum period of 72 months, the maintained minimum luminance values for the modules under normal operating conditions shall not be less than 5300 cd/m2 for the Walking Person icon and 3750 cd/m^2

for the Hand icon when measured perpendicular to the surface of the module at nine (nine) separate points on the icon. These values may decrease up to 50% of these table values beyond 15° from the perpendicular in either to the left or right on a horizontal plane.

The uniformity of the walking person and hand icons' illumination shall meet a ratio of not more than 1 to 5 between the minimum and maximum luminance measurements (in Cd/m2).

2. **Chromaticity.** The standard colors for the LED Pedestrian Signal Module shall be White for the walking person and Portland Orange for the hand icon and countdown digits.

G. Electrical.

1. **General.** The modules shall be operationally compatible with traffic signal controllers, cabinets and accessories manufactured to the California Department of Transportation (Caltrans) Traffic Signal Control Equipment Specifications, January 1989 Edition.

   Maximum power consumption requirements for each indication are as follows (in Watts):

Icon	25 C	74 C
Hand	10.0W	12.0W
Waking Person	9.0W	12.0W
Countdown 2 digit	8.0W	11.0W

   All wiring and terminal blocks shall meet the requirements of Section 13.02 of the VTCSH Standard. Three secured, color coded, 36 in long 600 V, 16 AWG minimum, jacketed wires, conforming to the National Electrical Code, rated for service at +105°C, are to be provided for electrical connection.

   Each LED signal module shall be designed so that there is no noticeable light output when connected to rated voltage through an impedance of 15 Kohm (either resistive or capacitive). The signal module shall be designed so that, under normal operation, an AC voltage of no greater than 10 volts RMS shall be developed across the unit when it is connected in series with any value of impedance greater than 15 Kohms and for any applied AC voltage between 95 and 135 volts RMS that is connected across this series combination. In addition, the signal module shall be designed so that the voltage across the module shall reduce in value to less than 10 volts RMS within 100 msec when the module is switched off by any solid state switch or switch pack having an impedance of 15 Kohms or greater.

2. **Voltage Range.**

   a. LED modules shall operate from a 60 +3 Hertz ac line power over a voltage range from 80 to 135 VAC RMS. The current draw shall be sufficient to ensure compatibility and proper triggering and operation of load current switches and conflict monitors. Nominal operating voltage for all measurements shall be 120 +3 Volts rms. Fluctuations in line voltage over the range of 80Vac to 135Vac shall not affect luminous intensity by more than +10%. The LED circuitry shall prevent flickering at less than 100 Hz over the voltage range stated above. The modules shall

be designed and constructed so that the failure of a single LED will not result in the loss of additional LEDs.

b. There should be no illumination of the module when the applied voltage is less than 35 VAC RMS. To test for this condition the each icon must first be fully illuminated at the nominal operating voltage. The applied voltage shall then be reduced to the point where there is no illumination. This point must be greater than 35 VAC RMS.

c. Turn-On and Turn-Off Time: Each icon of the module shall reach 90% of their full illumination (turn-on) within 100 ms. of the application of the nominal operating voltage. The modules shall not be illuminated (turn-off) after 100 ms. of the removal of the nominal operating voltage.

d. For abnormal conditions when nominal voltage is applied to the unit across the two-phase wires (rather than being applied to the phase wire and the neutral wire) the pedestrian signal unit shall default to the hand symbol.

3. **Transient Voltage Protection.** The module's on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1998, or the latest version.

4. **Electronic Noise.** The modules and associated on-board circuitry must meet Federal Communications Commission (FCC) Title 47, Sub Part B, Section 15 regulations concerning the emission of electronic noise.

5. **Power Factor (PF) and AC Harmonics.** The modules shall provide a power factor of 0.90 or greater when operated at nominal operating voltage, and 77ºF. Total harmonic distortion induced into an AC power line by the module, operated at nominal operating voltage, at 77ºF shall not exceed 20%.

H. Module Functions.

1. **Cycle.** The module shall operate in one mode: ***Clearance Cycle Countdown Mode Only***. The module will start counting when the flashing clearance signal turns on and will countdown to "0" and turn off when the steady "Don't Walk" signal turns on. ***Module will not have user accessible switches or controls for modification of cycle.***

2. **Learning Cycle.** At power on, the module enters a single automatic learning cycle. During the automatic learning cycle, the countdown display shall remain dark.

3. **Cycle Modification.** The unit re-programs itself if it detects any increase or decrease of Pedestrian Timing. The counting unit will go blank once a change is detected and then take one complete pedestrian cycle (with no counter during this cycle) to adjust its buffer timer.

4. **Recycling.** The module shall allow for consecutive cycles without displaying the steady Hand icon ("Don't Walk").

5. **Preemption.** The module shall recognize preemption events and temporarily modify the crossing cycle accordingly. If the controller preempts during the walking man, the countdown will follow the controller's directions and will adjust from walking man to

flashing hand. It will start to count down during the flashing hand. If the controller preempts during the flashing hand, the countdown will continue to count down without interruption. The next cycle, following the preemption event, shall use the correct, initially programmed values.

6. **"Don't Walk" Steady.** If the controller output displays Don't Walk steady condition and the unit has not arrived to zero or if both the hand and man are dark for some reason, the unit suspends any timing and the digits will go dark.

I. Quality Assurance.

1. **General.**

   a. Unless otherwise specified all of the test will be conducted at an ambient temperature of 77°F and at the nominal operating voltage of 120 VAC RMS.

   b. The following production quality assurance tests shall be performed on each new module prior to shipment. Before any measurements are made, the unit shall be energized at the rated voltage for a 30-minute burn-in period at an ambient temperature of +77°F. Following the burn-in period, the initial luminous intensity shall be measured. A single point measurement with a correlation to the intensity requirement of Section 1.04 of VTCSH for circular indications may be used. The current flow and power factor shall also be determined. Units found to have parameters outside the ranges allowed by this specification shall be rejected.

   c. The modules shall be manufactured in accordance with a vendor quality assurance (QA) program. The QA program shall include two types of quality assurance: (1) design quality assurance and (2) production quality assurance. QA process and test result documentation shall be kept on file for a minimum period of seven years.

2. **Conformance.** The module designs not satisfying design qualification testing and the production quality assurance testing performance requirements shall not be labeled, advertised, or sold as conforming to this specification.

3. **Design Qualification Assurance.** Design Qualification testing shall be performed on new module designs, and when a major design change has been implemented on an existing design. Unless otherwise specified, all of the tests shall be conducted on the same set of randomly selected modules, hereafter called the sample set, at an ambient temperature of 77°F and at the nominal operating voltage of 120 VAC RMS. Testing shall be performed once every 5 years or when the module design or LED technology has been changed. Test data shall be retained by the module manufacturers for a minimum period of 7 years and for a period of at least 5 years beyond the last date of manufacture of that model type.

4. **Production Quality Assurance.** All new modules shall undergo Production Quality Assurance testing prior to shipment. Failure of any module to meet requirements of the QA tests shall be cause for rejection. QA test results shall be maintained for a period of 4 years. The production quality assurance shall include statistically controlled routine tests to ensure minimum performance levels of modules built to meet this specification. Prior to packaging for shipment, each module shall be visually inspected for any exterior physical damage or assembly anomalies. Careful attention shall be paid to the surface of

the lens to ensure there are no scratches (abrasions), cracks, chips, discoloration or other defects.

5. **Delivery and Acceptance.** Compatibility with a controller unit, conflict monitor and load switch will be tested by connecting the module under test to the output of a standard load switch connected to a variable AC voltage supply with the output of the load switch in the off state. The AC voltage developed across each LED module so connected shall not exceed ten (10) Vrms as the input to the LED module is varied from 95 Vrms to 135 Vrms.

J. Warranty. LED signal modules shall be replaced or repaired if it fails to function as intended due to workmanship or material defects within the first 60 months from date of delivery.

683.5. MEASUREMENT: This Item will be measured by each installed LED Countdown Pedestrian Signal Module.

683.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement," will be paid for at the unit bid price for "LED Countdown Pedestrian Signal Module." This price is full compensation for furnishing and installing the module; and equipment, labor, tools, and incidentals.

683.7. BID ITEM:

Item 683.1 - LED Countdown Pedestrian Signal Module - per each

ITEM

684 TRAFFIC SIGNAL CABLES

684.1. DESCRIPTION: *Furnish and install traffic signal cables.*

684.2. MATERIALS: Provide polyethylene-jacketed multi-conductor cables in accordance with details shown on the plans. Individual conductors must be copper with polyethylene insulation rated for 600 volts. Furnish new materials. Provide traffic signal cables in accordance with Texas Department of Transportation (TxDOT) DMS-11110, "Traffic Signal Cables." All cable shall be #14 AWG solid copper.

A. Type A Cables. Use Type A cables meeting the requirements of IMSA 20-1 for underground conduit installation or for aerial cable supported by a messenger.

B. Type B Cables. Use Type B cables meeting the requirements of IMSA 20-3 as the integral messenger cable for aerial installations.

C. Type C Cables. Use Type C cables meeting the requirements of IMSA 50-2 for loop detector lead-in installations consisting of 2-conductor shielded cable.

D. Types A and B Cable Materials. Provide the following materials for Type A and B cables:

- Use the size and number of conductors shown on the plans. Unless otherwise shown on the plans, use conductors consisting of solid copper.
- Ensure color coding of conductors and sequence for cables are in compliance with Table 1. Base color is the insulation color. Tracer color is the colored stripe that is part of or is firmly adhered to the insulation surface for the full length of the conductor.
- Ensure 2-conductor cable is of the round twisted type with fillers used where necessary to form a round cable.
- For cables with more than 2 conductors, ensure individual conductors are laid up symmetrically in layers with fillers used when necessary, to produce a uniform assembly of conductors with a firm compact cylindrical core.
- Ensure fillers are a non-metallic, moisture-resistant, non-wicking material.
- Supply conductor assemblies that are covered with a wrapping of a moisture-resistant tape applied to overlap at least 10% of the tape width.
- Ensure that the taped conductor assembly is covered with a tightly fitting black polyethylene jacket that is smooth and free from holes, splits, blisters, and any other imperfections.
- Supply cables that clearly show the name of the manufacturer and the IMSA specification number applied at approximate 2-ft. intervals to the outer surface of the jacket by indent printing.

Table 1
Conductor Color and Sequence for Cables

Conductor No.	Base Color	Tracer Color
1	Black	
2	White	
3	Red	
4	Green	
5	Orange	
6	Blue	
7	White	Black
8	Red	Black
9	Green	Black
10	Orange	Black
11	Blue	Black
12	Black	White
13	Red	White
14	Green	White
15	Blue	White
16	Black	Red
17	White	Red
18	Orange	Red
19	Blue	Red
20	Red	Green
21	Orange	Green

E. Additional Requirements for Type B Cable Materials. Additional material requirements particular to Type B cable are as follows:

- Ensure cables consisting of 5 or more conductors have a 0.25-in. nominal diameter messenger. For the messenger, use Class A galvanized Extra High Strength Steel Strand with 3 or 7 wires.

- A solid strand messenger with 0.134-in. diameter may be used for cables with less than 5 conductors.

- To provide corrosion protection, ensure the messenger strand is coated and the interstices are flooded with a rubber asphalt compound or equivalent.

- Ensure the integral messenger and conductors are enclosed in the jacket forming a cross section similar to a figure 8.

F. Type C Cable Materials. Use the following materials for Type C cables:

- Unless otherwise shown on the plans, use No. 14 AWG solid copper insulated conductors with black insulation on 1 of the 2 conductors and clear insulation on the other conductor. Ensure conductors have a minimum of 2 twists per foot within the cable.

- Use cables that have 100% shield coverage utilizing aluminum bonded to a Mylar film. Ensure the drain wire is stranded tinned copper, 2 AWG sizes less than the conductor, and in continuous contact with the aluminum side of the shield material.

- Ensure the jacket is black polyethylene.
- Use cables that legibly show the name of the manufacturer and the IMSA specification number applied at approximate 2-ft. intervals on a tape under the outer jacket.

G. Sampling. The Engineer may take samples from each roll of each size of cable for establishing conformity to IMSA. The samples will be at least 3 ft. in length. Replace any cable failing to meet IMSA requirements.

684.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

684.4. CONSTRUCTION: For each cable run in underground conduit, coil an extra 5 ft. of cable in each ground box.

Splices are not permitted in Type A and B cables unless shown on the plans or approved by the Engineer in writing. Ensure that splices are watertight.

Make splices between Type C cable and loop detector wires only in the ground box near the loop the cable is servicing. Use non-corrosive solder for splices. Ground the drain wire of Type C cable to earth ground only at the controller or detector cabinet. Ensure the resistance from the drain wire to the ground rod is less than 1 ohm.

Test the cables after installation and prior to any connection to the cables. Cables testing less than 50 megohms insulation resistance at 500 volts will be rejected.

684.5. MEASUREMENT: This Item will be measured by the foot of traffic signal cables.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Change Order. Additional measurements or calculations will be made if adjustments of quantities are required.

684.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Traffic Signal Cables" of the types and sizes specified. This price is full compensation for furnishing and installing materials and for equipment, labor, tools, and incidentals, except as shown below.

Cables inside traffic signal pole assemblies will be paid for under this Item.

Cables used for inside signal heads and controllers or for coils in ground boxes, pole bases, and on span wires will not be paid for directly but will be subsidiary to pertinent Items.

684.7. BID ITEM:

Item 684.1 - Traffic Signal Cables [Type/Size] - per foot

ITEM

685 FLASHING BEACON ASSEMBLIES

685.1. DESCRIPTION: When installing, furnish, fabricate, and erect flashing beacon assemblies. When relocating, remove and relocate existing flashing beacon assemblies. When removing, remove existing flashing beacon assemblies.

685.2. MATERIALS: Furnish new materials in accordance with the following Items and with details shown on the plans:

A. Steel Structures.

1. Overhead. Item 686, "Traffic Signal Pole Assemblies (Steel)"

2. Pedestal Pole. Item 687, "Pedestal Pole Assemblies"

B. Metal for Structures. Item 302, "Metal for Structures"

C. Galvanizing. TxDOT Standard Specification Item 445, "Galvanizing"

D. Anchor Bolts. TxDOT Standard Specification Item 449, "Anchor Bolts"

E. Foundations. Item 656, "Foundations for Traffic Control Devices"

F. Flasher Controller Assemblies. Provide flasher controller assemblies in accordance with TxDOT DMS-11160, "Flasher Controller Assembly."

G. Pedestal Pole Base. Provide pedestal pole bases in accordance with TxDOT DMS-11140, "Pedestal Pole Base."

H. Solar Power Flasher Controller Assembly. When shown on the plans, provide solar powered flasher controller assemblies in accordance with TxDOT DMS-11150, "Solar Power Flasher Controller Assembly."

I. School Flasher Control Unit.

1. Control Device.

a. The School Flasher Control Unit shall be a wireless controller able to receive commands generated by a Location Flasher Programming Device with a modem or a touch tone telephone through a pager service. It shall be compatible with commercial 900 MHz frequency range alpha-numeric paging services using POCSAG/FLEX protocol. The unit shall use a pager receiver that is programmable to respond to one of 100,000 individual codes and at least four group codes, out of possible 1,000 separate group codes. The control unit shall be capable of integration, without special procedures, in to the existing "CPR 2100" system (as supplied by RTC Manufacturing, Inc.).

b. Controller programming software shall be able to reset the POSAG, CAPCODE, and other communications settings of the controller through the serial port.

c. Controller units shall be provided as individual units to be mounted in existing enclosures, on existing back panels in place of a typical solid state time switch.

2. Enclosure.

a. The controller shall be housed in an aluminum enclosure with a means for mounting on a suitable back plate. Mounting holes that provide clearance for at least a #10 screw are required.

b. The enclosure shall not exceed 4 ¾ inches width, 8 inches height and 2 inches depth. Interface to the power line and/or to the flasher cabinet shall be provided by means of a wiring harness (minimum 36 inches long). Each wire shall be appropriately labeled for ease of installation into an existing cabinet.

3. Electrical. The controller unit shall be capable of operating on 12 VDC. or an AC power source between 95 and 135 VAC.

4. Manual Operations. The controller shall be equipped with a push button switch that will allow manual activation and/or deactivation of the relay output. The manually activated or deactivated relay shall remain in the manual condition until the next program is received.

5. Controller Addressing. Each controller unit shall have a programmable unique address which can be individually addressed by the software in the Location Flasher Programming Device.

6. Output Relay. The controller shall have SPDT relay output with contacts rated at 15 amperes resistive at 120 VAC.

7. Antenna. Each controller unit shall be provided with an external, 3Bd Gain, Omni-Directional antenna.

a. Antenna shall be provided with "in base" mounted female BNC type connector (Amphenol #31-221-RFX or equivalent) for connection to supplied cable.

b. Antenna shall be provided with 15' length coaxial cable with male BNC type connector (amphenol #31-4541-RFX or equivalent) for connection to controller unit and antenna respectively.

c. Antenna connector hardware shall be solder type, crimped or screw-on connectors will not be accepted.

