

CITY OF BRENHAM
STANDARD SPECIFICATIONS



August 1996

FINAL DRAFT

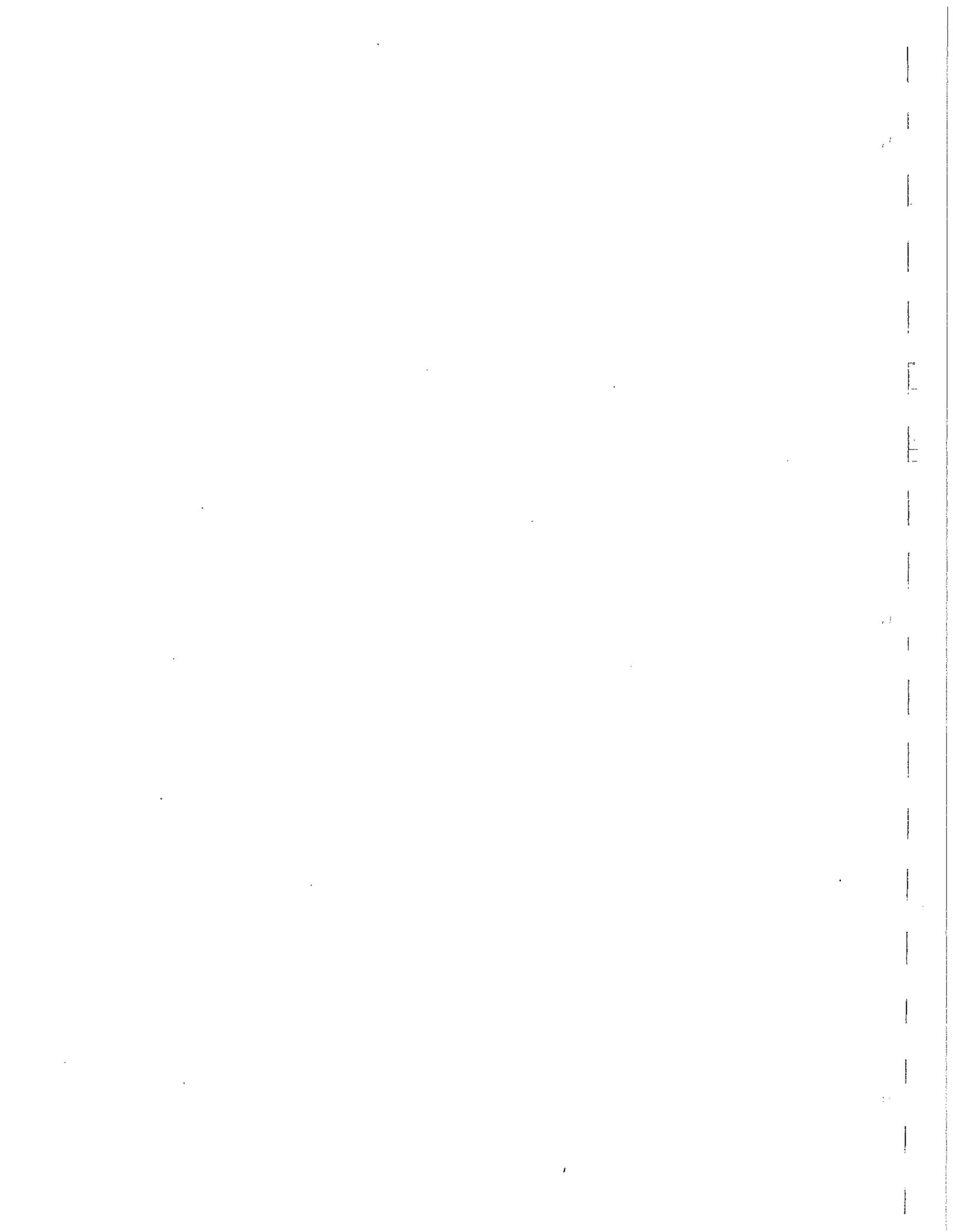


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SECTION 02222

EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES

PART 1 GENERAL

1.01 SUMMARY

This section covers the requirements for the excavation, trenching and backfilling of the following utilities and their respective appurtenances:

1. Storm sewers,
2. Sanitary sewers,
3. Water lines,
4. Gas lines,
5. Electrical cables and ducts.

1.02 RELATED SECTIONS

Section 02240	Cement Stabilized Sand
Section 02229	Excavation Safety

1.03 MEASUREMENT AND PAYMENT

There will be no direct measurement or separate payment for the items covered under this Section unless otherwise indicated in the bid form. Costs for the excavation, trenching and backfilling of utilities shall be included in the related items of work listed in the bid form. All excavation required for locating existing underground utilities will not be measured or paid for as a separate bid item. Include cost for locating existing underground utilities in the related items in the bid form.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

ASTM	American Society for Testing of Materials
OSHA	Occupational Safety and Health Administration
AASHTO	American Association of State Highway and Transportation Officials

1.05 SUBMITTALS

When requested, submit adequate amounts of backfill material for evaluation by the Director of Public Works.

1.06 SCHEDULING

No open excavation or trenches shall be left overnight without proper lighting and barricades. Schedule backfilling such that there is a minimum of excavations and trenches that are left open during hours of no work.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

- A. Cement Stabilized Sand. When required, provide cement-stabilized sand backfill material in accordance with Section 02240, Cement Stabilized Sand.
- B. Bank Sand. When required, provide clean bank sand from an approved source which is free of clay, organic material or other foreign substances. The bank sand shall be such that not more than 12 percent by weight passes the 200 mesh sieve and the plasticity index (P.I.) shall not exceed not 4.0.
- C. Select Material. Select material shall be excavated trench material or imported material which is free from rock fragments and clods that will not break down when compacted unless the rocks or clods are 1-1/2 inches or smaller and scattered in the spoil. Select material shall be free of organic materials and free of sharp or angular materials which could damage the utility being installed or any coating/cover on the utility being installed.
- D. Common Backfill. Common backfill shall be excavated trench material free of organic, soft or spongy materials.
- E. Soil Embedment Materials. Soils to be used for embedment material shall be classified according to the Unified Soils Classification System (USCS) in ASTM D2487, Standard Method for Classification of Soils for Engineering Purposes. The following USCS Soils Classifications correspond to the soil classifications required for the various types of embedments shown on the plan details and/or listed in other sections of these specifications:

1. Class I Soils. Manufactured angular, granular material, 1/4 to 1-1/2 inches size, including materials having regional significance such as crushed stone or rock, broken coral, crushed slag, cinders, or crushed shells. Class I soils are not defined in ASTM D2487 and are subject to approval before being used.
2. Class II Soils. In accordance with ASTM D2487, less than 5% pass No. 200 sieve.
 - a. GW Soil Type: Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
 - b. GP Soil Type: Poorly graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
 - c. SW Soil Type: Well-graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
 - d. SP Soil Type: Poorly graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.
3. Class III Soils. In accordance with ASTM D2487, more than 12% pass No. 200 sieve. Soils with 5% to 12% pass No. 200 sieve fall in borderline classification, for example, GP-GC.
 - a. GM Soil Type: Silty gravels, gravel-sand-silt mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
 - b. GC Soil Type: Clayey gravels, gravel-sand-clay mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.
 - c. SM Soil Type: Silty sands, sand-silt mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.

- d. SC Soil Type: Clayey sands, sand-clay mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.
4. Class IV Soils.
- a. ML Soil Type: Inorganic silts, very fine sands, rock flour, silty or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
 - b. CL Soil Type: Inorganic clays of low to medium plasticity, gravel clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
 - c. MH Soil Type: Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
 - d. CH Soil Type: Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
5. Class V Soils.
- a. OL Soil Type: Organic silts and organic silty clays of low plasticity. Liquid limit 50% or less. 50% or more passes No. 200 sieve.
 - b. OH Soil Type: Organic clays of medium to high plasticity. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.
 - c. PT Soil Type: Peat, muck and other highly organic soils.
- F. Concrete Embedment. Concrete used for utility embedment shall have minimum strength of 2,000 psi at twenty-eight (28) days. Dry mix will not be permitted. The concrete cushion portion of the embedment or encasement shall be mixed moist or damp such that a slump of not more than 1-inch is achieved. Concrete for the sides and top, if required, shall be mixed such that a slump of not less than 1-inch, and not more than 3-inches, is obtained.

PART 3 EXECUTION

3.01 PREPARATION

- A. **Location of Existing Utilities.** The City of Brenham will assist in locating known existing utilities. The Contractor shall call 409-836-7911 during normal working hours Monday through Friday and request utility line locations at least 24 hours before excavating in a public street, alley or easement. Excavating shall be confined to Monday through Friday without prior City approval. Contractor shall have final responsibility to verify the existence and location of all existing underground utilities along the route of the work.
- B. **Protection of Existing Utilities.** Contractor shall take the necessary precautions to protect all existing utilities from damage due to his operations. Any damage to the existing utilities will be repaired at the Contractor's expense by qualified personnel. In order to protect existing utilities that are required to be exposed, Contractor's operation shall be such that a sufficient distance back from the edge of the excavation is maintained to avoid overloading and to prevent slides or caving. No unnecessary excavation or exposing of existing underground utilities will be allowed.
- C. **Convenience to Public.** All trenching and excavating shall be performed in a manner that will cause as little inconvenience to the public as possible. All excavated material shall be kept trimmed such that minimum inconvenience is caused to the public or adjoining property owners. At street crossings, sidewalks and other points deemed necessary by the Director of Public Works, trenches and excavations shall be bridged in a secure manner so as to prevent serious interruption of travel and to provide access to fire hydrants, public property, and private property. All bridging shall be preapproved by the Director of Public Works.
- D. **Traffic Control.** Provide and maintain traffic control in conformity with the applicable statutory requirements and within highway right-of-way as required by the authority having jurisdiction thereover. Adequate traffic control devices shall be in place prior to removal of any existing control devices, construction equipment move in or any work within public right-of-way. Traffic control shall be in accordance with the Texas Manual on Uniform Traffic Control devices. The Contractor shall notify all required emergency service providers in the event of a road closure or other activity that may impair the emergency travel of the provider.

1. Maintenance of Traffic. Conduct work in a manner that will interfere as little as possible with public travel, whether vehicular or pedestrian, whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private. The Contractor shall, at his own expense, provide and maintain suitable and safe bridges, detours, or other temporary structures for the accommodation of public and private travel and shall give reasonable notice to owners of private drives before interfering with them; provided however, that such maintenance of traffic will not be required at any point where the Contractor has obtained permission from the owner and tenant of the private property involved, to obstruct traffic at any designated point thereon and for the duration of whatever period of time as may be agreed on.
2. Barricades, Lights, and Signs. All streets, roads, highways and other public thoroughfares which are closed to traffic shall be protected by means of effective barricades on which shall be placed acceptable warning signs. Barricades shall be located at the nearest intersection, public highway or street on each side of the blocked section. All open trenches or other excavations shall be provided with suitable barriers, signs, and lights to the extent that adequate protection is provided to the public. Obstructions, such as material piles and equipment, shall be provided with similar warning lights and signs. All barricades and obstructions shall be illuminated by means of warning lights. Materials stored upon or alongside public streets and highways shall be so placed, and the work conducted at all times, as to cause minimum obstruction and inconvenience to the traveling public.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. EXCAVATION.

1. General: Excavation shall include the removal of any trees, stumps, brush, debris or other obstacles that may obstruct the line of work, and the excavation and removal of all earth, rock or other material to the extent necessary to install the utility and all appurtenances in conformance with the line and grades shown on the plans or as specified herein.
2. Trench Width: The sides of all trenches shall be cut as near vertical as possible. Whenever the prescribed maximum trench width is exceeded for pipe utilities, except as such excess may be

required for compliance with plans or specifications, the pipe shall be cradled with 2,000 psi concrete at the expense of the Contractor. Unless shown or specified otherwise, the maximum and minimum trench widths for the associated utility shall be measured at 12-inches above the top of the utility line and shall be as follows:

a. Storm sewers.

Minimum width: 16-inches plus O.D. of Pipe.

Maximum width: 24-inches plus O.D. of Pipe.

b. Sanitary sewers.

Minimum width: 16-inches plus O.D. of Pipe.

Maximum width: 24-inches plus O.D. of Pipe.

c. Water lines.

Minimum width: 16-inches plus O.D. of Pipe.

Maximum width: 24-inches plus O.D. of Pipe.

d. Gas lines.

Minimum width: 6-inches plus O.D. of Pipe.

Maximum width: 12-inches plus O.D. of Pipe.

e. Electric cables and ducts.

Minimum width: 6-inches plus O.D. of Cable / Duct.

Maximum width: 12-inches plus O.D. of Cable / Duct.

3. Trench Depth. Unless shown or specified otherwise, trenches shall be excavated to a depth such that the following minimum depths of cover are maintained on the associated utility (as measured from final grade):

a. Water mains: 42-inches of cover.

b. Gas mains: 30-inches of cover. Gas Services: 1-1/4" and smaller: 18-inches of cover.

c. Electric cables and ducts: 30-inches of cover.

4. Trench Bottom. Accurately grade trench bottom such that uniform bearing and support is provided for the utility being installed. Trench bottom shall be such that the utility is supported along its entire length by undisturbed soil except where bell holes or depressions are required. When bell holes or depressions are required for the proper installation of a utility, the trench bottom

shall be completely graded before the bell hole or depression is excavated. Bell holes or depressions shall be no larger than required for the proper installation of the utility. The following procedures shall be used when various types of trench subgrades are encountered:

a. Earth Subgrade. Where a firm and stable foundation for the utility being installed can be obtained in the natural soil and where special embedment is not shown on the plan details or specified herein, the bottom of the trench shall be carefully trimmed to fit the lower portion of the utility line. Should the excavation be carried below grade, except when otherwise detailed on the plans or specified herein, the Contractor shall refill it with Class I embedment material and tamp it until it is compacted such that the bottom of the trench is firm and unyielding. This procedure shall be accomplished at the expense of the Contractor.

b. Rock Subgrade. Where the bottom of the excavation for the utility line is in rock or other hard material, the rock or other hard material shall be removed to a depth not less than four (4") inches below subgrade and the bottom of the trench brought to true subgrade elevation by filling with Class I embedment or other suitable materials as approved by the Director of Public Works. The fill shall be compacted by means of tamping until a firm and uniformly unyielding foundation is established for the utility line being installed.

c. Soft Subgrade. Where a soft or spongy material is encountered in the excavation at subgrade level, it shall be removed only upon the direction of the Director of Public Works. When directed, remove the soft material and replace it with Class I embedment or other suitable materials as approved by the Director of Public Works. The fill replacing the soft material shall be compacted by means of tamping and shall be to a depth that will result in a true trench subgrade that provides a firm and uniformly unyielding foundation for the utility being installed.

5. Sheeting, Shoring, and Bracing. Shore all excavations in accordance with OSHA Standards and the applicable section, or sections, of these specifications. When excavations are made adjacent to existing buildings or other structures, or in paved roadways, particular care shall be taken to adequately sheet, shore, and brace the sides of the excavation to prevent

3. Bank Sand. Install approved bank sand backfill in accordance with and in the locations shown on the plan details. Place sand backfill in maximum 12-inch loose lifts above the embedment zone and compact each layer to 95% Modified Proctor.
4. Common Backfill. Unless specified or shown otherwise on the plan details, backfill all trenches with approved common backfill material from the trench excavation. Place common backfill in 12-inch layers above the embedment zone and compact each layer to 92% Modified Proctor.
5. Compaction and Consolidation of Backfill. Compact each layer of backfill with mechanical equipment to the required density. As an option, the Contractor may elect to consolidate the backfill by jetting and flooding until full settlement has been reached. Jetting and flooding will not be allowed in any areas where the utility system is being installed under a paved section. If used, jetting shall be accomplished by pumping water through a pipe that is slowly inserted vertically into the backfill. The end of the pipe shall be lowered to a point near the top of the embedment zone, taking care not to disturb the bedding or cause the utility to float. The trench shall then be flooded in puddles until no more appreciable absorption of water into the backfill occurs.
6. Excess Material: Excavated material unsuitable for backfilling and excess material shall be disposed of in a manner approved by the Director of Public Works. Acceptable surplus spoil may be neatly distributed and spread on the right-of-way in open areas or pastures.

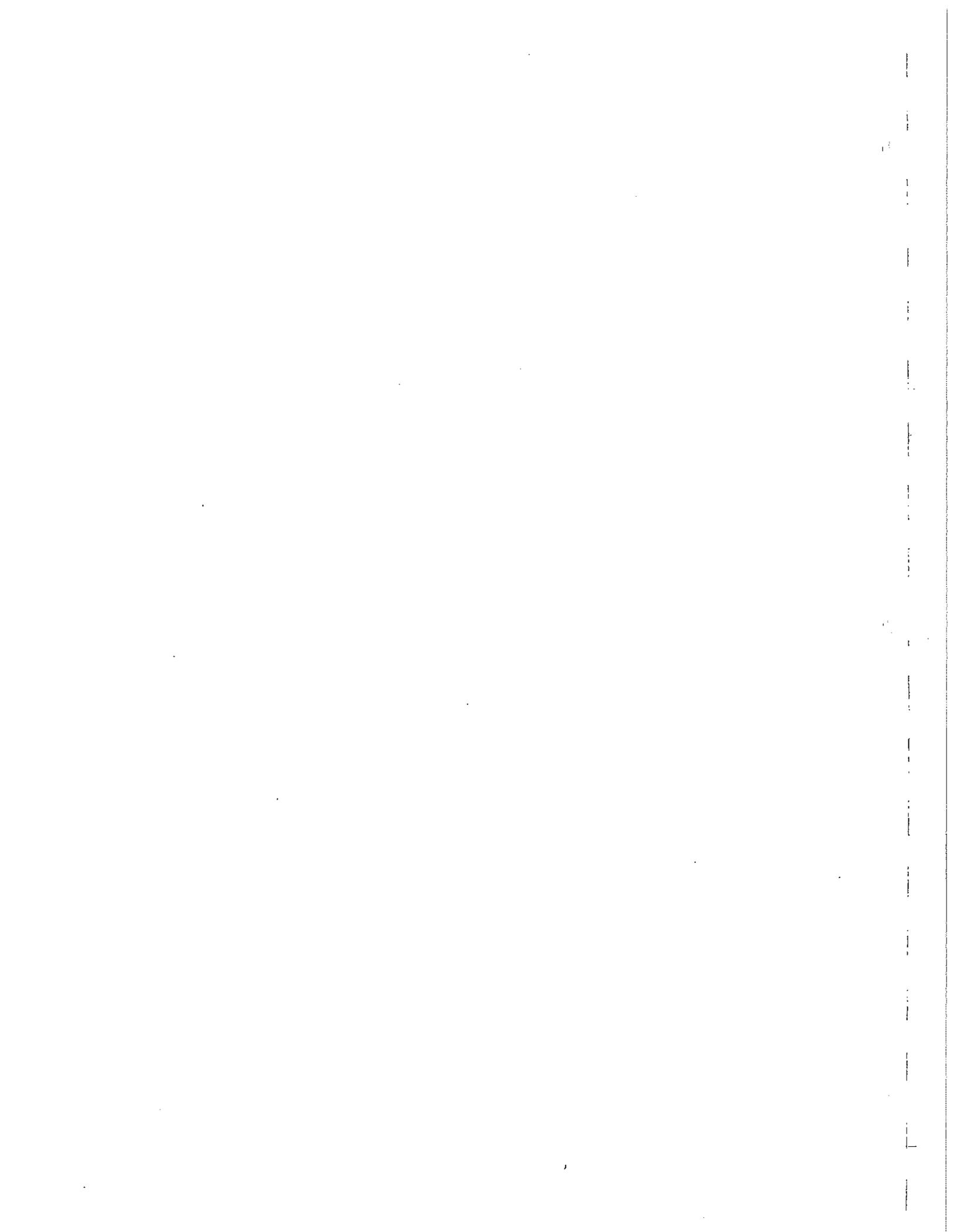
3.03 REPAIR / RESTORATION

Restore surfaces at construction sites to a condition equal to condition prior to construction.

3.04 ADJUSTING / CLEANING

All premises shall be left in an "as found" condition.

END OF SECTION



SECTION 02223

EXCAVATING, BACKFILLING, AND COMPACTING FOR PAVEMENT

PART 1 GENERAL

1.01 SUMMARY

This section describes the requirements for the excavation, backfilling, embankment, and compacting for all types of pavement including, but not limited to, concrete pavement and hot mix asphalt concrete pavement. Also included in this specification are the requirements for clearing and grubbing for roadway construction and the requirements for traffic control in the construction of a roadway.

1.02 RELATED SECTIONS

Section 02229 Excavation Safety

1.03 MEASUREMENT AND PAYMENT

There will be no separate measurement or payment for work performed under this section unless otherwise indicated in the bid form.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

ASTM	American Society of Testing and Materials
AASHTO	American Association of State Highway and Transportation Officials
OSHA	Occupational Safety and Health Administration

1.05 DEFINITIONS

A. Embankment. Embankment is hereby defined as any additional placement and compaction of material required to construct a designated roadway section, a roadway embankment, levee and/or dike.

- B. Backfill. Backfill is hereby defined as any additional placement and compaction of material required to install all structures associated with the construction of a designated roadway section such as curb and gutters, storm sewer inlets, guardrail or other similar roadway structures.
- C. Excavation. Excavation is hereby defined as the removal and subsequent handling of all materials excavated or otherwise removed in the performance of the work, regardless of type, character, composition or condition thereof. All excavation shall be unclassified and includes the removal of all material regardless of the nature of the material unless otherwise indicated in the bid form.
- D. Borrow. Borrow is hereby defined as the material which is stripped, excavated, transported and properly utilized as backfill or embankment material and is obtained only from an approved and/or designated source.

1.06 SUBMITTALS

Submit suitable sample quantities of embankment, backfill, and/or subgrade materials when directed by the City Engineer.

1.07 DELIVERY, STORAGE, AND HANDLING

All material used for embankment or backfill shall be delivered, stored, and handled in a manner that will prevent any harmful contamination of the material or damage to any adjacent property or structures. The delivery, storage, and handling of embankment and backfill materials is subject to the approval of the City Engineer.

1.08 PROJECT / SITE CONDITIONS

Contractor shall be responsible for locating all underground utilities which are in conflict with the proposed work.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

- A. Embankment. Furnish embankment material which is obtained from roadway, borrow, channel and structural excavations. Embankment

material shall be obtained only from an approved source and shall meet the approval of the City Engineer. In general, embankment material shall consist of earth which is free from rocks, clods, vegetation or other foreign material. Each layer of embankment shall be uniform as to material, density and moisture content and shall be suitable for forming a stable embankment. Other requirements for embankment material shall be as shown on the plans.

- B. Backfill. Furnish backfill material in accordance with the requirements as shown on the plans. Backfill material shall be obtained only from an approved source and shall meet the approval of the City Engineer. Obtain approved backfill material from roadway, borrow, channel and structural excavations.
- C. Subgrade Material. Use existing subgrade material, or when necessary furnish subgrade material, which contains sufficient fines to form a firm subgrade capable of being shaped and compacted to the lines, grades and densities shown on the plans.
 - 1. Lime Stabilization. If required, lime stabilization of subgrade shall be in accordance with Section 02244, Lime Stabilization of Materials in Place.
 - 2. Cement Stabilization. If required, cement stabilization of subgrade shall be in accordance with Section 02242, Cement Stabilization of Materials in Place.
- D. Topsoil. Furnish topsoil material which is capable of sustaining vegetation. All topsoil material and the source from which it comes shall meet with the approval of the City Engineer and shall be obtained from roadway, borrow, channel and structural excavations. When acceptable to the City Engineer, the top four (4) inches of roadway, channel and structural excavations shall be stripped and separately stockpiled for later use as topsoil. When the top four (4) inches of roadway, channel or structural excavations do not, in the City Engineer's opinion, provide the necessary material for sustaining vegetation, or there does not exist enough of this material, topsoil shall be obtained from an approved borrow source. All existing large vegetation or other unsuitable material shall be removed from topsoil before it is stockpiled or transported.

PART 3 EXECUTION

3.01 PREPARATION

- A. **Rights-of-Way.** The necessary rights of way for the work will be provided by the City of Brenham. The Contractor shall confine his construction operations to the immediate vicinity of the location shown on the plans, and shall use due care in placing construction tools, equipment, excavated materials, and paving materials and supplies, so as to cause the least possible damage and interference with traffic. The placing of such tools, equipment, and materials shall be subject to the approval of the City Engineer.
- B. **Work Within Highway Right-of-Way.** All work performed, and all operations of the Contractor, his employees, or his subcontractors, within the limits of highway right-of-way shall be in conformity with the requirements of the highway authority owning, or having jurisdiction over, the right-of-way in each case.
- C. **Bench Marks, Stakes, and Monuments.** No work shall be performed that will destroy or disturb any bench marks or property line monuments. In the event that it becomes necessary to remove any bench mark or property line monument in the performance of the work, the Contractor shall notify the City Engineer prior to removal so that such points may be referenced in preparation for replacement. All costs to reestablish disturbed or destroyed bench marks and property line monuments shall be the responsibility of the Contractor.
- D. **Clearing and Grubbing.** All trees and vegetation, except such trees and vegetation that are to remain in place as designated by the City Engineer, shall be removed from the site. Trees and other vegetation to be left standing shall be protected from damage by the erection of barriers or by such other means as the circumstances require as directed and approved by the City Engineer. Clearing operations shall be conducted so as to prevent damage by falling trees to trees that are to be left standing, to existing structures and equipment, and to structures which are under construction. Perform clearing operations so as to provide safety for employees and other bystanders. All roots, stumps and other debris shall be removed to a depth of two (2) feet below the lowest elevation of an excavation or below the existing surface in area to receive embankment. All depressions resulting from these removals

shall be filled with suitable materials and compacted to make the surface conform to the surrounding grounds.

- E. Protection and Maintenance of Public and Private Property. The Contractor shall protect, shore, brace, support, and maintain all underground pipes, conduits, drains, and other underground uncovered or otherwise affected by the construction work performed by him. All pavement, surfacing, driveways, curbs, walks, buildings, utility poles, guy wires, and other surface structures affected by the construction operations in connection with the performance of the contract, together with all sod and shrubs in yards and parking areas removed or otherwise damaged, shall be restored to the original condition thereof as determined and approved by the City Engineer. All replacements of such underground construction and surface structures, or parts thereof, shall be made with new materials conforming to the requirements of these specifications or, if not specified, as approved by the City Engineer. Utility poles and fire hydrants will be relocated by others. The Contractor shall be responsible for all damage to streets, roads, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property facilities, regardless of location or character, which may be caused by moving, hauling, or otherwise transporting equipment, materials or men to or from the work or any part or site thereof, whether by him or his subcontractor(s). The Contractor shall make satisfactory and acceptable arrangements with the owner of, or the agency or authority having jurisdiction over, the damaged property or facility concerning its repair or replacement or payment of costs incurred with said damage. All fire hydrants and water control valves shall be kept free from obstructions and available for use at all times.
- F. Erosion Control. Employ measures and construction practices to prevent erosion at, or adjacent to, the project site. Adequacy of erosion control is subject to the approval of the City Engineer and includes, but shall not be limited to, filter fabric fences, rock dams and berms. Erosion control shall begin at the onset of the project and be maintained throughout the duration of the work until final acceptance.
- G. Traffic Control. Provide and maintain traffic control in conformity with the applicable statutory requirements and within highway right-of-way as required by the authority having jurisdiction thereover. Adequate traffic control devices shall be in place prior to removal of any existing control devices, construction equipment move in or any work within public right-

of-way. Traffic control shall be in accordance with the Texas Manual on Uniform Traffic Control Devices. The Contractor shall notify all required emergency service providers in the event of a road closure or other activity that may impair the emergency travel of the provider.

1. Maintenance of Traffic. Conduct work in a manner that will interfere as little as possible with public travel, whether vehicular or pedestrian, whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private. The Contractor shall, at his own expense, provide and maintain suitable and safe bridges, detours, or other temporary structures for the accommodation of public and private travel and shall give reasonable notice to owners of private drives before interfering with them; provided however, that such maintenance of traffic will not be required at any point where the Contractor has obtained permission from the owner and tenant of the private property involved, to obstruct traffic at any designated point thereon and for the duration of whatever period of time as may be agreed on.
2. Barricades, Lights, and Signs. All streets, roads, highways and other public thoroughfares which are closed to traffic shall be protected by means of effective barricades on which shall be placed acceptable warning signs. Barricades shall be located at the nearest intersection, public highway or street on each side of the blocked section. All open trenches or other excavations shall be provided with suitable barriers, signs, and lights to the extent that adequate protection is provided to the public. Obstructions, such as material piles and equipment, shall be provided with similar warning lights and signs. All barricades and obstructions shall be illuminated by means of warning lights. Materials stored upon or alongside public streets and highways shall be so placed, and the work conducted at all times, as to cause minimum obstruction and inconvenience to the traveling public.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. General. Perform all excavations, construction of embankments, backfilling, compacting and subgrade preparation to the lines, grades, and densities shown on the plans. All work performed under this specification shall be completed in strict accordance to the rules and regulations of the Federal Occupational Safety and Health Act.

- B. Excavation. All excavations for pavement and associated structures shall be held to the minimum required for the proper performance of the work. Blasting is hereby strictly prohibited to aid in the performance of the excavation work. The Contractor is expected to familiarize himself completely with the type of excavation to be performed and the type of materials to be handled. There will be no consideration of claims for extra compensation due to encountering difficult or unstable material in the excavations to be made.
- C. Subgrade Preparation. Uniformly place and spread approved subgrade material which has been obtained from a borrow source and compact to the required thickness using approved compacting equipment. Subgrade material which is existing or is hauled in from another source, and is not to be cement or lime stabilized, shall be within 2% of optimum moisture content and shall be compacted to 95% Modified Proctor as determined by ASTM D1557. Compaction of subgrade which is to be cement stabilized shall be in accordance with Section 02242, Cement Stabilization of Materials in Place. Compaction of subgrade which is to be lime stabilized shall be in accordance with Section 02244, Lime Stabilization of Materials in Place.
- D. Embankments. No embankment work shall be performed without the City Engineer's approval of the embankment material. Unless otherwise shown on the plans, embankments shall be constructed in successive layers for the full width of the cross section and in appropriate lengths which are suitable for the sprinkling and compaction methods being used. Maximum depth of layers before compaction shall be six (6) inches. Form each successive layer of embankment by utilizing equipment which will evenly spread and distribute the piles or windrows of material which have been placed from excavations or hauling equipment. All embankment material shall be placed by blading or some other approved similar method. All clods and lumps shall either be removed or broken and then subsequently blended into the embankment material by a blading, harrowing or other approved method such that each layer is of uniform density. When necessary, the Contractor shall evenly sprinkle each layer of embankment material to obtain the required moisture content that will allow for maximum compaction. Contractor shall be responsible for obtaining a uniform moisture content within 2% of optimum moisture throughout each successive layer of embankment material by using such methods as may be necessary. Each layer of

embankment shall be compacted to 93% Modified Proctor as determined by ASTM D1557.

- E. Backfilling and Compacting. No backfilling and compacting around any pavement or associated structures shall be done without the prior approval of the City Engineer. Place and compact approved backfill at all required locations including behind curbs and around inlets when necessary. Unless otherwise shown on the plans, backfill shall be placed and compacted in maximum eight (8) inch layers to the density of the surrounding earth or the density shown on the plans.
- F. Grading. Upon the completion of the pavement, grade the surrounding earth and ditches to the finished line and grade as shown on the plans. Evenly spread the stockpiled top soil over all embankments, berms, slopes and surrounding grounds. The top soil shall be harrowed and dragged so as to break up all lumps in preparation of sodding or seeding. Unless specifically shown on the plans, drainage shall away from all structures and slabs.

3.03 REPAIR / RESTORATION

The Contractor shall correct any erosion of embankments or other areas during the progress of construction and up to the final acceptance of the entire project.

3.04 FIELD QUALITY CONTROL

Placement of any backfill or embankment materials shall not be done without the prior approval of the City Engineer. Contractor is responsible for notifying the City Engineer prior to starting backfill operations. Notification will be such that will allow the City Engineer sufficient time to inspect the excavated areas prior to the beginning of backfill operations.

3.05 ADJUSTING / CLEANING

Dispose of excess or unsuitable excavated materials at a location away from the project site limits and in a legal manner. Upon approval of the City Engineer, disposal of such materials may be within the site limits.

END OF SECTION

undermining of, or the settlement beneath, the structures or pavements. Underpinning of adjacent structures or pavement, and the costs associated with it, shall be the responsibility of the Contractor. All sheeting, shoring, and bracing shall be done in such a manner that will not cause any caving or sliding of banks and will not endanger any human life or damage any existing structures or property. Fill and compact all holes or voids left by the removal of sheeting, shoring or bracing with suitable materials. If for any reason, the Contractor, with the approval of the Director of Public Works, elects to leave in place the sheeting, shoring or bracing, no payment will be allowed for such material left in place.

6. Dewatering Excavations. Immediately remove all surface water, ground water or seepage water from sewers, drains, ditches, or other sources which may accumulate in the excavation during construction. Removal of water shall be done by pumping, bailing, draining, well pointing, or other approved methods. The Contractor shall have available, at all times, sufficient equipment in proper working order for dewatering excavations. Disposal of all water from excavations shall be in a legal and safe manner. All dewatering of excavations including pumping, bailing, draining, ditching, well pointing, underdrain, etc., is incidental work and will not be paid for separately.
7. Open Cut Excavations. Except where otherwise shown on the plans, all utility installations shall be accomplished by open cut. In all cases where open cuts are allowed through pavements, the methods of construction must meet the requirements of the appropriate regulating agency in all respects including deviations from these specifications or plans. Open cut excavations crossing paved or unpaved public roadways and driveways shall be done such that inconvenience to users is minimized. Repair all open cut pavements in accordance with the plan details or to the original condition, whichever is more stringent. Repair all open cut pavements in a timely fashion. Where a utility line is to be installed across a paved roadway by open cut, the Contractor, with the approval of the Director of Public Works, may elect to install the utility by boring and in such case will be paid for the corresponding pavement repair if provided for in the bid form.
8. Boring, Jacking or Drilling. When shown on the plans, the utility line shall be installed by boring, jacking or drilling under roadways, streets or railroads, or the line shall be installed in a casing that

has been placed by boring, jacking or drilling in accordance with requirements of all regulating agencies.

9. Excavation of Appurtenances. Excavate as required for appurtenances of the utility being installed. For manholes and other similar structures leave at least two (2) feet clear between the outer surfaces and the embankment or timber that may be used to hold or protect the banks. Any over excavating below appurtenances is not allowed. If over excavating of appurtenances occurs, the excavation will be refilled with cement stabilized sand or concrete. The cost for this refilling shall be the responsibility of the Contractor.
10. Explosives. The use of explosives to aid excavation work is strictly prohibited.

B. EMBEDMENT

All embedment for utilities shall be in accordance with the plan details and shall use the materials outlined in this specification. In general, the embedment zone of a utility line is 4-inches below the bottom of the utility to 12-inches above the top of the utility. All materials for the embedment of a utility being installed shall be placed in layers or lifts that do not exceed 6-inches in thickness. Compaction of embedment zone material shall be in strict accordance with the plan details.

C. BACKFILLING

1. General. The three (3) types of backfill that may be used include: cement stabilized sand, bank sand, and common backfill. Install the various types of backfill material in accordance with and at the locations detailed on the plans. Backfilling shall include the refilling and consolidation of the required fill in trenches and excavations from the top of the embedment zone of the utility being installed to the surrounding ground surface or to the bottom limits of a required pavement repair as detailed on the plans.
2. Cement Stabilized Sand. Installation of cement stabilized sand backfill shall be in conformance with the applicable paragraphs of SECTION 02240, Cement Stabilized Sand and shall be installed in accordance with and at the locations shown on the plan details.

SECTION 02224

PIPELINE CROSSINGS OF HIGHWAYS, RAILROADS, AND DRIVEWAYS BY BORING, OR TUNNELING

PART 1 GENERAL

1.01 SUMMARY

This section pertains to furnishing all labor, materials, equipment, supervision, and tools for the installation of pipe within an encasement pipe or within a bored or tunneled hole without encasement. Steel encasement pipe shall be installed for all crossings of highways, railroads, and where designated on the plans.

1.02 RELATED SECTIONS

Section 02222	Excavation, Trenching, and Backfilling for Utilities
Section 02229	Excavation Safety

1.03 MEASUREMENT AND PAYMENT

Casing pipe installed by bore, including carrier pipe, and the construction of a bored hole for pipe without casing, including the pipe within the bored hole, shall be measured by the linear foot. Payment shall be made at the unit price bid for all labor, materials, equipment, etc. required for the completed casing with carrier pipe or carrier pipe installation by bore. Where installation of the casing pipe is allowed by open cut, payment shall be made at the unit price bid for casing installed by open cut, including the carrier pipe.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society of Testing and Materials
AWWA	American Water Works Association

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

- A. Casing Pipe. Encasement pipe shall be welded steel pipe of the diameter and minimum wall thickness as shown on the plans. If not shown on plans, the minimum casing wall thickness shall be 0.25 inches or the thickness of standard weight steel pipe, whichever is greater. Uncontaminated used welded steel pipe may be used for casing as long as it meets the minimum thickness and no indentations exceed 1/2".
- B. The encasement pipe sizes shown on the plans are the minimum acceptable for the project. The Contractor shall be responsible for insuring that the casing materials are of sufficient strength for the installation method he chooses and for the soil conditions encountered. Casing shall be clean inside and outside with exception of minor rust and scale.
- C. Casing Insulators. When required on the plans, manufactured casing insulators shall be used on the carrier pipe in lieu of wooden skids or spacers. Casing insulator size, spacing and width shall be as recommended by the insulator manufacturer and by the pipe manufacturer. Insulators shall dielectrically insulate the carrier pipe in the casing pipe and shall adequately support the pipe under all working and installation conditions. One insulator shall be placed within two feet of each end of the casing pipe.
- D. Casing Seals: Casing seals shall be manufactured rubber seals for the size of casing specified, fastened to the casing and carrier pipes with stainless steel bands.

PART 3 EXECUTION

3.01 PREPARATION

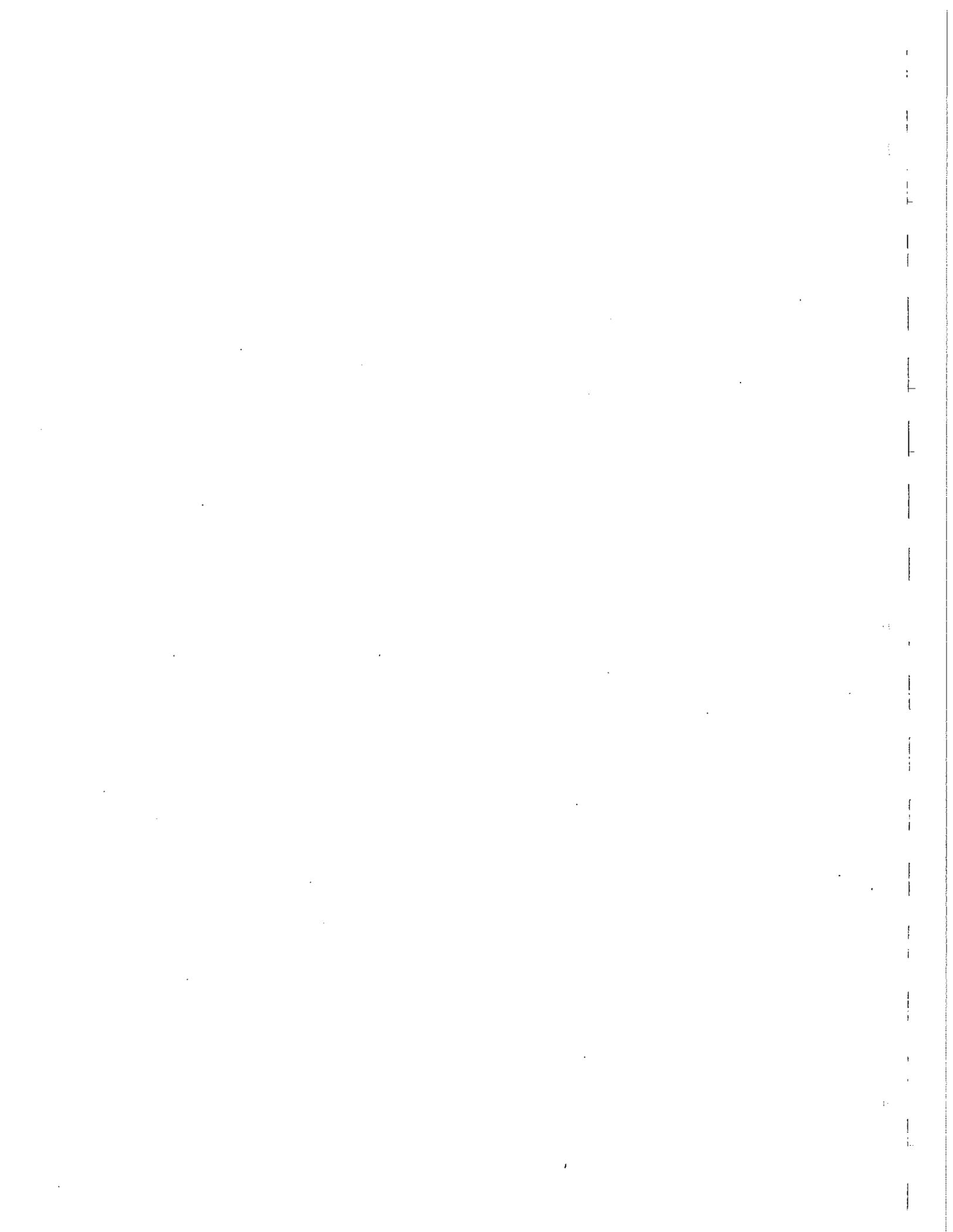
Permits for pipeline crossings of or longitudinal installation within State, Railroad and County right-of-way shall be obtained by the City of Brenham. All work performed within State, Railroad and County right-of-way shall be completed according to the requirements contained in the permits of those Agencies. Copies of the permits are available to the Contractor. The Contractor shall obtain insurance to the minimum requirements of the Railroad as required by

the Railroad to perform work within its right-of-way and shall execute an Agreement with the Railroad, if required, to perform work within its right-of-way.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. Casing or Carrier Pipe by Bore or Tunneling. Installation by bore or tunneling of casing or carrier pipe shall be true to line and grade. The Contractor shall conform to the permit requirements of the appropriate Agency as to the construction methods used. After pipeline installation, immediate backfilling shall be performed on all pits and trenches excavated for the boring operation. For excavations performed by tunneling and jacking, the excavation for the underside of the pipe for at least one third of the circumference of the pipe shall conform to the contour and grade of the pipe.
- B. Grout Around Casing or Carrier Pipe. If the bored or tunneled hole exceeds the outside diameter of the casing pipe or the outside diameter of the carrier pipe barrel by more than one inch, the space between the outside wall of the casing and the excavation shall be completely filled with grout consisting of 1 part of portland cement to 3.5 parts of clean sand by volume. This requirement does not apply to carrier pipes installed by bore under trees unless the hole exceeds the diameter of the pipe bell by more than one inch.
- C. Installing Carrier Pipe in Casing.
 - 1. Treated wooden skids, spacers or insulating rings shall be installed in accordance with the pipe manufacturer's recommendations to prevent the pipe from bearing on the bells, and to position the pipe within the casing. The carrier pipe shall be installed to prevent floating within the casing if the casing fills with water. Fasten wooden skids to pipe with minimum one half (1/2) inch wide, 10 gauge, stainless steel straps.
 - 2. Lubricants such as flax soap or drilling mud may be used when installing the carrier pipe. No petroleum products shall be used for this purpose. After installation is completed on the carrier pipe, the ends of the casing shall be sealed with a mechanical casing seal.

END OF SECTION



SECTION 02229
EXCAVATION SAFETY

PART 1 GENERAL

1.01 SUMMARY

This section covers the minimum requirements and responsibilities of the Contractor for excavations and shoring/safety of same.

1.02 MEASUREMENT AND PAYMENT

The cost for performing the safety requirements set forth herein shall be paid for on a linear foot basis according to the depth of cut as set forth in the Bid Form and shall include all labor, materials, services and equipment to perform this item of work.

1.03 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

OSHA Occupational Safety and Health Administration, 29CFR,
Part 1926

1.04 SYSTEM DESCRIPTION

The Contractor shall shore or otherwise protect all excavations from cave-ins, protect employees from exposure to vehicular traffic, falling loads, hazardous atmospheres, water accumulation and unstable structures in and adjacent to excavations and provide acceptable means of access to and egress from excavations. Notwithstanding these suggestions, the Contractor is solely responsible for the safety of his employees and the general public as they interface with this construction project.

1.05 QUALITY ASSURANCE

- A. Excavation safety system shall meet the current standards established by OSHA, 29CFR, Part 1926, Subpart P-Excavations.
- B. Any construction not in accordance with OSHA regulations may not be eligible for payment and delays in construction to bring the project into

OSHA regulations will not be the responsibility of the Owner or the Engineer.

1.06 PROJECT/SITE CONDITIONS

Contractor shall develop and implement an excavation safety program based on the actual conditions encountered on the project.

PART 2 PRODUCTS (Not used.)

PART 3 EXECUTION

Contractor has the sole responsibility for providing an adequate excavation safety system. The Contractor agrees that neither the Owner nor the Engineer has such responsibility and Contractor shall not rely on the Owner or the Engineer or any of their representatives for inspection, design, supervision, construction or any other aspect of excavation safety.

END OF SECTION

SECTION 02230

FLEXIBLE BASE

PART 1 GENERAL

1.01 SUMMARY

This section covers construction of a foundation course for pavement surface course or other base courses. The base shall be composed of crushed stone and shall be constructed in one or more courses to the lines and grades shown on the plans. All construction procedures and materials shall be in accordance with TxDOT Item 247.

1.02 RELATED SECTIONS

Section 02223 Excavation, Backfilling and Compacting for Pavement

1.03 MEASUREMENT AND PAYMENT

The accepted materials and work for this item will be measured by the square yard of the compacted in place base of the thickness shown on the plans or in the Bid Form. The unit price bid for "Flexible Base" shall be full compensation for furnishing all materials; for delivery on the road; for spreading, shaping, compacting, and finishing; and for all manipulations, labor, tools and incidentals necessary to complete the work.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

TxDOT Texas Department of Transportation Standard Specifications for
Construction of Highways, Streets and Bridges

1.05 SUBMITTALS

Submit certification from supplier or manufacturer that base material meets the requirements of this section.

1.06 QUALITY ASSURANCE

Provide samples of flexible base material delivered for incorporation into the project for testing by Owner. Failed tests shall be paid for by Contractor.

1.07 DELIVERY, STORAGE, AND HANDLING

Handle and store base material to prevent segregation of aggregate.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

The Materials will consist of crushed or uncrushed coarse aggregate mixed with any approved binding material necessary to meet the specified requirements.

A. Material Types. Type A material shall consist of broken or crushed aggregate. All material used must meet the requirements specified in the test limitations tabulation.

B. Grades. The base material shall consist of Grades 1 or 2, unless specified otherwise on the plans. All grades shall meet the requirements in the specification test limit tabulation, according to standard Texas Department of Transportation Laboratory test procedures. When pilot grading is designated in the plans, the City Engineer will specify the grading and allowable tolerances to be achieved during production. When necessary, the City Engineer may vary the pilot grading to insure the base material produced shall meet the physical requirements specified.

C. TYPES	Physical Requirements For Flexible Base Materials.	
	<u>Grade 1:</u> (Triaxial Class 1) Min. compressive strength, psi: 45 to 0 psi lateral pressure and 175 at 15 psi lateral pressure	<u>Grade 2:</u> (Triaxial Class 1 to 2.3) Min. compressive strength, psi: 35 to 0 psi lateral pressure and 175 at 15 psi lateral pressure

TYPE A Crushed or Broken Aggregate	<u>Retained on</u>		<u>Retained on</u>	
	<u>Square Sieve</u>	<u>Percent</u>	<u>Square Sieve</u>	<u>Percent</u>
	1-3/4"	0	1-3/4"	0 - 10
	7/8"	10 - 35	No. 4	45 - 75
	3/8"	30 - 50	No. 40	60 - 85
	No. 4	45 - 65	Max. LL	45
	No. 40	70 - 85	Max. PI	15
	Max. LL	40	*Max Wet Ball Mill	50
	Max. PI	12		
	*Max Wet Ball Mill	40		

*Unless otherwise shown on plans, the maximum increase in material retained on the number 40 sieve resulting from the Wet Ball Mill Test shall not exceed 20.

1. Materials with plasticity greater than those specified may be accepted if the PI is lowered by addition of lime. The lime for this purpose shall be furnished at the Contractor's expense.
 2. The City Engineer may accept the material, providing not more than two (2) out of ten (10) consecutive gradation tests performed are outside of the specified limit on any individual or combination of sieves by no more than five (5) percent and where not two (2) consecutive tests are outside the specified limits.
 3. The City Engineer may accept the material providing not more than two (2) out of ten (10) consecutive plasticity index samples tested are outside of the specified limit by no more than two (2) points and where no two consecutive tests are outside the specified limits.
- D. Contractor shall supply pneumatic and/or steel wheel rollers of sufficient weight to apply a minimum compression of 325 pounds per linear inch of wheel width. Rolling shall start longitudinally at the sides and proceed toward the center, overlapping on successive trips to provide a uniform final surface of the base. Operate rollers at a speed that optimizes compaction.

2.02 SOURCE QUALITY CONTROL

- A. The material shall be secured from the sources approved by the City Engineer. The pits which the acceptable material to be used shall be taken from, shall be opened up to immediately expose the vertical faces of all of the strata and the material shall be secured in successive

vertical cuts extending through all exposed strata, unless otherwise directed.

B. Testing.

1. Testing of the flexible base materials shall be in accordance with the following Texas Department of Transportation standard laboratory test procedures:

Preparation for Soil

Constants and Sieve Analysis	Tex-101-E
Liquid Limit	Tex-104-E
Plastic Limit	Tex-105-E
Plasticity Index	Tex-106-E
Sieve Analysis	Tex-110-E
Wet Ball Mill	
Tex-116-E	
Triaxial Test (part II)	Tex-117-E

2. Job control samples for testing Soil Constants, Gradation and Wet Ball Mill shall be completed prior to the compaction operations, unless otherwise specified.
3. Job control samples for triaxial tests shall be taken from the production stockpile and/or from the temporary stockpile on site, unless directed otherwise from the City Engineer.

PART 3 EXECUTION

3.01 PREPARATION

The subgrade shall be completed within specification and approved by the City Engineer prior to placement of the base material.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. The base material shall be placed in lifts not exceeding 8-inches compacted thickness. The material shall be delivered in uniform capacity on approved vehicles. The Contractor shall insure that the required amount of the specified material is uniformly placed in each one hundred (100) foot station. The material placed upon the subgrade shall be

spread and shaped on the same day, unless it is impractical to do so or otherwise directed by the City Engineer. If it is impractical to spread the material during the first twenty-four (24) hour period, due to poor weather or an unforeseen circumstance, then the material must be scarified and spread as directed by the City Engineer. The material shall meet the specified moisture content, and then be manipulated, bladed, rolled and shaped to achieve the sections required on the plans. Areas of segregated coarse and fine material shall be corrected or removed and replaced with well graded material.

- B. After the material is spread and shaped, it may be essential or desirable for additional binder material to be added. The additional binder will be furnished and applied as directed by the City Engineer. The binder material shall be carefully and evenly incorporated with the material in place by scarifying, harrowing, brooming, or other approved methods. The course shall be rolled and sprinkled as required in order to achieve a uniform compaction. 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 on plans and to the established lines and grades.
- C. The base course shall be kept open for all traffic, unless otherwise directed by the City Engineer. The surface shall be kept free from irregularities and ruts by sprinkling and blading.
- D. Compact flexible base to 97% Modified Proctor density as determined by ASTM D-1557. Moisture content shall be at or to 3% above optimum.

3.03 REPAIR / RESTORATION (Not Used)

In areas on which surface pavement is to be placed, any deviation over three-eighths (3/8) inch in sixteen (16) feet shall be corrected by loosening, adding or removing material, reshaping, and recompacting by rolling and sprinkling. The surface course shall be checked for deviations by using a straightedge or template. All depressions, irregularities, or weak spots that develop shall be corrected by scarifying the areas, adding approved material required, reshaping and recompacting by rolling and sprinkling. Additional base courses may be added once the preceding course has been compacted, cured and is approved by the Engineer.

3.04 FIELD QUALITY CONTROL

Allow access to completed portions of flexible base for field density testing by nuclear method.

END OF SECTION

SECTION 02240

CEMENT STABILIZED SAND

PART 1 GENERAL

1.01 SUMMARY

This section provides for the use of cement stabilized sand as a utility bedding or backfill material or for structural backfill.

1.02 RELATED SECTIONS

Section 2222 Excavation, Trenching and Backfilling for Utilities

1.03 MEASUREMENT AND PAYMENT

There will be no separate measurement and payment for cement stabilized sand unless otherwise shown in the Bid Form.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety :

ASTM American Society of Testing Materials

1.05 SYSTEM DESCRIPTION

Provide sand - cement mixture that will produce a minimum unconfined compressive strength of 100 pounds per square inch (psi) in 48 hours.

1.06 QUALITY ASSURANCE

Upon request of the Engineer, the Contractor or his supplier will furnish samples of the sand and cement for testing before and/or during project construction. Samples shall be submitted two (2) days prior to stabilized sand being delivered to the project site. If the material source is changed during project construction, new samples shall be submitted.

1.07 DELIVERY, STORAGE AND HANDLING

Material not in place within three (3) hours of mixing will be rejected.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Sand. Use clean durable sand containing not more than the following:

1. Deleterious Materials.

- (a) Clay lumps, ASTM C-142; less than 0.5 percent (0.5%).
- (b) Lightweight pieces, ASTM C-123; less than five percent (5.0%).
- (c) Organic impurities, ASTM C-40; shall not show a color darker than the standard color.
- (d) Other deleterious materials such as coal, shale, coated grains of soft flaky particles; less than two percent (2.0%).