J. Suppliers. Provide flasher assemblies, pedestal pole bases, and solar powered flasher controller assemblies from manufacturers prequalified by the Texas Department of Transportation. The TxDOT Traffic Operations Division maintains a list of prequalified flasher assembly, pedestal pole base, and solar power flasher controller assembly manufacturers.

Provide shop drawings for the complete assembly. Refer to the appropriate ASTM or Aluminum Association designation for all materials shown in submittals. Use the fabricator's model number to identify the base in all tests, drawings, documentation, and other references.

685.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

685.4. CONSTRUCTION: For installation and relocation, install foundations in accordance with Item 656, "Foundations for Traffic Control Devices."

A. Fabrication. Provide poles and bases in accordance with Item 687, "Pedestal Pole Assemblies." Provide mild steel anchor bolts in accordance with TxDOT Item 449, "Anchor Bolts." Use galvanized bolts, nuts, and washers.

B. Galvanizing. Galvanize all fabricated parts in accordance with TxDOT Item 445, "Galvanizing." Repair galvanizing for any steel part or member damaged in assembly, transit, or erection, or for any steel part or member welded after galvanizing, in accordance with TxDOT Item 445.3.D, "Repairs."

C. Installation. Install flashing beacon assemblies or solar-powered (photovoltaic) school zone flasher assemblies at the locations shown on the plans or as directed. Unless otherwise shown on the plans, stake the assembly locations for verification by the Engineer.

Install pole, breakaway base, connectors, wiring, signal beacons, sign, and foundation as shown on the plans or as directed. Install the flasher controller assembly on the electrical service pole. Install watertight breakaway electrical fuse holders in all line and neutral conductors at the breakaway base.

Use established industry and utility safety practices to erect assemblies near overhead or underground utilities. Consult with the appropriate utility company prior to beginning such work.

D. Relocation. Disconnect and isolate the electrical power supply prior to removal of the assembly. Remove existing assembly as directed. Unless otherwise directed, salvage existing components such as sign, beacons, pole, and base. Repair or replace lost or damaged components as directed.

Relocate existing assembly to the location shown on the plans or as directed. Install existing assembly at new foundations in accordance with Section 685.4.C, "Installation." Remove existing foundations in accordance with Section 685.4.E, "Removal." Accept ownership of unsalvageable materials and dispose of in accordance with federal, state, and local regulations.

E. Removal. Disconnect and isolate existing electrical power supplies prior to removal of the assembly. Remove existing sign panel, beacons, pole, and base from existing assembly. Store items to be reused or salvaged without damaging. Store sign panels above the ground in a vertical position at locations shown on the plans or as directed. Accept ownership of unsalvageable materials and dispose of in accordance with federal, state, and local regulations.

Unless otherwise shown on the plans, remove abandoned foundations, including steel, to 2 ft. below the finished grade. Backfill with material equal in composition and density to the surrounding area, and replace any surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

685.5. MEASUREMENT: This Item will be measured by each installed, relocated, or removed flashing beacon assembly.

685.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Flashing Beacon Assemblies," "Relocate Flashing Beacon Assemblies," "Remove Flashing Beacon Assemblies," or "Solar-Powered (Photovoltaic) School Zone Flasher Assemblies." The City will pay for electrical energy consumed by the flashing beacon.

New electrical services will be paid for under Item 628, "Electrical Services." For mast arm installation, pole shall be paid for under Item 686, "Traffic Signal Pole Assemblies (Steel)" and the foundation under TxDOT Item 416, "Drilled Shaft Foundations."

A. Installation. This price is full compensation for furnishing, fabricating, galvanizing, assembling, and erecting the flashing beacon assemblies; foundations; furnishing and placing anchor bolts, nuts, washers, and templates; controller; signs, signal heads and LED Lenses; and equipment, materials, labor, tools, and incidentals.

B. Relocation. This price is full compensation for removing the flashing beacon assemblies; removing existing foundations; installing new foundations; furnishing, fabricating, and installing any new components as required and replacing the assembly on its new foundations with all manipulations and electrical work; controller; salvaging; disposal of unsalvageable material; loading and hauling; and equipment, material, labor, tools, and incidentals.

C. Removal. This price is full compensation for removing the various flashing beacon assemblies components; removing the foundations; storing the components to be reused or salvaged; disposal of unsalvageable material; backfilling and surface placement; loading and hauling; and equipment, materials, tools, labor, and incidentals.

D. Installation of Solar-Powered (Photovoltaic) School Zone Flasher Assemblies. This Item will be measured as each complete in place solar-powered (photovoltaic) school zone flasher assembly including photovoltaic modules, batteries, flasher controller assembly including the cabinet, pole, signs, signal heads, LED lenses, internal electrical conductors and connectors, school flasher control unit, and complete mounting assemblies. The school flasher control unit shall include all the components detailed in this specification as well as any additional items needed for a fully functional installation.

685.7. BID ITEM:

Item 685.1 - Install Flashing Beacon Assemblies - per each

Item 685.2 - Relocate Flashing Beacon Assemblies - per each

Item 685.3 - Remove Flashing Beacon Assemblies - per each

Item 685.4 - Solar-Powered (Photovoltaic) School Zone Flasher Assemblies - per each

ITEM

686 TRAFFIC SIGNAL POLE ASSEMBLIES (STEEL)

686.1. DESCRIPTION: *When installing, fabricate, furnish, and erect steel cantilever traffic signal pole assemblies. When relocating, remove and relocate steel cantilever traffic signal pole assemblies.*

686.2. MATERIALS: Provide new materials that comply with the details shown on the plans, the requirements of this Item, and the pertinent requirements of the following Items:

A. Concrete. Item 300, "Concrete"

B. Steel Structures. Texas Department of Transportation (TxDOT) Standard Specification Item 441, "Steel Structures"

C. Metal. Item 302, "Metal for Structures"

D. Galvanizing. TxDOT Standard Specification Item 445, "Galvanizing"

E. Anchor Bolts. TxDOT Standard Specification Item 449, "Anchor Bolts." Furnish alloy steel or medium-strength mild steel anchor bolts in accordance with Item 449.2.A, "Bolts and Nuts."

686.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

686.4. Construction.

A. Standard Design. Alternate designs are not acceptable. Deviations that affect the basic structural behavior of the pole are considered to be alternate designs. For deviations that do not affect the basic structural behavior of the pole, submit 3 sets of shop drawings to the City Engineer for approval.

B. Fabrication. Fabricate and weld in accordance with TxDOT Item 441, "Steel Structures"; AWS D1.1, Structural Welding Code—Steel; and the requirements of this Item. Fabrication tolerances are given in Table 1.

Table 1
Conductor Color and Sequence for Cables

Part	Dimension	Tolerance (in.)
Pole and mast arm shaft	Length	±1
	Thickness	+0.12, -0.12
	Difference between flats or diameter	±3/16
	Straightness	1/8 in 10 ft.
	Attachment locations	±1
Base and mast arm mounting plates	Overall	±3/16
	Thickness	+1/4, -0
	Deviations from flat	3/16 in 24 in.
	Spacing between holes	±1/8
	Bolt hole size	±1/16
Anchor bolts	Length	±1/2
	Threaded length	±1/2
	Galvanized length	-1/4
Assembled shaft	Angular orientation	1/16 in 12 in.
	Centering	±3/16
	Twist	3° in 50 ft.

Provide properly fitting components. Provide round or octagonal shafts for poles and mast arms tapered as shown on the plans. Fabricate mast arms straight in the unloaded condition unless otherwise shown on the plans. The City will accept bolted slip joints overlapping by at least 1.5 diameters in mast arms 40 ft. and longer.

Provide circumferential welds only at the ends of the shafts. Provide no more than 2 longitudinal seam welds in shaft sections. Grind or smooth the exterior of longitudinal seam welds to the same appearance as other shaft surfaces. Ensure 100% penetration within 6 in. of circumferential base welds and at least 60% penetration at other locations along the longitudinal seam welds. Use a welding technique that minimizes acid entrapment during later galvanizing. Hot-dip galvanize all fabricated parts in accordance with TxDOT Item 445, "Galvanizing."

Treat welds with Ultrasonic Impact Treatment as shown on the plans after galvanization and with the dead load (actual or simulated) applied. Repair damaged galvanizing in accordance with Section 445.3.D, "Repairs."

Connect the luminaire arm to the pole with simplex fittings. Ensure the fittings have no defects affecting strength or appearance.

Ensure that the design wind speed is identified and permanently visible on the pole base plate and mast arm mounting plate.

Deliver each traffic signal pole assembly with fittings and hardware either installed or packaged with its associated components. Ship all components with a weatherproof tag identifying the manufacturer, contract number, date, and destination of shipment.

C. Installation. Locate traffic signal poles as shown on the plans unless otherwise directed to secure a more desirable location or to avoid conflict with utilities. Stake the traffic signal pole locations for verification by the Engineer.

Construct foundations in accordance with Item 308, "Drilled Shafts and Under-Reamed Foundations." Orient anchor bolts as shown on the plans.

Use established industry and utility safety practices when working near underground or overhead utilities. Consult with the appropriate utility company before beginning such work.

Erect structures after foundation concrete has attained its design strength as required in the plans and Item 300, "Concrete." Coat anchor bolt threads and tighten anchor bolts in accordance with TxDOT Item 449, "Anchor Bolts."

After the traffic signal pole assembly is plumb and all nuts are tight, tack-weld each anchor bolt nut in 2 places to its washer. Tack-weld each washer to the base plate in 2 places. Do not weld components to the bolt. Tack-weld in accordance with TxDOT Item 441, "Steel Structures."

After tack-welding, repair galvanizing damage on bolts, nuts, and washers in accordance with Section 445.3.D, "Repairs." Do not grout between the base plate and the foundation.

D. Relocation. Disconnect and isolate traffic signal cables before removing the pole. Remove existing traffic signal poles as directed. Ensure that the poles or attached components suffer no undue stress or damage. Signs, signal heads, mounting brackets, luminaires, etc., may be left on the poles. Repair or replace damaged components as directed.

Unless otherwise shown on the plans, remove abandoned concrete foundations to a point 2 ft. below final grade. Backfill the hole with materials equal in composition and density to the surrounding area. Replace surfacing material with similar material to an equivalent condition.

Move existing poles to locations shown on the plans or as directed. Install existing poles on new foundations in accordance with Section 686.4.C, "Installation."

Accept ownership of unsalvageable materials and dispose of in accordance with federal, state, and local regulations.

686.5. MEASUREMENT: This Item will be measured by each traffic signal pole assembly installed or relocated.

686.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Install Traffic Signal Pole Assemblies (Steel)" of the types and sizes specified or "Relocate Traffic Signal Pole Assemblies (Steel)" of the types specified.

New drilled shaft foundations will be paid for under Item 308, "Drilled Shafts and Under-Reamed Foundations."

A. Installation. This price is full compensation for furnishing, fabricating, galvanizing, assembling, and erecting the pole upon a foundation; furnishing and erecting required mast arms and luminaire arms; furnishing and placing anchor bolts, nuts, washers, and templates; and equipment, materials, labor, tools, and incidentals.

B. Relocation. This price is full compensation for removing traffic signal poles; removing existing foundations; backfilling and surface placement; storing the components to be reused or salvaged; furnishing, fabricating, and installing required new components; placing and

securing traffic signal poles on new foundations; furnishing and placing conduit, ground rods, and wiring; disposal of unsalvageable material; loading and hauling; and equipment, material, labor, tools, and incidentals.

686.7. BID ITEM:

Item 686.1 - Install Traffic Signal Pole Assemblies (Steel) [Type/Size] - per each

Item 686.2 - Relocate Traffic Signal Pole Assemblies (Steel) [Type] - per each

ITEM

687 PEDESTAL POLE ASSEMBLIES

687.1. DESCRIPTION: *Furnish and install pedestal pole assemblies for vehicle and pedestrian signals.*

687.2. MATERIALS: Furnish new materials in accordance with the following Items and with details shown on the plans:

A. Galvanizing. Texas Department of Transportation (TxDOT) Standard Specification Item 445, "Galvanizing"

B. Anchor Bolts. TxDOT Standard Specification Item 449, "Anchor Bolts"

C. Foundations. Item 656, "Foundations for Traffic Control Devices"

D. Pedestal Pole Base. Provide pedestal pole bases in accordance with TxDOT DMS-11140, "Pedestal Pole Base." Provide pedestal pole bases from manufacturers prequalified by the Texas Department of Transportation. The Traffic Operations Division maintains a list of prequalified pedestal pole base manufacturers.

E. Pedestal Pole. Provide 4-in. diameter schedule 40 steel pipe or tubing, aluminum pipe (alloy 6061-T6), or rigid metal conduit. Do not use aluminum conduit. Galvanize pedestal pole assemblies in accordance with TxDOT Item 445, "Galvanizing," unless otherwise shown on the plans.

687.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

687.4. CONSTRUCTION: Install foundations in accordance with Item 656, "Foundations for Traffic Control Devices."

A. Pedestal Pole Base. Ground the base with connectors to the 1/2-13 NC female threaded hole. Fabricate the base for 4 L-bend anchor bolts arranged in a square pattern with a 12-3/4-in. bolt circle. Provide mild steel anchor bolts in accordance with TxDOT Item 449, "Anchor Bolts," for each base. Provide three 1/16-in.-thick and three 1/8-in.-thick U-shaped galvanizing steel shims for each base. Size shims to fit around the anchor bolts.

B. Installation. Install pedestal pole assemblies as shown on the plans or as directed. Pedestal pole assemblies include foundation, pole shaft, base, anchor bolts, anchor bolt nuts, anchor bolt template, shims, and miscellaneous components. Watertight breakaway electrical disconnects are required for pedestal pole assemblies used in conjunction with vehicle and pedestrian heads and components.

Use established industry and utility safety practices to erect assemblies near overhead or underground utilities. Consult with the appropriate utility company prior to beginning such work.

Repair damaged galvanizing in accordance with Section 445.3.D, "Repairs."

C. Painted Finish. When required, paint pedestal pole assemblies in accordance with details shown on the plans.

687.5. MEASUREMENT: This Item will be measured by each pedestal pole assembly.

687.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pedestal Pole Assembly." This price is full compensation for furnishing and installing the shaft; base, shims, anchor bolts, and foundation; and materials, equipment, labor, tools, and incidentals.

New signal heads will be paid for under Item 682, "Vehicle and Pedestrian Signal Heads."

687.7. BID ITEM:

Item 687.1 - Pedestal Pole Assembly - per each

ITEM

688 PEDESTRIAN DETECTORS AND VEHICLE LOOP DETECTORS

688.1. DESCRIPTION: *Furnish and install traffic signal detectors.*

688.2. MATERIALS: Furnish all new materials. Furnish and construct materials in accordance with the following:

A. Conduit. Item 618, "Conduit"

B. Ground Boxes. Item 624, "Ground Boxes"

C. Signal Heads. Item 682, "Vehicle and Pedestrian Signal Heads"

D. Traffic Signal Cables. Item 684, "Traffic Signal Cables"

E. Pedestrian Detectors. Ensure the push-button assembly is weather-tight and tamper-proof, is designed to prevent an electrical shock under any weather condition, has provisions for grounding in accordance with the NEC, and is in compliance with the Americans with Disabilities Act (ADA).

Supply a sturdy 2-piece cast-aluminum housing unit consisting of a base housing and a removable cover. Ensure the internal components provide a push button with normal open contacts, and include all electrical and mechanical parts required for operation. Supply housing or an adapter (saddle) that conforms to the pole shape, fitting flush to ensure a rigid installation. Supply adapters of the same material and construction as the housing. Provide threaded holes for 0.5-in. conduit in the housing for any necessary conduit attachment. Close unused openings with a weather-tight closure painted to match the housing. Provide a 0.75-in. hole with an insulating bushing through the back of the housing.

Meet the paint requirements of Item 682, "Vehicle and Pedestrian Signal Heads," for the complete body of the housing.

Ensure the manufacturer's name or trademark is located on the housing. Supply push-button switches that have single-pole, single-throw contacts and screw-type terminals and have a design life of at least 1 million operations.

Use sheet aluminum having a minimum thickness of 0.080 in. for information signs for push buttons.

F. Vehicle Loop Detectors. Unless otherwise shown on the plans, use solid copper No. 14 AWG XHHW cross-linked-thermosetting polyethylene insulated conductor rated for 600 volts AC for vehicle detector loop wire. Ensure each length of wire shows the name or trademark of the manufacturer, the insulation voltage rating, the wire gauge, and the insulation type at approximate 2-ft. intervals on the insulation surface.