2. Plasticity index shall be four (4) or less when tested in accordance with ASTM D-43 and ASTM D-424.

3. Gradation Requirements.

	<u>% Retained</u>
3/8-inch sieve	0%
1/4-inch sieve	0% - 5%
10-mesh sieve	5% - 35%
20-mesh sieve	15% - 55%
40-mesh sieve	35% - 85%
60-mesh sieve	60% - 95%
100-mesh sieve	80% - 97.5%
200-mesh sieve	95% - 100%
270-mesh sieve	100%

4. Color test ASTM C40. Color not darker than standard color.

B. Portland Cement. Furnish Portland cement to conform with ASTM C-150, Type 1.

C. Water. Water shall be reasonably clean and free from injurious amounts of oil, acid, alkalies, salt, organic matter, or other deleterious material.

PART 3 EXECUTION

3.01 PREPARATION

Add not less than 1 1/2 sacks of Portland cement to stabilize one (1) cubic yard

of sand mixture. Mix thoroughly in an approved pug-mill type mixer. Stamp batch ticket with the time of loading.

3.02 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Bedding

1. Place cement-sand in a trench or excavation prepared for utility pipe to the depth shown on the drawings.
2. After bedding material is in place, set pipes in position to grade.
3. Add additional cement-sand material around pipe, filling to at least twelve inches (12") above pipe crown. Place cement-sand material at optimum moisture content, and in layers not to exceed six-inches (6") measured loose.
4. Compact with mechanical hand tamps to at least 95 percent (95%) of Modified Proctor Density, ASTM D-1557.

B. Foundations

Use cement stabilized sand for stabilizing below the foundation for precast manholes, inlets or concrete structures.

C. Backfill

1. When required, place cement-sand in utility trenches as backfill for lines under existing or future pavement.
2. Place cement-sand material at optimum moisture content in layers not to exceed twelve inches (12"), measured loose.
3. Compact with mechanical hand tamps to at least 95 percent (95%) of Modified Proctor Density, ASTM D-1557.

3.03 FIELD QUALITY CONTROL

Allow access to completed portions of bedding or backfill for field density testing by nuclear method.

END OF SECTION



SECTION 02242

CEMENT STABILIZATION OF MATERIALS IN PLACE

PART 1 GENERAL

1.01 SUMMARY

This section covers treating of subgrade by pulverizing, adding cement, mixing, wetting, and compacting the mix to the required density.

1.02 MEASUREMENT AND PAYMENT

Work performed and material furnished for cement stabilization of subgrade shall be measured and paid for by the square yard of surface area of completed and accepted work. The unit price bid per square yard shall include full compensation for preparing the roadbed, furnishing all material, for pulverizing, mixing and sprinkling the cement, compacting, finishing, labor, equipment, and incidentals necessary to complete the work.

1.03 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

ASTM	American Society of Testing and Materials
TxDOT	Texas Department of Transportation - Standard Specifications for Construction of Highways, Streets and Bridges

1.04 SYSTEM DESCRIPTION

Contractor shall provide a completed course of treated subgrade material containing a consistent cement mixture having no loose or segregated areas, of uniform density and moisture content, well bound and compacted for its full depth and with a smooth surface suitable for placing subsequent courses. The Contractor shall be responsible for regulating the sequence of his work, for processing a sufficient quantity of material to provide a full depth as shown on plans, using the proper amount of Portland cement, maintaining the work, and reworking of the courses as necessary to meet the requirements.

1.05 SUBMITTALS

Weight Certificates from public scale for cement delivered in trucks.

1.06 DELIVERY, STORAGE, AND HANDLING

Adequate storage facilities must be provided to protect the cement on the project from exposure to air and moisture until immediately before it is applied. If storage bins are used, they shall be totally enclosed. Sacked cement shall be stored in watertight buildings.

1.07 PROJECT / SITE CONDITIONS

Cement shall not be placed or mixed when the atmospheric temperature is forty (40) degrees Fahrenheit and falling, but it may be placed and mixed when the atmospheric temperature is thirty-five (35) degrees and rising, if other weather conditions are suitable. The temperature shall be taken in the shade away from artificial heat.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Materials.

1. Subgrade. The subgrade shall consist of approved material free from vegetation or other questionable matter encountered in the existing roadbed and other acceptable material used in preparation of the roadbed.
2. Portland Cement. Portland cement shall be Type 1 of a standard brand and conform to the requirements of ASTM Designation C-150. One (1) sack containing one (1) cubic foot of cement, shall be considered as weighing ninety-four (94) pounds net. One (1) barrel of cement shall be considered as weighing three hundred seventy-six (376) pounds net, and containing four (4) cubic feet. The Contractor may use bulk cement, provided the apparatus for handling, weighing and spreading the cement is acceptable.
3. Water. Water shall be free from substances deleterious to the hardening of the cement treatment.

- B. Equipment. Equipment necessary for the proper construction of the work shall be on the project prior to the start of construction operations. All equipment shall be maintained in a satisfactory working condition.

PART 3 EXECUTION

3.01 PREPARATION

The subgrade shall be shaped to the sections, lines and grades shown on the plans, prior to applying cement.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. Pulverization. Soil shall be pulverized so that at the completion of moist-mixing, one hundred (100) percent by dry weight passes a one (1) inch sieve, and a minimum of eighty (80) percent passes a No. 4 sieve, excluding gravel or stone retained on the sieves.
- B. Application of Cement. Portland cement shall be spread uniformly on the soil at the rate specified on the plans. If a bulk cement spreader is used, it shall be positioned by string lines or other approved method during spreading to insure a uniform distribution of cement. Cement shall only be applied to an area that all the operations can be continuous and completed in daylight within six (6) hours of application. At the time of application, the moisture percentage in the soil shall not exceed the quantity that will permit uniform and intimate mixture of soil and cement during dry mixing operations, and it shall not exceed the specified optimum moisture content for the soil cement mixture. Only equipment used in spreading and mixing will be allowed to pass over the freshly spread cement.
- C. Mixing and Processing. Either a multiple-pass traveling mixing plant or a single-pass traveling mixing plant can be used. The cement shall be dry mixed with the soil to prevent the formation of cement balls when water is applied. Any mixture of soil and cement that has not been compacted and finished shall not remain undisturbed for more than thirty (30) minutes. The necessary amount of water shall be applied and incorporated into the mixture immediately after the dry mixing of soil and cement is complete. The water supply and distribution equipment provided shall be sufficient to ensure continuous application of the required amount of water to sections being processed within three (3) hours of application of the cement. Care shall be exercised to insure proper moisture distribution at all times. After the last increment of water

has been added, mixing shall continue until a thorough and uniform full depth mix has been obtained.

- D. **Compaction and Finishing.** The material shall be compacted to not less than 95% of Modified Proctor Density as determined by ASTM D-1557 within two (2) hours of mixing. When compaction begins, the percentage of moisture in the mixture and unpulverized soil lumps, based on oven-dry weights, shall not be less than or greater than two (2) percentage points above the specified optimum moisture content and shall be less than that quantity which will cause the soil cement mixture to become unstable during compaction and finishing. If the uncompacted soil cement mixture is wetted by rain so that the average moisture content exceeds the allowable tolerance at the time of final compaction, then the entire section shall be reconstructed at the expense of the Contractor. After the soil and cement mixture is compacted, water shall be applied uniformly as needed and mixed in thoroughly with a spiketooth harrow or equal. The surface shall be reshaped to the required lines, grades and cross section and lightly scarified to loosen any imprint left by the compacting or shaping equipment. Surface compaction and finishing shall proceed in such a manner as to produce, in not more than two (2) hours, a smooth, closely knit surface, free of cracks, ridges or loose material conforming to the crown, grade and line shown on the plans.
- E. **Curing.** After cement treatment course has been finished, the surface shall be protected against rapid drying by either of the following curing methods for a period as shown on the plans but in no case less than three (3) days or until the surface or subsequent courses are placed:
1. Sprinkling to maintain a thorough and continuously moist condition.
 2. Apply a two (2) inch layer of earth on the completed course and maintain in a moist condition.
 3. An asphalt membrane may be applied to the treated course. The type and quantity of asphalt shall be sufficient to completely cover and seal the total surface of the subgrade and fill all voids. The asphalt must be approved by the City Engineer. The asphalt membrane shall be protected from being picked up by traffic by sanding or dusting the surface. The asphalt membrane may remain in place when the proposed surface or other base courses are placed.

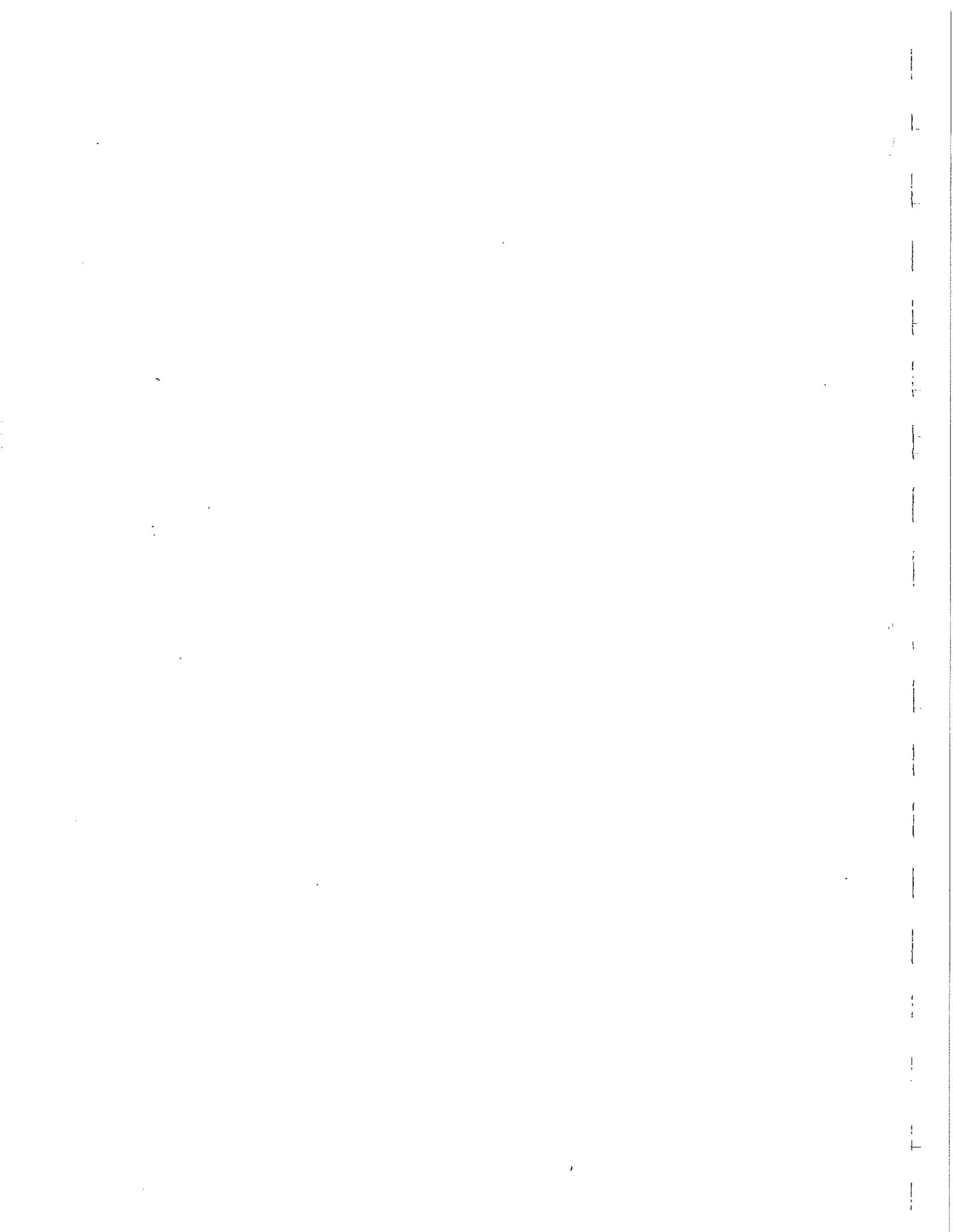
Base courses may be applied on the finished subgrade as soon after completion as operations will permit.

- F. Construction Joints. At the end of each day's construction a straight transverse construction joint shall be formed by cutting back into the total width of completed work to form a true vertical face free of loose and shattered material. Cement treatment for large, wide areas shall be built in a series of parallel lanes of convenient length and width.
- G. Traffic. Local traffic and construction equipment may travel on completed sections of cement treated material in place, and all traffic may travel on the completed section after the curing period, provided the cement treated course has hardened sufficiently to prevent being damaged.

3.03 REPAIR / RESTORATION

The Contractor shall maintain the cement stabilized material in good condition until all work has been completed and accepted. Maintenance shall include immediate repairs of any defects that may occur. This work shall be repeated as often as necessary and at the expense of the Contractor. Faulty work shall be replaced for the full depth of treatment. The Contractor shall construct the plan depth of cement stabilization in one homogeneous mass, so the addition of thin stabilized layers will not be permitted in order to provide the minimum specified depth.

END OF SECTION



SECTION 02244

LIME STABILIZATION OF MATERIALS IN PLACE

PART 1 GENERAL

1.01 SUMMARY

This item specifies the addition of lime, mixing and compacting the mixed material for subgrade.

1.02 MEASUREMENT AND PAYMENT

Lime stabilization of subgrade shall be measured and paid for by square yard of surface area to the lines shown on the plans and to the depth and at the percentage of lime (by dry solids weight) specified. The unit price bid per square yard shall include full compensation for supplying the lime, for all mixing, shaping, compacting, and for all incidentals necessary to complete the work.

1.03 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

AASHTO	American Association of State Highway and Transportation Officials
TxDOT	Texas Department of Transportation - Standard Specifications for Construction of Highways, Streets and Bridges

1.04 SYSTEM DESCRIPTION

Contractor shall provide a completed course of treated subgrade material containing a consistent lime mixture, having no loose or segregated areas, of uniform density and moisture, well compacted to its full depth and having a smooth surface adequate for placing additional subbase, base or surface courses. The Contractor shall be responsible for regulating the sequence of the work, for processing a sufficient quantity of material to provide a full depth as shown on the plans, using the appropriate amount of lime, maintaining the work and performing any reworking of the courses if necessary to meet the requirements.

1.05 SUBMITTALS

Weight certificates from public scale for lime delivered in trucks.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Hydrated lime shall be stored and handled in closed, waterproof containers until immediately before distribution. Hydrated lime bags must be stored in waterproof buildings and protected against ground dampness. If storage bins are used, they must be completely enclosed.
- B. If lime is delivered in bags, then each bag must have the manufacturer's certified weight. Bags that vary more than five percent (5%) from the Manufacturer's weight can be rejected. The average weight of the bags in any shipment, as calculated by weighing fifty (50) bags at random, shall not be less than the manufacturer's certified weight.
- C. If lime is furnished in trucks, each truck shall have the certified weight from public scales or the Contractor must supply a set of standard platform truck scales or hopper scales at a location approved by the City Engineer. The scales shall meet the criteria of TxDOT Item 520.

1.07 PROJECT / SITE CONDITIONS

Mixing of the lime-treated subgrade shall not be performed when the atmospheric temperature is forty (40) degrees Fahrenheit and falling, or when the weather indicates that within the next twenty-four (24) hours the weather will fall below forty (40) degrees Fahrenheit. Mixing shall also not occur when it is foggy or raining, or when the soil or subgrade is frozen.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

- A. Lime. The lime shall meet the requirements of TxDOT Item 264 for Type A - Hydrated Lime, Type B - Commercial Lime Slurry or Type C - Quicklime. Type C - Grade S, Quicklime shall not be used for dry placing.
- B. Water. Water that is used for mixing or curing shall be free of acid, alkali, oil, salt, vegetable, sugar and other substances that may be injurious to the finished product. Water shall be tested and must meet the requirements in AASHTO T-26. If water is used that is known to be

of potable quality, then no testing is required.

- C. Equipment. The equipment necessary for performing the work shall be on the project site prior to the beginning of construction operations. All machinery, tools and equipment shall be maintained in acceptable working condition. The Contractor shall conduct his operations in a workmanlike manner and shall use approved methods in performing the work.

PART 3 EXECUTION

3.01 PREPARATION

The subgrade shall be shaped to the sections, lines and grades shown on the plans, prior to applying lime.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. Lime may only be spread on areas where the mixing operations will be completed on the same working day. The application and mixing of lime with the material shall be accomplished by either "Dry Placing" or "Slurry Placing". Hydrated lime that has been exposed to open air for six (6) hours or more or to excessive loss due to washing or blowing will not be accepted for payment.
 - 1. Dry Placing. Spreading of hydrated lime shall be accomplished by an approved spreader or by bag distribution at the rates specified on the plans. The lime shall be distributed at a uniform rate and in such a way as to minimize the scattering by wind. No application of lime shall occur when the wind conditions are in such a manner that blowing lime becomes objectionable to traffic and adjacent property owners. Hydrated lime shall not be spread by a motorized grader. Quicklime may be spread by approved distributor or by motorized grader to achieve uniform distribution. The material shall be sprinkled until the proper moisture content has been established.
 - 2. Slurry Placing. The lime shall be mixed with water in approved distributor trucks and distributed as a thin water suspension or slurry. The required rate of lime distribution shall be achieved by successive passes over a measured area until the proper lime content and moisture have been obtained. On steep slopes, prevent runoff of slurry.

- B. **Mixing.** The subgrade material, lime and required water shall be thoroughly mixed and blended by an approved pulverizing mixer to the depth specified on the plans. Mixing shall proceed until a homogenous, friable mixture is obtained such that after removal on non-slaking material, 100 percent of the material passes the 1-3/4" sieve and a minimum of 85 percent passes the 3/4" sieve. If Type C - Grade DS Quicklime is used, moist cure the material for two (2) to seven (7) days and remix to the above required gradation.
- C. **Compaction.** The mixture shall be compacted after final mixing but not later than three (3) calendar days after final mixing unless approved by the City Engineer. The material shall be aerated or sprinkled as necessary in order to achieve optimum moisture. If the total thickness of the material cannot be mixed in one mixing, then the previously mixed material shall be bladed to a windrow from the area to be treated and the lime mixing for the next layer will begin. The first layer of treated material shall not be mixed with the underlying material. Compaction of the mixture shall begin at the bottom and continue for the entire depth until a uniform compaction to not less than 95% of Modified Proctor Density as determined by ASTM D-1557, or to the density shown on the plans.
- D. **Finishing, Curing and Preparation for Surfacing.** After the final layer or course of subbase or base has been compacted, it shall be brought to the required lines and grades in compliance with the typical sections. Completed sections shall be finished and rolled with a pneumatic roller or other suitable roller light enough to prevent hair cracking. Moist curing for the completed section shall be a minimum of seven (7) days before any other course is placed or traffic is permitted unless otherwise approved by the City Engineer. Moist curing shall be accomplished by sprinkling with water to prevent the surface from drying out or by addition of an asphalt material to retain moisture in the subbase or base. Layers on which the subbase sets up sufficiently to prevent unacceptable damage from traffic, may be opened up to traffic two (2) days after completion. If treated material is required to be sealed or covered by other courses of material, then such seal or course shall be applied within fourteen (14) days after compaction unless otherwise directed by the City Engineer.

3.03 REPAIR / RESTORATION

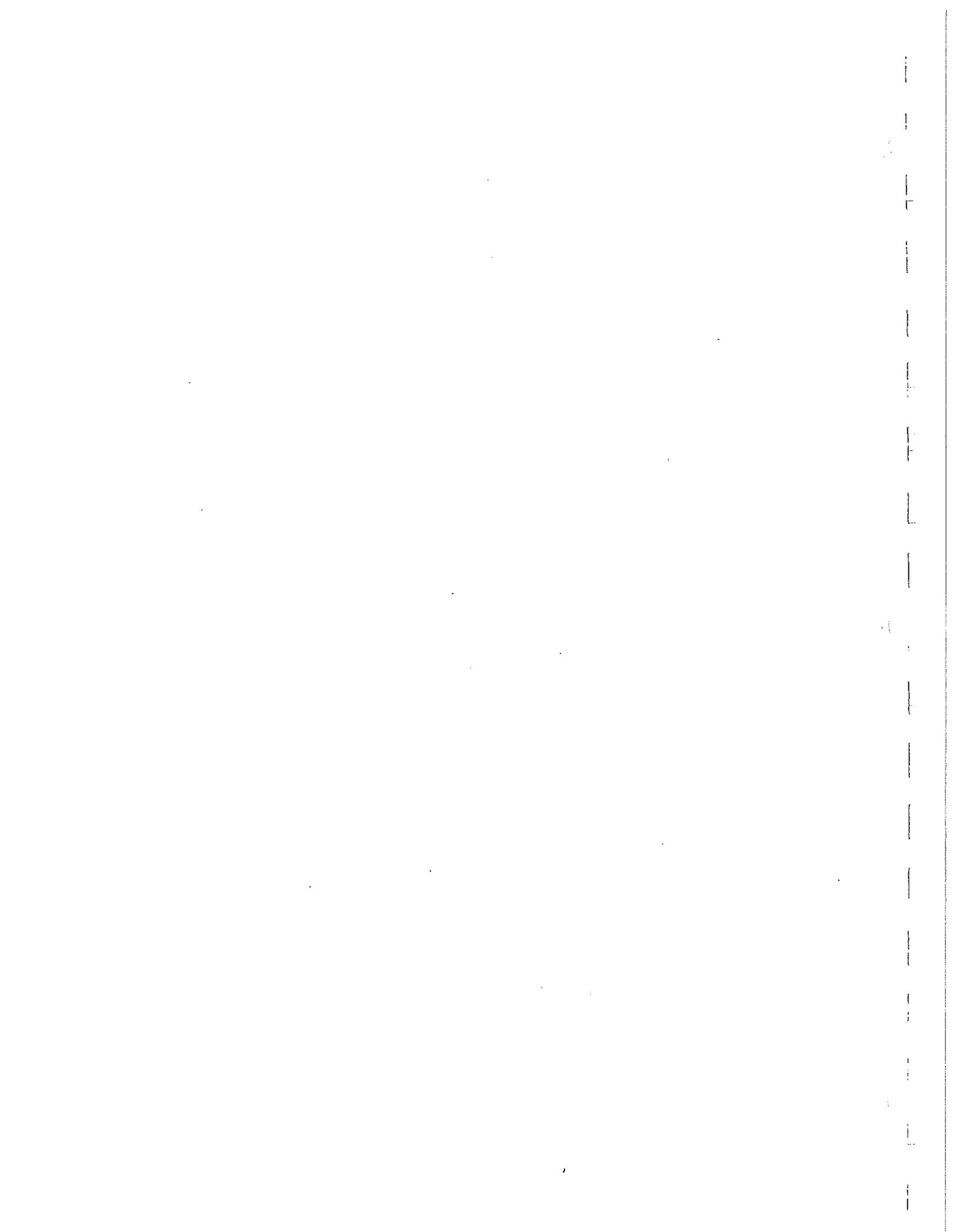
The course surface shall be maintained in a smooth condition, free from ruts and undulations, until it is accepted and/or another course is laid. If the

material should lose the required stability, density and finish for any reason, before the work is accepted or the next course is placed, then it shall be recompact and refinished at the expense of the Contractor

3.04 FIELD QUALITY CONTROL

Allow access to completed portions of work for field density testing by nuclear method.

END OF SECTION



SECTION 02510

HOT MIX ASPHALTIC CONCRETE PAVEMENT

PART 1 GENERAL

1.01 SUMMARY

This section describes the furnishing and installing of a surface for pavement consisting of compacted mixture of coarse and fine aggregates and asphaltic material. Paving construction will be on stabilized subgrades and/or base to conform with the lines, grades, compaction thickness and the typical cross sections as shown on the plans.

1.02 MEASUREMENT AND PAYMENT

The work performed and materials furnished for hot mix asphaltic concrete pavement shall be measured and paid for by the square yard at the unit price bid for asphaltic concrete pavement meeting the minimum thickness required. Prime and/or tack coat shall be considered a part of the asphaltic concrete surface course and no separate payment will be made for this work and materials. Measurement will be from the edges of the full thickness of in place asphalt concrete surface. The unit price will be complete compensation for all equipment, materials, labor, and supervision required to construct asphaltic concrete surface course as shown on the plans.

1.03 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

AASHTO	American Association of State Highway and Transportation Officials
TxDOT	Texas Department of Transportation Construction Bulletin No. 14
TxDOT	Texas Department of Transportation - Standard Specifications For Construction of Highways, Streets and Bridges

1.04 SYSTEM DESCRIPTION

Hot mix asphaltic concrete pavement shall include prime coat and/or tack coat, and asphaltic mixture.

1.05 SUBMITTALS

Samples and tests of coarse aggregate and fine aggregate.
Samples of any mineral filler.
Hot mix asphaltic concrete mix design and test results.

1.06 QUALITY ASSURANCE

The Contractor shall provide at his expense, laboratory test results for all the materials to be incorporated into the asphaltic concrete as well as the asphaltic concrete mix. The Contractor must furnish, operate, and maintain templates, straight edges, scales, and other measuring and weighing devices necessary for proper construction and checking of work.

1.07 PROJECT / SITE CONDITIONS

No asphaltic mixture, prime coat, nor tack coat shall be placed when the air temperature is below 50° F and falling but it may be placed when the temperature is 40°F and rising. Temperature readings shall be taken in the shade away from artificial heat. Place asphaltic mixtures only when weather conditions are suitable, in the opinion of the Engineer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

Both the materials and the source of the supply must be approved by the engineer prior to the delivery of any materials.

2.02 MATERIALS AND/OR EQUIPMENT

- A. Aggregate. Composition of the mineral aggregate shall be of both a coarse aggregate and a fine aggregate and may include a mineral filler. If required, samples of aggregates shall be submitted for testing.
 - 1. Coarse Aggregate. The coarse aggregate shall consist of that part of the aggregate retained on a No. 10 sieve. The coarse aggregate shall consist of clean, tough, durable fragments of stone, crushed gravel, or a combination of both, as specified herein, and shall be of a uniform quality throughout free from dirt, organic or other injurious matter occurring either freely in the material or as a coating of the aggregate. The coarse aggregate

shall have a maximum percent abrasion of 40 when subjected to the Los Angeles Abrasion Test (Tex-410-A) and a maximum percent loss of 30 when subjected to the 5 cycle Magnesium Sulfate Soundness Test (Tex-411-A).

2. Fine Aggregate. The fine aggregate shall be that part of the aggregate passing the No. 10 sieve and consist of sand and fine aggregate particles from the coarse aggregates' material sources or a combination thereof. The sand shall be composed of durable particles free from injurious foreign matter and shall be limited to 15% of the total fine aggregate. Screenings shall be of the same or similar materials as specified for coarse aggregates. The plasticity index of that passing the No. 40 sieve shall be a maximum six (6) when tested by AASHTO T-89 and T-90. Unless otherwise shown on the plans, stone screenings are required and shall be the result of a rock crushing operation and meet the following gradation requirements, when tested in accordance with Test Method Tex-200-F, Part I.

	<u>Percent by Weight</u>
Passing the 3/8" sieve	100
Passing the No. 10 sieve	70-100
Passing the No. 200 sieve	0-15

3. Mineral Filler. The mineral filler shall consist of thoroughly dry stone dust, portland cement, fly ash or other mineral dust approved by the City Engineer. The mineral filler shall be free from foreign and other injurious matter. The mineral filler shall meet the following grading requirements when testing in accordance with Tex-200-F, unless the plans show otherwise:

	<u>Percent by Weight</u>
Passing a No. 30 sieve	95 to 100
Passing a No. 80 sieve, not less than	75
Passing a No. 200 sieve, not less than	55

- B. Asphalt. The grade of the asphalt shall be AC-20. If more than one (1) type of asphaltic concrete mixture is specified for the project, only one (1) grade of asphalt will be required for all types of mixtures. The asphaltic materials shall be homogeneous, free from water, and shall not foam when heated to 350° F. The material shall meet the following requirements:

<u>Viscosity Grade</u> <u>Property</u>	<u>AC-20</u>	
	<u>Min.</u>	<u>Max.</u>
Viscosity, 140 F, poises	1600	2400
275 F, poises	2.5	—
Penetration, 77 F 100 g, 5 sec	55	—
Flash Point, C.O.C., F	450	—
Solubility in Trichloroethylene, %	99.0	—
Spot Test	Negative	
Tests on Residue from Thin Film Oven Test: Viscosity, 140 F, poises	—	6000
Ductility, 77 F, 5 cm per min., cm	70	—

All asphalt shall be obtained from TxDOT pretested stock.

Asphalt material for the prime coat shall be MC-30 and asphalt material for the tack coat shall be RC-250 or SS-1 and must meet the following requirements:

<u>Type-Grade</u> <u>Property</u>	<u>MC-30</u>		<u>RC-250</u>	
	<u>Min.</u>	<u>Max.</u>	<u>Min.</u>	<u>Max.</u>
Kinematic Viscosity @ 140 F, cst	30	60	250	400
Water, percent	—	0.2	—	0.2
Flash Point, T.O.C., F	100	—	80	—
Distillation Test: Distillate, percentage by volume of total distillate to 680 F				
to 437 F	—	25	40	75

1/2-inch	
3/8-inch	60 - 80%
1/4-inch	
No. 4	40 - 60%
No. 10	27 - 40%
No. 40	10 - 25%
No. 80	3 - 13%
No. 200	1 - 6%*
VMA % Minimum	12

*2 - 8 when Test Method Tex-200-F, Part II (Washed Sieve Analysis) is used.

The asphaltic material shall form three percent (3%) to eight percent (8%) of the mixture by weight.

2. Hot-Mix Asphaltic Concrete Surface Course - Type "D"

Master Grading Requirements for the Aggregates.

<u>Sieve Sizes</u>	<u>Total Percent Passing, by Weight</u>
1-1/2 - inch	
1-1/4 - inch	
1 - inch	
7/8 - inch	
5/8 - inch	
1/2 - inch	100%
3/8 - inch	85 - 100%
1/4 - inch	
No. 4	50 - 70%
No. 10	32 - 42%
No. 40	11 - 26%
No. 80	4 - 14%
No. 200	1 - 6%*
VMA % Minimum	14

*2-8 when Test Method Tex-200-F, Part II (Washed Sieve Analysis) is used.

The asphaltic material shall form four percent (4%) to eight percent (8%) of the mixture by weight.

- D. Type of Plant. Mixing plants must be approved by the City Engineer and have the capacity for producing mixtures that meet the specifications.

Continuous mixing type and weight batching-type are both acceptable. The plant must have acceptable conveyors, power units, aggregate handling equipment, hot aggregate screens and bins, and dust collectors. The plant must provide equipment to adequately supply materials in accordance with the plant's rated capacity and produce finished material within the specified tolerances. Essential equipment includes cold aggregate bins and proportioning device, dryer, screens, aggregate weight box and batching scales, mixer, asphalt storage and heating devices, and asphalt measuring devices.

2.03 FABRICATION

- A. Screening and Proportioning. Screening capacity and bin sizes shall be adequate to screen and store the amount of aggregate required to properly operate and keep the plant in continuous operation at full capacity.
- B. Drying. The mineral aggregate drying shall be done in a manner such that fine particles will not be lost with the furnace gases. A dust collector system will be required if forced draft is used. The City Engineer may require that a dust collector system be used during forced draft if a substantial amount of the finer particles are escaping. The aggregate shall be continuously agitated during heating in a suitable apparatus in which the temperature can be efficiently controlled so that the aggregate will not be damaged and the finished mixture will have a temperature of between 250 degrees and 375 degrees Fahrenheit.

A recording thermometer shall be used to record the temperature of the aggregate as it leaves the dryer. The temperature record shall be a 24 hour chart, and may be equipped to record both the temperature of the rock and the temperature of the aggregate incorporated into the batch. The dryer(s) shall be of adequate size to heat and dry the required amount of aggregate to keep the plant in continuous operation.

- C. Weigh Box. Tight cut-off gates shall be provided on the storage bins so that mineral aggregates will not leak into the weigh box. The weigh box shall be of a sufficient capacity to hold a complete batch of aggregate without wasting or leveling by hand. The weigh box shall be designed so that the entire batch will quickly discharge into the mixer. The weigh box shall have an open top so that any excess of one (1) size of mineral aggregate may be removed by the operator, during charging. The weigh box shall have a close fitting and quick operating cut-off gate so that no

Tests on Residue from Distillation:

Penetration at 77F, 100g, 5 sec	120	160
Solubility in Trichlorethylene, %	97.5	-
Ductility at 77F, 5 cm/min, cm	100	-

*Applies only when the Engineer designates material for winter use.

All prime coat or tack coat materials shall be obtained from TxDOT pretested stock.

C. Hot-Mix Asphalt Concrete.

Design Mixes. After being tested in accordance with these specifications and current Texas Department of Transportation methods, the design mixes and materials are subject to approval of the City Engineer. Design mixes and density and stability tests are the Contractor's responsibility and made at his expense. All certified test results, stating compliance with the specified requirements, for both the asphaltic materials and aggregates shall be furnished to the Engineer.

Density and Stability Requirements. Laboratory density and stability of the mixture shall be designed and tested in accordance with the methods outlined in the Texas Department of Transportation C-14 and meet the following:

<u>Density %</u>		<u>Optimum</u>	<u>Stability %</u>
<u>Min.</u>	<u>Max.</u>		<u>Not Less Than</u>
95	99	96	35

The compacted thickness of the mixture(s) used shall be specified on the plans.

1. Hot-Mix Asphaltic Concrete Base Course - Type "B".

Master Grading Requirements for the Aggregates

<u>Sieve Sizes</u>	<u>Total Percent Passing, by Weight</u>
1-1/2 inch	
1-1/4 inch	
1-inch	100%
7/8-inch	95 - 100%
5/8-inch	75 - 95%

mineral aggregate will leak into the mixer.

- D. Scales. Either the springless dial type or the multibeam-type scales may be used for weighing the different grades of mineral aggregate. If using a springless dial type, an adjustable indicating pointer shall be required for each grade of the mineral aggregate allowing for an accurate setting of the weight. If using a multibeam-type, there shall be sufficient weighing beams to weigh each grade of aggregate separately. All scales shall have a tare beam for balancing. The beam scale is also required to be equipped with a tell-tale dial indicator of the springless dial type indicating over and under load of at least 50 pounds. Scales that are not accurate within four (4) pounds per 1,000 pounds net load will not be considered adequate. The scales shall be insulated against shock or vibration so that neither case shall interfere with accurate weighing.

E. Mixing.

1. The mixer shall be the twin-pug-mill type and shall have a capacity of not less than 2,000 pounds in a single batch. The positioning and number of blades shall be sufficient to give a uniform and complete circulation of the batch in the mixer from the center to the four (4) ends of the mixer arms and then back to the center. A mixer will be considered inadequate if it fails to perform a uniform and thorough mixing with the asphalt cement and the aggregate, or it has a tendency to segregate mineral aggregate. Mixer determination will be made by mixing a standard batch for the required time, and then dumping out the batch in order to take samples from different parts of the batch for testing.
2. All mixers shall be provided with automatic time locks on the discharge gates and weigh box and will be locked for a period of 45 seconds after all of the mineral aggregate have been introduced into the mixer. The mixture shall have a temperature of 300 degrees to 375 degrees when discharged. The mixer dump door shall be tight to the dry mineral aggregate or dust so that there will be no spilling from the pug mill. All mineral aggregate shall be thoroughly mixed for a period of five (5) to ten (10) seconds before the asphalt cement is added. Mixing will then continue for the required time, or longer if necessary to produce a mixture with uniform consistency.

F. Heating and Weighing Asphalt.

1. Storage for the asphalt cement shall be adequate to meet the requirements of the plans. Asphalt cement in storage shall be heated by steam coils, tight enough to prevent moisture from leaking into the asphalt. Steam for heating shall not be at a temperature in excess of 400 degrees Fahrenheit. Direct fire heating of asphalt shall not be permitted.
2. The steam heating system shall insure that uniform draw-off heat of the asphalt cement is maintained between 250 degrees and 350 degrees Fahrenheit at the asphalt cement bucket. The temperature shall be maintained with an efficient and positive control of the heat beyond 250 degrees Fahrenheit, either before or during mixing with the mineral aggregate.
3. The asphalt cement draw-off valve shall be of a quick cutoff type that will not leak any asphalt into the bucket after the required weight of the asphalt cement has been drawn. The asphalt supply line must be of a circulating type, and must be equipped with a recording thermometer indicating the temperature of the asphalt at the draw-off valve. The recording thermometer may be a combination thermometer used for recording the temperature of the aggregate.
4. The asphalt cement shall flow from the asphalt cement weigh bucket into the mixer for approximately the full width of the mixer so as not to deposit the asphalt cement in the mixer in one (1) place. Scales used for weighing the asphaltic cement shall be of springless dial type arranged for quick adjustment at zero to provide for the change in tare. A pointer will indicate the weight of the asphaltic cement required in one (1) batch.

PART 3 EXECUTION

3.01 PREPARATION

The base course or asphalt course to be overlaid shall be cleaned by sweeping or other methods approved by the City Engineer. The base course shall be lightly sprinkled immediately before the prime coat is applied. All rate of application and pressure gauges will be inspected and calibrated prior to applying the prime or tack coat. MC-30 prime coat shall be applied at a rate of 0.30 gallons per square yard at a temperature between 70° and 150°

Fahrenheit. The prime coat shall dry for a period of forty-eighty (48) hours or longer if required by the City Engineer. RC-250 tack coat shall be applied at a rate of 0.10 gallons per square yard at a temperature between 70° and 150° Fahrenheit. The prime and tack coats will be applied in strict accordance with the requirements of Item 310 of the Texas Department of Transportation Standard Specifications for Construction of Highways, Streets and Bridges.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. Laying.

1. The asphaltic concrete mixture shall be hauled to the worksite in vehicles cleaned of all foreign materials and, if required by the City Engineer, covered with a canvas that is sufficient to protect the entire load. The vehicle dispatching shall be arranged so that all material delivered may be placed and initially rolled in the daylight. The mixture shall be pre-placed on approved subgrade. The "lay down" machine shall be capable of spreading the mix to the line, grade and crown as specified in the plans. The mixture shall be spread without segregation or tearing. The mixture must be at a temperature between 200 degrees and 350 degrees Fahrenheit.
2. The base course shall be spread in one (1) lift so that when compacted, the finished course will be smooth, of uniform density, and will be to section, line and grades as directed.
3. A surface course of two (2) inches or less in thickness may be spread in one (1) lift. All lifts shall be spread such that when compacted, the finished course will be smooth, of uniform density, and will be to section, line and grades as directed.
4. Asphalt base and surface courses may be spread and finished by hand if use of a paver is impractical. Steel or wood forms, rigidly supported to assure correct grade and cross-section, shall be used. Place the materials carefully in order to avoid segregation of the mix. Broadcasting of the material shall not be permitted. Any lumps which do not break down must be removed. Asphalt courses must be put down in the same sequence as if placed by machine.

- #### B. Rolling.
- Rolling equipment shall consist of pneumatic tire and steel wheel rollers.

1. Pneumatic tire rollers shall have equal size and diameter pneumatic tires that are capable of exerting a contact pressure varying from 40 to 110 psi by adjusting ballast and/or tire pressure. Wheel spacing will be such that one (1) pass will accomplish one (1) complete coverage equal to the width of the roller and have a 1/4-inch (1/4") minimum overlap. None of the wheels shall wobble. The tire pressure and operating weight shall be sufficient to achieve the desired density. The roller shall be self-propelled.
2. Steel wheel rollers shall be a three (3) wheel roller two-axle tandem roller or three-axle tandem roller weighing not less than eight (8) tons and developing a compression in the rear wheels of 250 to 350 pounds per inch of roller width. The rollers shall have power units and be equipped with the means of keeping the wheel wet to prevent the mixes from sticking to the rollers. The rollers shall also be equipped with scrapers to keep the wheels clean.
3. Rolling shall start at the sides longitudinally and proceed toward the center of the pavement, overlapping on successive trips by at least 1/2 of the width of the rear wheels. Alternate trips of the roller shall be slightly different in length. Continue rolling until no further compression can be obtained and all roller marks are eliminated. The roller motion shall be slow enough to insure no displacement of the hot mixture. The roller must not sit on completed pavement which has not cooled to the normal atmospheric temperature. The wheels shall be properly moistened with water to prevent the hot mixture from sticking to the rollers, but an excess of water shall not be permitted.
4. If the asphalt is not being compacted properly, in the opinion of the City Engineer, then cores will be taken and tested in order to determine the relative densities of the course at various locations.
5. The completed course shall have a uniform density over the entire roadway area. The City Engineer may, after testing under acceptable practices, have all or parts of the course removed and replaced on areas where the density is found to vary. The task of removing and replacing of the course because of unacceptable density variations shall be completed at the cost of the Contractor.

- C. Hand Tamping. In areas where compaction by a roller is not easily accomplished, such as along walls, curbs, headers, etc., a vibrating plate compactor or lightly oiled tamps shall be used to thoroughly compact the mixture in three-inch (3") layers.
- D. Density. The base course, binder course and surface course shall be compacted to a minimum density of 95 percent (95%) of the maximum possible density of a voidless mixture composed of the same materials in like proportions. If the results of the density tests for the base course, binder course or surface course indicate that the minimum density of 95 percent (95%) has not been obtained, additional rolling with a three-wheel or pneumatic roller will be required before the mix cools.
- E. Surface Requirements. The finished surface of plane areas shall not vary more than 1/4-inch (1/4") from a 16-foot (16') straightedge applied to the surface. The straightedge must overlap the previous test by 1/4 of its length. Any irregularities which vary more than 3/16-inch (3/16") in 10-foot (10') or 1/4-inch (1/4") in 16-feet in accordance with the grade, valley and crown shown on the plans shall be corrected.
- F. Construction Joints. Each course shall be placed as nearly continuous as possible. The roller shall only pass over the unprotected end of the freshly laid mixture when the laying of the course is discontinued for such a length of time as to allow for the mixture to become chilled. In such cases, when the work is resumed, the material laid shall be either cut back in order to obtain a beveled edge for the full thickness of the course or an acceptable lap joint shall be made.
- G. No portion of the finished asphalt course shall be opened to traffic until 12-hours after rolling has been completed, except where shown on the plans or in an emergency.

3.03 REPAIR / RESTORATION

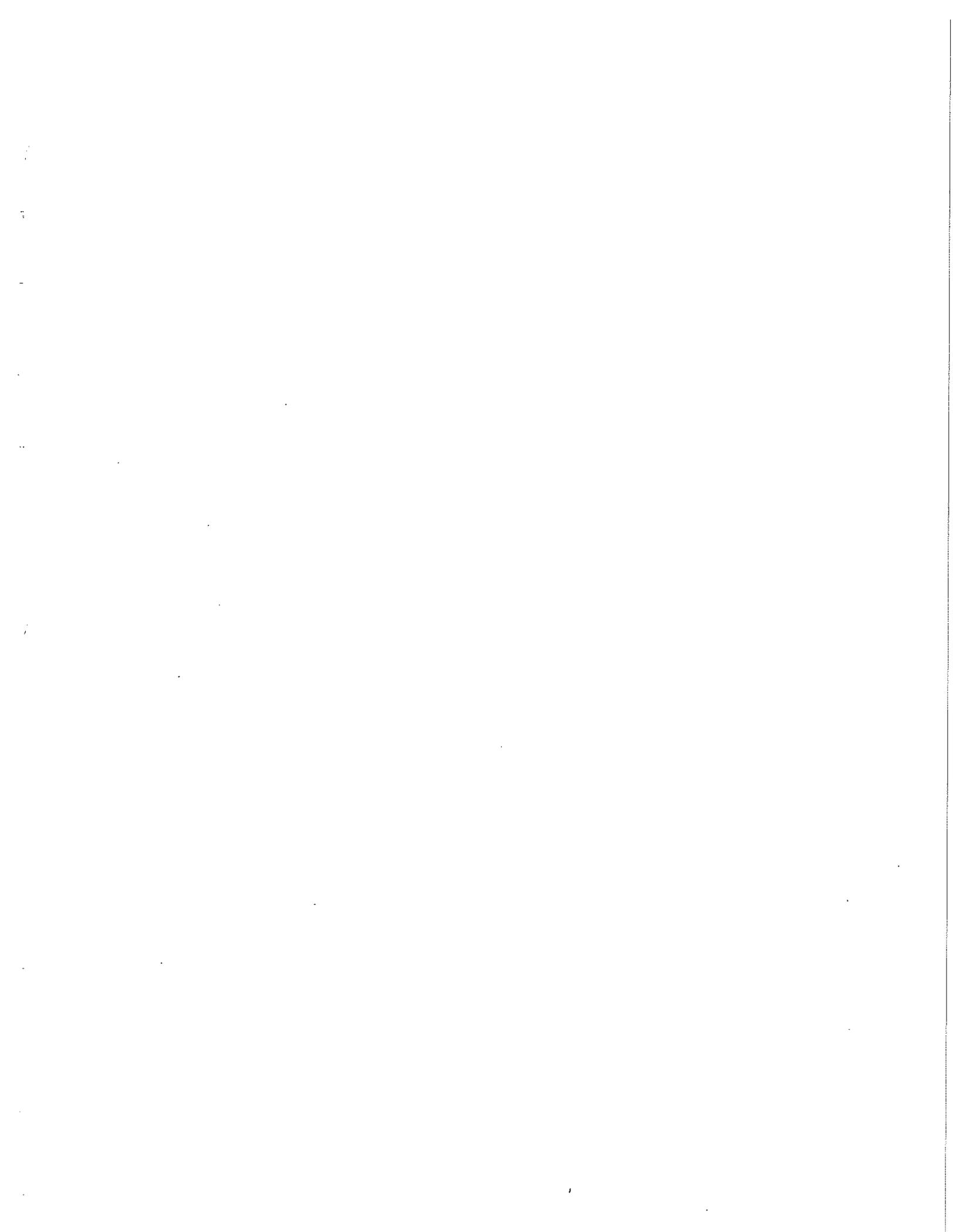
Pavement sections not meeting the specified densities shall be recompactd or replaced with new asphaltic concrete material. Pavement not having an acceptable surface course texture, not meeting surface test requirements or not meeting the minimum thickness shall be replaced with new material sections of surface course.

3.04 FIELD QUALITY CONTROL

- A. Extraction Test. The percentage of bitumen in any mixture shall not vary more than 1/2 of one percent (1%) from the proportion established by the City Engineer. Samples of the hot mixture may be taken from the trucks or from the finished pavement, when required by the City Engineer. The minimum weight of the test specimen in grams shall be determined by multiplying 3,000 by the maximum size aggregate in inches; and when tested by standard laboratory methods (in which benzol may be used as the solvent), it shall not vary from the grading proportions specified, according to the mix being tested, by more than five percent (5%) in any particular case.

- B. Cores may be taken from the finished hot-mix asphalt concrete. The quality and thickness of the cores will govern the acceptance of the pavement.

END OF SECTION



SECTION 02520

CONCRETE PAVEMENT

PART 1 GENERAL

1.01 SUMMARY

This section gives requirements for Portland cement concrete pavement, with or without curbs, on a prepared subgrade and/or other base material.

1.02 RELATED SECTIONS

Section 02223	Excavating, Backfilling, and Compacting for Pavement
Section 03300	Cast-In-Place Concrete

1.03 MEASUREMENT AND PAYMENT

- A. Measurement. Concrete pavement work performed under this section will be measured by the square yard (SY) of surface area of completed and accepted pavement of the designated thickness unless otherwise indicated in the bid form. The designated thickness shall mean the minimum allowable thickness. When the plans call for the construction of curbs with the pavement, the limits of pavement measurement will be from back to back of curb. When curb and gutter is to be constructed, the limits of measurement for concrete pavement shall be from lip to lip of the gutters.
- B. Payment. Unless otherwise indicated in the bid form, all work performed and material furnished as prescribed by this specification, and measured as provided under subparagraph A, "Measurement," shall be paid for at the unit price bid for concrete pavement in the bid form." Such payment shall be full compensation to the Contractor for shaping and fine grading the subgrade, for furnishing, mixing, placing, finishing and curing all concrete including curbs, where indicated on the plans; for furnishing, placing, finishing and sealing all joints required by the plans; for furnishing and placing all reinforcing steel; for all barricading and safety measures; for all form removal and cleanup; for all labor, equipment, appliances, tools and incidentals necessary to complete the work.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

ACI	American Concrete Institute
ASTM	American Society for Testing of Materials
AASHTO	American Association of State Highway and Transportation Officials
TxDOT	Texas Department of Transportation - Standard Specifications for Construction of Highways, Streets and Bridges
CRSI	Construction Reinforcing Steel Institute

1.05 QUALITY ASSURANCE

It shall be the responsibility of the Contractor to produce concrete pavement of the strength, durability, workability and specified finished; furnish representative materials for specimens in quantities required by the testing laboratory; take samples of materials for testing; check proportions of mix and immediately notify the City Engineer if proportions appear improper in any respect. The Contractor shall comply with all testing laboratory findings and the City Engineer's decisions in reference to these findings. The Contractor shall pay for the redesign of the concrete mix due to a change in the source of materials.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Reinforcing Steel. All steel reinforcement shall be stored above the ground on platforms, skids or other supports as approved by the City Engineer. Reinforcement shall be stored in a location such that it is protected from mechanical injury and rust. When placed in the work, steel reinforcement shall be free from dirt, scale, rust, oil, paint and other material.
- B. Miscellaneous Materials. All miscellaneous materials that are to be used to properly execute the work required to construct concrete pavement shall be stored and handled in accordance with the manufacturer's instructions and/or in a manner that meets with the approval of the City Engineer.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

- A. Concrete. Provide concrete in accordance with the applicable provisions of Section 03300, Cast-In-Place Concrete. Concrete pavement shall be "Normal Weight Structural Concrete" and shall have a minimum twenty-eight (28) day compressive strength of 3,000 pounds per square inch (psi).

B. Reinforcing Steel and Related Materials. Provide the following steel reinforcing items and related materials:

- 3.0
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#3
1. Reinforcing Steel. All steel reinforcing shall be open hearth, new billet steel manufactured in the United States and conforming to ASTM A615. All bars shall be Grade 60 with a minimum yield strength of 60,000 pounds per square inch (psi). Unless otherwise shown on the plans, all deformed steel reinforcing shall be #4 bars. All smooth steel reinforcing for doweling expansion and contraction joints shall be plain steel bars conforming to ASTM A-306, Grade 70, shop cut to length, straight, clean and free of rust or scale.
 2. Supports for Reinforcing. Supports for reinforcing bars shall be the correct type as intended and represented by the manufacturer. Bar supports shall be uniform high density polyethylene or fiberglass reinforced plastic and conform to CRSI Class 1, Maximum Protection. Concrete blocks or brick will not be accepted.
 3. Tie Wire. Use 18-gauge annealed steel for tie wire.

C. Expansion Joints. In addition to dowels, provide the following material for expansion joints:

1. Joint Filler Material. Filler material shall be preformed expansion joint filler of the bituminous type which conforms to the requirements of ASTM D1751. Unless otherwise shown on the plans, the thickness of the filler material shall be 3/4-inch.
2. Joint Sealing Compound. Joint sealing compound shall conform to the requirements of ASTM C-920, Type S, Grade P or NS.
3. Backer Rods and Backing Materials. Provide a compressible type material such as closed-cell, resilient foam or sponge rubber stock of vinyl, butyl or neoprene, or expanded polyethylene or polyurethane. The diameter of the backer rod shall be at least twenty-five (25) percent larger than the joint reservoir and shall be capable of holding the fluid joint sealing compound in open joint in place. Backer rods shall be of such a type that it will not bond to the joint sealing compound.

4. Sleeves. Sleeves for expansion joints shall be 26-gauge steel or PVC tubes which are capped at one end. Sleeves shall be in accordance with ASTM A120.
- D. Forms. Provide metal or wooden forms to construct the concrete pavement. Wooden forms shall be of sound 2 X material of a depth equal to the required edge thickness of the pavement, free from warps, twists, loose knots, splits or other defects and constructed to provide a straight edge on the concrete. Metal forms shall be of an approved shape and section with a depth of the form equal to the edge depth of the pavement. The metal forms shall be free from warps, bends and kinks and shall be constructed to provide a straight edge on the concrete.

PART 3 EXECUTION

3.01 PREPARATION

- A. General. In addition to any instructions specified herein, the preparations detailed in Section 03300, Cast-In-Place Concrete, paragraph 3.01, shall also apply here as if written in their entirety. This includes, but is not limited to, the minimum twenty-four (24) hour notification that shall be given to the City Engineer before any concrete is placed.
- B. Subgrade Preparation and Protection. Excavate, prepare, shape, and compact the subgrade to the grades and densities shown on the plans and in accordance with Section 02223, Excavating, Backfilling, and Compacting for Pavement. Subgrade shall be wetted sufficiently to minimize moisture loss from the concrete to the subgrade. Water puddles or muddy areas will not be allowed. Maintain the subgrade in a smooth, compacted condition at the proper grades until the concrete has been placed. No ready mix trucks or other equipment shall be allowed to operate within the forms unless clearance or other job conditions will not allow operation from outside the forms. If trucks must operate between the forms, the subgrade shall be protected from damage by use of runways. Any ruts or irregularities in the subgrade caused by equipment or by trucking material shall be corrected by second rolling or hand tamping.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. Placing of Reinforcing Steel. Reinforcing steel to be used in the construction of concrete pavement shall be placed in accordance with the plan details. Unless otherwise shown on the plans, reinforcing shall be

#3 deformed bars spaced eighteen (18) inches center to center; installed in a criss-cross pattern such that the longitudinal steel is parallel and the transverse steel is perpendicular to the centerline of the pavement section; and have twelve (12) inch lap splices when joining two (2) individual lengths of rebar together. Lap splices in adjacent bars shall be staggered such that splices do not occur in the same location in adjacent bars and, where possible, use full length reinforcing steel for executing the work. Steel reinforcing bars shall be tied together at all points of intersection with the specified tie wire and be securely held in place with bar supports (chairs), or other approved methods, during the placement of the concrete.