When shown on the plans, use flexible vinyl or polyethylene tubing with 0.184 in. minimum I.D., 0.031 in. minimum wall thickness, 0.26 in. maximum O.D., and a smooth bore. Use tubing that does not adhere to the loop wire in any way and is capable of resisting deterioration from oils, solvents, and temperatures up to 212°F. Use tubing that is abrasion-

resistant and remains flexible from –22°F to 212°F. Unless otherwise shown on the plans, use orange or red tubing.

Use sealant for the vehicle detector loops in accordance with Texas Department of Transportation (TxDOT) DMS-6340, "Vehicle Loop Wire Sealant."

G. Audible Pedestrian Signal Units.

1. Supply an APS that includes a pedestrian sign, a pushbutton, and an audible speaker contained in one unit and with the following features:

a. Cuckoo - 1250 Hz and 1000 Hz.

b. Chirp - 2700 to 1700 Hz.

c. Vibrating tactile arrow.

d. Pushbutton locator tone different from cuckoo or chirp.

e. Automatic volume adjustment - 60 dB range.

f. Actuation indicator-tone and light.

g. Extended button press which can be used to request a louder WALK signal and locator tone for subsequent clearance interval.

h. Weather-proof speaker protected by a vandal proof screen.

i. Pole unit and the central control unit shall be rated for the following temperature range: -30°F to +165°F.

j. Audible pedestrian signal units shall be operationally compatible with TS1, TS2, 170 and 2070 controllers, currently used by the City of San Antonio, the Texas Department of Transportation, and any other Texas government entities. In the case of conflicts between specifications, the latest City of San Antonio specifications will control.

k. Substituting Cuckoo and Chirp sounds with "walk" and "don't walk" audible sounds is optional.

l. Supply a central control unit (CCU) for the pushbutton detector unit that resides in the Traffic Signal Controller Cabinet capable of controlling a minimum of 8 units. Ensure the CCU is capable of controlling up to 4 phases. Ensure that all inputs and outputs on the CCU have Transient Voltage Protection.

688.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

688.4. CONSTRUCTION:

A. Pedestrian Detectors. Wire the push button to the nearest splicing point or terminal strip using solid No. 12 AWG XHHW wire with 600-volt insulation. Do not use terminal

connections or splice wire leads except in the hand holes located in the signal pole shaft, in the signal pole base, or at locations approved by the Engineer. All allowed splices must be watertight.

Attach wires to terminal posts with solderless terminals. Attach terminals to the wires with a ratchet-type compression crimping tool properly sized to the wire.

Mount a pedestrian push button sign near each push button as shown on the plans.

B. Vehicle Loop Detectors. Provide the loop location, configuration, wire color, and number of turns shown on the plans. Loops may be adjusted by the Engineer to fit field conditions.

1. **Saw Cuts.** Cut the pavement with a concrete saw to form neat lines. Do not exceed 1 in. in depth on concrete bridge slab saw cuts. Cut all other saw cuts deep enough to provide a minimum of 1 in. depth of sealant over the wire. Unless otherwise shown on the plans, cut a separate saw cut from each loop to the edge of the pavement. Ensure the cut is clean and dry when the wire and sealant are placed.

2. **Conduit.** Place conduit between the pavement and ground box as shown on the plans.

3. **Loop Wire Color.** Unless otherwise shown on the plans, use the following color code. Use white for the first loop on the right followed by black, orange, green, brown, and blue. Use the same color for all loops in the same lane. Loops installed in multi-lanes will have the same color code in the order the loops are installed.

   When facing the same direction that traffic flows, the color code will read from right to left for all lanes carrying traffic in that direction. If traffic moves in 2 directions, the color code will be repeated for the other direction of traffic.

4. **Loop Wire Installation.** When shown on the plans place the loop wire in a flexible vinyl or polyethylene tubing in accordance with Article 688.2, "Materials." The loop wire color requirements do not apply to wires in tubing.

   Twist the wire from the loop to the ground box a minimum of 5 turns per foot. When only 1 pair of wires is in a saw cut, it need not be twisted while in the saw cut. Do not splice loop wire in the loop or in the run to the ground box.

   Hold the loop wire in place every 2 ft. with strips of rubber, neoprene flexible tubing, or polyethylene foam sealant approximately 1 in. long. Leave these strips in place, and fill the slot with loop sealant.

   Splice the loop lead-in cable and loop detector wires only in the ground box near the loop it is serving. Use non-corrosive solder for splices, and ensure that the splice is watertight. Ground the drain wire of the loop lead-in cable to earth ground only at the controller or detector cabinet. Ensure the resistance from the drain wire to the ground rod is less than 1 ohm.

C. Audible Pedestrian Signal Units. Wire the APS to the nearest splicing point or terminal strip using solid No. 12 AWG XHHW wire with 600-volt insulation. Do not use terminal connections or splice wire leads except in the hand holes located in the signal pole shaft, in the signal pole base, or at locations approved by the Engineer. All allowed splices must be

watertight. Attach wires to terminal posts with solderless terminals. Attach terminals to the wires with a ratchet-type compression crimping tool properly sized to the wire.

1. **Documentation Requirements.** Each APS shall be provided with the following documentation:

   a. Complete and accurate installation wiring guide.

   b. Contact name, address, and telephone number for the representative, manufacturer, or distributor for warranty repair.

   c. If requested by the purchaser, the bidders shall supply schematics for all electronics. One schematic diagram shall be provided for each unit, along with any necessary installation instructions.

2. **Warranty.** The Audible Pedestrian Signal unit shall be warranted against any failure due to workmanship, material defects or intensity within the first 60 months of field operation. Audible Pedestrian Signal unit shall operate as required above after 60 months of continuous use over the temperature range of -30°F to +165°F in a traffic signal operation. The manufacturer shall provide a written warranty against defects in materials and workmanship for Audible Pedestrian Signal unit for a period of 60 months after installation. Replacement Audible Pedestrian Signal unit shall be provided within 5 days after receipt of failed Audible Pedestrian Signal unit at no cost to the State, except the cost of shipping the failed modules.

688.5. MEASUREMENT: This Item will be measured by the foot of saw cut containing loop wire, by each pedestrian push button, and by each APS installed per intersection.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Change Order. Additional measurements or calculations will be made if adjustments of quantities are required.

688.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Vehicle Loop Detectors" of the type specified, "Pedestrian Detectors" of the type specified, or "Audible Pedestrian Signal Units" of the type specified. This price is full compensation for furnishing, installing, and testing the detectors; sawcutting, excavation, backfill, sealant, and sealant placement; pavement repair associated with saw-cutting; and equipment, materials, labor, tools, and incidentals, except as follows.

The conduit and loop wire from the edge of pavement to the ground box used for the vehicle loop detectors will not be measured or paid for directly, but will be subsidiary to this Item.

New ground boxes will be paid for under Item 624, "Ground Boxes." New loop lead-in cable will be paid for under Item 684, "Traffic Signal Cables."

688.7. BID ITEM:

Item 688.1 - Vehicle Loop Detectors [Type] - per foot

Item 688.2 - Pedestrian Detectors [Type] - per each

Item 688.3 - Audible Pedestrian Signal Units [Type] - per each

ITEM

691 SPREAD SPECTRUM RADIOS FOR TRAFFIC SIGNALS

691.1. DESCRIPTION: *Furnish and install spread spectrum radios.*

691.2. MATERIALS: Supply complete manufacturer specifications for radio, antennas, cables, connectors, power supply, mounting hardware, and lightning surge protector, including the exact gain of the antenna.

A. Spread Spectrum Radio. Furnish spread spectrum radios with the following operating minimum characteristics:

FREQUENCY	902 - 928 MHz
RANGE	15 Miles line of sight
REPEAT CAPABILITIES	Store and Forward Repeater Capabilities
POWER	1.0 Watt Transmitting Power
ENVIRONMENT	Temperature -22°F to 140°F
FCC APPROVAL	No License Requirements Type acceptance under FCC Part 15.247
DATA CHARACTERISTICS	Half or Full Duplex Operation RS232C interface Selectable1,200 thru 19,200 bps
REGULATED POWER SUPPLY	Voltage 12 DC Amperage 3 Amp Operating Temp -22°F to 140°F

Install the radios as shown on the plans or as directed.

Supply radios with diagnostic software capable of testing the link between the master radio and the remote radios. Provide software capable of detecting channels which are not adequate for the transmission of data and allow for the exclusion of these frequencies in the selection of frequencies to be scanned.

B. Radio Antenna. Furnish radio antennas with the following minimum characteristics:

REMOTE SITE	Unidirectional (Yagi), Minimum 9 dB gain (dB reference to half wave dipole)
MASTER SITE	Omni-directional, Minimum 6 dB gain (dB reference to half wave dipole)
RANGE	15 Miles
IMPEDANCE	50 Ohm
WIND RATING	125 miles per hour
CONNECTORS	Type “N” Female

Mount the antenna on a traffic signal pole, an illumination pole, or a separate steel pole as directed. Ground the antenna to the metal support. Do not use a wood pole or support.

C. Cable. Furnish low loss coaxial cable with the following minimum characteristics:

NOMINAL IMPEDANCE	50 Ohm
MAX ATTENUATION	4.2 dB/100 ft. at 900 MHz

Furnish heliax type cable for runs over 100 ft. in length. Furnish cable connectors with a type "N" male connector. Install cable connectors in accordance with manufacturer's recommendations. Install cable as shown on the plans or as directed.

Furnish a coaxial protector (PolyPhaser IS-50NX-C2, Andrew APG-BNFNF- 090, Huber Suhner 3400-41-0048, or equivalent). Mount coaxial protector adjacent to and bonded to the cabinet ground bus

691.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

691.4. CONSTRUCTION:

A. Testing. Provide a factory certified representative for installation and testing of the equipment. Conduct a test site survey prior to the installation of the equipment. The City reserves the right to conduct their own site survey as needed.

B. Training. When required, provide up to 2 days of training to personnel of the Department in the operation, setup and maintenance of the spread spectrum radio system. Provide instruction and materials for a maximum of 20 persons and at a location selected by the Department. Provide instruction personnel certified by the manufacturer. The User's Guide is not an adequate substitute for practical classroom training and formal certification.

C. Warranty. Provide equipment with no less than 95% of the manufacturer's standard warranty remaining when equipment invoices are submitted for payment. Any equipment with less than 95% of its warranty remaining will not be accepted.

Provide updates of the spread spectrum radio software free of charge during the warranty period, including the update to NTCIP compliancy.

691.5. MEASUREMENT: This Item will be measured by each spread spectrum radio, antenna and by the linear foot of cable furnished and installed.

691.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Spread Spectrum Radio", "Antenna" of the type specified, "Coaxial Cable" and "Heliax Cable". The price is full compensation for furnishing, assembling, and installing the spread spectrum radios, antennas, and the cable; for mounting attachments; for testing, labor, tools, equipment and incidentals.

691.7. BID ITEM:

Item 691.1 - Spread Spectrum Radio - per each

Item 691.2 - Antenna [Type] - per each

Item 691.3 - Coaxial Cable - per each

Item 691.4 - Heliax Cable - per each

ITEM

692 COMMUNICATION CABLE

692.1. DESCRIPTION: *Furnish, install, and test communication cable.*

692.2. MATERIALS: Provide a low-density, high molecular weight polyethylene, aluminum shielded, telephone cable with standard twisted pairings of copper conductors. Provide the number and gauge of working pairs as shown on the plans.

A. Underground Cable. When underground cable is required, provide single-jacketed cable with a 0.008 in. aluminum shield and a filled core (for moisture resistance), in accordance with RUS 1753F 205 (PE-39) "Specification for Filled Telephone Cable."

B. Direct Burial Cable. When direct burial cable is required, provide gopher-resistant, single-jacketed cable with a 0.008 in. aluminum shield and a filled core (for moisture resistance), in accordance with RUS 1753F 205 (PE-39) "Specification for Filled Telephone Cable."

C. Aerial Cable. When aerial cable is required, provide a single-jacketed cable with a 0.008 in. aluminum shield and an integral messenger strand, in accordance with RUS 1753F 205 (PE-39) "Specification for Filled Telephone Cable." If an external messenger is required by the plans, provide a Single-jacketed cable with a 0.008 in. aluminum shield and an external messenger strand, in accordance with the pertinent requirements of Item 625, "Zinc-Coated Steel Wire Strand" and RUS 1753F 205 (PE-39) "Specification for Filled Telephone Cable."

692.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

692.4. CONSTRUCTION: Install communication cable in accordance with the pertinent requirements of the following:

- RUS Form 515a, 1753F 150, "Specifications and Drawings for Construction of Direct Buried Plant"
- RUS Form 515b, 1753F 151, "Specifications and Drawings for Construction of Underground Plant"
- RUS Form 515c, 1753F 152, "Specifications and Drawings for Construction of Aerial Plant"
- National Electrical Safety Code
- National Electrical Code
- Local regulations

Install the number of pairs shown on the plans. The Engineer will not compensate for any pairs of wires over the number shown in the plans. Provide test equipment necessary to test the installed cable. Identify and document any wire pairs that fail the test procedure. Replace cable as directed.

Terminate every cable run that enters a cabinet on a cable termination strip as shown on the plans. When communication cable enters a building, leave 20 ft. of each cable coiled on the floor of the building. Seal the ends of the communication cable to prevent moisture from entering the cable.

A. Splicing. Splice cable in accordance with the pertinent requirements of the following:

- RUS 1753F 401 (PC-2), "Standard for Splicing Copper and Fiber Optic Cable"
- National Electrical Safety Code
- National Electrical Code

B. Inspection, Testing, and Test Reports. Before installation, select representative samples of cable on reels and inspect the samples with the Engineer for the following:

- Proper cable identification on reel identification labels corresponds with shield, number of pairs, gauge size, jacket, etc.
- Physical damage to cable or wet cable
- Presence of filling compound at the ends
- Uniform jacket thickness and tightness of the jacket

Conduct inspection and testing in accordance with RUS Forms 515a, 515b, and 515c. Replace nonconforming reels of cable.

Perform continuity tests for each cable and wire shield containing a splice immediately after installation, before backfilling excavation, under direct supervision of the Engineer. Include tests for leakage, crosses, and splits.

Conduct a joint inspection with the Engineer of splice enclosures, terminals, surge protectors, loading coils, and all other materials necessary for the complete installation.

Inspect and test cable in accordance with pertinent requirements of RUS "Telephone System Construction Contract", and RUS 1753F 401 (PC-2), "Standard for Splicing Copper and Fiber Optic Cable". Test in accordance with the following paragraphs of RUS 1753F 201 (PC-4), "Standard for Acceptance Tests and Measurements of Telecommunications Plant":

- Ground Resistance Measurement
- Shield or Shield/Armor Continuity
- Conductor Continuity
- DC Insulation Resistance (IR) Measurement
- DC Loop Resistance and DC Resistance Unbalance Measurement
- Carrier Insertion Loss Measurement

Perform field testing jointly with the Engineer.

C. Telephone Hand Sets and Jacks. When specified in the plans, provide plug-in telephone handsets for communicating between the central master controller and the intersection controllers.

Provide jacks for plug-in telephone handsets at the central master controller and at each intersection controller.

692.5. MEASUREMENT: This item will be measured by the foot of communication cable installed.

692.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Communication Cable," of the type, size, and number of pairs specified. This price is full compensation for furnishing and installing all messenger strand; pulling through conduit or attaching to overhead messenger strand; excavating and backfilling the trenches, replacing base, seal, riprap, pavement, sod, or other surface treatment; and labor, tools, equipment and incidentals.

692.7. BID ITEM:

Item 692.1 - Communication Cable [Type/Size] - per foot

ITEM

693 INTERNALLY LIGHTED STREET NAME SIGN ASSEMBLIES

693.1. DESCRIPTION: *Furnish and install internally lighted street name sign assemblies.*

693.2. MATERIALS: Provide new material that complies with the details shown on the plans, the requirements of this Item, and the NEC. Provide 6 copies of material brochures, shop drawing submittals, or both.

Provide internally lighted street sign panels that comply with Texas Department of Transportation (TxDOT) DMS-8311, "Internally Illuminated Street Sign Panels." Provide single side message or double side message signs as shown on the plans.

Use a clamp-on street name sign mast arms as shown on the plans. Form mast arm clamp brackets and hanger bars with heat treated aluminum bar stock or galvanized steel.

Provide a mounting bracket as shown on the plans. Use a minimum 3/8 in. stainless steel bar. Provide an adjustment bolt for each mounting bracket.

A. Housing. Construct sign fixture housing of extruded, cast, and fabricated aluminum components. Construct top shell and bottom pan assembly with extruded aluminum alloy 6063-T6 and join to end plates with continuous weld joints. Place a 0.050 in. thick aluminum back side panel for single sided signs.

Provide drip rails on the top shell. Provide 4 screened weep holes at strategic points in the bottom of the housing assembly. Design the housing for continuous gasketing between housing and sign frame members. Use closed cell neoprene sponge rubber gaskets.