- B. Placement of Concrete. Place and compact concrete for the construction of concrete pavement in accordance with the applicable provisions for "Normal Weight Structural Concrete" outlined in Section 03300, Cast-In-Place Concrete.
- C. Concrete Pavement Finish. The pavement shall be struck-off and consolidated with mechanical finishing machines or by hand-finishing methods. Associated concrete curbs shall be given the same finish as the concrete pavement.
 - 1. Mechanical Finishing. When mechanical finishing machines are used for finishing, the concrete shall be struck-off at such a height that after consolidation and final finishing, it shall be at the exact elevation as shown on the plans. The mechanical finishing machines shall consist of a power driven transverse finishing machine and a longitudinal finishing machine. Finishing machines shall be equipped with rubber tires for rolling on concrete pavement. The transverse finishing machine shall be provided with two (2) screeds that are accurately adjusted to the pavement slope or crown as indicated on the plans. The transverse finishing machine shall ride on the forms and be so designated and operated as to strike off and consolidate the concrete. The Contractor shall make at least two (2) trips over the pavement area with the transverse finisher but, shall make as many trips over the pavement area as required to obtain the required grades. The longitudinal finishing machine shall ride on the forms and be equipped with a longitudinal float not less than ten (10) feet in length. The machine shall be so designed and operated as to finish the pavement to the grades and elevations shown on the plans. Just before the concrete becomes non-plastic, the pavement surface shall be belted with a canvas belt with a width between six (6) and ten (10) inches wide and a length at least two

(2) feet longer than the pavement width. The belt shall be moved with short strokes transversely across the pavement and advanced rapidly in the longitudinal direction to produce a gritty, textured surface.

2. Hand Finishing. When the pavement is finished by hand, the concrete shall be struck-off with a screed of an approved cross section and a length at least two (2) feet longer than the pavement width. The strike-off screed shall be moved forward with combined transverse and longitudinal motion in the direction the work is progressing, maintaining the screed in contact with the forms and keeping a slight excess of material in front of the cutting edge. The concrete shall then be tamped with an approved tamping template to thoroughly compact it and eliminate surface voids. The surface shall then be screeded to the required section. After completion of the strike-off, tamping and transverse screeding, a longitudinal float shall be operated to level the surface to the required grade. Just before the concrete becomes non-plastic, the surface shall be belted with a canvas belt as described in the preceding subparagraph to produce a gritty, textured surface.

D. Curing of Concrete. All concrete pavement shall be cured for a period of not less than seventy-two (72) hours. Curing of all exposed concrete surfaces shall begin immediately after the completion of the finishing operations. The following are acceptable methods for curing concrete:

1. Polyethylene Film Curing. After completion of the finishing and after initial set of the concrete, apply a fine spray of water to the concrete and cover it with a polyethylene film. Place and secure polyethylene film in direct contact with the concrete surface such that an airtight seal is maintained for the entire duration of the specified curing time. Contractor is responsible for preventing and repairing any damage to the polyethylene film during the entire curing time. The polyethylene film blankets are subject to the approval of the City Engineer. The film blankets shall be rejected at any time when, in the opinion of the City Engineer, the required airtight seal is not maintained.
2. Curing Compound. After completion of the finishing operations and the disappearance of the free surface moisture, uniformly spray the concrete surface with an approved curing compound. The curing compound membrane shall be applied in accordance with the manufacturer's instructions. If water drops do not bead or

water soaks into concrete after application of the curing compound, a full additional coat of compound shall be applied. Contractor is responsible for preventing and repairing any damage to the curing compound membrane during the entire duration of the specified curing time.

- E. Joints. All joints shall be of the types shown and at the location and spacing indicated on the plans. All joints shall be constructed true to line with their faces perpendicular to the pavement. Transverse joints shall be at right angles to the centerline of the pavement and shall extend the full width of the slab. Longitudinal joints shall be installed parallel to the centerline of the pavement. Transverse joints in succeeding lanes shall be placed in line with similar joints in the existing pavement. All joints shall be so prepared, finished and cut to provide a groove of sufficient width and depth to receive and retain joint sealing material.
1. Construction Joints. Transverse construction joints of the types shown on the plans shall be placed wherever the placing of concrete is suspended for a period of more than thirty (30) minutes. These transverse joints, when planned, shall be placed at either an expansion joint or at a contraction joint. The joint shall not be allowed within eight (8) feet of a regularly spaced transverse joint. If the pouring of concrete is stopped and a joint is required in these limits, then it shall not be installed and the fresh concrete shall be removed back to the previously spaced regular joint. Dowel assemblies or other approved load transfer devices shall be installed at the joint as required by the plans. Longitudinal construction joints necessary for lane construction shall be of the dimensions and type shown on the plans. These joints shall be either a keyed joint or a butt type joint with dowels. The keyed joint shall be formed by placing a deformed metal plate against the form when the first lane adjacent to the joint is placed. This plate is to be removed with the forms. The edge of the joint shall be finished with an edging or grooving tool and a slot, of the dimensions indicated, shall be formed to receive joint sealing material.
 2. Expansion Joints. Transverse and longitudinal expansion joints shall be installed at the location and spacing as shown on the plans and shall be installed and finished to insure complete separation of the slabs. The expansion joint material shall be of the preformed type conforming to these specifications. If joints are to be equipped with dowels, they shall be at the spacing and location indicated on the plans. They shall be firmly supported in

place, accurately aligned parallel to the pavement grade and the centerline of the pavement by means of dowel support which will remain in the pavement and will insure that the dowels are not displaced during construction. One-half of each dowel shall be painted with rust preventative paint and greased with an approved lubricant and, in expansion joints, shall be equipped with the specified tight fitting 26-gauge steel or PVC sleeve. The sleeve shall provide for an unobstructed expansion space of one (1) inch to permit dowel movement. The closed end of the sleeve shall be watertight. In the construction of transverse joints in pavement with integral curbs, special care shall be taken to see that all transverse joints extend continuously through the pavement curb. When dowels are not specified, the thickness of the concrete at these joints shall be increased by at least twenty-five (25) percent of the normal pavement thickness to the nearest inch, but not more than two (2) inches. This increased thickness shall slope to the normal pavement thickness in not less than five (5) feet from the joint or to the nearest joint. Following the placement of the concrete, all excess concrete shall be cleaned from the top of the expansion joint material, and before opening to traffic, this space shall be swept clean and filled with a joint sealing compound as specified herein. Following the removal of the forms, any concrete bridging the joint space at the ends shall be removed.

3. Contraction Joints. Transverse contraction joints shall be of the sawed or formed dummy groove type and shall be at the locations and spacing and of the dimensions shown on the plans. The joints shall consist of a groove in the top of the slab sawed in the hardened concrete or formed in plastic concrete. When sawed, the groove shall be straight, of a uniform width and depth, and shall be sawed as soon as possible after the placement of the concrete to prevent contraction cracks in the slab. When formed, the groove shall be true to line and shall be uniform in width and depth. The sides of the groove shall be finished even and smooth with an edging tool. Reinforcing steel shall be continued through all contraction joints. Dummy groove contraction joints shall extend vertically downward $\frac{1}{4}$ of the slab depth from the surface and prior to opening for traffic shall be cleaned and filled with the specified joint sealing material. Longitudinal contraction joints shall be of the deformed metal strip type located according to plans.

- F. Opening to Traffic. The Contractor shall erect and maintain barricades to keep public and construction traffic from traveling on the newly placed concrete pavement. All barricades are subject to the approval of the City Engineer. Prior to allowing traffic on the pavement, all joints shall first be sealed, the pavement cleaned, and earth placed against the pavement edges. If approved by the City Engineer, traffic will be allowed on the pavement after the concrete has been in place for ten (10) days, but will be limited to vehicles with a gross weight of 14,000 pounds or less. After fourteen (14) days, if approved by the City Engineer, the pavement shall be opened to all traffic except any equipment not licensed for operation on public highways. The opening of the pavement to traffic shall in no way relieve the Contractor from his responsibilities for the work as stated in the Contract and any Conditions thereto.

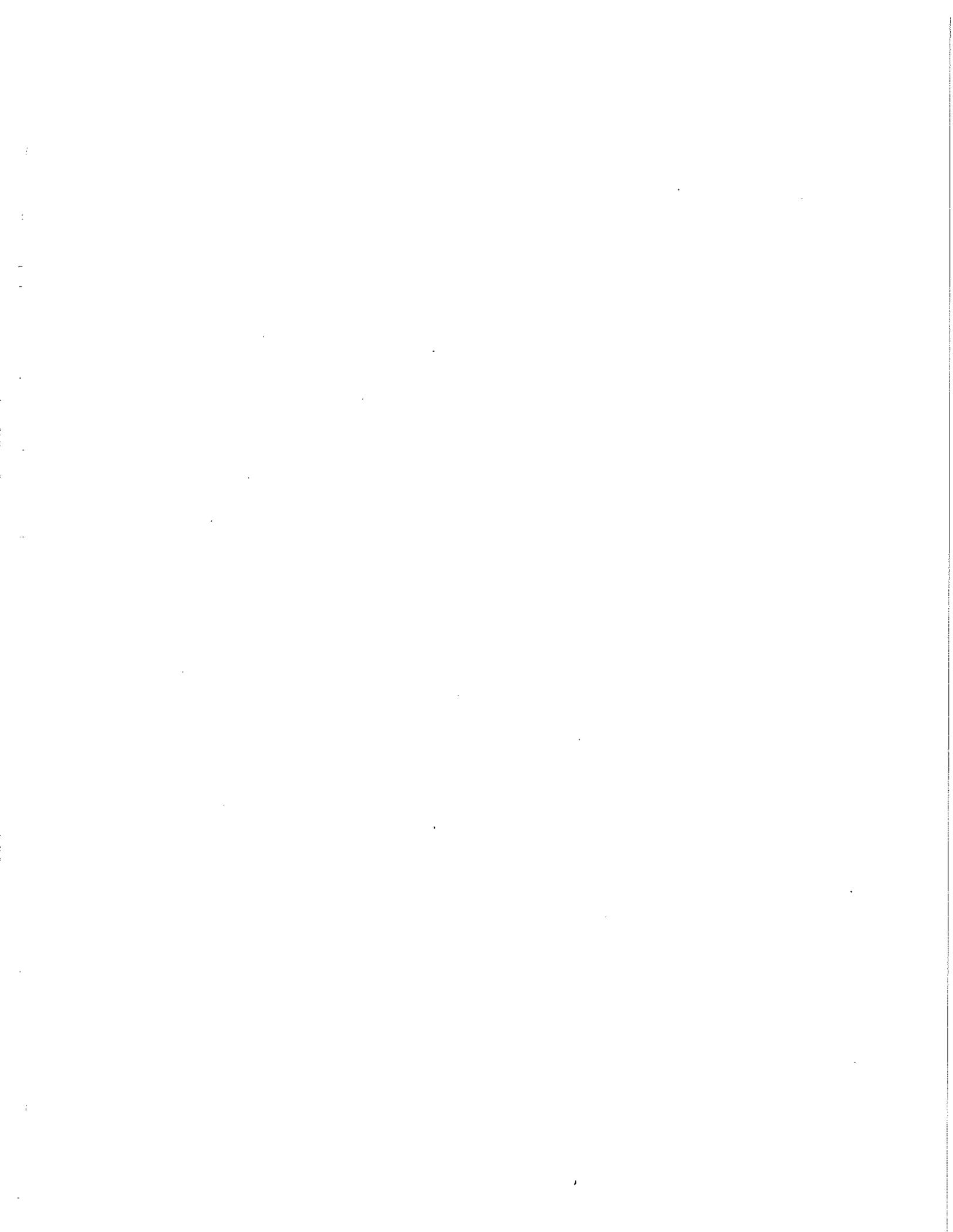
3.03 REPAIR / RESTORATION

Any pavement which does not meet the specified thickness.

3.04 FIELD QUALITY CONTROL

- A. General. Field quality control shall be in accordance with the applicable provision of Section 03300, Cast-In-Place Concrete, and any other provisions specified herein.
- B. Cores. The thickness of the completed pavement will be determined prior to final acceptance by the measurement of cores taken at such points as the City Engineer may select. These cores, if taken, shall be at the rate of at least one (1) core for each five-hundred (500) square yards of pavement.

END OF SECTION





SECTION 02521

CONCRETE CURBS AND GUTTERS AND VALLEY GUTTERS

PART 1 GENERAL

1.01 SUMMARY

This specification covers the construction of concrete curbs and gutters and valley gutters, complete.

1.02 RELATED SECTIONS

Section 02223	Excavation, Backfilling and Compacting for Pavement
Section 03200	Concrete Reinforcement
Section 03300	Cast-In-Place Concrete

1.03 MEASUREMENT AND PAYMENT

- A. Curb and Gutter. Measurement and payment of curb and gutter will be by the linear foot measured along the face of curb and payment will be by the unit price bid per linear foot. Where omission of the vertical portion of the curb and gutter occurs, the length shall be measured along a line one (1) foot six (6) inches from the inside edge of the gutter. No deductions or additions from the unit price bid will be made for omissions of the vertical portions of the curb and gutter occurring at driveways and other locations. The unit price shall include compensation for all labor, tools, equipment, materials, excavation and backfill, reinforcing steel, expansion joint filler and other incidentals necessary to complete the work. Inlet structures shall be paid for separately, and their length shall not be included in the length for curb and gutter. The difference in the cost for the variable height curb and gutter shall be included in the price for the inlet.
- B. Valley gutters will be measured and paid for at the unit price per each valley gutter shown in the Bid Form, regardless of length. The unit price shall include compensation for all labor, tools, equipment, materials, earthwork, removal and replacing of existing asphalt pavement and base, reinforcing steel, premolded expansion joint filler and other incidentals necessary to complete the work.

- C. The removal of existing concrete driveways will be measured and paid for at the unit price per square yard shown on the proposal regardless of the thickness. Measurement will be the actual amount of concrete driveway removed. Payment for this item will be complete compensation for tools, labor, equipment, disposal of removed materials and all other incidentals necessary to complete the work.
- D. Replacement of concrete driveways will be measured by the square yard. Payment will be at the unit price per square yard as shown on the bid form. The unit price will include full compensation for labor, tools, equipment, materials, reinforcing mesh and all incidentals necessary to complete the work.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

ACI American Concrete Institute

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

- A. Concrete. All curbs and gutters and valley gutters shall be constructed of Class C concrete.
- B. Expansion Joints. Expansion joints shall consist of three-fourths (3/4) inch premolded bituminous expansion joint filler per ASTM D-1751. Seal with joint sealing compound meeting ASTM C920, Type S, Grade P or NS.
- C. Expansion Joint Dowels. Plain steel bars conforming to ASTM A-306, grade 70. Cut dowels to length at shop or mill before delivery to the site. Dowels must be straight and clean, free of loose flaky rust and loose scale. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04-inches from the end. Provide approved dowel sleeve with inside diameter 1/16" larger than dowel to provide free movement of dowel for a distance of 150 percent of the joint width. Grease dowel in sleeve with approved lubricant.

PART 3 EXECUTION

3.01 PREPARATION

Stabilize and compact subgrade or base material as shown on plans for pavement. Dry subgrade or base to be moistened prior to concrete placement.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

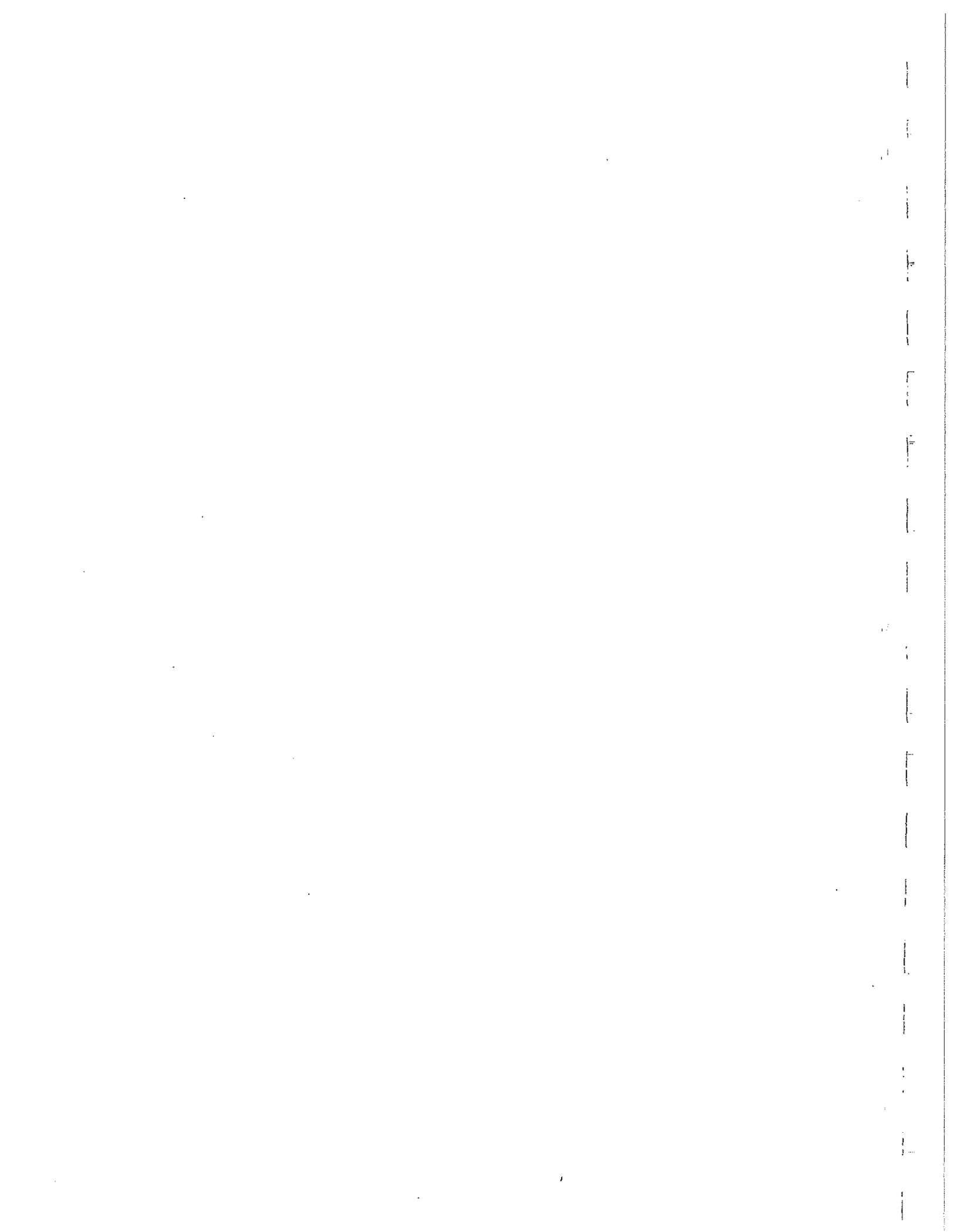
- A. Curbs and Gutters. The curbs and gutters shall be of the thickness, width, and at the locations and elevations shown on the plans. With the aid of a straight edge, steel trowel and steel "gooseneck," all curbs and gutters will be finished true to line, grade and cross section. The straight edge will be used for the face of the curb and in the gutter. The curb and gutter shall be worked with a steel trowel and "gooseneck" to give the work the appearance of a trowel finish, then edged and jointed.
1. Forms. Forms shall be of metal or well seasoned wood and shall be clean and straight. Wood forms for straight sections shall be 2" nominal thickness. Securely stake forms to line and grade and maintain position during concrete placement. Lightly oil forms before use.
 2. Reinforcing Steel. Reinforce all curbs and gutters and valley gutters. The reinforcing steel shall be accurately placed and secured in position in the forms. Plastic chairs or spacers shall be used to keep the reinforcing steel in proper position. Bars shall be lapped at least twenty-four (24) diameters where splicing is necessary, unless otherwise noted. No bar shall be spliced at points of maximum tension. The concrete covering the reinforcing steel shall have a minimum thickness as indicated on the plans, or if not shown, the applicable requirements of ACI Building Code 318-63 shall govern.
 3. Joints. Joints shall be provided as specified herein and where directed on the plans. An edging tool shall be used to provide the joints with rounded edges of one-eighth (1/8) inch radius.
 - a. Dummy Groove. Dummy groove joints shall be placed at ten (10) foot intervals in curbs and gutters. The dummy groove joints shall not be less than one (1) inch in depth.

shall conform to the applicable requirements specified for new valley gutters.

3.03 FIELD QUALITY CONTROL

Notify City Engineer prior to placing concrete to allow inspection of forms, reinforcing and joints.

END OF SECTION



SECTION 02605

CONDUCTIVE TRACE WIRE FOR NONMETALLIC PIPE INSTALLATION

PART 1 GENERAL

1.01 SUMMARY

This section covers the requirements for installation of a conductive tracer wire with non metallic pipe underground.

1.02 MEASUREMENT AND PAYMENT

No separate payment will be made for tracer wire or its installation. Include cost for same in the price bid for pipe installation.

1.03 SYSTEM DESCRIPTION

Install electrically continuous trace wire with access points as described herein to be used for locating non metallic pipe with an electronic pipe locator after installation.

PART 2 PRODUCTS

Trace wire to be twelve (12) gauge minimum solid copper with thermoplastic insulation recommended for direct burial. Wire connectors to be 3M DBR, or approved equal and shall be watertight and provide electrical continuity.

PART 3 EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

When required, tracer wire shall be installed in the same trench and inside bored holes and casing with nonmetallic pipe during pipe installation. It shall be secured to the pipe as required to insure that the wire remains adjacent to the pipe. The tracer wire shall be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity, and it shall be accessible at all water valve boxes, water meter boxes, sewer manholes, sewer cleanouts, gas valves and gas meter risers. At manholes, the wire shall be installed from the exterior of the manhole to the interior by installing the wire underneath the manhole frame. For lines with more than 5 feet of cover, the wire shall be installed directly over the pipe at a depth of 5 feet. If the spacing of water valve boxes and water meter boxes is greater than one mile, the tracer

wire on water lines shall be looped up in a 2" PVC pipe to be located at the right-of-way fence line or at a cross fence line, as applicable, for protection. A cap shall be placed on the 2" pipe when used, but it shall not be solvent welded onto the pipe. Where access points for trace wire on gas lines exceeds 500', install test lead boxes such that maximum access point spacing is 500'.

3.02 REPAIR/RESTORATION

If the trace wire is not found to be continuous after testing by the Owner, Contractor shall repair or replace the failed segment of the wire.

END OF SECTION

SECTION 02660

WATER SUPPLY LINES AND PIPING

PART 1 GENERAL

1.01 SUMMARY

This section covers furnishing all labor, materials, equipment, supplies, supervision and tools and performing all operations in connection with the installation of water supply lines, couplings and fittings of the types and pressure classes as shown on the plans or in the bid form.

1.02 RELATED SECTIONS

Section 2605 - Conductive Trace Wire for Underground Pipe Installation

Section 2222 - Excavation, Trenching and Backfilling for Utilities

Section 2676 - Hydrostatic Testing of Water Lines

Section 2675 - Sterilization of Water Lines

1.03 MEASUREMENT AND PAYMENT

Unless otherwise indicated in the bid form, all materials specified herein shall be measured and paid for as follows:

- A. Pipe: Measure and pay for by linear foot from centerline of fitting to centerline of fitting along pipe of size and type installed. All trenching, bedding, backfill and concrete blocking shall be included in the unit price bid per linear foot of pipe. Pipe installed in casing by boring, or in casing by open cut will be measured by linear foot and paid for at the unit price bid for those items.
- B. Fittings: Ductile iron and cast iron fittings, excluding tees in fire hydrant units, will be measured by the ton and paid for at the unit price bid per ton. Concrete thrust blocking and joint restraints at fittings shall be included in the bid price per ton.
- C. Valves: Valves with valve boxes and concrete collars and valve markers will be measured per each, excluding valves in fire hydrant units, for each size furnished and installed and will be paid for at the unit price bid per each.

- D. Fire Hydrant Unit: Fire hydrant units, including tee, lead, valve, valve box and fire hydrant will be measured per each and paid for at the unit price bid per each.
- E. Flush Valve Unit: Flush valve unit, including tee or saddle, valve, riser, valve box with concrete collar and valve marker will be measured per each and paid for at the unit price bid per each.
- F. Miscellaneous Valves: Measure miscellaneous valves with valve boxes and concrete collars furnished and installed as shown on Plans per each and pay for each at the unit price bid.
- G. Water Meters: Measure water meters including meter boxes per each and pay for meters at the unit price bid per each.
- H. Water Service: Measure and pay for water service per each. A water service consists of tapping saddle on water main, corporation stop, 10 linear feet of service line, and either a curb stop or an angle stop connected to water meter according to plans. Additional service line over 10 linear feet will be measured and paid for by the linear foot.
- I. Insulation: There will be no separate pay for insulation.
- J. Conductive Trace Wire: Measure and pay for trace wire by the linear foot, measured along the centerline of the pipe for which is installed.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
AWWA	American Water Works Association
NSF	National Sanitation Foundation

1.05 SUBMITTALS

Submit four (4) copies of shop drawings showing materials being offered, including dimensions and catalog data verifying the products meet the requirements of this section.

1.06 QUALITY ASSURANCE

- A. Pipe shall bear the NSF seal of approval for potable water pipe. Pipe manufacturer shall mark pipe with appropriate ASTM designation.
- B. Contractor shall notify Director of Public Works not less than 24 hours before each load of pipe is to be delivered to the jobsite to allow for inspection. When a load of pipe is found to have inadequate wall thickness or tolerances greater than specified, randomly selected samples of the pipe shall be immediately sent to the National Sanitation Foundation, with instructions to check the pipe for compliance with not only National Sanitation Foundation specifications but other specifications for the specific contract. When the National Sanitation Foundation or other commercial laboratory selected concurs that the pipe does not meet specifications, it shall be immediately removed and replaced by the Contractor at no additional cost to the Owner.

1.07 DELIVERY, STORAGE AND HANDLING

Handle and store pipe and appurtenances in accordance with manufacturer's recommendations. Interiors of pipe and appurtenances shall be kept clean prior to and during construction. Protect PVC pipe and gaskets from excessive exposure to heat and sunlight.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

Pipes and related products must conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 and must be certified by an organization accredited by ANSI. Pipe shall be of domestic origin.

- A. PVC Pipe: PVC water lines shall be of the type designated on plans or in the bid form.
 - 1. C-900 PVC: C-900 PVC water line shall meet the requirements of AWWA C-900 (latest revision), "Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water" and shall be approved by the State Board of Insurance and Underwriters Laboratories for fire service without penalty. All Class 150 pipe shall meet the requirements of DR 18 and Class 200 pipe shall meet the requirements of DR 14. Pipe shall bear the NSF seal of approval indicating that the pipe is suitable for conveying potable water.