Use stainless steel Type 302 or 305, brass, or aluminum fasteners and screws. Galvanize steel nuts, bolts, and hardware in accordance with TxDOT Item 445, "Galvanizing."

Form reflectors using 0.040 in. thick aluminum. Finish the reflector surface with baked white enamel or catalyzed polyurethane finish and a minimum reflectance value of 86%.

Provide a full length extruded aluminum hinge to mount the sign panel to the sign housing. Provide at least 2 knurled knobs, thumb screws, or 1/4 turn wing-head fasteners and at least two 1/4-20 captive nuts to secure the sign panel to the housing.

B. Fluorescent Lamps. Unless otherwise shown on the plans, furnish F36 T12 type lamps. Operate each lamp from 1 lamp ballast. Use U.L. listed ballasts that conform to the requirements of ANSI Standard C 82.1 and C 82.2. Provide instant start type ballast capable of starting lamps at 0°F and above. Use high power factor type ballast that operates on 120 VAC, 60 Hz. Provide ballasts rated at 200 mA. for 6 ft. lamps and 425 mA. for 8 ft. lamps.

Use U.L. listed lamp holders. Provide spring compression type lamp holders with a circular cross section of neoprene rubber. Removal of a lamp will de-energize the primary system of the ballast.

Provide a miniature, slow blow type fuse in the primary circuit of the ballast. Provide surface mounting type fuse holders with threaded bayonet knob.

Use U.L. listed conductors on loadside of power supply terminal block inside fixture. Use 18 AWG stranded wire with 2/64 in. thermoplastic insulation rated at 1000 V., 90°C. Terminate wiring on a 2 pole phenolic barrier type terminal block rated at 30 A., 600 V.

693.3. EQUIPMENT: Provide the machinery, tools and equipment necessary for proper prosecution of the work. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.

693.4. CONSTRUCTION: Fabricate and install internally lighted street name signs as shown on the plans. Sampling of fixtures for testing will be done in accordance with TxDOT Standard Test Method Tex-1110-T, except the minimum sample size is 1. Install signs level and plumb brackets. Attach internally lighted street name signs to traffic signal poles as shown on the plans.

Use established industry and utility safety practices when erecting sings near overhead or underground utilities. Consult with appropriate utility companies prior to beginning work.

Power the internally lighted street name sign from the traffic signal service pole. Install a 20 A. circuit breaker and a photocell for the internally lighted street name sign.

Ground the sign to a grounding conductor connected between the fixture and the grounding conductor in the base of the pole.

693.5. MEASUREMENT: This Item will be measured by each unit installed.

693.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement," will be paid for at the unit bid price for "Internally Lighted Street Name Signs" of the sizes and types specified. This price is full compensation for furnishing and installing the signs; support arm clamp assembly; liquid tight flexible metal conduit; circuit breakers and photocells; and equipment, labor, tools, and incidentals.

693.7. BID ITEM:

Item 693.1 - Internally Lighted Street Name Signs [Type/Size] - per each

ITEM

694 VIDEO IMAGING VEHICLE DETECTION SYSTEM

694.1. DESCRIPTION: *Install a Video Imaging Vehicle Detection System (VIVDS) that monitors vehicles on a roadway via processing of video images and provides detector outputs to a traffic controller or similar device.*

A VIVDS configuration for a single intersection will consist of four (4) variable focal length cameras (unless otherwise specified in the plans), a VIVDS processor system (unless otherwise specified in the plans), a field communications link, and all associated equipment required to setup and operate in a field environment including a video monitor, a field laptop, connectors and camera mounting hardware. The Contractor shall supply support equipment which includes an additional VIVDS processor unit and an additional VIVDS camera per intersection. Support equipment shall be delivered to the City of San Antonio Traffic Operations Traffic Signal Shop. The actual quantity and proposed location of equipment to be furnished, installed and made fully functional, as a complete VIVDS, by the Contractor is shown on the plans.

The system is composed of these principal items: the camera(s), the field communications link between the camera and the VIVDS processor unit, and the VIVDS processor unit along with a PC, video monitor or associated equipment required to setup the VIVDS and central control software to communicate to the VIVDS processor.

The VIVDS Processor Unit must have the capability to interface directly with the Type 332 controller cabinet detector input file.

694.2. DEFINITIONS:

A. VIVDS Processor Unit. The electronic unit that converts the video image provided by the cameras, generates vehicle detections for defined zones, and collects vehicular data as specified.

B. VIVDS Processor System. One or more VIVDS processor modular units required to handle the number of camera inputs.

C. Central Control. A remotely located control center, which communicates with the VIVDS. The VIVDS operator at the central control has the ability to monitor the operation and modify detector placement and configuration parameters. The equipment that constitutes central control is comprised of a workstation microcomputer along with the associated peripherals as described in this special specification.

D. Field Setup Computer. A portable microcomputer used to set up and monitor the operation of the VIVDS processor unit. If required to interface with the VIVDS processor unit, the field setup computer with the associated peripherals described in this special specification and a video monitor, also described in this special specification, must be supplied as part of the VIVDS.

E. Field Communications Link. The communications connection between the camera and the VIVDS processor unit. The primary communications link media may be coaxial cable or fiber optic cable.

F. Remote Communications Link. The communications connection between the VIVDS processor unit and the central control.

G. Camera Assembly. The complete camera or optical device assembly used to collect the visual image. The camera assembly consists of a charged coupled device (CCD) camera, environmental enclosure, sun shield, temperature control mechanism, and all necessary mounting hardware.

H. Occlusion. The phenomenon when a vehicle passes through the detection zone but the view from the sensor is obstructed by another vehicle. This type of occlusion results in the vehicle not being detected by the sensor or when a vehicle in one lane passes through the detection zone of an adjacent lane. This type of occlusion can result in the same vehicle being counted in more than one lane.

I. Detection Zone. The detection zone is a line or area selected through the VIVDS processor unit that when occupied by a vehicle, sends a vehicle detection to the traffic controller or freeway management system.

J. Detection Accuracy. The measure of the basic operation of a detection system (shows detection when a vehicle is in the detection zone and shows no detection when there is not a vehicle in the detection zone).

K. Live Video. Video being viewed or processed at 30 frames per second.

L. Lux. The measure of light intensity at which a camera may operate. A unit of illumination equal to one lumen per square meter or to the illumination of a surface uniformly one meter distant from a point source of one candle.

M. Video Monitor. As a minimum must be a 9-in. black and white monitor with BNC connectors for video in and out.

694.3. FUNCTIONAL CAPABILITIES:

The system software must be able to detect either approaching or departing vehicles in multiple traffic lanes. A minimum of 4 detector outputs and a minimum of 2 video inputs per video processor module card and each card must have a minimum of 24 detection zones. Each zone and output must be user definable through interactive graphics by placing lines and/or boxes in an image on a video or VGA monitor. The user must be able to redefine previously defined detection zones.

The VIVDS must provide real time vehicle detection (within 112 milliseconds (ms) of vehicle arrival).

The VIVDS processor unit must be capable of simultaneously processing information from various video sources, including CCTV video image sensors and video tape players. The video sources may be, but are not required to be, synchronized or line-locked. The video must be processed at a rate of 30 times per second by the VIVDS processor unit.

The system must be able to detect the presence of vehicles in a minimum of 12 detection zones within the combined field of view of all cameras (a minimum of 12 detection zones per camera input to the VIVDS processor unit).

Detection zones must be provided that are sensitive to the direction of vehicle travel. The direction to be detected by each detection zone must be user programmable.

The VIVDS processor unit must compensate for minor camera movement (up to 2% of the field of view at 400 ft.) without falsely detecting vehicles. The camera movement must be measured on the unprocessed video input to the VIVDS processor unit.

The camera must operate while directly connected to VIVDS Processor Unit.

Once the detector configuration has been downloaded or saved into the VIVDS processor unit, the video detection system must operate with the monitoring equipment (monitor and/or laptop) disconnected or on-line.

When the monitoring equipment is directly connected to the VIVDS processor unit, it must be possible to view vehicle detections in real time as they occur on the field setup computer's color VGA display or the video monitor.

694.4. VEHICLE DETECTION:

A. Detection Zone Placement. The video detection system must provide flexible detection zone placement anywhere within the combined field of view of the image sensors. Preferred presence detector configurations must be lines or boxes placed across lanes of traffic or lines placed in line with lanes of traffic. A single detector must be able to replace one or more conventional detector loops. Detection zones must be able to be fully overlapped. In addition, detection zones must have the capability of implementing “AND” and “OR” logical functions including presence, extension and delay timing. These logical functions may be excluded if provisions are made to bring each detector separately into the controller and the controller can provide these functions.

B. Detection Zone Programming. Placement of detection zones must be by means of a graphical interface using the video image of the roadway. The monitor must show images of the detection zones superimposed on the video image of traffic while the VIVDS processor is running.

The detection zones must be created by using the mouse or keypad to draw detection zones on the monitor. The detection zones must be capable of being sized, shaped and overlapped to provide optimal road coverage and detection. It must be possible to upload detector configurations to the VIVDS processor unit and to retrieve the detector configuration that is currently running in the VIVDS processor unit.

The mouse or keypad must be used to edit previously defined detector configurations so as to fine tune the detection zone placement size and shape. Once a detection configuration has been created, the system must provide a graphic display of the new configuration on its monitor. While this fine-tuning is being done, the detection must continue to operate from the detector configuration that is currently called.

When a vehicle occupies a detection zone, the detection zone on the live video must indicate the presence of a vehicle, thereby verifying proper operation of the detection system. With the absence of video, the card must have an LED that will indicate proper operation of the detection zones.

Detection zones must be provided that is sensitive to the direction of vehicle travel. The direction to be detected by each detection zone must be user programmable. The vehicle detection zone should not activate if a vehicle traveling any direction other than the one specified for detection occupies the detection zone. Cross-street and wrong way traffic should not cause a detection.

C. Design Field of View. The video detection system must reliably detect vehicle presence in the design field of view. The design field of view must be defined as the sensor view when the image sensor is mounted 24 ft. or higher above the roadway, when the camera is adjacent (within 15 ft.) to the edge of the nearest vehicle travel lane, and when the length of the detection area is not greater than 10 times the mounting height of the image sensor. Within this design field of view, the VIVDS processor unit must be capable of setting up a single detection zone for point detection (equivalent to the operation of a 6 ft. by 6 ft. inductive loop). A single camera, placed at the proper mounting height with the proper lens, must be able to monitor up to and including 5 traffic lanes simultaneously.

D. Detection Performance. Detection accuracy of the video detection system must be comparable to properly operating inductive loops. Detection accuracy must include the presence of any vehicle in the defined detection zone regardless of the lane, which the vehicle is occupying. Occlusion produced by vehicles in the same or adjacent lanes must not be considered a failure of the VIVDS processor unit, but a limitation of the camera placement. Detection accuracy (a minimum of 95%) must be enforced for the entire design field of view on a lane by lane and on a time period basis. When specified in the plans, furnish up to 24 continuous hours of recorded video of all installed intersection cameras within the 30 day test period for verification of proper camera placement, field of view, focus, detection zone placement, processor setup and operation. The video from each camera must show vehicle detections for all zones.

E. Equipment failure, either camera or VIVDS processor unit, must result in constant vehicle detection on affected detection zones.

694.5. VIVDS PROCESSOR UNIT:

A. Cabinet Mounting. The VIVDS processor unit must be rack mountable.

B. Environmental Requirements. The VIVDS processor unit must be designed to operate reliably in the adverse environment found in the typical roadside traffic cabinet. It must meet the environmental requirements set forth by the latest NEMA (National Electrical Manufacturers Association) TS1 and TS2 standards as well as the environmental requirements for Type 170, Type 179 and 2070 controllers. Operating temperature must be from -30°F to +165°F at 0% to 95% relative humidity, non condensing.

C. Electrical. The VIVDS must have a modular electrical design.

The VIVDS must operate within a range of 89 to 135 VAC, 60 Hz single phase. Power to the VIVDS must be from the transient protected side of the AC power distribution system in the traffic control cabinet in which the VIVDS is installed.

Serial communications to the field setup computer must be through an RS 232, USB or Ethernet port. This port must be able to download the real time detection information needed to show detector actuations. A connector on the front of the VIVDS processor unit must be used for serial communications.

The unit must be equipped with RS 170 (monochrome) or RS170A (color) composite video inputs video inputs, so that signals from image sensors or other synchronous or asynchronous video sources can be processed in real time. BNC connectors on the front of the VIVDS processor unit or video patch panel must be used for all video inputs.

The unit must be equipped with a single RS 170 composite video output. This output must be capable of corresponding to any one of the video inputs, as selected remotely via the field setup computer or front panel switch. Multiple video outputs requiring external cable connections to create a combined single video output must not be acceptable. A BNC or RCA connector must be used for video output on the front of the processor unit. Any other video formats used must prior approval by the City's Signal Operations Engineer.

Software upgrades and/or changes MUST be presented to and approved by the City Traffic Engineering division, before being used. Failure to do so will be grounds for termination of contract and probation for responsible party(s).

The unit software and the supervisor software must include diagnostic software to allow testing the VIVDS functions. This must include the capability to set and clear individual detector outputs and display the status of inputs to enable setup and troubleshooting in the field.

694.6. CAMERA ASSEMBLY:

A. Camera. The video detection system must use medium resolution, monochrome image sensors as the video source for real time vehicle detection. The cameras must be approved for use with the VIVDS processor unit by the supplier of the VIVDS. As a minimum, each camera must provide the following capabilities:

1. Images must be produced with a Charge Coupled Device (CCD) sensing element with horizontal resolution of at least 480 lines for black and white or 470 lines for color and vertical resolution of at least 350 lines for black and white or color. Images must be output as a video signal conforming to RS170.

2. Useable video and resolvable features in the video image must be produced when those features have luminance levels as low as 0.1 lux for black and white, and as low as 1.0 lux for color, for night use.

3. Useable video and resolvable features in the video image must be produced when those features have luminance levels as high as 10,000 lux during the day.

4. The camera must include an electronic shutter or auto-iris control based upon average scene luminance and must be equipped with an electronic shutter or auto-iris lens with variable focal length and variable focus that can be adjusted without opening up the camera housing to suit the site geometry. The variable focal length must be adjustable from 6 mm to 34 mm.

B. Camera and Lens Assembly. The camera and lens assembly must be housed in an environmental enclosure that provides the following capabilities:

1. The enclosure must be waterproof and dust tight to the latest NEMA 4 specifications.

2. The enclosure must allow the camera to operate satisfactorily over an ambient temperature range from -30°F to +165°F while exposed to precipitation as well as direct sunlight.

3. The enclosure must allow the camera horizon to be rotated in the field during installation.

4. The enclosure must include a provision at the rear of the enclosure for connection of power and video signal cables fabricated at the factory. Input power to the environmental enclosure must be nominally 115 VAC 60 Hz.

5. A thermostatically controlled heater must be at the front of the enclosure to prevent the formation of ice and condensation, as well as to assure proper operation of the lens's iris mechanism. The heater must not interfere with the operation of the camera electronics, and it must not cause interference with the video signal.

6. The enclosure must be light colored or unfinished and must include a sun shield to minimize solar heating. The front edge of the sunshield must protrude beyond the front edge of the environmental enclosure and must include provision to divert water flow to the sides of the sunshield. The amount of overhang of the sun shield must be adjustable to block the view of the horizon to prevent direct sunlight from entering the lens. Any plastics used in the enclosure must include ultra violet inhibitors.

7. The total weight of the image sensor in the environmental enclosure with sunshield must be less than 10 lb.

8. When operating in the environmental enclosure with power and video signal cables connected, the image sensor must meet FCC class B requirements for electromagnetic interference emissions.

The video output of the cameras must be isolated from earth ground. All video connections for the cameras to the video interface panel must also be isolated from earth ground.

Use waterproof, quick disconnect connectors to the image sensor for both video and power.

A camera interface panel capable of being mounted to sidewalls of a controller cabinet must be provided for protection of the VIVDS processor unit, camera video and power inputs/outputs. The panel must consist of, as a minimum, 4 Edco CX06 coax protectors, a Edco ACP-340 for the cameras and VIVDS processor unit power, a 10 amp breaker, a convenience outlet protected the ACP-340 and a terminal strip with a minimum of sixteen 8-32 binder head screws. The terminal strip must be protected by a piece of 1/8 in. Plexiglas.

When the connection between the image sensor and the VIVDS processor unit is coaxial cable, the coaxial cable used must be a low loss, 75 ohm, precision video cable suited for outdoor installation, such as Belden 8281 or TxDOT approved equal.

Camera mounting hardware must allow for vertical or horizontal mounting to the camera enclosure. Pelco AS-0166-4-62 or equivalent is acceptable.

694.7. FIELD COMMUNICATION LINK: The field communications link must be a one way communications connection from the camera to the equipment cabinet. The primary communications link media may be coaxial cable or fiber optic cable accompanied by a 3

conductor minimum 18 AWG, 24 VDC or 115 VAC camera power cable, or appropriate cable as approved.

The following requirements must govern for the various types of field communications link media described on the plans:

A. Coaxial Cable. In locations where the plans indicate coaxial cable is required as the primary communications link, this cable must be of the RG 59 type with a nominal impedance of 75 ohms. All cable must have a polyethylene dielectric with copper braid shield having a minimum of 98 percent shield coverage and not greater than 0.78 dB attenuation per 100 ft. at 10 MHz with a minimum 18 AWG external 3 conductor power cable or approved equivalent as directed by the Engineer.

B. Fiber Optic Cable. If specified by the plans, furnish fiber optic cable in accordance with the special specification for fiber optic cable.

C. Twisted Wire Pairs. Must be Belden 9556 or equivalent 18 AWG TWP control cable.

All connection cables must be continuous from the equipment cabinet to the camera. No splices of any type will be permitted.

Install lightning and transient surge suppression devices on the processor side of the field communications link to protect the peripheral devices. The suppression devices must be all solid state. Lightning protection is not required for fiber optic communication lines. The devices must present high impedance to, and must not interfere with, the communications lines during normal operation. The suppression devices must not allow the peak voltage on any line to exceed 300% of the normal operating peak voltage at any time. The response time of the devices must not exceed 5 nanoseconds.

694.8. VIVDS SET-UP SYSTEM: The minimum VIVDS set-up system, as needed for detector setup and viewing of vehicle detections, must consist of a field setup computer and Windows based interface software (if required) or a video monitor with interface software built-in to the VIVDS processor unit. Live video (30 frames per second) must be available on the field setup computer to determine proper operation of detectors. The field set-up computer as a minimum, must have an NTSC video input port or equivalent.

If a field setup computer is required for system set-up, it must be supplied by the supplier of the VIVDS.

The field setup computer must include all necessary cabling and a Windows based program to interface with the VIVDS processor unit. This software must provide an easy to use graphical user interface and support all models/versions of the supplied VIVDS.

Live video with the detection overlaid is required for field verification of the system.

694.9. TEMPORARY USE AND RETESTING:

A. Temporary Use. When shown on the plans, the VIVDS equipment must be used to provide vehicle detection on a temporary basis. When the permanent vehicle detection system and related equipment are installed and made operational, the VIVDS equipment must be carefully removed and delivered to the location shown on the plans.

B. State Retesting and Acceptance. Prior to acceptance, all VIVDS equipment may be retested by the State, even if the system was operating properly before removal. Repair or replace any equipment damaged during removal or transport and any equipment that does not meet the various test requirements.

694.10. OPERATION FROM CENTRAL CONTROL: The central control must transmit and receive all information needed for detector setup, monitor the vehicle detection, view the vehicle traffic flow at a rate of 2 frames per second or greater for telephone, or 5 frames a second or greater for ISDN lines (as specified by the plans), and interrogate all required stored data. The remote communications link between the VIVDS processor unit and central control may be dial-up (telephone or ISDN lines) or dedicated twisted wire pair communications cable which may be accompanied with coaxial cable or fiber-optic cable, as shown on the plans. Communications with the central control must not interfere with the on-street detection of the VIVDS processor. Quality of the video at 2 frames per second rate must be such that the view with the traffic flow is clear and in focus.

694.11. INSTALLATION AND TRAINING: The supplier of the video detection system must supervise the installation and testing of the video and computer equipment. A factory certified representative from the supplier must be on site during installation.

In the event that the field setup computer is furnished by the contracting agency, such installation and testing must be done at the time that training is conducted.

Provide up to 2 days of training to the contracting agency personnel in the operation, setup and maintenance of the video detection system. Provide instruction and materials for a maximum of 20 persons and conduct at a location selected by the contracting agency. The contracting agency will be responsible for any travel and room and board expenses for its own personnel.

Instruction personnel are required to be certified by the equipment manufacturer. The User's Guide is not an adequate substitute for practical, classroom training and formal certification by an approved agency.

Formal levels of factory authorized training are required for installers, contractors and system operators. All training must be certified by the manufacturer.

694.12. WARRANTY, MAINTENANCE AND SUPPORT: The video detection system must be warranted to be free of defects in material and workmanship for a period of 5 years from date of shipment from the supplier's facility. During the warranty period, the supplier must repair with new or refurbished materials, or replace at no charge, any product containing a warranty defect provided the product is returned FOB to the supplier's factory or authorized repair site. Return product repair or replaced under warranty by the supplier with transportation prepaid. This warranty does not apply to products damaged by accident, improperly operated, abused, serviced by unauthorized personnel or unauthorized modification.

During the warranty period, technical support must be available from the supplier via telephone within 4 hours of the time a call is made by a user, and this support must be available from factory certified personnel or factory certified installers.

Ongoing software support by the supplier must include updates of the VIVDS processor unit and supervisor software (if a field setup computer is required for set up). Provide these updates free of charge during the warranty period. The update of the VIVDS software to be NTCIP compliant must be included.

The supplier must maintain a program for technical support and software updates following expiration of the warranty period. Make this program available to the contracting agency in the form of a separate agreement for continuing support.

The supplier must maintain an ongoing program of technical support for the wireless camera system. This technical support must be available via telephone or personnel sent to the installation site.

The supplier must maintain an adequate inventory of parts to support maintenance and repair of the camera system.

694.13. MEASUREMENT: The VIVDS will be measured as each major system component furnished, installed, made fully operational, and tested in accordance with this special specification or as directed by the Engineer.

The VIVDS communication cable will be measured by the linear foot of the appropriate media type furnished, installed, made fully operational, and tested in accordance with this specification, other referenced Special Specifications or as directed by the Engineer.

When the VIVDS is used on a temporary basis, the VIVDS must be measured as each system furnished, installed, made fully operational, including reconfiguration and removal if required by the plans, and tested in accordance with this special specification or as directed by the Engineer.

This is a plans quantity measurement Item. Unless modified by Change Order, the quantity to be paid is the quantity shown in the proposal and in the "Estimate and Quantity" sheet of the contract plans. Additional measurements or calculations will be made if adjustments of quantities are required.

When recorded video is required by the plans it will be paid for by each camera recorded.

694.14. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for each item listed in Section 694.15, "Bid Items", and all accompanying software. These prices are full compensation for furnishing, placing, and testing all materials and equipment, and for all tools, labor, equipment, hardware, operational software package(s), supplies, support, personnel training, shop drawings, documentation, and incidentals. A 3-conductor power cable must be included with the communication cable.

The Contractor shall furnish one (1) VIVDS Processor Unit for each VIVDS Camera Assembly.

These prices also include any and all interfaces required for the field and remote communications links along with any associated peripheral equipment, including cables; all associated mounting hardware and associated field equipment; required for a complete and fully functional visual image vehicle detection system component.

694.15. BID ITEMS:

Item 694.1 - VIVDS Processor Unit - per each

Item 694.2 - VIVDS Camera Assembly - per each

Item 694.3 - VIVDS Central Control - per each

Item 694.4 - VIVDS Set-up System - per each

Item 694.5 - VIVDS Temporary - per each

Item 694.6 - VIVDS Communication Cable (Coaxial) - per linear foot

Item 694.7 - VIVDS Communication Cable (Fiber Optic) - per linear foot

Item 694.8 - VIVDS Video Recording - per each

ITEM

695 EMERGENCY VEHICLE TRAFFIC SIGNAL PRIORITY CONTROL SYSTEM

695.1. DESCRIPTION: *This Item governs the furnishing and installation of emergency vehicle traffic signal priority control system in field location(s) as shown on the plans and as detailed herein. This system shall enable designated vehicles to remotely cause the traffic signal controller to advance to and/or hold a desired traffic signal display by using existing controller functions.*

The system shall consist of the following components:

A. ***Emergency Preemption Emitter:*** *This shall be mounted on the emergency vehicle and shall transmit optical energy signals only in the forward direction.*

B. ***Emergency Preemption Phase Selector:*** *This shall cause the signal controller to advance to and/or hold the desired traffic signal display for the emergency vehicle.*

C. ***Emergency Preemption Detector:*** *This shall be mounted on or near a traffic signal and shall receive the optical energy signals generated by the vehicle emitter.*

D. ***Emergency Preemption Detector Cable:*** *This is used for communication between Emergency Preemption Detector and Emergency Preemption Phase Selector.*

695.2. MATERIALS: Provide new, corrosion resistance materials for all items furnished, assembled, fabricated or installed under this Item, in strict accordance with the details shown on the plans and in the specifications.

695.3. EQUIPMENT:

A. Emergency Preemption Emitter.

1. Functional Requirements.

a. Provide a compact, single source Emergency Preemption Emitter that shall consist of a high priority emitter and is compatible with all other equipment used for this project.

b. The Emergency Preemption Emitter shall have isolated power supply and emitter for positive or negative ground vehicle power system.

c. The Emergency Preemption Emitter shall have discrete, penetrating infrared communication that is directional, consistent day and night transmission, and all weather performance.

d. The Emergency Preemption Emitter shall also consist of power supply and an Emitter Control Switch assembly. The Emitter assembly will be mounted on a vehicle and shall produce a flashing optical signal with a controlled repetition rate and shall have the capability for adjusting intensity.

e. The Emergency Preemption Emitter shall comprise of a flash-tube/reflector and housing assembly with an integral power supply and the required cables.

f. The Emergency Preemption Emitter shall have the capability to be customized through its interface software.

g. The Emergency Preemption Emitter shall be controlled by a single on/off switch that requires no other adjustments by the operator. The on/off condition shall be indicated by a light located adjacent to the switch.

h. The Emergency Preemption Emitter shall have a command (high) and advantage (low) priority operation as well as probe frequency capability selected by model and switch combination.

i. The Emergency Preemption Emitter shall have a remote range setting capability, meet FCC part 15, subpart J, Class A regulations for electromagnetic interference, RS-485, and J1708 serial interface.

j. The Emergency Preemption Emitter shall be automatically disabled or de-activated by one or a combination of the following: seat switch, emergency brake switch, door switch, and transmission safety switch, and is indicated by slow flashing of the emitter switch indicator light.

k. The Emergency Preemption Emitter shall separate timed pulses of high intensity light in the infrared and visible wavelengths at the base flash rate of approximately 10, 12, or 14 Hz. It shall also interleave programmed encoded pulses that carry the vehicle class and ID number information.

l. The Emergency Preemption Emitter shall have a cumulative flash counts available through the interface software.

m. The Emergency Preemption Emitter shall be configured with a grating for precise directionality control.

n. The Emergency Preemption Emitter shall have an optional light-blocking filter.

o. The Emergency Preemption Emitter shall produce optical energy in a cone of not more than 90 degrees horizontal and not more than 30 degrees vertical. The detectors and/or phase selector shall not sense a pre-emption signal from an emitter outside this cone.

p. The Emergency Preemption Emitter shall have a transmission range up to 2,500 ft. with clear lens and up to 1,800 ft. with visible light filter.

q. Contractor shall supply switches as approved by the engineer and shall be subsidiary to this pay item.

r. Contractor shall supply the interface software kit including but not limited to instructional manual, cables, interface software, and storage container and shall be subsidiary to this item.

s. Contractor shall install the software on a workstation designated by the City. This work shall be subsidiary to this item.

2. Electrical Requirements.

a. The Emergency Preemption Emitter shall operate on 10 to 15 volts DC input voltage, but shall not be damaged by input voltage surges up to 25 volts DC.

b. The Emergency Preemption Emitter shall not generate voltage transients on the battery input line which exceed battery voltage by more than four volts.

c. The Emergency Preemption Emitter shall convert 12 Volt DC vehicle battery power to the high voltage required for operation of the unit.

d. The Emergency Preemption Emitter shall draw less than 5 amps peak current.

3. Mechanical Requirements.

a. The Emergency Preemption Emitter shall be a compact, lightweight, weather resistant encoded signal device intended for use on priority and probe vehicles.

b. The Emergency Preemption Emitter shall have the installation flexibility to mount directly on vehicle or ability to be installed into most lightbars.

c. The Emergency Preemption Emitter shall operate over an ambient temperature range of minus 30°F to plus 140°F.

d. The Emergency Preemption Emitter shall operate in 0 to 95% humidity.

B. Emergency Preemption Phase Selector.

1. Functional Requirements.

a. Provide Emergency Preemption Phase Selector that shall be compatible with all other equipment used for this project.

b. The Emergency Preemption Phase Selector shall be a plug-in two channel, dual priority, encoded signal device. It shall have the capability to be installed directly into the input file of Type 2070 traffic controllers equipped with priority phase selection software and in virtually any other traffic controller equipped with priority phase selection inputs and related software.

c. The Emergency Preemption Phase Selector shall recognize and discriminate among three distinct emitter frequency rates via Emergency Preemption Detectors:

(1) Command priority,

(2) Advantage priority, and

(3) probe vehicles.

Within each of these three frequency rates, the Emergency Preemption Phase Selector shall further discriminate among 10 classes of vehicle identification codes, with 1,000 individual vehicle codes per class - 10,000 total per frequency rate.

d. When Emergency Preemption Detector signals are recognized as a valid call, the Emergency Preemption Phase Selector shall cause the signal controller to advance to and/or hold the desired traffic signal display. This is accomplished by utilizing Emergency Preemption Phase Selector circuitry in conjunction with normal internal controller functions.

e. The Emergency Preemption Phase Selector shall be capable of assigning priority traffic movement to one of two channels on a first come, first serve basis. Each channel shall be connected to select a particular traffic movement from those normally available within the controller.

f. Once a call is recognized, "commit to green" circuitry in the Emergency Preemption Phase Selector shall function so that the desired green indication will be obtained even if optical communication is lost. After serving a priority traffic demand, the Emergency Preemption Phase Selector shall release the controller to follow normal sequence operation.

g. The phase selector shall not change the timing of the following intervals for any normal controller phase:

(1) Minimum green,

(2) WALK,

(3) Pedestrian clearance,

(4) Yellow change,

(5) Red clearance,

h. The Emergency Preemption Phase Selector shall also have the following features:

(1) Two auxiliary detectors per channel,

(2) Compatible with encoded signal and non-encoded emitters,

(3) Computer-based interface,

- RS232 communications front port, and rear backplane
- User-selected communications baud rate 1200 to 9600 bits per second
- Customizable ID code validation

(4) Erasable write-on pads for phase or movement labeling,

(5) Unit can be operated without computer configuration,

(6) Crystal controlled circuitry,

- Accurate optical signal recognition circuitry
- Precise output pulse

- Definitive call verification

(7) Optically isolated outputs,

(8) Front panel switches and diagnostic indicators for testing,

(9) Multi-function test switch,

- High and low test calls
- Reset to default parameters
- Range setting
- Diagnostic test

(10) Internally record each activation of the system. Each entry shall contain the:

- Intersection name
- Date and time of the activity
- Vehicle class code of the activating vehicle
- Activating vehicle's ID number
- Channel called
- Priority of the activity
- Final green signal indications displayed at the end of the call
- Time spent in the final greens
- Duration of the activation
- Near intersection location information

2. Electrical Requirements.

a. The Emergency Preemption Phase Selector shall be powered from AC mains and shall provide 24-volt DC output for its associated Emergency Preemption Detectors.

b. The Emergency Preemption Phase Selector shall utilize solid state and relay circuitry to interface between the Emergency Preemption Detector and the traffic signal controller.

c. The Emergency Preemption Phase Selector shall supply power to and receive electrical signals from the Emergency Preemption Detector.

d. The Emergency Preemption Phase Selector shall be tested to NEMA electrical test specifications.

e. The Emergency Preemption Phase Selector shall operate at a voltage range of 89 to 135 VAC +10% and 60Hz + 3Hz.

f. Provide equipment that is not affected by the transient voltages, surges and sags normally experienced on commercial power lines. It is the Contractor's responsibility to check the local power service to determine if any special design is needed for the equipment. Any extra cost, if required, is subsidiary to this Item.

g. Install appropriate surge protectors in the cabinet for the Emergency Preemption Phase Selector and Emergency Preemption Detector.

h. Provide equipment that meets the requirements of Sec. 2.1.6, "Transients, Power Service" of the NEMA Standard TS2-1992, and/or the latest revision.

i. Provide all wiring to the requirements of the National Electric Code. Cut all wires to proper length. Provide cable slacks to facilitate removal and replacement of assemblies, panels, and modules. Do not double back any wires to take up slack. Neatly lace wires into cable with nylon lacing or plastic straps. Secure cables with clamps.

j. Provide diodes or other protective devices across the coils of all DC relays, solenoids, and holding coils for transient suppression.

k. Furnish equipment with readily accessible, manually re-settable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.

l. Design the equipment such that the failures of the equipment shall not cause the failure of any other unit of equipment.