- (a) Joints: Pipe joints shall be push-on type with one elastomeric gasket, or coupling type with two elastomeric gaskets furnished with each coupling. Joints and gaskets shall conform to AWWA C-900.
 - (b) Fittings-Full Body: Unless otherwise shown on Plans, fittings shall be cast or ductile iron mechanical joint type. Cast or ductile iron push-on type and mechanical joint type fittings shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11. Class 250 for 4" through 12" and Class 150 for 14" and larger unless otherwise shown on plans.
 - (c) Fittings-Short Body: Unless otherwise shown on plans, ductile iron short body fittings may be used and shall be mechanical joint type. Push on and mechanical joint ductile iron short body fittings shall conform to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.11, Class 350 for all sizes.
 - (d) Coating, Lining and Encasement for Cast Iron and Ductile Iron Fittings: Fittings shall be asphalt coated outside in accordance with ANSI/AWWA C151/A21.51, have cement mortar lining inside in accordance with ANSI/AWWA C104/A21.4, and shall be wrapped with 8 mil low density polyethylene or 4 mil high density polyethylene in accordance with ANSI/AWWA C105/21.5.
2. PVC Pressure Pipe: PVC pressure pipe shall meet the requirements of ASTM D2241 "Specification for Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR) and shall bear the NSF seal of approval indicating that the pipe is suitable for conveying potable water. The following standards shall also apply to the installation of PVC pressure pipe:
- (a) Joints: Unless otherwise shown on Plans, pipe joints shall be push-on type conforming to ASTM D-3139, "Standard Specification for Joints for Plastic Pressure Pipe Using Flexible Elastomeric Seals." Solvent weld joints shall meet the requirements of ASTM 2672, "Standard Specification for Bell End Polyvinyl Chloride (PVC) Pipe.
 - (b) Gasket: ASTM F-477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

- (c) Fittings for 4" and larger pipe shall be cast or ductile iron meeting ANSI/AWWA C110/A21-10. PVC fittings shall be Class 200 minimum rubber gasket type, except for pipe sizes less than 2". For special applications with approval of Director of Public Works, solvent weld PVC fittings may be used for pipe size 3" and smaller. Fittings for pipe size less than 2" shall be solvent weld.
 - (d) PVC Material: ASTM D-1784, "Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds.
- B. Ductile Iron Pipe: Unless otherwise shown on Plans, ductile iron pipe shall be pressure Class 350 in accordance with ANSI/AWWA C151/A21.51.
- 1. Joints: Unless otherwise shown on Plans, pipe joints shall be push-on type conforming to ANSI/AWWA C111/A21.11. Mechanical joint pipe shall conform to ANSI/AWWA C111/A21.11 and flanged joint pipe shall conform to ANSI/AWWA C115/A21.15.
 - 2. Fittings-Full Body: Unless otherwise shown on Plans, fittings shall be cast iron or ductile iron mechanical joint type. Mechanical joint and push-on fittings shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11, Class 250 for 4" through 12" and Class 150 for 14" and larger unless shown otherwise on Plans. Flanged fittings to be in accordance with ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11, Class 250 for 4" through 12" and Class 150 for 14" and larger unless shown otherwise on plans, both with one hundred twenty-five (125) pound template flanges.
 - 3. Fittings-Short Body: Unless otherwise shown on plans, ductile iron short body fittings may be used and shall be mechanical joint type. Mechanical joint and push-on ductile iron short body fittings shall conform to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.11, Class 350 for all sizes. Flanged fittings shall have full body dimensions.
 - 4. Coating, lining and encasement for Pipe and Fittings: Pipe and fittings shall be asphalt coated outside in accordance with ANSI/AWWA C151/A21.51 except for above ground pipe and fittings which are to be painted. Pipe and fittings shall have cement mortar lining inside in accordance to ANSI/AWWA C104/A21.4. Underground pipe and fittings shall be wrapped with 8 mil low density polyethylene or 4 mil high density polyethylene in accordance with ANSI/AWWA C105/A21.5.

5. Gaskets: Gaskets for push-on and mechanical joints shall conform to ANSI/AWWA C111/A21.11. Gaskets for flanged joints shall be 1/8 inch thick rubber, either ring or full face, conforming to dimensions in Appendix to ANSI/AWWA C115/A21.15.
- C. Steel Pipe: Steel pipe, 6 inches diameter and larger shall be Grade "A", seamless pipe conforming to AWWA C200 and shall have a minimum wall thickness as shown on Plans.
1. Joints: Unless otherwise shown on Plans, joints shall be butt welded field joints in accordance with AWWA C206. All welders assigned to apply metal arc welding to pipe joints under this specification shall have been tested under the American Welding Society "Standard Qualifications Procedures." The Contractor shall provide copies of certificates showing that all welders are qualified under the above standards.
 2. Fittings: Steel flanges and fittings shall conform to AWWA C207 and C208.
 3. Coatings and Lining for Pipe and Fittings: All interior and exterior surfaces of pipe and fittings shall receive shop applied coatings of Coal Tar Epoxy conforming to the requirements of AWWA C210. Weld joints and damaged coating shall be field repaired using materials and procedures recommended by the manufacturer of the coating used on the pipe.
 4. Holiday Detection: Prior to installation, the coated pipe and fittings shall be holiday detected with a wet sponge holiday detector and all holidays shall be repaired in accordance with the requirements of AWWA C210.
- D. Copper Tubing: Copper tubing shall conform to the requirements of ASTM B-88, Type "K". Joints for underground work shall be compression-pattern, flared, for soft copper tubing and shall be made with fittings meeting approved standards. Tubing shall be cut off square and expanded with a proper flaring tool.
- E. Polybutylene Tubing: Polybutylene tubing shall be PB 2110, DR9, Class 250, meeting AWWA C902, with cold flare or compression type connections.
- F. Gate Valves: Gate valves 3 inches and larger shall be iron-body, resilient rubber seat, non-rising stem and shall conform to AWWA C-509. Smaller valves shall be brass ball valves with 2" square adapter nut.

Valves shall have ends as required for the piping in which they will be installed. Gate valves shall have a clear waterway equal to the full nominal diameter of the valve and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow cast in the metal indicating the direction of opening. Valves located inside structures shall be wheel operated and underground valves shall be nut operated. Each valve shall have the maker's initials, pressure rating, and year of manufacture cast on the body. Valves 3 inches through 12 inches shall have a 200 psig working pressure and valves 16 inches and larger shall have 150 psig working pressure. Prior to shipment from the factory each valve shall be tested by hydraulic pressure equal to twice the specified water working pressure. Gate valves shall be American Darling, Mueller, Waterus, or preapproved equal.

- G. Check Valves: Unless otherwise shown on Plans, check valves 2 inches in diameter and larger shall be iron body, bronze mounted, horizontal swing check valves with balanced weight and lever arm. Check valves shall have a 150 psi working pressure and meet the requirements of AWWA C-508.
- H. Butterfly Valves: Butterfly valves shall be cast iron body, rubber-seated, short body, pressure Class 150 meeting the requirements of AWWA C-504.
- I. Miscellaneous Valves: Flush, blow off, air relief and pressure regulating valves shall be of the types and sizes and at the locations shown on the Plans.
- J. Fire Hydrants: Fire hydrants shall be dry barrel, compression type, 150 psi working pressure, traffic model, with 5-1/4" valve opening and shall meet the requirements of AWWA C-502. Rotate fire hydrant barrel to face direction directed by Engineer. Fire hydrants shall be American Darling, Mueller or preapproved equal.
- K. Valve Boxes: Valves buried underground shall be provided with adjustable cast iron valve boxes of proper dimensions to fit over the valve and to extend to finished grade or slightly above as directed by Engineer. Valve boxes to have lids cast with the word "Water".
- L. Water Meters: Water meters 5/8" through 2" shall be sealed register, displacement type and conform to AWWA C-700. Compacted meters 2" to 6" shall conform to AWWA C-702. Meter size and type shall be as shown on Plans.

- M. Tapping Sleeves: Tapping sleeves shall be stainless steel body with ductile iron flange, 200 psi working pressure with 125 pound outlet flange, Smith-Blair, Ford or preapproved equal.
- N. Service Fittings: Tapping saddles, corporation stops and curb stops shall conform to AWWA C800.
- O. Joint Restraints. EBAA Iron Model 2000 or preapproved equal.
- P. Insulation System: Two (2) inch thick rigid wrap as manufactured by E. O. Wood Co., Fort Worth, Texas or preapproved equal. Aluminum jacketing with integrally bonded moisture barrier as manufactured by Childers, 1100, 3003, 3105, 5005 or 5010 aluminum alloy, 0.016 inch minimum thickness. Mastic coating system to be Childers Vi-Cryl CP-11 and glass cloth membrane to be Chil-Glas #10.

PART 3 EXECUTION

3.01 PREPARATION

Expose all underground utilities which may be in conflict with proposed water lines prior to installing new lines.

3.02 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

- A. General: All pipe shall have a cover of at least 42 inches unless shown otherwise on Plans. No pipe shall be laid in water or when trench condition or weather is unsuitable for such work and pipe shall be kept clean before, during and after laying. Sanitary precautions shall be taken during water line installation as called for by AWWA Standards. Do not install pipe with radius of curvature less than the minimum recommended by pipe manufacturer.
 - 1. PVC Pipe: PVC pipe shall be uniformly and continuously supported by stable soil. Bedding in the pipe zone from 4 inches below bottom of pipe up to 12 inches above top of pipe shall be hand placed select material free from rocks, organic refuse, or lumps greater than 1-1/2 inches, which will not break down readily when compacted. Bedding shall be placed in thin (approximately 4-inch) layers, moistened if necessary, and thoroughly compacted under and on each side of the pipe to provide support that is free from voids. The balance of the ditch may be machine backfilled unless otherwise shown on Plans.

2. Ductile Iron and Steel Pipe: Lay pipe on firm earth foundation and carefully backfill to 6" over pipe with acceptable material free from clods, rocks, or other sharp debris which may damage protective coating or cause pipe to shift. The balance of the trench may be machine backfilled unless otherwise shown on Plans.
 3. Valves, Valve Boxes and Fire Hydrants: Install valves, valve boxes and fire hydrants plumb. Place valve boxes directly over valve stem. Before installation of valves or fire hydrants, clean all foreign material from interior and open and close valves to insure that they are in good working order. Hand tamp backfill around valve boxes and fire hydrants out to undisturbed trench face.
- B. Conductive Trace Wire: Install conductive trace wire in compliance with Section 2605 - Conductive Trace Wire for Nonmetallic Pipe Installation with all main water lines and services.
- C. Separation of Water and Sewer Lines: The following criteria shall be followed for water and sewer line separations:

When water mains and sanitary sewers are installed, they shall be installed no closer to each other than nine feet in all directions and parallel lines must be installed in separate trenches. Where the nine foot separation distance cannot be achieved, the guidelines in this subsection shall apply. The guidelines also are listed in tabular form in the following table.

TABLE I
SEPARATION OF WATER & SEWER LINES

CONDITION	LOCATION	MATERIAL		SEPARATION (MIN)		COMMENTS
		WATER	SEWER	VERT.	HORZ.	
<u>NEW WATER & NEW SEWER SYSTEM</u>						
Sewer Force Main and Gravity Sewer Parallel to Water Main	Water above Sewer	Std.	Cl, DI PVC; 150 PSI	2'	4'	Separate Trenches
Gravity San. Sewer Crossing Water Main	Water above Sewer or Sewer Above Water	Std.	Cl, DI PVC; 150 PSI	6"	NA	Center one joint of sewer pipe on water main
Gravity Sewer Crossing Water Main	Water above Sewer	Std.	ABS, Clay Conc. Composite	2'	NA	Cement stabilize sand backfill initial backfill zone of sewer for 9 ft. on each side of crossing. Center one joint of sewer pipe on water main.
<u>CONDITION</u>	<u>LOCATION</u>	<u>MATERIAL</u>		<u>SEPARATION (MIN)</u>		<u>COMMENTS</u>
		<u>WATER</u>	<u>SEWER</u>	<u>VERT.</u>	<u>HORZ.</u>	
<u>NEW WATER & EXISTING SANITARY SEWER</u>						
New Water Parallel Existing Sewer	Water Above Sewer	Std.	Clay, Concrete ABS, Cl, DI, PVC	2'	4'	If sewer shows no sign of leakage, then leave sewer alone. If sewer shows signs of leakage, then repair or replace.
New Water Crossing Existing Sewer	Water above Sewer	Std.	ABS, Clay, Concrete Composite	2'	NA	If sewer shows no sign of leakage, then leave sewer alone. If sewer shows signs of leakage then repair or replace.
New Water Crossing Existing Sewer	Sewer Above Water	Std.	ABS, Clay, Concrete Composite	2'	NA	Replace existing sewer with one joint Cl, DI, PVC-150 PSI, centering over water line.
New Water Parallel Existing Sewer	Sewer Above Water	Std.	ABS, Clay, Concrete Composite	2'	4'	Replace existing sewer with Cl, DI, PVC-150 to psi or cement stabilized sand backfill in initial backfill zone of sewer where parallel closer than 9 ft., or encase the water in 150 PSI pipe two nominal sizes larger.

EXISTING WATER & NEW SANITARY SEWER

New Sewer Parallel Existing Water	Water Above Sewer or Sewer Above Water	Std.	CI, DI PVC, 150 PSI	2'	4'	Separate trenches
New Sewer Crossing Existing Water	Water Above Sewer or Sewer Above Water	Std.	CI, DI PVC, 150 PSI	6"	NA	Center one joint of sewer pipe on water line.
New Sewer Crossing Existing Water	Water Above Sewer	Std.	ABS, Clay, Concrete Composite	2'	NA	Cement stabilize sand backfill initial zone of sewer for 9 ft. each side of crossing. Center one joint of sewer pipe on water main.

1. Where a sanitary sewer parallels a water line, the sewer shall be constructed of cast iron, ductile iron or PVC meeting ASTM specifications with a pressure rating for both the pipe and joints of 150 psi. The vertical separation shall be a minimum of two feet between outside diameters and the horizontal separation shall be a minimum of four feet between outside diameters. The sewer shall be located below the water line.
2. Where a sanitary sewer crosses a water line and the sewer is constructed of cast iron, ductile iron or PVC with a minimum pressure rating of 150 psi, an absolute minimum distance of six inches between outside diameters shall be maintained. In addition, the sewer shall be located below the water line where possible and one length of the sewer pipe must be centered on the water line.
3. Where a sewer crosses under a water line and the sewer is constructed of ABS truss pipe, similar semi-rigid plastic composite pipe, clay pipe or concrete pipe with gasketed joints, a minimum two foot separation distance shall be maintained. The initial backfill shall be cement stabilized sand (two or more bags of cement per cubic yard of sand) for all sections of sewer within nine feet of the water line. This initial backfill shall be from one quarter diameter below the centerline of the pipe to one pipe diameter (but not less than 12 inches) above the top of the pipe.

4. Where a sewer crosses over a water line all portions of the sewer within nine feet of the water line shall be constructed of cast iron, ductile iron or PVC pipe with a pressure rating of at least 150 psi using appropriate adapters. In lieu of this procedure, the new conveyance may be encased in a joint of 150 psi pressure class pipe at least 18 feet long and two nominal sizes larger than the new conveyance. The space around the carrier pipe shall be supported at five feet intervals with spacers or be filled to the spring line with washed sand. The encasement pipe should be centered on the crossing and both ends sealed with cement grout or manufactured seal.
5. The sewer need not be disturbed where a new water line is to be installed parallel to an existing sewer that shows no evidence of leakage and the water line is installed above the sewer a minimum of two feet vertically and four feet horizontally. Should excavation for the water line produce evidence that the sewer is leaking, the sewer must be repaired or replaced as described in subparagraphs 1 or 4 of this paragraph.
6. The sewer need not be disturbed where a new water line is to cross over (by two feet or more) existing sewer showing no evidence of leakage. Should excavation for the water line produce evidence that the sewer is leaking, then the sewer must be repaired or replaced as described in subparagraphs 3 or 4 of this paragraph.
7. Unless sanitary sewer manholes and the connecting sewer can be made watertight and tested for no leakage, they must be installed so as to provide a minimum of nine feet of horizontal clearance from an existing or proposed water line. Where the nine foot separation distance cannot be achieved, an encasement pipe as described above may be used for the water line.
8. Fire hydrants shall not be installed within nine feet vertically or horizontally of any sanitary sewer regardless of construction.

D. Thrust Blocking and Joint Restraint:

Concrete blocking and joint restraints shall be installed at all bends, tees, points where reducers or changes in pipe diameter occur, fire hydrants or valves and all plugged openings. Use concrete having compressive strength not less than 2,000 pounds per square inch. Place blocking against undisturbed solid ground, with area of bearing on pipe and on

ground as required by manufacturer's recommendation for the type of soil encountered. Place blocking so that pipe and fitting joints will be accessible for repair. See detail sheet for minimum sizing.

E. Insulation:

When 4" diameter or smaller water lines, valves and fittings and all sizes of drain valves are installed above ground, they shall be insulated to provide protection from freezing temperatures. The installation shall consist of a minimum 2 inch thick layer of Rigid-Wrap fiberglass insulation as manufactured by E.O. Wood Co., Fort Worth, Texas or a preapproved equal. All installation shall be weather proofed with Childers' aluminum jacketing or preapproved equal. The jacketing is to be manufactured from 1100, 3003, 3105, 5005 or 5010 aluminum alloy and have a minimum thickness of 0.016 inches. All jacketing shall have an integrally bonded moisture barrier over the entire surface in contact with the insulation.

Encapsulation of insulation around fittings shall be accomplished utilizing a two coat vinyl-acrylic mastic coating system, Vi-Cryl CP-11, as manufactured by Childers or a preapproved equal. A glass cloth membrane, Chil-Glas #10, shall be embedded on to the first coat. The minimum dry film thickness of the vinyl-acrylic mastic shall be 1/16 inch. There shall be no voids or holidays and the mastic shall be trowelled, sprayed or wet brushed to a smooth even finish.

All of the above specified insulation, jacketing and encapsulation shall be installed in strict accordance with manufacturer's recommendations to provide a waterproof membrane around the insulation.

3.03 REPAIR/RESTORATION

Sections of water line determined to be defective either prior to or during hydrostatic pressure test shall be replaced with sound materials at no expense to the Owner. No repair clamps will be allowed on new construction.

3.04 FIELD QUALITY CONTROL

Prior to final acceptance, hydrostatic pressure test and sterilize water lines according to the applicable sections.

3.05 · ADJUSTING/CLEANING

Adjust all fire hydrants, valve boxes and meter boxes to proposed or existing grade as applicable. Upon completion of water line construction, all debris and surplus materials resulting from the work shall be removed from the project site.

END OF SECTION

SECTION 02675

STERILIZATION OF WATER LINES

PART 1 GENERAL

1.01 SUMMARY

This section covers the procedures for sterilization of water lines and appurtenances.

1.02 RELATED SECTIONS

Section 02660 - Water Supply Lines and Piping
Section 02676 - Hydrostatic Testing of Water Lines

1.03 MEASUREMENT AND PAYMENT

There will be no separate payment for sterilization of water lines.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

AWWA American Water Works Association

1.05 SYSTEM DESCRIPTION

Furnish pump, pipe connections, gauges, meters, appurtenances and chlorinating agent to sterilize water lines and make bacteriological analyses to check effectiveness.

1.06 STORAGE AND HANDLING

Store chlorinating agent in a safe place according to manufacturer's recommendation.

1.07 SCHEDULING

Perform final flushing and bacteriological test after successful hydrostatic test of line segment(s).

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

Chlorinating agent to be liquid chlorine, sodium hypochlorite solution or calcium hypochlorite granules or tablets.

PART 3 EXECUTION

3.01 PREPARATION

Remove, by flushing or other means, contaminating materials that may have entered the water line during construction. Where necessary, install temporary flush valves at the end of new lines for flushing and sampling prior to tying into existing system.

3.02 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

A. Application Procedure - Apply chlorinating agent by one of the following procedures:

1. Tablet Method - Place calcium hypochlorite granules or tablets in the water line at the upstream end of the first section of pipe, at the upstream end of each branch and at 500 foot intervals such that when the pipe is filled with potable water the dose will be a minimum of 25 mg/l for 24 hours. Fill pipe such that water velocity does not exceed one (1) foot per second.
2. Continuous Feed Method - Fill line with water, eliminate air pockets and flush water line at a minimum of 2.5 feet per second velocity to remove particulates. Feed chlorine water solution having a free chlorine concentration of 25 mg/l into line until entire line is filled with heavily chlorinated water. Retain chlorinated water in line for 24 hours after which time the free chlorine residual shall not be less than 10 mg/l.
3. Slug Method - Place calcium hypochlorite granules in the line during construction, completely fill the line to eliminate all air pockets, flush the line to remove particulates and slowly flow a slug of water dosed with chlorine to a concentration of 100 mg/l through the line such that all parts of the line and appurtenances will be exposed to no less than 50 mg/l of free chlorine for not less than 3 hours.

B. Chlorination of Appurtenances

Operate valves and hydrants several times while exposed to the required chlorine concentration to assure disinfection of appurtenances and pipe branches.

C. Final Flushing

In order to prevent damage to pipe and linings, flush heavily chlorinated water from system until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system.

D. Bacteriological Test

After final flushing, collect samples and test for presence of coliform organisms. A minimum of one sample shall be collected from each 1,000 feet of water line or at the next available sampling point beyond 1,000 feet as designated by the Director of Public Works. Samples shall be collected in the presence of a representative of the Director of Public Works.

3.03 REPAIRS/RESTORATION

If initial disinfection fails to produce tests showing absence of coliform organisms, the new line may be reflashed and shall be resampled. If check samples also fail to produce acceptable results, the main shall be rechlorinated until satisfactory results are obtained.

3.04 FIELD QUALITY CONTROL

Testing for bacteriological quality shall be in accordance with Standard Methods for the Examination of Water and Wastewater.

END OF SECTION



SECTION 02676

HYDROSTATIC TESTING OF WATER LINES

PART 1 GENERAL

1.01 SUMMARY

This section covers the procedure for hydrostatic pressure testing of all new water lines and appurtenances.

1.02 RELATED SECTIONS

Section 02660 - Water Supply Lines and Piping

1.03 MEASUREMENT AND PAYMENT

There will be no separate payment for hydrostatic testing of water lines.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

AWWA American Water Works Association

1.05 SYSTEM DESCRIPTION

Furnish pump, pipe connections, gauges, meters, appurtenances and labor as required to perform pressure test and measure leakage on completed water line segments.

1.06 SCHEDULING

Perform hydrostatic pressure test on newly laid pipe or any valved section of piping after complete installation of pipe and all appurtenances, but prior to final sterilization or connecting to water system.

PART 2 PRODUCTS (Not Used.)

PART 3 EXECUTION

3.01 PREPARATION

Notify Director of Public Works prior to testing and allow City representative to observe testing. After new water line has been laid and backfilled, but prior to replacement of pavement, fill each valved section of pipe slowly with water. Before commencing test, expel all air from line. If necessary, tap pipe at points of highest elevation to expel all air. On completion of tests, taps to be tightly plugged with brass fittings.

3.02 ERECTION/INSTALLATION/APPLICATION AND/OR CONSTRUCTION

Apply specified test pressure by means of pump connected to pipe. Provide means to measure or meter water pumped into the line to the nearest 0.1 gallon and a pressure gauge with a 6" minimum face and calibration marks at 1 psi intervals. At intervals during test, inspect route of pipe to locate any leaks or breaks.

3.03 REPAIR/RESTORATION

Remove and replace defective joints, cracks or defective pipe or fittings. Should any test of sections of pipe disclose leakage greater than that specified, locate and repair defective joints or defective pipe until test proves that leakage is within specified allowance.

3.04 FIELD QUALITY CONTROL

Hydrostatic pressure test shall be at the rated pressure of the pipe measured at the lowest point in elevation in the section of pipe being tested. Test pressure shall not vary ± 5 pounds per square inch for the duration of the test. Duration of test shall be two (2) hours.

The maximum allowable leakage for a test section shall not exceed the amount determined from the following formula:

$$L = \frac{N \times D \times \text{Square Root of } P}{7,400}$$

where "L" is the allowable leakage, in gallons per hour; "N" is the number of joints in the length of pipe tested (pipe and fittings); "D" is the nominal diameter of the pipe, in inches; and "P" is the average test pressure in pounds per

square inch gauge. Leakage loss shall be within the allowances specified before acceptance of the project.

END OF SECTION

SECTION 02685

NATURAL GAS DISTRIBUTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

This section covers the supplying all labor, equipment, materials and appliances and performing all other procedures necessary for the construction of a natural gas distribution system in accordance with the plans and these specifications. The distribution system includes the distribution mains, valves, pipeline markers, service valves and service regulators and meters.

1.02 RELATED SECTIONS

Section 02222	Excavation, Trenching and Backfilling for Utilities
Section 02229	Excavation Safety
Section 02605	Conductive Tracer Wire for Nonmetallic Pipe Installations

1.03 MEASUREMENT AND PAYMENT

- A. Polyethylene Gas Mains. Polyethylene gas line installation including fittings and conductive trace wire shall be measured to the nearest foot and paid for at the unit price per foot of various sizes of pipe installed. Payment for boring of street, highway and railroad crossings shall be measured to the nearest foot and included in the contract price per foot of bore for the various sizes of boring required. The bid price for boring shall be the additional cost for boring over and above the gas line unit price.
- B. Valves. Valves shall be measured and paid for per each. The unit price for each valve shall include the valve, valve box, couplings and all additional fittings required to complete the valve installation according to these plans and specifications.
- C. Service Lines. Measurement and payment for the installation of service lines including all fittings, except for main line tap and valve tee and the anodeless riser shall be by the linear foot of various sizes of service line. Payment for service connections shall be per each for various sizes installed and shall include main line tap and valve tee, anodeless riser, and tie in to meter, if existing. Tie ins to existing meter shall include relighting customer pilot lights. A successful shut-in test shall be performed by City gas department personnel prior to a customer's gas

service being turned on and pilots being lighted. New regulator and meter installations with related stops and fittings to complete the service installation shall be by others.

- D. Pipeline Markers. The installation of the pipeline markers shall include the sign and post and payment shall be at the unit price bid per each marker installed.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

ANSI	American National Standards Institute
ASTM	American Society of Testing and Materials
DOT	United States Department of Transportation
RRC	Railroad Commission of Texas

1.05 SUBMITTALS

- A. Pipe. Certification that the pipe passes the sustained 1,000 hour test as outlined in ASTM D-2513 is required from the pipe producer. The production tests report that must be furnished to the Director of Public Works shall include:

1. Date of Test
2. Maximum and minimum O.D. and minimum wall thickness
3. Lot number
4. Quick burst value
5. Sustained pressure test certification

- B. Pipe Joiners. Provide certificate of qualification issued by an acceptable organization for each person joining plastic pipe.

1.06 QUALITY ASSURANCE

Only persons qualified under 49 CFR.192.285 shall be allowed to join plastic pipe. Persons installing or repairing the natural gas system shall undergo drug testing in accordance with DOT and RRC requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Polyethylene Pipe. In shipping, delivering, and installing, pipe and accessories shall be handled in such a manner as to insure a sound undamaged condition. Care shall be exercised in order to avoid rough handling. The pipe and accessories shall not be dropped or have any objects dropped upon it, nor shall it be pushed or pulled over sharp projections. Caution shall be taken to prevent kinking and buckling. Any damage, including kinks and buckles which occur shall be removed by cutting out as a cylinder and replacing at the cost of the Contractor.
- B. Regulators and meters. All regulators and meters must be shipped with dust caps or seals to prevent the entry of dust or moisture under normal shipping and handling conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Polyethylene Pipe. All polyethylene pipe used in the Project must comply with ASTM D-2513 and be manufactured in the United States. Approved manufacturers are as follows:
 - 1. Phillips Driscopipe, Inc.
 - 2. Plexco Pipe Company
- B. Polyethylene Valves and Valve Boxes. All valves on the polyethylene pipe shall be compatible with the piping material, and be manufactured in the United States. Approved valve and valve box manufacturers are as follows:
 - 1. KEROTEST Poly-gas Valves
 - 2. Rockwell POLYVALVE Ball Valves
 - 3. Lyall Poly Ball Valve
 - 4. Handley Valve Box
 - 5. Continental Industries Roadway Valve Box

2.02 MATERIALS AND/OR EQUIPMENT

- A. Polyethylene pipe. The polyethylene pipe for the natural gas distribution lines shall meet the following requirements:

1. Pipe and Fitting Material. All pipe shall conform to the requirements of the currently approved ASTM D-2513 specification "Thermoplastic Gas Pressure Pipe, Tubing and Fittings." All fittings shall conform to the requirements of ASTM D-2683 specification "Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe" or ASTM D-3261 "Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing." All pipe shall be manufactured of virgin material, with the exception of the clean rework material that is generated from the manufacturer's own production, as long as the pipe and/or fittings meet the required specifications. All pipe formulation must have suitable outdoor weather resistance. The color of all polyethylene pipe shall be yellow.
2. Pipe Design. All pipe shall be designed for direct burial as specified in D.O.T. Title 49, Part 192, "Transportation of Natural and Other Gas By Pipeline: Minimum Federal Safety Standards," through current Amendment, for natural gas mains and services operated at 60 p.s.i.g. or less. The pipe must also be suitable for replacing old steel mains and services. The pipe must be homogeneous and be free of holes, cracks, foreign material, blisters or other deleterious faults. The minimum design stress must comply with the requirements of ASTM D-2513.
3. Pipe Size. The pipe shall be designed and pressure rated to conform to the requirements in ASTM D-2513. The minimum wall thickness for distribution pressures shall be as follows:

<u>Size</u>	<u>O.D.</u>	<u>S.D.R.</u>	<u>Minimum Wall Thickness</u>
1/2"	0.840	9.3	0.090
3/4"	1.050	11.0	0.095
1"	1.315	11.0	0.119
1 1/4"	1.660	11.0	0.151
1 1/2"	1.900	11.0	0.173
2"	2.375	11.0	0.216
3"	3.500	11.5	0.307
4"	4.500	11.5	0.395
6"	6.625	11.5	0.581

4. Any defect such as a groove, notch, or gouge, greater than ten percent (10%) of the wall thickness of the pipe, shall not be used.

B. Valves. Gas distribution system valves shall be in compliance with the following specifications:

1. Service-Line Valves (Meter Stops). Service-line valves (meter stops) installed above ground shall be a "tamper-proof" iron body, brass (or bronze) core, lock wing stop which complies with the requirements of Code of Regulations D.O.T. Title 49, 192.363. The minimum working pressure shall be 125 p.s.i.g.
 2. Polyethylene Valves. The polyethylene valve stub ends must be fabricated from material that is compatible with the pipe used, including the Standard Dimension Ratios (SDR).
- C. Service Taps. Service Taps shall be made by a self-tapping tee that also acts as a positive shut off at the main. The base of the tapping tee shall be designed for heat fusion to polyethylene pipe and a socket end branch connection for heat fusion to the service line pipe. The heat fusion base and socket must be manufactured from the same material as the pipe.
- D. Service Riser. Service riser to be 1" IPS epoxy coated Schedule 40 steel with 1" IPS polyethylene transition. Riser to be 24" vertical by 36" horizontal.
- E. Valve Boxes. Valve boxes shall provide access for operation and maintenance for all valves. The boxes shall be provided with a drop-in lid and the word "GAS" clearly visible. Box shall be self adjusting, have a 6" shaft with an arch base and be suitable for use in areas with vehicular traffic. Paint box lid yellow upon completion of construction.
- F. Service Regulators.
1. Regulators shall comply with the current American National Standards Institute (ANSI) Service-type regulator Specification X-50865 and the requirements of Paragraph 192.197(a) and (b), D.O.T. Title 49, Code of Federal Regulations. Regulators shall be shipped with dust caps or seals to prevent dust or moisture from entering in under shipping and handling conditions. Regulators shall be Equimeter 143-80-2, or preapproved equal and have the following physical characteristics:

Body Size	1-inch
Orifice Size.....	1/8-inch
Maximum Inlet Pressure	125 p.s.i.g.
Set Point	7-inches water column (w.c.)
Capacity.....	360 cu.ft./hr. (min.) @ 10 p.s.i.g. Inlet
Internal Relief Valve	1-inch vent
Finish	Gray enamel (ASA #49) or equal

G. Service Meters.

1. All meters shall comply with the American Gas Association (A.G.A.) Specification OP-58-2. Meters must be shipped or sealed to keep moisture or dust from entering under shipping and handling conditions. The meters shall be manufactured by Equimeter, or preapproved equal, and shall have the following physical characteristics:

Body & Cover(s)... Aluminum
Index Standard 1/2', 2' & four circles
Index Cover..... Clear, high impact strength molded Lexan or other approved plastic
Diaphragms..... Synthetic
Identification Plate Non-corrosive metallic material Year of manufacture must be shown
Performance..... Meters shall meet all requirements for Class 275 meters
Proof Meter proofs at capacity and check rates of flow shall be zero percent (0%) error with a tolerance of plus or minus one half percent ($\pm 1/2\%$), but in no case shall the proof at the capacity rate be slower than the check rate. Factory meter proof data sheets shall be supplied for all meters.
Swivels 1-inch black steel male connections
Swivel Washers.... 1/8" thick Neoprene or other material suitable for use with natural gas
Swivel Nuts (Caps) Black Steel
Finish Gray enamel (ASA #49) or equal

2. Large capacity meters shall comply with current A.G.A./ANSI Specifications. The large capacity meters shall be manufactured by Equimeter, or preapproved equal, and shall have the following physical characteristics:

Body & Cover(s)... Aluminum
Index Vertical circular reading
Index Cover..... Clear, high impact strength molded Lexan, or other approved plastic
Diaphragms..... Synthetic
Identification Plate Non-corrosive metallic material Year of manufacturer must be shown
Capacity See Plans

Connections..... See Plans
Finish Gray enamel (ASA #49) or equal

- G. Pipeline Markers. Signs and posts must be used to mark the gas pipeline at each crossing of a public road or highway, or wherever it is necessary to identify the location of the pipeline to reduce the possibility of damage or interference as specified by the Director of Public Works. All markers must meet the D.O.T. requirements.
1. Signs. Six (6) foot long composite pipeline markers, Carsonite CUM-375, Sentry Posts, or preapproved equal shall be used. Each sign must have the following printed legibly on a background of sharply contrasting color:
 - a. The word "WARNING" followed by the words "Gas Pipeline" with a letter height of at least one (1) inch and a one-quarter (1/4) inch wide stroke.
 - b. The name "CITY OF BRENHAM, TEXAS" followed by "409/836-7911" and "AFTER HOURS, WEEKENDS AND HOLIDAYS, CALL 409/836-0027". The Contractor shall verify the telephone numbers before manufacturing signs.

PART 3 EXECUTION

3.01 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. Polyethylene Pipe.
1. Heat Fusion Joints. Heat fusion, in accordance with D.O.T. Title 49, Code of Federal Regulations and with the proper tools designed for this purpose, or butt fusion with socket fittings shall be used to join the pipe. Threaded fittings and joints shall not be permitted. The same materials as the pipe shall be used to manufacture the main body and fusion surfaces of the pipe fittings. Heat fusion tools shall be maintained in a good working, clean condition. All heating irons used will be checked for the correct temperature each day before production continues. After each jointing procedure is completed, the heater faces must be cleaned in order to remove any accumulated material. All pipe ends must be chamfered in accordance with the manufacturer's recommendations before joining the pipe to socket type fittings. Pipe ends shall be planed perfectly flat for butt fusion joints. Align component parts so that no strain is placed on the joint when they are finally positioned. Couplings and fittings shall be set true.

2. Mechanical Joints. Compression type mechanical joints to connect polyethylene pipe to steel pipe shall be designed for natural gas use and the gasket material in the coupling must be compatible with the polyethylene pipe. The coupling must be used in combination with an internal tubular rigid stiffener. When installed, the tubular rigid stiffener must be flush with the end of the pipe and project at least 1/2 inch beyond the outside end of the compression fitting. The stiffener must be free of rough or sharp edges and must not be a force fit in the pipe. Use of a split tubular stiffener shall not be allowed. Joints shall be designed and installed to effectively sustain the longitudinal pull-out forces caused by contraction of the piping or by external loading. Compression couplings shall not be used in above ground installations.
3. Pipe Placement and Backfill.
 - a. When installing polyethylene pipe, sufficient slack shall be provided to allow for possible contraction. The polyethylene pipe shall not have a bend that is less than 25 times the outside diameter of the pipe. If a bend is required that is less than 25 times the outside diameter of the pipe, then an approved polyethylene elbow fitting is required. A fusion joint shall not be placed at a bend. During extremely high temperature conditions it may be necessary to cool the pipe before the last connection.
 - b. No polyethylene gas line shall be installed above ground. During maintenance, repair, and tie-in work, temporary polyethylene gas lines may be used above ground.
 - c. The minimum clearance required between the distribution piping and other underground structures is twelve (12) inches. Trench width and minimum cover shall comply with Section 02222, Excavation, Trenching and Backfilling for Utilities. Unless otherwise shown on plans, pipe embedment shall be select material and remainder of trench may be backfilled with spoil from trenching operation.
4. Pipe Installed in Casing. Each end of the casing shall be sealed to prevent soil and water from migrating into the casing, when the carrier pipe is installed in casing. All casing shall meet the requirements in 192.323 D.O.T., Title 49, Code of Federal

Regulations, as well as those imposed by permit, easement and other appropriate controlling factors.

5. Service Lines. Service lines to be 1-inch diameter unless otherwise shown on plans. All materials and equipment shall be installed with the approved recommendations of the manufacturer to comply with the contract documents and the requirements of Paragraph 192.361, D.O.T., Title 49, Code of Federal Regulations. Workmen skilled in this installation must perform the work. All joints on the service line must conform to the requirements of Paragraphs 192.281, 192.283, & 192.285, D.O.T., Title 49, Code of Federal Regulations.
 - a. Service Lines Connected to a Polyethylene Main. All hot taps shall be made by qualified fusers using self-tapping tees. A sidewall fusion jig must be used for tapping tees. When the outlet fusion joint is finished, it must be covered by a protective sleeve.
 - b. Service Lines Connected to a Steel Main. An approved self tapping welded tee shall be used for making service taps on steel mains. All welding shall be done by certified welder under API-1104 Standards.
 - c. Service Riser. The service riser must be protected from vehicular traffic. Support for the riser must prevent the transferral of forces to the service pipe as a result of accidental movement of the riser or natural settling.
6. Conductive Trace Wire. Install conductive trace wire complying with Section 02605, Conductive Trace Wire for Nonmetallic Pipe Installations with all polyethylene gas lines.
7. Swabbing and Pigging. Prior to joining, all individual gas main lengths shall be swabbed. All gas mains shall be pigged prior to initiation of gas service, but after joining has been complete. The pigs used shall be suitable for different size pipes and be designed for polyethylene pipe use. Any pig which could damage the pipe, such as wire brush type pigs, shall not be acceptable for use. Only use of compressed air to drive the pig through the pipe shall be permitted.

- C. Valves and Valve Boxes. Install valves and valve boxes plumb. All boxes shall be installed flush with the finished grade. Support box with brick or other approved material. Adequate backfill shall be placed around the valve boxes and valve extension boxes to prevent any damage or settlement to the pipeline that may be transferred to the pipe through the valve box. Protective sleeves shall be installed over fusion joints and extend through the valve boxes on the polyethylene valve installations.
- D. Signs and posts. After the pipeline installation has been completed, the Contractor shall install signs and posts at the locations designated by the Director of Public Works. Bury the anchor end of all posts approximately two (2) feet deep.
- E. When work has shut down for each day, all lines shall be capped, sealed, and pressured to 20 pounds with air. When a Project is not immediately tied-in, plug and seal all openings in the pipe. If a pipeline is to be abandoned in place, then disconnect the gas supply source, purge all of the gas from the abandoned system, and seal all of the ends.
- F. Purging Pipes and Fittings. A combustible gas indicator shall be used when purging mains and piping. When purging gas from abandoned lines, the air and the gas must be discharged aboveground and directed away from power lines or structures. When purging air from new lines, installation of a 3/4 service saddle and non-corrodible riser is required four (4) feet from each deadend on all new installations of pipe in order to purge air from all deadends simultaneously. Release gas into new lines at a rate that will prevent formation of a hazardous mixture of gas and air or precede natural gas with a slug of inert gas.

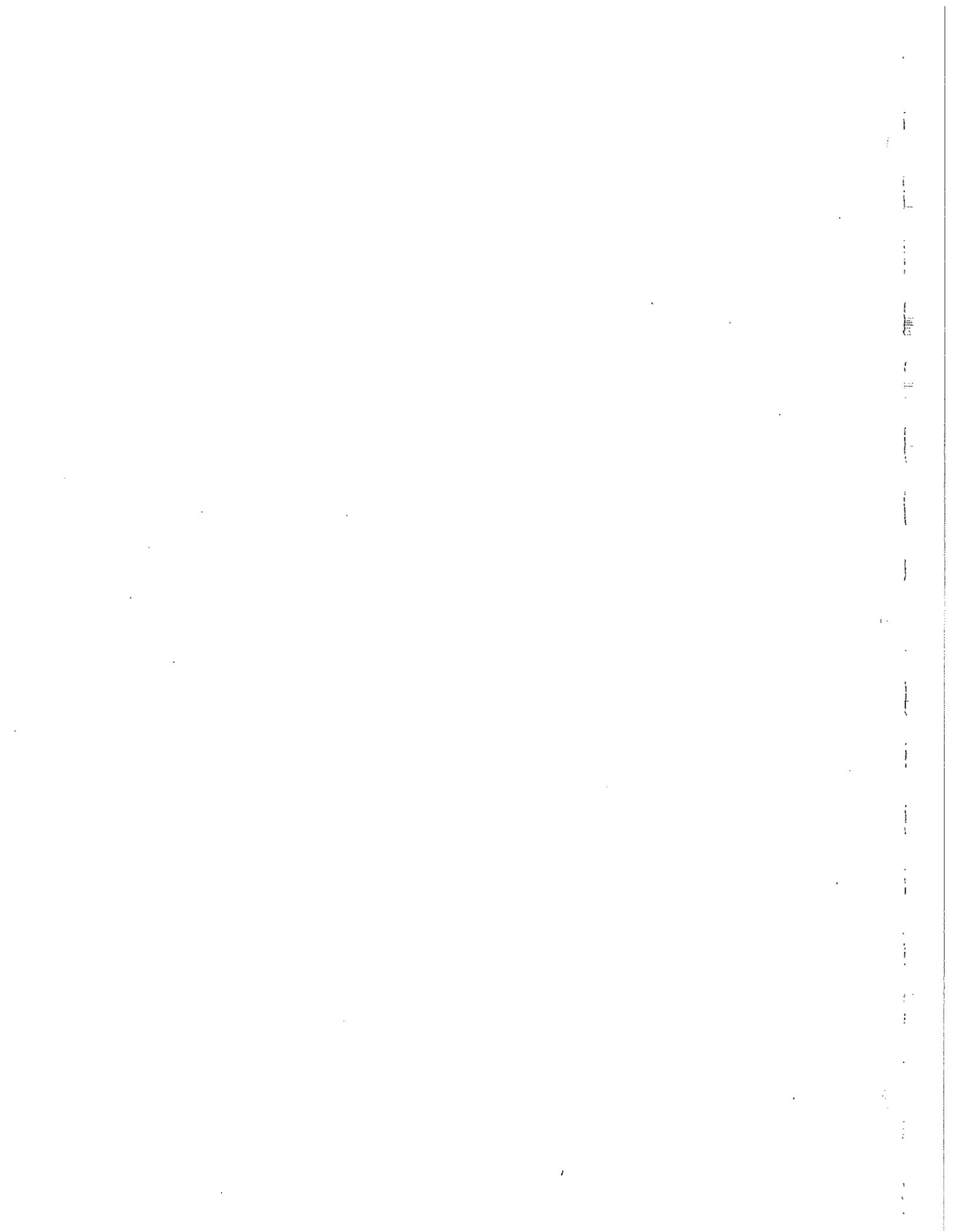
3.02 FIELD QUALITY CONTROL

- A. The Contractor shall test all gas mains with 90 p.s.i.g. air and show that the lines are leak free, prior to the initiation of gas service. Each day's work shall be tied into the preceding day's work and tested overnight. A pressure-time gauge with a range no greater than 0 - 200 p.s.i.g. and in good working order shall be furnished by the Contractor. All testing shall comply with D.O.T. Title 49, Part 192, Transportation of Natural and Other Gas By Pipeline: Minimum Federal Safety Standards."
- B. The location of the project along with the temperature at the time the test pressure is placed upon the pipe shall be recorded on the pressure chart. The pressure charts shall be given to the Director of Public Works

on a daily basis. In order to facilitate daily testing, appropriate testing apparatus shall be used. Leaks shall be repaired in a manner approved by the Director of Public Works, before additional lengths of pipe that need to be tested are added to the main.

- C. If service lines are installed at the same time as the mains, then service lines shall be included in the testing of the mains. If service lines are installed after gas service has been initiated, then the Contractor shall test each service line individually to stand up to an air test of 90 p.s.i.g. for twenty (20) minutes. If a leak is discovered, then the Contractor shall immediately make the appropriate repairs, in a method approved by the Director of Public Works. All existing service lines that are disconnected from the main temporarily shall be tested as if they are new lines before being placed back into service.
- D. A 24 hour test shall be placed on the entire system of mains prior to initiation of gas service. If a portion of the gas service has met the requirements of the leak test and it is possible for the other sections to be tested independently, then the Director of Public Works may approve initiation of gas service for that portion.

END OF SECTION



SECTION 02720

STORM SEWERS AND APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

This specification covers storm sewers, headwalls, inlets, culvert extensions, alterations of existing structures and miscellaneous items that are related to the drainage system.

1.02 RELATED SECTIONS

Section 02222, Excavation, Trenching, and Backfilling for Utilities
Section 02229, Excavation Safety

1.03 MEASUREMENT AND PAYMENT

- A. Storm Sewers and Culverts. Storm sewer length will be measured by the linear foot from the inner face of the inlets to the outer face of existing conduits and/or headwalls. No length deductions will be made for fittings such as wyes or tees. Storm sewers and culverts shall be measured and paid for according to diameter and type of pipe regardless of the trench depth. The unit price for the each individual pipe size shall include all work required for trenching operations, furnishing and installing pipe and all operations not designated to be paid for separately. Trench sheeting and shoring of depths less than five (5) feet and dewatering will be included in the unit prices for storm sewers. Fittings shall not be paid for separately.
- B. Connection to Existing Culvert. Unless a separate unit price is established in the proposal, then connections to existing culverts will be included in the unit price for pipe. The unit price shall include removing the existing culvert wall, grouting the new lead pipe in place, and all other related work as shown on the plans. Separate payment will be made for the lead pipe.
- C. Culvert Extension. Culvert extensions will be paid for at the unit price stated in the bid form. The unit price shall include the furnishing of all necessary materials, tools, labor and equipment, removing the existing headwall and a portion of the existing culvert barrel, disposal of the

removed materials, constructing an extension to the existing culvert, grading the road ditch and all other necessary work needed to complete the operation as directed on the plans.

- D. Headwalls. Headwalls will be paid for per each at the unit price bid. The price shall include all excavation, materials, labor and equipment to construct the headwalls and regrade the adjacent ditch.
- E. Curb Inlets. Curb inlets will be paid for per each at the unit price bid. The unit price shall include cutting and removing pavement, disposal of the materials removed, excavation, backfill, construction of the curb inlet structure as shown on the plans, and all appurtenant work. The height variance from the curb at the inlet to the standard curb and gutter shall be included in the unit price. Payment for the lead pipe from the inlet to the storm sewer main shall be paid for separately.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in there entirely:

AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society of Testing and Materials
TxDOT	Texas Department of Transportation Standard Specifications for Construction of Highways, Streets and Bridges

1.05 SUBMITTALS

Submit manufacturer's certification that pipe meets the specified standards.

1.06 DELIVERY, STORAGE, AND HANDLING

Handle pipe according to manufacturer's recommendations. Protect rubber gaskets from excessive heat and sunlight.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

- A. Reinforced Concrete Pipe. Unless otherwise shown on plans, use reinforced concrete pipe (RCP), ASTM C76, Class III, with rubber gasket

joints.

- B. Corrugated Galvanized Metal Pipe. Corrugated metal pipe shall only be used with prior City approval. Corrugated metal pipe shall be aluminized steel meeting AASHTO M274, shall be bituminous coated, with paved invert. Diameter and thickness shall be as shown on the plans. Coupling bands to have "O" ring rubber gaskets for watertight seal.
- C. PVC Pipe. PVC pipe shall only be used with prior City approval. PVC pipe and fittings shall be manufactured from 12454B or 12454C cell class material per ASTM D1784 and shall have a minimum stiffness of 46 lb./in./in. at 5% deflection in accordance with ASTM D2412. Joints may be either external plastic sleeve with gaskets or an integral bell, gasketed joint. Joints shall be watertight in accordance with ASTM D3212.
- D. Precast Concrete Box Culverts. Precast concrete boxes shall conform to ASTM C789 or C850. Unless otherwise shown on plans, design for earth dead load plus H520 live load.
- E. Rubber Joint Gaskets. Gaskets for joints in bell and spigot concrete pipe shall meet ASTM C-443.
- F. Materials for Drainage Structures.

Mortar. The mortar used for other drainage structure connections shall consist of one (1) part by volume of Portland cement and two (2) parts of sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of AASHTO Specification M-45. Hydrated lime may be added to the sand and cement mixture in an amount of ten (10) percent of the volume of cement used. The hydrated lime shall comply with ASTM Specification C207, Type S requirements. The water quantity mixture shall be adequate to produce a stiff workable mortar, but shall not be greater than six (6) gallons of water per sack of cement. Water shall be clean and free of acids, alkalies, and organic impurities. The mortar shall be used within thirty (30) minutes from the time the ingredients are mixed with water. The mortar shall be protected on the outside in order to obtain a sufficient curing time.

2.02 SOURCE QUALITY CONTROL

Control cylinders of the reinforced concrete pipe (RCP) shall obtain a compressive strength of at least eighty (80) percent of the specified minimum strength before any concrete pipe can be delivered to the work site.

PART 3 EXECUTION

3.01 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. Laying pipe. The ends of the pipe shall be cleaned before the pipe is placed. The pipe shall be laid on a prepared foundation starting at the outlet end with the spigot ends pointed in the direction of the flow and shall continue toward the inlet end with the adjoining sections matched properly. The pipe shall be laid true to the lines and grades indicated on the plans. The mouth of the pipe shall be protected to prevent earth and bedding material from entering the pipe as each section is laid. The pipe shall be matched and fitted to form a smooth, uniform conduit when placed in the bed. The trench bottom shall be shaped and the excavation shall be performed as specified under Section 2222 "Excavation, Trenching and Backfilling for Utilities". No pipe shall be laid on unsuitable soft material, under any circumstances. Proper facilities are to be provided for hoisting and lowering the pipe sections into the trench without disturbing the prepared trench bottom or sides. The Contractor shall be responsible for dewatering of the trenches and the diversion of drainage during construction. Any pipe section that is laid and found to be defective or damaged shall be taken up and replaced or relaid at the cost of the Contractor.
- B. Jointing. Assemble rubber gasket joints in accordance with recommendations of gasket manufacturers.
- C. Inlets, headwalls, and other miscellaneous alterations and connections to existing drainage structures shall conform to the dimensions, locations and elevations and be constructed of the materials specified herein and shown on the plans.
- D. Stub ends. Stubs for connection of future storm sewer pipe shall have watertight plugs installed in the end of the pipe such as a double course of brick or precast concrete plug.

3.02 REPAIR / RESTORATION

Any line in which opening or faulting of the joints occurs during backfilling or before the final inspection and acceptance, such that infiltration of materials or a change in flow characteristics may result, shall be repaired or replaced by the Contractor to the satisfaction of the City Engineer.

END OF SECTION

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SECTION 02730

SANITARY SEWERAGE SYSTEM

PART 1 GENERAL

1.01 SUMMARY

This section applies to the construction of sanitary sewers, including installation of pipe, valves, fittings, manholes, cleanouts and other incidentals and testing of the installations. The work performed under this section applies to both gravity sewers and force mains.

1.02 RELATED SECTIONS

Section 02222	Excavation, Trenching and Backfilling for Utilities
Section 02229	Excavation Safety

1.03 MEASUREMENT AND PAYMENT

- A. Sanitary Sewer Pipe. Measurement and payment will be by the linear foot for each size sanitary sewer pipe required including service line, without deductions for space occupied by manholes. Sewer line classification will be established according to the depth of cut that is required in bid form. The unit price per linear foot for various sizes, types, and depths of sanitary sewer shall include compensation for furnishing all equipment, tools, materials and labor necessary to construct the sewer and place in the backfill, including the disposal of surplus excavated material, in compliance with the plans and specifications. The unit price shall also include connections with existing sewers and between non-compatible new pipe and costs for the appropriate tests to be conducted. Unless it is specified as a bid item, no compensation shall be given for rock excavation, bedding, backfill, or clearing and grubbing.
- B. Manholes. Measurement of standard manholes will be taken at the center of the manhole, from the invert to the rim of the frame. Payment for standard manholes shall be at the contract unit price per each including manholes six (6) feet or less in depth, complete in place, according to the diameter. Payment for extra depth of standard manholes more than six (6) feet in depth will be paid for according to the diameter, on the basis of the unit contract price per foot of depth in excess of six (6) feet, as actually constructed. The unit price shall

include compensation for furnishing all labor, materials, tools, equipment, and incidentals and performing all work necessary for the completion of the manholes in accordance with the provisions of the plans and these specifications.