3. Mechanical Requirements.

a. Furnish equipment that is modular in design to allow major portions to be readily replaced in the field.

b. The Emergency Preemption Phase Selector shall have mechanically key modules of unlike functions to prevent insertion into the wrong socket or connector.

c. Clearly identify all modules and assemblies with name, model number, serial number, and any other pertinent information required to facilitate equipment maintenance.

d. Make all external connections by means of connectors. Key the connectors to preclude improper hookups. Color code and/or appropriately mark all wires to and from the connectors.

e. Pleat every conductive contact surface or pin with no less than 20 microns of gold.

f. Provide equipment that meets all its specified requirements during and after being subjected to any combination of the following requirements:

(1) Ambient temperature range of -35°F to +165°F

(2) Relative humidity from 0% to 95%

g. A card rack shall be supplied with every Emergency Preemption Phase Selector.

h. The card rack shall be a metallic enclosure with a dedicated card slot for one phase selector with either two or four channel units.

i. The front panel of the card rack shall include a terminal strip for connecting the detectors, as well as a 9-pin circular connector and harness to connect the phase selector's inputs and outputs.

j. The card rack shall be subsidiary to the Emergency Preemption Phase Selector.

C. Emergency Preemption Detector.

1. Functional Requirements.

a. Provide Emergency Preemption Detector that is compatible with all other equipment used for this project. Furnish Emergency Preemption Detector that shall seamlessly operate with the vehicle emitters used in the project area.

b. The Emergency Preemption Detector shall transform the optical energy detected from an approaching, vehicle mounted emitter to an electrical signal. The electrical signal shall be transmitted along an Emergency Preemption Detector Cable to the Emergency Preemption Phase Selector for processing.

c. The Emergency Preemption Detectors shall permit a direct, unobstructed line-of-sight to vehicle approaches. The Emergency Preemption Detector shall be designed for two direction - single channel configuration.

d. The Emergency Preemption Detector shall have a cone of detection of not more than 13 degrees. The Emergency Preemption Detector and/or Emergency Preemption Phase Selector shall not sense a pre-emption signal from an emitter outside this cone.

e. The Emergency Preemption Detector shall also have the following features:

(1) Solid state circuitry

(2) Advanced electrical transient immunity

f. The Emergency Preemption Detector shall have a reception range of 200 ft. and is adjustable up to 2500 ft.

2. Electrical Requirements. The Emergency Preemption Detector shall operate at an electrical voltage of 24 to 28 VDC, 50 MA minimum.

3. Mechanical Requirements.

a. The Emergency Preemption Detector shall operate at a temperature range of -30ºF to 165ºF.

b. The Emergency Preemption Detector shall include mounting hardware, as specified, for mast arm mounting, span wire mounting, pole-side mounting, mounting on top of a signal head, or mounting on top of a pipe or pedestal.

c. The Emergency Preemption Detector shall have an adjustable turret configuration to accommodate skewed approaches.

d. The Emergency Preemption Detector housing shall be of light weight, durable, high-impact polycarbonate material having stainless steel and brass fittings.

e. The Emergency Preemption Detector shall operate at a humidity of 5% to 95% relative.

D. Emergency Preemption Detector Cable.

1. Functional Requirements.

a. Provide Emergency Preemption Detector Cable that shall be compatible with all other equipment used for this project.

b. The Emergency Preemption Detector Cable shall be individually tinned copper strand three-conductor cable with yellow, orange, and blue conductor wires. It shall also have a bare shield drain wire.

2. Electrical Requirements.

a. The Emergency Preemption Detector Cable shall be AWG #20 (7x28), stranded with conductor insulation of 600 volt, 75°C (167°F).

b. The Emergency Preemption Detector Cable shall have a DC resistance not to exceed 11.0 ohms per 1000 ft.

c. The capacitance from one conductor to other 2 conductors and shield shall not exceed 48 pf./ft.

d. Mechanical Requirements. The Emergency Preemption Detector Cable shall also have the following features:

(1) Jacket: 600 volts, 80°C (176°F), minimum average wall thickness 0.045 in.

(2) Finished O.D.: 0.3 in. max.

695.4. CONSTRUCTION:

A. General.

1. Utilize the latest available techniques with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality for equipment construction.

2. Design the equipment for ease of maintenance, with all component parts readily accessible for inspection and maintenance. Provide test points for checking essential voltages and waveforms.

B. Electronic Components. Furnish all electronic components in compliance with TxDOT Special Specification 6013 (or latest version), "Electronic Components."

C. Mechanical Components.

1. Use stainless steel for all external screws, nuts, and locking washers; do not use any self-tapping screws unless approved by the Engineer.

2. Fabricate all parts of corrosion resistant material, such as plastic, stainless steel, anodized aluminum, or brass.

3. Protect all materials used in construction from fungus growth and moisture deterioration.

4. Separate all dissimilar metals with an inert dielectric material.

5. All equipment shall be installed and wired in a neat and orderly manner in conformance with the manufacturers' instructions.

6. Emergency Preemption Detector Cables shall be installed continuous with no splices between the Emergency Preemption Detector and the cabinet.

7. Emergency Preemption Detector locations shown on the plan are for illustration purposes only. Exact location shall be determined by the manufacturer or the designated representative or the site engineer for the best possible line of sight.

8. All connections from the Emergency Preemption Phase Selector to the cabinet wiring shall be made at the termination panel. The termination panel shall have AC+ Lights, AC-, and a switched logic ground. The switched logic ground feeds all the pre-empt inputs to the Emergency Preemption Phase Selector. When switched off by the preemption disconnect switch, the traffic controller shall not be affected by preempt calls from the optical preemption system. A minimum of two test buttons shall be provided. If there are more than two preempt runs, a button for each shall be installed. A chart or print out, indicating the program steps and settings shall be provided along with the revised cabinet wiring diagrams.

D. Testing.

1. Conduct testing in accordance with the TxDOT Special Specification 6011 (or latest version), "Testing, Training, Documentation, Final Acceptance and Warranty" Sections 2. through 2.(F).

2. Contractor shall notify and provide copies of test plans to the City 2 weeks prior to the scheduled test date.

3. If a malfunction is found or the system needs adjustment (such as range, emitter intensity, or detector location), schedule a follow-up test.

4. All adjustments such as Emergency Preemption Phase Selector range, sensitivity, detector placement, shall be made at the intersection, by the contractor so that the optical preemption operates correctly with other major manufacturers' equipment currently owned by the agencies in the project area.

E. Training.

1. Provide training in accordance with TxDOT Special Specification 6011 (or latest version), "Testing, Training, Documentation, Final Acceptance and Warranty," Article 3.

2. Contractor shall provide one eight-hour emergency preemption software training session for 10 people at a facility designated by the City. The contractor shall pay for all expenses incurred during the training. This work shall be subsidiary to various bid items under this specification.

F. Documentation Requirements. Provide documentation in accordance with the TxDOT Special Specification 6011 (or latest version), "Testing, Training, Documentation, Final Acceptance and Warranty," Article 4.

G. Warranty. Provide a warranty in accordance with the TxDOT Special Specification 6011 (or latest version), "Testing, Training, Documentation, Final Acceptance and Warranty," Article 6.

695.5. MEASUREMENT: This Item will be measured as follows:

A. "Emergency Preemption Emitter" shall be measured as each unit furnished in accordance with the requirements of this specification or as directed by the Engineer.

B. "Emergency Preemption Phase Selector" shall be measured as each unit furnished, installed, made fully operational and tested in accordance with the requirements of this specification or as directed by the Engineer.

C. "Emergency Preemption Detector" shall be measured as each unit furnished, installed, made fully operational and tested in accordance with the requirements of this specification or as directed by the Engineer.

D. "Emergency Preemption Detector Cable" shall be measured in foot of cable furnished, installed, made fully operational and tested in accordance with the requirements of this specification or as directed by the Engineer.

695.6. PAYMENT: The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Emergency Preemption Emitter," "Emergency Preemption Phase Selector," "Emergency Preemption Detector," and "Emergency Preemption Detector Cable." This price will include all equipment described under this Item with all cables and connectors, all documentation and testing; and includes the cost of furnishing all labor, materials, training, warranty, equipment, and incidentals.

695.7. BID ITEM:

Item 695.1 - Emergency Preemption Emitter - per each

Item 695.2 - Emergency Preemption Phase Selector - per each

Item 695.3 - Emergency Preemption Detector - per each

Item 695.4 - Emergency Preemption Detector Cable - per foot

PROJECT SCHEDULING & DATA MANAGEMENT

ITEM

700 COST LOADED PROJECT SCHEDULES

700.1. DESCRIPTION: *This item shall govern the creation, maintenance, and delivery of Critical Path Method (CPM) project schedules.*

700.2. CRITICAL PATH METHOD PROJECT SCHEDULE: The Contractor shall create and maintain a Critical Path Method (CPM) Project Schedule showing the manner of execution of work that he intends to follow in order to complete the contract within the allotted time. The project schedule shall employ computerized CPM for the planning, scheduling and reporting of the work as described in this specification. The CPM project schedule shall be prepared using the Precedence Diagram Method (PDM) and shall be resource and cost loaded. The Contractor shall create and maintain the schedule using Primavera Project Manager 5.x or Primavera Contractor 4.1 or above. The observance of the requirements herein is an essential part of the work to be done under the contract. No direct compensation will be allowed for fulfilling these requirements, as such work is considered subsidiary to the various bid items of the contract.

700.3. PERSONNEL: The Contractor shall provide an individual, referred to hereafter as the Scheduler, to create and maintain the Project Schedule. The Scheduler shall be proficient in Critical Path Method (CPM) analysis as demonstrated through certification from Project Management Institute (PMI), Association for the Advancement of Cost Engineering (AACE) or possess sufficient experience to be able to perform required tasks on the specified software and be able to prepare and interpret reports from the software. The Scheduler shall be made available for discussion or meetings when requested by the City.

700.4. PROJECT SCHEDULE:

A. General. At least twenty (20) calendar days prior to the preconstruction conference, the Contractor shall submit a Project Schedule, which shall show the sequence and interdependence of activities required for complete performance of the work. All schedule submittals shall be in the electronic form to include PDF plots of the schedule, a PDF plot defining the Critical Path and two week look-ahead, and include the native Primavera file format. The Contractor shall submit the schedule to the Web-portal and via electronic mail, CD-Rom, floppy disc, or any other electronic media acceptable to the City. The City will review the Project Schedule within twenty (20) calendar days for compliance with the specifications and notify the Contractor at the pre-construction conference of its acceptability. No work shall begin until the City has accepted the Project Schedule.

B. Sequence. The Project Schedule shall show the sequence and interdependence of activities required for complete performance of the work. The Contractor shall be responsible for assuring all work sequences are logical and show a coordinated plan of the work. The purpose of the City requiring the Project Schedule shall be to:

1. Ensure adequate planning during the execution and progress of the work in accordance with the allowable number of calendar days and all milestones,

2. Assure coordination of the efforts of the Contractor, City, Utilities and others that may be involved in the project and that activities are included in the schedule highlighting coordination points with others,

3. Assist the Contractor and City in monitoring the progress of the work and evaluating proposed changes to the contract, and

4. Assist the City in administering the contract time requirements.

C. Activities. Each activity on the Project Schedule shall include:

1. An activity number utilizing an alphanumeric designation system that is agreeable to the City;

2. Concise description of the work represented by the activity; and

3. Activity durations in whole work days with a maximum of twenty (20) work days. Durations greater than twenty (20) work days may be used for non-construction activities (mobilization, submittal preparation, curing, etc.), and other activities mutually agreeable between the City and Contractor.

The Contractor shall provide to the City a legend for all abbreviations. The activities shall be coded so that organized plots of the Project Schedule may be produced. Typical activity coding includes traffic control phase, location and work type. Activity durations shall be based on the quantity for the individual work activity divided by a production rate.

D. Work Duration and Resources. The schedule layout shall be grouped by Project and then by WBS for organizational purposes. The original and remaining duration shall be displayed. The grouping band will, by default, report work days planned. One additional level of effort activity shall be added to the schedule as a "time calculator" with a seven-day calendar without holidays. The calculation of their days will show up in the duration columns in Primavera.

If specified by general note, the Contractor shall plan and incorporate major resources into the Project Schedule. Major resources are defined as crews and equipment that constrain the Contractor from pursuing available work. The resources shall accurately represent the Contractor's planned equipment and manpower to achieve the productivity rates specified above.

Work shall be scheduled based upon the Contractor's standard work week utilizing the appropriate calendar assignments in Primavera software for the purpose of establishing an accurate baseline S-curve that accurately represents the Contractor planned rate of earned value. If the Contractor initial baseline plan is to perform the Work on a six or seven-day work week, then the appropriate calendar in Primavera must be used and the Engineer must be notified in writing through the Submittal process. This does not affect the total calendar days allotted by the contract.

Assign working calendars for the days you plan to work. Designate all City holidays (12) as non-working days (holidays). For dates beyond the current calendar year assume that the City holidays are the same as the current calendar year.

Seasonal weather conditions shall be considered and included in the Project Schedule for all work influenced by temperature and/or precipitation. Seasonal weather conditions shall be determined by an assessment of average historical climatic conditions. Average historical weather data is available through the National Oceanic and Atmospheric Administration (NOAA). These effects will be simulated through the use of work calendars for each major work type (i.e., earthwork, concrete paving, structures, asphalt, drainage, etc.). Project and work calendars should be updated each month to show days actually able to work on the various work activities.

Total float is defined as the amount of time between the early start date and the late start date, or the early finish date and the late finish date, for each and every activity in the schedule. Float time in the Project Schedule is a shared commodity between the City and the Contractor.

Only City responsible delays in activities that affect milestone dates or the contract completion date, as determined by CPM analysis, will be considered for a time extension.

E. Resources and Cost Loading Requirement. Assign resources to each activity to include budgeted units and budgeted cost calculated as budgeted units x unit price.

Percent complete type shall be Physical Percent Complete.

Duration type shall be Fixed Units

Earned value shall be reported from the schedule.

F. Other Requirements. Code and organize all work by WBS.

Submittals shall be included in the schedule with a logical tie to what each drives.

Proposed Change Orders shall be added the schedule identifying it as a Proposed Change Order. This task must be linked to the schedule with logical ties and approved by the City. Upon approval of Change Order, task will be renamed identifying work performed and Change Order number and resources will be added to the task.

Constraints are limited to project start, project finish, material delivery, and use on Submittals. If a schedule requires additional constraints, then an explanation shall accompany the schedule Submittal.

The schedule shall include activity milestones for material delivery.

Must Finish By date shall be identified in the schedule based on the Contract time.

Default progress is disallowed. Quantities installed shall be the basis of earned value.

If work is performed out of sequence, then an explanation must be included in the project narrative.

700.5. JOINT REVIEW, REVISION AND ACCEPTANCE: Within twenty (20) calendar days of receipt of the Contractor's proposed Project Schedule, the City shall evaluate the schedule for compliance with this specification, and notify the Contractor of its findings. If the City requests a revision or justification, the Contractor shall provide a satisfactory revision or adequate justification to the satisfaction of the City within seven (7) calendar days. If the Contractor

submits a Project Schedule for acceptance, which is based on a sequence of work not shown in the plans, then the Contractor shall notify the City in writing, separate from the schedule submittal.

The City's review and acceptance of the Contractor's Project Schedule is for conformance to the requirements of the contract documents only. Review and acceptance by the City of the Contractor's Project Schedule does not relieve the Contractor of any of its responsibility for the Project Schedule or of the Contractor's ability to meet interim milestone dates (if specified) and the contract completion date, nor does such review and acceptance expressly or by implication warrant, acknowledge or admit the reasonableness of the logic, durations, manpower or equipment loading of the Contractor's Project Schedule. In the event the Contractor fails to define any element of work, activity or logic and the City review does not detect this omission or error, such omission or error, when discovered by the Contractor or City shall be corrected by the Contractor at the next monthly schedule update and shall not affect the project completion date.

700.6. UPDATES: The Project Schedule shall be updated on a monthly basis. The Project Schedule update shall be submitted in conjunction with the pay application. The Contractor will meet with the City each month at a scheduled update meeting to review actual progress made through the Data Date of the schedule update as determined the Project Manager. The review of progress will include dates activities actually started and/or completed, the percentage of work completed, the remaining duration of each activity started and/or completed, and the amount of work to complete with an analysis of the relationship between the remaining duration of the activity and the quantity of material to install over that given period of time with a citation of past productivity. The percentage of work complete shall be calculated by utilizing the quantity installed divided by the budgeted quantity from the baseline schedule. The monthly schedule update shall include a progress narrative explaining progress, defining the Critical Path, identification of any potential delays, etc.

The project schedule update layout shall be grouped by Project, then WBS. The layout shall include the following columns:

A. Activity ID

B. Activity Description

C. Original Durations

D. Remaining Durations

E. Start and Finish Dates

F. Baseline Start and Finish Dates

G. Total Float

H. Performance Percent Complete

I. Budgeted Total Cost

J. Earned Value

K. Display logic and target bars in the Gantt bar chart view

700.7. PROJECT SCHEDULE REVISIONS: If the Contractor desires to make major changes in the Project Schedule, the Contractor shall notify the City in writing and submit the proposed schedule revision. The written notification shall include the reason for the proposed revision, what the revision is comprised of, and how the revision was incorporated into the schedule. Major changes are hereby defined as those that may affect compliance with the contract requirements or those that change the critical path. All other changes may be accomplished through the monthly updating process without written notification.

700.8. TIME IMPACT ANALYSIS: The Contractor shall notify the City when an impact may justify an extension of contract time or adjustment of milestone dates. This notice shall be made in writing as soon as possible, but no later than the end of the next estimate period after the commencement of an impact or the notice for a change is given to the Contractor. Not providing notice to the City within twenty (20) calendar days after receipt will indicate the Contractor's approval of the time charges as shown on that time statement. Future consideration of that statement will not be permitted and the Contractor forfeits his right to subsequently request a time extension or time suspension unless the circumstances are such that the Contractor could not reasonably have knowledge of the impact by the end of the next estimate period.

When changes are initiated or impacts are experienced, the Contractor shall submit to the City a written time impact analysis describing the influence of each change or impact. A “time impact analysis” is an evaluation of the effects of changes in the construction sequence, contract, plans, or site conditions on the Contractor's plan for constructing the project, as represented by the schedule. The purpose of the time impact analysis is to determine if the overall project has been delayed, and if necessary, to provide the Contractor and the City a basis for making adjustments to the contract.

A time impact analysis shall consist of one or all of the steps listed below:

A. Establish the status of the project before the impact using the most recent project schedule update prior to the impact occurrence.

B. Predict the effect of the impact on the most recent project schedule update prior to the impact occurrence. This requires estimating the duration of the impact and inserting the impact into the schedule update. Any other changes made to the schedule including modifications to the calendars or constraints shall be noted.

C. Track the effects of the impact on the schedule during its occurrence. Note any changes in sequencing, and mitigation efforts.

D. Compare the status of the work prior to the impact (Step 1) to the prediction of the effect of the impact (Step 2), and to the status of the work during and after the effects of the impact are over (Step 3). Note that if an impact causes a lack of access to a portion of the project, the effects of the impact may extend to include a reasonable period for remobilization.

The time impact analysis shall be electronically submitted to the City. If the Project Schedule is revised after the submittal of a time impact analysis but prior to its approval, the Contractor shall promptly indicate in writing to the City the need for any modification to its time impact analysis. One (1) copy of each time impact analysis shall be submitted within fourteen (14) calendar days after the completion of an impact. The City may require Step 1 and Step 2 of the time impact analysis be submitted at the commencement of the impact, if needed to make a decision regarding the suspension of contract time. Approval or rejection of each time impact analysis by the City

shall be made within fourteen (14) calendar days after receipt unless subsequent meetings and negotiations are necessary.

700.9. MEASUREMENT and PAYMENT: Cost Loaded Project Schedules will not be measured or paid for directly, but shall be included in the unit price bid for the items of construction in which the operations occur.

700.10. BID ITEM:

N/A

ITEM

1000 WEB PORTAL

1000.1. DESCRIPTION: *This item shall govern the creation, maintenance, and delivery of projects on the Web Portal.*

1000.2. WEB PORTAL: City utilizes a Web Portal Program Management tool for all major construction projects. Contractor will be required to access and utilize this system as part of the project. Contractor will be required to have an email account and access to a computer with internet access and Citrix Client software loaded. City provides a Citrix Client software download for Windows 32 bit Operating System (Windows 2000, XP, 2003, or Vista) running Internet Explorer 6 or Internet Explorer 7. Contractor will be required to obtain a Web Portal user account from the City. Contractor will be responsible for utilizing the Web Portal to process Change Order, Requests For Information, Invoices, Submittals and other related documents through the portal. City will assist Contractor with system and provide procedures and processes on the Web Portal.

1000.3. MEASUREMENT and PAYMENT: Use of the Web Portal will not be measured or paid for directly, but shall be included in the unit price bid for the items of construction in which the operations occur.

1000.4. BID ITEM:

N/A

BID ITEM SUMMARY

DIVISION I - EARTHWORK

Item 100.1 - Mobilization - lump sum
Item 100.2 - Insurance and Bond - lump sum

Item 101.1 - Preparing Right-of-Way - lump sum

Item 102.1 - Obliterating Abandoned Street - per square yard

Item 103.1 - Remove Concrete Curb - per linear foot
Item 103.2 - Remove Concrete Traffic Barrier - per linear foot
Item 103.3 - Remove Sidewalks and Driveways - per square foot
Item 103.4 - Remove Miscellaneous Concrete - per square foot

Item 104.1 - Street Excavation - per cubic yard

Item 105.1 - Channel Excavation - per cubic yard

Item 106.1 - Box Culvert Excavation and Backfill - per cubic yard

Item 107.1 - Embankment (Final) - per cubic yard
Item 107.2 - Embankment (Original) - per cubic yard
Item 107.3 - Embankment (Vehicle) - per cubic yard

Item 108.1 - Lime Treated Subgrade - (inches compacted depth) - per square yard
Item 108.2 - Lime - per ton

Item 109.1 - Cement Treated Subgrade - (inches compacted depth) - per square yard
Item 109.2 - Cement - per ton

DIVISION II - BASE & SURFACE COURSES

Item 200.1 - per square yard per ___ inches compacted depth

Item 201.1 - Cement Treatment (Existing Material) __-inches compacted depth - per square yard
Item 201.2 - Cement Treatment (New Base) __-inches compacted depth - per square yard
Item 201.3 - Cement Treatment (Mixing Existing Material and New Base) __-inches compacted depth - per square yard
Item 201.4 - Cement - per ton

Item 202.1 - Prime Coat - per gallon
Item 202.2 - Prime Coat and Blotter - per gallon

Item 203.1 - Tack Coat - per gallon

Item 204.1 - One Course Surface Treatment - per square yard
Item 204.2 - Two Course Surface Treatment - per square yard

Item 205.1 - Hot Mix Asphaltic Pavement Type A - per square yard __inches pavement thickness
Item 205.2 - Hot Mix Asphaltic Pavement Type B - per square yard __inches pavement thickness
Item 205.3 - Hot Mix Asphaltic Pavement Type C - per square yard __inches pavement thickness
Item 205.4 - Hot Mix Asphaltic Pavement Type D - per square yard __inches pavement thickness
Item 205.5 - Hot Mix Asphaltic Pavement Type F - per square yard __inches pavement thickness

Item 206.1 - Asphalt Treated Base - per square yard ___inches compacted depth

BID ITEM SUMMARY

Item 207.1 - Single Course Bituminous Slurry Seal - per square yard
Item 207.2 - Single Course Bituminous Slurry Seal - per ton

Item 208.1 - Salvaging, Hauling, and Stockpiling Reclaimable Asphaltic Pavement (___inches depth) - per square yard
Item 208.2 - Salvaging, Hauling, and Stockpiling Reclaimable Asphaltic Pavement - per cubic yard (loose vehicle measurement)

Item 209.1 - Concrete Pavement - per square yard at __inches of depth

Item 210 - Rolling N/A

Item 220 - BladingN/A

Item 230.1 - Flexible Pavement Structure Repair - __inches compacted depth - per square yard
Item 230.2 - Concrete Pavement Full-Depth Repair - __inches compacted depth - per square yard

Item 234.1 - Base Reinforcement - per square yard

Item 236.1 - Emulsion per gallon
Item 236.2 - Emulsion Treatment (Existing Base) (__ inches compacted depth) per square yard
Item 236.3 - Emulsion Treatment (Mixing Existing Material and New Base) (__ inches compacted depth) per square yard

Item 237.1 - Pothole Repair - per square yard
Item 237.2 - Emergency Mobilization - per each

Item 238.1 - Rubberized Emulsion Aggregate Slurry with Polymer (REAS) - per square yard

Item 239.1 - Micro-Surfacing - per square yard
Item 239.2 - Micro-Surfacing - per ton

Item 240.1 - Warm Mix Asphaltic Concrete Type A - per square yard __inches pavement thickness
Item 240.2 - Warm Mix Asphaltic Concrete Type B - per square yard __inches pavement thickness
Item 240.3 - Warm Mix Asphaltic Concrete Type C - per square yard __inches pavement thickness
Item 240.4 - Warm Mix Asphaltic Concrete Type D - per square yard __inches pavement thickness
Item 240.5 - Warm Mix Asphaltic Concrete Type F - per square yard __inches pavement thickness

DIVISION III - CONCRETE & CONCRETE STRUCTURES
Item 300 - Concrete N/A

Item 301 - Reinforcing Steel N/A

Item 302.1 - Metal for Structures - per pound

Item 303 - Welded Wire Flat Sheets N/A

Item 306.1 - Structural Excavation - per cubic yard

Item 307.1 - Concrete Structure - per cubic yard
Item 307.2 - Concrete Structure - per square yard
Item 307.3 - Concrete Structure - per foot

BID ITEM SUMMARY

Item 307.4 - Concrete Structure - per square foot
Item 307.5 - Concrete Structure - per each structure

Item 308.1 - Drilled Shafts - per linear foot
Item 308.2 - Bell Footing - per cubic yard

Item 309.1 - Precast Reinforced Concrete Box Culverts - per linear foot

Item 310.1 - Precast, Prestressed Bridge Beams - per linear foot

Item 311.1 - Concrete Surface Finish - Adhesive Grout Finish - per square yard
Item 311.2 - Concrete Surface Finish - Concrete Paint Finish - per square yard
Item 311.3 - Concrete Surface Finish - Opaque Sealer Finish - per square yard
Item 311.4 - Concrete Surface Finish - 742 Appearance Coating Finish - per square yard
Item 311.5 - Concrete Surface Finish - Epoxy Paint Finish - per square yard
Item 311.6 - Concrete Surface Finish - Blast Finish - per square yard
Item 311.7 - Concrete Surface Finish - Rub Finish - per square yard

DIVISION IV - STORM SEWERS
Item 400 - Excavation Trenching and Backfilling N/A

Item 401.1 - Reinforced Concrete Pipe - per linear foot (Class _) (_ inches dia.)
Item 401.2 - Reinforced Concrete Pipe (Arch) - per linear foot (Design Size _)
Item 401.3 - Reinforced Concrete Pipe (Elliptical) - per linear foot (Design Size _)
Item 401.4 - Safety End Treatment (Type __) - per barrel of each structure end

Item 402.1 - Corrugated Polyethylene Pipe - per linear foot (per depth of cut)

Item 403.1 - Junction Box (Complete) 4'x4'x4'
Item 403.2 - Junction Box (Complete) 5'x5'x5'
Item 403.3 - Junction Box (Complete) 6'x6'x6'
Item 403.4 - Junction Box (Complete) 7'x7'x7'
Item 403.5 - Junction Box (Complete) 8'x8'x8'
Item 403.6 - Special Junction Boxes (Complete)
Item 403.7 - Inlet (Complete) 5'
Item 403.8 - Inlet (Complete) 10'
Item 403.9 - Inlet (Complete) 15'
Item 403.10 - Inlet (Complete) 20'
Item 403.11 - Inlet (Complete) 25'
Item 403.12 - Inlet (Complete) 30'
Item 403.13 - Special Inlets (Complete)
Item 403.14 - Inlet Extensions

Item 404.1 - Corrugated Metal Pipe - per linear foot
Item 404.2 - Corrugated Metal Pipe Arch - per linear foot
Item 404.3 - Spiral Rib Corrugated Metal Pipe - per linear foot
Item 404.4 - Spiral Rib Corrugated Metal Pipe Arch - per linear foot

Item 405.1 - Fiber Reinforced Concrete Pipe - per linear foot (Class _) (_ inches dia.) (Type _)

Item 406.1 - Jacking, Boring, or Tunneling Pipe - per linear foot
Item 406.2 - Jacking or Tunneling Box Culvert - per linear foot

BID ITEM SUMMARY

Item 407.1 - Concrete Encasement - per cubic yard
Item 407.2 - Concrete Cradles - per cubic yard
Item 407.3 - Concrete Saddles - per cubic yard
Item 407.4 - Concrete Collars - per cubic yard

Item 409.1 - Grate - per each
Item 409.2 - Frame - per each
Item 409.3 - Grate and Frame - per each
Item 409.4 - Frame and Cover - per each
Item 409.5 - Ring and Cover - per each

Item 410.1 - Concrete Subgrade Filler - per cubic yard
Item 410.2 - Gravel Subgrade Filler - per cubic yard

Item 411.1 - Glass Cullet Use for Utility Bedding and Backfill - per cubic yard

Item 412.1 - Cement Stabilized Sand - per cubic yard

Item 413.1 - Flowable Fill (Low Strength) - per cubic yard
Item 413.2 - Flowable Fill (High Strength) - per cubic yard
Item 413.3 - Flowable Fill (High Strength Emergency Repair) - per cubic yard

Item 414 - Flexible Pipe-to-Manhole Connector N/A

DIVISION V - MISCELLANEOUS CONSTRUCTION
Item 500.1 - Concrete Curb - per linear foot
Item 500.2 - Concrete Curb (Mono) - per linear foot
Item 500.3 - Concrete Gutter - per linear foot
Item 500.4 - Concrete Curb and Gutter - per linear foot

Item 502.1 - Concrete Sidewalks - Conventionally Formed - per square yard
Item 502.2 - Concrete Sidewalks - Machine Laid - per square yard

Item 503.1 - Portland Cement Concrete Driveway - per square yard
Item 503.2 - Portland Cement Concrete Driveway - Commercial - per square yard
Item 503.3 - Exposed Aggregate Driveway - per square yard
Item 503.4 - Asphaltic Concrete Driveway - per square yard
Item 503.5 - Gravel Driveway - per square yard

Item 504.1 - Concrete Median - per square yard
Item 504.2 - Concrete Directional Island - per square yard

Item 505.1 - Concrete Riprap - per square yard (__ inches thick)

Item 506.1 - Concrete Retaining Walls - Combination Type - per cubic yard
Item 506.2 - Exposed Aggregate Retaining Walls - Combination Type - per cubic yard

Item 507.1 - Chain Link Wire Fence - (4 ft. high) - per linear foot
Item 507.2 - Chain Link Wire Fence - (6 ft. high) - per linear foot
Item 507.3 - Chain Link Wire Fence - (8 ft. high) - per linear foot
Item 507.4 - Gates - Pedestrian - per each
Item 507.5 - Gates - Vehicular - per opening

BID ITEM SUMMARY

Item 508.1 - Relocating Wire Fence - per linear foot Item 509.1 - Metal Beam Guard Rail - per linear foot

Item 510.1 - Timber Guard Posts - per each

Item 511.1 - Replacing with Flexible Base and Pavement - __inches compacted depth - per square yard
Item 511.2 - Replacing with Cement Stabilized Base and Pavement __inches depth - per square yard
Item 511.3 - Replacing with Hot Mix Asphaltic Concrete Pavement - Type B __inches compacted depth - per square yard
Item 511.4 - Replacing with Portland Cement Concrete Pavement - __inches depth - per square yard
Item 511.5 - Replacing with Flexible Base and Surface Treatment - __inches compacted depth - per square yard

Item 512.1 - Adjusting Existing Manholes - per each
Item 512.2 - Reconstructing Existing Manholes - per each
Item 512.3 - Valve Box Adjustments - per each Item 513.1 - Removing and Relocating Mail Boxes - per each

Item 513.1 - Removing and Relocating Mail Boxes - per each
Item 513.2 - Community Mail Box Slab - per square yard

Item 514 - Paint And Painting N/A

Item 515.1 - Topsoil - per cubic yard

Item 516.1 - Bermuda Sodding - per square yard
Item 516.2 - St. Augustine Sodding - per square yard
Item 516.3 - Buffalo 609 Sodding - per square yard

Item 517.1 - Bridge Railing - per linear foot

Item 520.1 - Hydromulching (Residential or Commercial) - per square yard

Item 522.1 - Sidewalk Pipe Railing - per linear foot

Item 523.1 - Adjusting Vehicular Gates - per opening
Item 523.2 - Adjusting Pedestrian Gates - per each

Item 524.1 - Concrete Steps - per cubic yard

Item 525.1 - Concrete Traffic Barrier (Portable) - per linear foot

Item 526 - Field Office N/A

Item 530.1 - Barricades, Signs and Traffic Handling - lump sum

Item 531.1 - Metro Street Name, Block Numbers* (Varies x 15”)
Item 531.2 - Metro Street Name, Block Numbers* (Varies x 18”)
Item 531.3 - R1-1 STOP* (30”)
Item 531.4 - R1-2 YIELD* (36”)
Item 531.5 - R1-4 ALL WAY plate* (18” x 6”)
Item 531.6 - R2-1 Speed Limit* (24” x 30”)
Item 531.7 - R3-1 No Right Turn* (24” x 24”)
Item 531.8 - R3-2 No Left Turn* (24” x 24”)
Item 531.9 - R3-3 NO TURNS* (24” x 24”)
Item 531.10 - R3-4 No U-Turns*(24” x 24”)

BID ITEM SUMMARY

Item 531.11 - R3-5 Left or Right Only* (30” x 36”)
Item 531.12 - R3-6 Lane-Use Control* (30” x 36”)
Item 531.13 - R3-7 LEFT LANE MUST TURN LEFT or RIGHT LANE MUST TURN RIGHT* (30” x 30”)
Item 531.14 - R3-8 Lane-Use Control* (30” x 30”)
Item 531.15 - R3-8 U-Turn Only* (24” x 30”)
Item 531.16 - R3-9 Two Way Left Turn Only* (30” x 36”)
Item 531.17 - R4-7 Keep Right* (24” x 30”)
Item 531.18 - R5-1 DO NOT ENTER* (30” x 30”)
Item 531.19 - R6-1 ONE WAY* (36” x 12”)
Item 531.20 - R6-2 ONE WAY* (18” x 24”)
Item 531.21 - R7-1 NO PARKING ANYTIME* (18” x 24”)
Item 531.22 - R7-18 NO PARKING THIS SIDE THIS BLOCK*(18” x 24”)
Item 531.23 - R1-1 (STOP)* (18” X 18”)
Item 531.24 - R9-3a Pedestrian Crossing Prohibited*(18” X 18”)
Item 531.25 - R10-11 NO TURN ON RED 7-9 AM AND 2-4 PM, SCHOOL DAYS ONLY*
Item 531.26 - R10-11a NO TURN ON RIGHT*(24” x 30”)
Item 531.27 - R10-12 LEFT TURN YIELD ON “Green Ball”*(30” x 36”)
Item 531.28 - R10-5 LEFT ON ARROW ONLY*(24” x 30”)
Item 531.29 - R10-6 STOP HERE ON RED* (24” x 36”)
Item 531.30 - R10-7 DO NOT BLOCK INTERSECTION*(24” x 30”)
Item 531.31 - S-25 NO PARKING 7-9 AM AND2-4 PM SCHOOL DAYS ONLY*(18” x 24”)
Item 531.32 - S-26 NO PARKING 7-9 AM AND2-4 PM STUDENT LOADING, SCHOOL DAYS ONLY*(18” x 24”)
Item 531.33 - S-27 NO PARKING 7-9 AM AND 2-4 PM SCHOOL BUS ZONE, SCHOOL DAYS ONLY*(18” x 24”)
Item 531.34 - S1-1 Advance School Crossing and School Crossing**(36” x 36”)
Item 531.35 - W16-7 Diagonal Arrow sign**(30” x 18”)
Item 531.36 - S4-1 1\20 MPH School Sign***(24” x 48”)
Item 531.37 - W1-1 Turn*(30” x 30”)
Item 531.38 - W1-2 Curve*(30” x 30”)
Item 531.39 - W1-3 Reverse Turn*(30” x 30”)
Item 531.40 - W1-4 Reverse Curve*(30” x 30”)
Item 531.41 - W1-5 Winding Road*(30” x 30”)
Item 531.42 - W1-6 Large Arrow* (48” X 24”)
Item 531.43 - W1-7 Large Arrow* (48” X 24”)
Item 531.44 - W16-7 Diagonal Arrow sign* (30” x 18”)
Item 531.45 - W1-8 Chevron Alignment* (18” x 24”)
Item 531.46 - W3-3 Signal Ahead* (36” x 36”)
Item 531.47 - W8-1 BUMP* (30” x 30”)
Item 531.48 - W8-2 DIP* (30” x 30”)
Item 531.49 - W9-2 Lane Ends Merge Left* (30” x 30”)
Item 531.50 - W10-1 Railroad Advance Warning* (36” Dia.)
Item 531.51 - W11-2 Ped Crossing* (30” x 30”)
Item 531.52 - W13-1 Advisory Speed* (18” x 18”)
Item 531.53 - W14-1 DEAD END* (30” x 30”)
Item 531.54 - W14-2 NO OUTLET* (30” x 30”)
Item 531.55 - OM-3 Type 3 Object Marker* (12” x 36”)
Item 531.56 - OM-4P End of Road Marker* (18” x 18”)
Item 531.57 - 9 inch Street Name, Block Numbers* (Varies x 9”)
Item 531.58 - W14-1P Dead End Street Marker* (36” x 9”)
Item 531.59 - Special Sign*
Item 531.60 - W14-2P No Outlet Street Marker* (36” x 9”)
Item 531.61 - S5-1 School Speed Limit When Flashing*** (24” x 48”)

BID ITEM SUMMARY

Item 531.62 - W16-9p Ahead** (36” x 20”)
Item 531.63 - W16-2 XXX FT** (30”x 18”)
Item 531.64 - W13-1 30MPH Advisory** (18” x 18”)
Item 531.65 - S4-3A School Zone Arrows* (24” x 18”)
Item 531.66 - S5-2A, End School Zone* (24” x 9”)
Item 531.67 - R9-6 (YIELD TO PEDS)* (12” X 18”)
Item 531.68 - R3-17 (BIKE LANE)* (30” X 24”)
Item 531.69 - R3-17a (AHEAD)* (30” X 12”)
Item 531.70 - R3-17b (ENDS)* (30” X 12”)
Item 531.71 - R4-4 (BEGIN RIGHT TURN LANE YIELD TO BIKES)* (36” X 30”)
Item 531.72 - R1-2 (YIELD)* (18” X 18” X 18”)
Item 531.73 - W11-1 (Bicycle Warning)* (30” X 30”)
Item 531.74 - R5-3 (NO MOTOR VEHICLES)* (24” X 24”)
Item 531.75 - D11-1 (Bike Route)* (24” X 18”)
Item 531.76 - M4-11 (BEGIN)* (Bicycle Route Supplemental Plaques) (12” X 4”)
Item 531.77 - M4-12 (END)* (Bicycle Route Supplemental Plaques) (12” X 4”)
Item 531.78 - M4-13 (TO)* (Bicycle Route Supplemental Plaques) (12” X 4”)
Item 531.79 - M7-1 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)
Item 531.80 - M7-2 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)
Item 531.81 - M7-3 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)
Item 531.82 - M7-3 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)
Item 531.83 - M7-3 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)
Item 531.84 - M7-3 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)
Item 531.85 - M7-3 (arrow)* (Route Sign Supplemental Plaques) (12” X 9”)
* High Intensity
** Diamond Grade (Fluorescent Yellow Green)
*** Diamond Grade (Fluorescent Yellow Green) with High Intensity White Background
NOTE: All overhead mounted signs shall be Diamond Grade

Item 533 - Cleaning and Removal of Pavement Markings and Markers N/A

Item 535.1 - 4 inch wide yellow line
Item 535.2 - 4 inch wide white line
Item 535.3 - 8 inch wide yellow line
Item 535.4 - 8 inch wide white line
Item 535.5 - 12 inch wide white line
Item 535.6 - 16 inch wide white line
Item 535.7 - 24 inch wide white line
Item 535.8 - Right White Arrow (per each)
Item 535.9 - Left White Arrow (per each)
Item 535.10 - Combination Thru/Right White Arrow (per each)
Item 535.11 - Combination Thru/Left White Arrow (per each)
Item 535.12 - Word “ONLY” (per word)
Item 535.13 - Straight White Arrow (per each)
Item 535.14 - Railroad Crossing Symbol, including two R's, crossbuck and 3 transverse bars (per each)
Item 535.15 - White Diamond (per each)
Item 535.16 - Straight White Arrow Bicycle Facility (per each)
Item 535.17 - Bicycle Rider Symbol (per each)
Item 535.18 - Solid White Yield Lines (6” x 9”) (per each)
Item 535.19 - Word “STOP” (per word)
Item 535.20 - Word “YIELD” (per word)
Item 535.21 - Word “BUS) (per word)

BID ITEM SUMMARY

Item 536.1 - 4 inch Wide Yellow Line
Item 536.2 - 4 inch Wide White Line
Item 536.3 - 8 inch Wide Yellow Line
Item 536.4 - 8 inch Wide White Line
Item 536.5 - 12 inch Wide White Line
Item 536.6 - 16 inch Wide White Line
Item 536.7 - 24 inch Wide White Line
Item 536.8 - Right White Arrow (per each)
Item 536.9 - Left White Arrow (per each)
Item 536.10 - Combination Thru/Right White Arrow (per each)
Item 536.11 - Combination Thru/Left White Arrow (per each)
Item 536.12 - Word "ONLY" (per word)
Item 536.13 - Straight White Arrow (per each)
Item 536.14 - Railroad Crossing Symbol, including two R's, crossbuck and 3 transverse bars (per each)
Item 536.15 - White Diamond (per each)
Item 536.16 - Straight White Arrow Bicycle Facility (per each)
Item 536.17 - Solid White Yield Lines (6" x 9") per each)
Item 536.18 - Word "STOP" (per word)
Item 536.19 - Word "YIELD" (per word)
Item 536.20 - Word "BUS" (per word)

Item 537.1 - Traffic Button (Type W) per each
Item 537.2 - Traffic Button (Type Y) per each
Item 537.3 - Jiggle Bar (Type W) per each
Item 537.4 - Jiggle Bar (Type Y) per each
Item 537.5 - Pavement Marker (Type I-A) per each
Item 537.6 - Pavement Marker (Type I-C) per each
Item 537.7 - Pavement Marker (Type I-R) per each
Item 537.8 - Pavement Marker (Type II-A-A) per each
Item 537.9 - Pavement Marker (Type II C-R) per each

Item 539.1 - 4 inch wide yellow line
Item 539.2 - 4 inch wide white line
Item 539.3 - 8 inch wide yellow line
Item 539.4 - 8 inch wide white line
Item 539.5 - 12 inch wide white line
Item 539.6 - 16 inch wide white line
Item 539.7 - 24 inch wide white line
Item 539.8 - Right White Arrow (per each)
Item 539.9 - Left White Arrow (per each)
Item 539.10 - Combination Thru/Right White Arrow (per each)
Item 539.11 - Combination Thru/Left White Arrow (per each)
Item 539.12 - Word "ONLY" (per word)
Item 539.13 - Straight White Arrow (per word)
Item 539.14 - Railroad Crossing Symbol, including. two R's, crossbuck and 3 transverse bars (per each)
Item 539.15 - White Diamond (per each)
Item 539.16 - Straight White Arrow Bicycle Facility (per each)
Item 539.17 - Bicycle Rider Symbol (per each)
Item 539.18 - Solid White Yield Lines (6" x 9") (per each)
Item 539.19 - Word "STOP" (per word)
Item 539.20 - Word "YIELD" (per word)
Item 539.21 - Word "BUS" (per word)

BID ITEM SUMMARY

Item 540.1 - Rock Filter Dams (Install/Remove) - per linear foot (Type _)
Item 540.2 - Rock Filter Dams (Install/Remove) - per cubic yard (Type _)
Item 540.3 - Temporary Pipe Slope Drains - per foot (_ inches in diameter)
Item 540.4 - Baled Hay - per bale
Item 540.5 - Temporary Paved Flume (Install/Remove) - per square yard
Item 540.6 - Construction Exits (Install/Remove) - per square yard
Item 540.7 - Construction Perimeter Fence - per foot
Item 540.8 - Sandbags for Erosion Control - per foot (_ inches high)
Item 540.9 - Temporary Sediment-Control Fence - per foot
Item 540.10 - Curb Inlet Gravel Filters - per linear foot

Item 550.1 - Trench Excavation Safety Protection – per linear foot

Item 551.1 - Temporary Special Shoring - per square foot

Item 552.1 - Removing and Relocating Irrigation Systems - per linear foot

Item 554.1 - Erosion Control Matting - per square yard

Item 556 - Cast In Place Detectable Warning Surface Tiles N/A

DIVISION VI - TRAFFIC SIGNALS
Item 600 - Traffic Signal General Conditions N/A

Item 609.1 - Optic Programmable Head Type 1 - per each
Item 609.2 - Optic Programmable Head Type 2 - per each
Item 609.3 - Optic Programmable Head Type 3 - per each
Item 609.4 - Optic Programmable Head Type 5 - per each
Item 609.5 - Optic Programmable Head Type 6 - per each
Item 609.6 - Optic Programmable Head Type 8 - per each
Item 609.7 - Optic Programmable Head Type 9 - per each

Item 615.1 - Traffic Signal Controller Assembly (Type 332 Cabinet) - per each
Item 615.2 - Traffic Signal Controller Assembly (Type 303 Cabinet) - per each
Item 615.3 - Traffic Signal Controller Assembly (Type 337 Cabinet) - per each
Item 615.4 - Traffic Signal Controller Assembly (Type 336 Cabinet) - per each

Item 618.1 - Conduit [Type/Size/Method] - per foot

Item 620.1 - Electrical Conductors [Type/Size] - per foot of each single conductor

Item 622.1 - Duct Cable [Type/Size] - per foot

Item 624.1 - Ground Boxes [Type/Size] - per each

Item 625 - Zinc-Coated Steel Wire Strand N/A

Item 627 - Treated Timber Poles N/A

Item 628.1 - Electrical Services - per installation
Item 628.2 - Remove Electrical Services - per removal

Item 633.1 - Battery Backup System - per each

BID ITEM SUMMARY

Item 636.1 - Aluminum Signs [Type] - per square foot of sign face
Item 636.2 - Replacing Existing Aluminum Signs [Type] - per square foot of sign face
Item 636.3 - Refurbishing Aluminum Signs [Type] - per each

Item 655.1 - Type 332 Controller Foundation - per each
Item 655.2 - Controller Pedestal Post - per each

Item 656 - Foundations for Traffic Control Devices N/A

Item 680.1 - Installation of Highway Traffic Signals [Isolated] - per each
Item 680.2 - Installation of Highway Traffic Signals [System] - per each
Item 680.3 - Installation of Highway Traffic Signals [Flashing Beacon] - per each

Item 681.1 - Temporary Traffic Signals - per each intersection

Item 682.1 - Pedestrian Signal Section [Type/Size] - per each
Item 682.2 - Vehicle Signal Section [Type/Size] - per each
Item 682.3 - Back Plate [Type/Size] - per each
Item 682.4 - Louver [Type/Size] - per each

Item 683.1 - LED Countdown Pedestrian Module -per each

Item 684.1 - Traffic Signal Cables [Type/Size] - per foot

Item 685.1 - Install Roadside Flashing Beacon Assemblies - per each
Item 685.2 - Relocate Roadside Flashing Beacon Assemblies - per each
Item 685.3 - Remove Roadside Flashing Beacon Assemblies - per each
Item 685.4 - Solar-Powered (Photovoltaic) School Zone Flasher Assemblies - per each

Item 686.1 - Install Traffic Signal Pole Assemblies (Steel) [Type/Size] - per each
Item 686.2 - Relocate Traffic Signal Pole Assemblies (Steel) [Type] - per each

Item 687.1 - Pedestal Pole Assembly - per each

Item 688.1 - Vehicle Loop Detectors [Type] - per foot
Item 688.2 - Pedestrian Detectors [Type] - per each
Item 688.3 - Audible Pedestrian Signal Units [Type] - per each

Item 691.1 - Spread Spectrum Radio - per each
Item 691.2 - Antenna [Type] - per each
Item 691.3 - Coaxial Cable - per each
Item 691.4 - Heliax Cable - per each

Item 692.1 - Communication Cable [Type/Size] - per foot

Item 693.1 - Internally Lighted Street Name Signs [Type/Size] - per each

Item 694.1 - VIVDS Processor Unit - per each
Item 694.2 - VIVDS Camera Assembly - per each
Item 694.3 - VIVDS Central Control - per each
Item 694.4 - VIVDS Set-up System - per each
Item 694.5 - VIVDS Temporary - per each

BID ITEM SUMMARY

Item 694.6 - VIVDS Communication Cable (Coaxial) - per linear foot
Item 694.7 - VIVDS Communication Cable (Fiber Optic) - per linear foot
Item 694.8 - VIVDS Video Recording - per each

Item 695.1 - Emergency Preemption Emitter - per each
Item 695.2 - Emergency Preemption Phase Selector - per each
Item 695.3 - Emergency Preemption Detector - per each
Item 695.4 - Emergency Preemption Detector Cable - per foot

PROJECT SCHEDULING & DATA MANAGEMENT
Item 700 - Cost Loaded Project Schedules N/A

Item 1000 - Web Portal N/A