- C. Cleanouts. Cleanouts for both the main lines and service lines shall be measured for payment per each, complete in place, regardless of depth. Payment will be made at the unit contract price for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work including earth excavation and disposal of surplus materials and backfill as specified and shown on the plans.
- D. Drop Connections. Drop connections will be measured per each and shall be paid for at the unit price per each installed for drop connections five (5) feet height or less measured from the flowline of the sewer main to the flowline of the drop pipe at the manhole wall. Payment for extra depth of drop connections over five (5) feet will be per vertical foot of height as constructed.
- E. Service Connections. Service connections shall consist of installing a wye fitting or saddle on the main line and shall be measured per each and paid for at the unit price bid per each.
- F. Testing. There shall be no separate payment made for testing sanitary sewers, but the testing will be included in the unit cost bid for sanitary sewer pipe.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

ANSI	American National Standards Institute
ASTM	American Society of Testing and Materials
AWWA	American Water Works Association

1.05 SUBMITTALS

The pipe manufacturer shall furnish three (3) copies of a certification that the pipe is in full compliance with the commercial standards applicable to the pipe specified. The manufacturer shall furnish the engineer three (3) copies of data showing the physical properties of the pipe. Properties should include normal

bursting pressure, manufacturer's maximum working pressure, physical dimensions, and tolerances.

1.06 DELIVERY, STORAGE, AND HANDLING

The Contractor shall notify the Engineer of pipe delivery to the job site in advance in order to allow inspection of the pipe by the Engineer prior to unloading of the pipe. Store pipe on a flat surface away from sunlight and heat. Do not stack bundles of pipe. Use a tarp to cover all pipe left for prolonged periods of time.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

- A. Pressure Rated PVC Pipe. Pressure rated PVC pipe, used for force mains or gravity lines, shall be polyvinyl chloride Type 1, Grade 1. The pipe shall meet AWWA specifications and bear the seal of the National Sanitation Foundation on each joint. The diameter and applicable commercial standard shall be shown on each length of pipe. The type of PVC pressure rated pipe required for the project shall be as shown on the plans.
1. Schedule 40 PVC Pipe. Schedule 40 PVC pipe shall conform to the requirements of ASTM D-1785. Joints for schedule 40 PVC shall be solvent weld with recessed bells. Pipe and fittings shall be made of PVC plastic having cell classification of 12454-B as specified in ASTM D-1784.
 2. ASTM D-2241 PVC Pipe. Pipe other than schedule 40 PVC shall comply with the requirements of ASTM D-2241. The pressure rating of the pipe shall be Class 160 unless otherwise shown on the plans or in the bid form. Joint seals for ASTM D-2241 PVC pipe shall conform to ASTM F-477. Pipe and fittings shall be made of PVC plastic having cell classification of 12454-B as specified in ASTM D-1784.
- B. Non Pressure Rated PVC Pipe. Pipe for gravity sewers shall conform to ASTM D-3034 or ASTM F-675, SDR 26 unless otherwise shown on the plans. Pipe shall have fluid tight gasket type joints with joint bells formed integrally with the pipe. Pipe and fittings shall be made of PVC plastic having cell classification of 12454-B as specified in ASTM D-1784. The

diameter and applicable commercial standard shall be shown on each length of pipe.

- C. PVC Fittings. PVC fittings for the pipe shall be constructed of the same material as the pipe. Fittings shall be of the molded type or machined from extruded stock. PVC fittings for pressure rated PVC pipe conforming to ASTM D-2241 used for gravity lines shall have a minimum pressure rating of 150 p.s.i. PVC fittings for pressure rated PVC pipe conforming to ASTM D-2241 used for force mains shall be rubber gasket and shall have a minimum pressure rating of 200 p.s.i. PVC fittings for Schedule 40 PVC pipe shall normally be Schedule 40 solvent weld, but rubber gasket fittings may be used in some applications. Fittings for ASTM D-3034 and ASTM D-2241 PVC pipe shall be push on type and have elastomeric seals and shall be compatible with the pipe. The seals shall meet ASTM F-477 for elastomeric seals. Fittings shall have smooth interior free of ridges or obstructions to sewer flow.
- D. Ductile Iron Pipe. Ductile iron pipe shall be thickness Class 50 per ANSI/AWWA C151/A21.51, unless shown otherwise on the plans. Pipe joints shall be push on joint per ANSI/AWWA C111 unless shown otherwise. Interior flange pipe shall conform to ANSI/AWWA C115.
1. Coating, Lining and Encasement. Underground pipe and fittings shall be asphaltic coated outside per ANSI/AWWA C151/A21.51 unless shown otherwise. Inside lining shall consist of a 30 mil dry film thickness of polyurethane high solids, high build two component coating (Corropipe II TX Five Minute Number 17115) as manufactured by Madison Chemical Industries, Inc., or 24 mil dry film thickness epoxy coating. Applicators of polyurethane and epoxy lining shall be approved by the pipe manufacturer. Encase pipe with 8 mil low density or 4 mil high density polyethylene in accordance with ANSI/AWWA C105/21.5.
 2. Ductile Iron Fittings - Full Body. Fittings shall be cast iron or ductile iron push-on type conforming to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11, unless shown otherwise on the plans. Mechanical joint fittings shall conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11, Class 250 for 4" through 12" and Class 150 for 14" and larger unless shown otherwise on the plans. Flanged fittings to be in accordance with ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11, Class 250 for 4" through 12" and Class 150 for 14" and larger unless

shown otherwise on plans, both with one hundred twenty-five (125) pound template flanges.

3. Ductile Iron Fittings - Short Body. "Short body" fittings shall be ductile iron push-on type conforming to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.11, Class 350 for all sizes, unless shown otherwise on the plans. Mechanical joint ductile iron short body fittings shall conform to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/21.11, Class 350 for all sizes. Flanged fittings shall have full body dimensions.
4. Gaskets. Flanged joint gaskets shall be of SBR or Neoprene rubber. Gaskets shall extend to the full flange with holes to match ANSI A21.10 or B16.1 Class 125 flange drilling. Gaskets shall be rated for 250 psi water working pressure as a minimum.
- E. Concrete. All concrete shall meet the requirements specified in Section 03300, Cast-In-Place Concrete.
- F. Mortar. Mortar shall conform to the current specification for Mortar for Unit Masonry, ASTM Designation C270, Type S. Mortar shall be composed of two parts of fine aggregate thoroughly mixed with one part Portland cement and the amount of water required to produce a homogeneous mixture of such consistency that it can be easily handled and spread by trowel. Aggregate for the mortar shall meet ASTM C-144.
- G. Manhole Covers. Manhole covers and rings shall be made of the best quality of gray iron, ASTM A-48, Class No. 20. The covers shall possess a tensile strength of not less than eighteen thousand (18,000) pounds per square inch. All casting shall conform to the shape and dimensions shown on the plans and shall be clean and perfect without defects of any kind. All sanitary sewer manhole covers must include the words "Sanitary Sewer". Use Vulcan 24" Model V 1342 with 2-Type 6 Pick Bars, or approved equal.
- H. Inflow Protection Covers. Manhole inflow protector, valve, and strap shall be manufactured from corrosion proof material suitable for use in areas containing hydrogen sulphide and dilute sulphuric acid as well as other gases associated with wastewater collection systems. The relief valve shall be designed to relieve at a pressure of one (1) psi and have a water leak of five (5) gallons per 24 hours. The body shall be made from ABS high impact, high grade LS material. Gaskets shall be made of closed cell neoprene and have a pressure sensitive adhesive on one

side. The adhesive shall form a long lasting bond in either wet or dry conditions.

- I. Cleanout Covers. Cleanout covers shall be made of the best quality of gray cast iron. The cover shall be free from perforations and shall conform to the detail specified in the plans.
- J. Fiberglass Manholes. Use manufactured reinforced fiberglass plastic as manufactured by Owens/Corning, or preapproved equal. A traffic model designed for H₂O wheel loading is required when installed in a travelled way.
- K. Precast Concrete Manholes. Precast concrete manholes shall meet the requirements of ASTM C-478. Ring sections shall be of the diameter specified. Precast concrete manholes joint gasket connections shall be made with an O-Ring type rubber gasket meeting ASTM C361-89 and C443-85 as manufactured by Press-Seal Gasket, Inc. or approved equal. Precast manhole sections shall be specifically manufactured for O-Ring application. Installation shall be in accordance with the manufacturer's recommendations.
- L. Grade Rings. Precast concrete grade rings shall be used to adjust all types of manholes to final grade. Bricks shall not be used to adjust manhole grades.
- M. Manhole Coating. The interiors of precast or cast-in-place concrete manholes shall be coated with a 10 mil thickness of coal tar epoxy, Pittsburgh two (2) part coal cat coating component A is 97-640 and component B is 97-641.
- N. Gate Valves. Gate valves 3 inches and larger shall be iron-body, resilient rubber seat, non-rising stem and shall conform to AWWA C-509. Gate valves smaller than 3 inches shall be brass ball valves with 2 inch square adapter nut. Valves shall have the required ends for the piping in which they shall be installed. Gate valves shall have a clear waterway equal to the full nominal diameter of the valve and shall be opened by turning counterclockwise. An arrow shall be cast in the metal of the operating nut or wheel to indicate the direction to open. Underground valves shall be nut operated and valves located in structures shall be wheel operated. Each valve shall have the maker's initials, pressure rating, and year of manufacture cast on the body. Valves 2 inches through 12 inches shall have a 200 psig working pressure and valves 16 inches and larger shall have a 150 psig working pressure. Prior to

shipment from the factory each valve shall be tested by hydraulic pressure equal to twice the specified water working pressure. Gate valve coating shall be the same as for the pipe.

- O. Check Valves. Check valves two and one-half (2-1/2) inches in diameter and larger shall be iron body, bronze mounted, horizontal swing check valves with balanced weight and lever arm designated for one hundred fifty (150) pounds working pressure, unless otherwise designated on the plans. Check valves shall have the same coating as the pipe.
- P. Plug Valves. Plug valves shall be manufactured by Dezurik or preapproved equal. Coatings for plug valves shall be same as for the pipe.
- Q. Valve Boxes. All valves buried in the ground shall be provided with cast iron boxes of proper dimensions to fit over the valve. The tops shall be complete with covers and adjustable.
- R. Shear Gates. Shear gates shall be all iron, Clow No. F-3000; Neenah Foundry Company, R-5005 Series; Olympic shear gate; or approved equal. Shear gates shall have lifting handle extension where required.

PART 3 EXECUTION

3.01 PREPARATION

Expose all underground utilities which may be in conflict with proposed sanitary sewer lines prior to installing new lines. If faults, caverns or subsidence are discovered during construction, halt work to allow features to be inspected by design engineer. Construction may only be resumed with approval of design engineer.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. Pipe Laying and Jointing. Once the foundation has been prepared, pipe shall be laid with the spigot ends in the direction of the outlet or low end of the pipeline. The interior of the pipe shall be free from all dirt, joint material and foreign material as the work progresses and shall be clean upon its completion. Inside surfaces of adjacent sections of pipe shall be constructed in such a manner to provide the best possible flow conditions. Tight fitting stoppers or bulkheads shall be placed in the ends of all pipelines when the work has stopped, to prevent dirt or trash from entering the pipe.

B. PVC Pipe. Bedding of the pipe shall be as detailed on the plans for the laying conditions.

1. Solvent Weld Joints. When joints are made, the pipe fittings and couplings shall be at the same temperature. All joints shall be tested for a snug dry fit before solvent is applied. If the dry fit is such that the couplings are loose or if force is required to test dry fit, the pipe shall be rejected. A nonsynthetic brush shall be used to apply solvent cement in accordance with the manufacturer's recommendations. Lightly apply cement to the inside of the fitting and more generously to the outside of the pipe. The joint shall then be stabbed into the fitting and given a quarter turn. If sufficient cement has been used, a small bead will form between the pipe and the shoulder of the fitting. Remove this excess solvent. The joint shall not be moved until the cement weld has set. Fittings for service lines or laterals shall be assembled so that no strain is placed on the pipe during or after the backfill operation.
2. Push-On Joints. Before jointing, both bell and spigot ends shall be thoroughly cleaned and a lubricant supplied by the pipe manufacturer shall be applied according to the manufacturer's recommendations. Spigot end shall be beveled so it will not dislodge or damage gasket. To insure proper sealing of the joint, sufficient pressure shall be applied until reference mark on spigot is flush with end of bell.
3. Cutting Pipe. If it is necessary to cut the pipe, a fine tooth hacksaw shall be used and the burrs removed with a file. The outer surface of the pipe and the inner surface of the fittings shall be wiped with a clean cloth to remove all foreign matter and moisture before application of the solvent cement, for solvent weld joints. Bevel end of pipe per manufacturer's recommendations for push-on joints.

C. Ductile Iron Pipe. Bedding of the pipe shall be as detailed on the plans for the laying conditions.

1. Before jointing, both bell and spigot ends shall be thoroughly cleaned and a lubricant supplied by the pipe manufacturer shall be applied according to the manufacturer's recommendations. Spigot end shall be beveled so it will not dislodge or damage gasket. To

insure proper sealing of the joint, sufficient pressure shall be applied until reference mark on spigot is flush with end of bell.

2. Mechanical Joints. Joints shall be made in a workmanlike manner, using rubber gasket seals, follower glands, and standard bolts. Overstressing of bolts to stop leaks resulting from poor installation practice will not be permitted.
 3. Wall Sleeves. At all points where the pipe must pass through a wall of a structure, the Contractor shall furnish and install suitable sleeves and wall castings, unless otherwise shown on the plans. The wall sleeve or wall casting shall be a mechanical joint and/or flange fitting flush with the wall, with flanges tapped for studs.
- D. Curved Alignment. For curved sewer lines, the Contractor shall not exceed the pipe manufacturer's recommended maximum deflection at each joint. Each joint shall be pushed "home" prior to deflecting the pipe and pipe shall not be stressed or bent to achieve curvature. The Contractor shall reduce the pipe lengths according to the manufacturer's recommendations, if the radius of curvature cannot be achieved without exceeding the maximum deflection using standard length joints of pipe.
- E. Valve Boxes. Valves buried in the ground shall be provided with cast iron valve boxes of proper dimensions to fit over the valve, and to extend to such elevation, at slightly above the finished ground line. Valve boxes shall be set vertical and centered with the valve stem. If a valve box moves from its original position as to prevent the application of the valve key, then the valve box must be reset by the Contractor at his own expense.
- F. Thrust Blocking. Thrust blocking for pressure sewers (force mains) shall be in accordance with the pipe manufacturer's recommendation.
- G. Embedment and Encasement. Embedment and encasement shall be placed at the locations shown on the plans and in conformance with Section 02222 Excavation, Trenching and Backfilling for Utilities. If the maximum width is exceeded at any point, the Contractor shall use the next number of embedment higher than that designated on the plans. The additional cost for using the higher type of embedment required because of over cutting will be at the expense of the Contractor.
1. Typical DIP Embedment. Unless otherwise shown on plans use Type 2 embedment in accordance with ASTM A746.

2. Typical PVC Embedment. Pipe shall be imbedded in sand or gravel with fines meeting the designation of Class I or II Soil per ASTM 2321 compacted to a minimum of eighty-five (85) percent Standard Proctor. The embedment shall extend from four (4) inches below the pipe to a point twelve (12) inches above the top of the pipe.

H. Fiberglass Manhole Construction.

1. The manhole shall be constructed on a concrete foundation of the size and shape shown on the plans. The foundation shall be placed against undisturbed earth and the thickness shall be a minimum of eight (8) inches below the bottom of the outside diameter of the sewer pipe or bottom edge of manhole section. If the manhole is over twelve (12) feet deep, then the foundation thickness shall be a minimum of twelve (12) inches below the bottom of the sewer pipe's outside diameter or bottom edge of manhole section.
2. The base of the reinforced fiberglass manhole shall be cut to accommodate the size of the sewer pipe indicated on the plans. The maximum tolerance for the cutout is one-half (1/2) inch greater than the required opening. The base shall be embedded in a concrete foundation to a minimum depth of six (6) inches. The base and foundation shall be placed as soon as practicable after the sewer line is completed through the manhole location. To get the proper seal where the manhole cutout fits over the pipe, fresh concrete which is monolithic with slab concrete must be used as shown on the outside of the manhole and waterstop gaskets shall be installed on all pipes penetrating the manhole. Manholes will be rejected if this seal is not made when the slab is poured and the manhole is placed. Grout with a cold joint between grout and the concrete slab is not acceptable.
3. Where sewer pipe for a drop connection enters a manhole other than at bottom cut out, a saddle type connection to the manhole for the pipe size will be provided as shown. Connections depending upon grout for sealing will not be allowed.
4. Manholes shall be installed as one basic unit. The Contractor is responsible for verifying the correct manhole depth before construction. Top of fiberglass portion of manhole shall not be less than twelve (12) inches nor greater than eighteen (18) inches

from final grade. The Contractor is responsible for the correct depth of manholes relocated in the field because of unforeseen conflicts. Manhole tops shall be adjusted with precast concrete rings and be set as follows:

- a. Developed Areas. Manhole tops shall be set one (1) inch higher than final grade or flush with paved surfaces, unless shown otherwise on the plans.
 - b. Undeveloped Areas. Manhole tops shall be set six (6) inches above existing grade. Where manholes are located in a ditch bottom, set manhole top minimum of twelve (12) inches above the ditch bottom and reshape the ditch around the manhole.
5. Backfill around manholes and drop connections immediately after mortar and concrete have set. Backfill around manholes in paved street, driveway or alley shall be bank sand. Place backfill around the manhole evenly in twelve (12) inch layers and in such a manner that no torque is applied to the manhole. Where a proposed sewer line connects to an existing manhole at or near a manhole invert, reshape the invert of the existing manhole so that no turbulence is created in the manhole as a result of the connection.
6. Precast concrete rings shall be used to adjust the top of the manhole to the proposed grade if necessary.
- I. Precast Manholes. Construction of precast concrete manholes shall follow the general procedures for fiberglass manholes except that precast manhole bottoms may be used if cast as an integral part of the bottom ring.
 - J. Cast-in-Place Manholes. Manholes shall be constructed of concrete conforming to Section 03300, Cast-in-Place Concrete. Manholes shall be poured in place as shown on the plan sanitary sewer detail sheet. The foundation shall be placed against undisturbed earth and shall be a minimum of eight (8) inches thick below the bottom of the sewer outside diameter, except if the manhole is over twelve (12) feet deep make the foundation twelve (12) inches thick below the bottom of the sewer pipe outside diameter. The manhole foundation, walls and cone section shall be constructed in a single continuous monolithic concrete pour.

K. Construction Methods For All Manholes.

1. Manhole Connections. Watertight, size-on-size resilient connectors allowing for differential settlement shall be used to connect pipe to manholes. Pipe to manhole connectors shall conform to ASTM C-923. Water stop gaskets shall be installed on the pipe for connection to existing manholes and shall be grouted in place with non-shrink grout having a minimum thickness of one (1) inch around the gasket.
2. Manhole Inverts. The bottom of the manhole shall be provided with a "U" shaped channel that is as much as possible a smooth continuation of the inlet and outlet pipes. For manholes connected to pipes less than fifteen (15) inches in diameter the channel depth shall be at least half the largest pipe diameter. For manholes connected to pipes greater than twenty-four (24) inches in diameter the channel depth shall be at least equal to the largest pipe diameter. Invert flow channels shall be on an even slope from pipe to pipe. The bench provided above the channel shall be sloped at a minimum of 0.5 inch per foot. Where sewer lines enter the manhole higher than twenty-four (24) inches above the manhole invert, the invert shall be filleted to prevent solids deposition. Where the main sewer (lowest line) passes straight through the manhole and the degree of deflection of the main sewer is less than five (5) degrees, and no other line or stub out is shown entering the manhole below the center line of the main sewer, lay the sewer continuously through the manhole. After the manhole walls have been completed, cut out and remove the top half of the barrel of the sewer pipe that was previously laid through the manhole. Use concrete with one (1) inch mortar topping and construct the remainder of invert as shown on plans. Where the main sewer (lowest line) alignment deflects greater than five (5) degrees at the manhole or where another sewer or stub out enters at or below the center line of the main sewer, terminate the main sewer pipe laying in such a manner that the ends of pipe protrude inside of the manhole. The invert shall be constructed with concrete and topped with one (1) inch of mortar. The invert shall be shaped to allow for a smooth flow across the floor of the manhole and slope the side as required to prevent deposition of solids.
3. Stubs Outs. Stub outs shall be installed to line and grade where shown. One (1) full joint of pipe, of the size indicated, will be used for the stub out. Seal the stub out with a plug. The plug shall be

installed in such a manner as to prevent seepage or leakage through stub outs. The plug shall be installed such that it may easily be removed in the future without damaging the bell or groove end of the stub out.

4. Contractor shall meet all OSHA requirements relating to entry into confined spaces prior to personnel entering manholes for any reason.

L. **Cleanout Structures.** Cleanout structures shall be constructed where shown on the plans and as specified. Cleanouts shall consist of six (6) inch riser pipe laid on an angle on undisturbed natural ground. Machine tamp all backfill around and above the pipe in layers six (6) inches or less in depth so that no settlement shall occur after the cleanout is constructed. Other construction details shall conform to the cleanout detail shown on the plans.

M. **Connections.**

1. **Drop Connections.** Drop connections on manholes shall be constructed according to the plans and these specifications. The connection shall include the indicated fittings and necessary backfill material.
2. **Service Connections.** Standard service connections shall consist of a wye and forty-five (45) degree bend and the necessary four (4) inch diameter PVC sewer pipe to reach the property line, or be plugged and sealed at the end. If required, the Contractor shall raise the lateral by means of a steeper grade from the main. Locations of the service outlets and the depth to the top of the lateral pipe, if depth is not shown on the plans, will be designated at the time of construction. Minimum depth of cover over the end of the lateral pipe shall be five (5) feet.

N. **Separation Distances.** The following are separation distances that shall apply between potable water and wastewater treatment plants, and water lines and sanitary sewers.

1. **Potable Water Treatment Plant Separation.** Sanitary sewers located within 50 feet of any underground treatment plant units shall be constructed of ductile iron or PVC with a minimum pressure rating of 150 pounds per square inch and watertight joints.

2. Water Line / New Sewer Line Separation. Sanitary sewers shall not be installed within nine (9) feet, in all directions, to existing water lines. Sewer lines parallel to water lines must be installed in separate trenches. If the nine (9) feet separation distance cannot be achieved, the following guidelines apply.
- a. Where a sanitary sewer parallels a water line, the sewer shall be constructed of cast iron, ductile iron or PVC meeting ASTM specifications with a pressure rating of 150 psi for both the pipe and joints. A minimum vertical distance of two (2) feet and a minimum horizontal distance of four (4) feet between the outside diameters of the pipes is required. The sewer shall be located below the water line.
 - b. Where a sanitary sewer crosses a water line, and the sewer is constructed of cast iron, ductile iron or PVC with a minimum pressure rating of 150 psi, an absolute minimum distance of six (6) inches between the outside diameters shall be maintained. The sewer line shall be placed below the water line if possible, and one length of the sewer pipe must be centered on the water line.
 - c. Where a sewer line crosses under a water line and the sewer line is constructed of ABS truss pipe, similar semi-rigid plastic composite pipe, or concrete pipe with gasketed joints, a minimum separation distance of two (2) feet must be maintained. The initial backfill shall be cement stabilized sand (two and one-half bags of cement per cubic yard of sand) for all sections of sewer within nine feet of the water line. This initial backfill shall be from one quarter diameter below the centerline of the pipe to one pipe diameter (but not less than twelve (12) inches) above the top of the pipe.
 - d. Where a sewer crosses over a water line all portions of the sewer within nine (9) feet of the water line shall be constructed of cast iron, ductile iron, or PVC pipe with a pressure rating of at least 150 psi using appropriate adapters. In lieu of this procedure the new conveyance may be encased in a joint of 150 psi pressure class pipe at least eighteen (18) feet long and two (2) nominal sizes larger than the new conveyance. The space around the carrier pipe shall be supported at five (5) foot intervals with

spacers or be filled to the springline with washed sand. The encasement pipe should be centered on the crossing and both ends sealed with cement grout or manufactured seal.

3. Water Line / Manhole Separation. If the sanitary sewer manholes and the connecting sewer cannot be made watertight and tested for no leakage, then a minimum horizontal separation distance of nine (9) feet must be provided between the manhole and the water line. If the minimum distance of nine (9) feet cannot be achieved, then a carrier pipe as specified in the preceding subsection shall be used.

3.03 FIELD QUALITY CONTROL

A. Test For Deflection of PVC Pipe. All PVC pipe installed for gravity sewers will be tested for deflection according to this specification after the pipe segment has been in place for a minimum of thirty (30) days. Maximum allowable deflection shall not exceed five percent (5%) of the inside diameter of the pipe. The inside diameter shall be the average outside diameter minus two (2) minimum wall thicknesses for outside diameter controlled pipe or the average inside diameter for inside diameter controlled pipe. A "go, no-go" mandrel will be used to check the deflection of an installed section of PVC pipe. The mandrel will be sized so that it will not "go" when encountering a deflection that is greater than permissible. The mandrel must be of such design as to minimize the possibility of it being hung up in the pipe by silt or other residues. A design sized to permit up to five percent (5%) deflection in pipe is shown in Figures 3.04A & 3.04B. Table 3.04A showing the required dimensions of mandrels for various pipes is attached. Suggested instructions for its use are as follows:

1. Completely flush the line making sure the pipe is clean of any mud or debris that would hinder the passage of the mandrel.
2. During the final flushing of the line, attach a floating block or ball to the end of the mandrel pull rope and float the rope through the line.
3. Once the rope is threaded through the line, connect the pull rope to the mandrel and place the mandrel in the entrance of the pipe.

4. Connect a retrieval rope to the back of the mandrel to pull it back, if necessary.
5. Remove all slack in the pull rope and place a tape marker on the rope at the ends of the pipe where the mandrel will exit, determining the location of the mandrel in the line.
6. Draw the mandrel through the sewer line by hand pulling only. If any irregularities or obstructions are encountered in the line, the Engineer should establish the corrective action, if required.
7. If a section with excessive deflection is found, locate it; dig down and uncover the pipe; inspect the pipe, if any damaged pipe is found, replace it; if pipe is not damaged, replace and thoroughly tamp the haunching and initial backfill; replace remainder of backfill.
8. Retest this section for deflection a minimum of thirty (30) days after completing the repair.

FIGURE 3.04.A

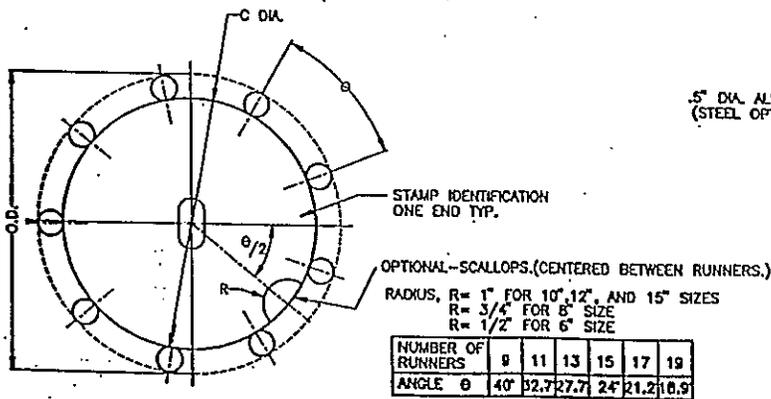
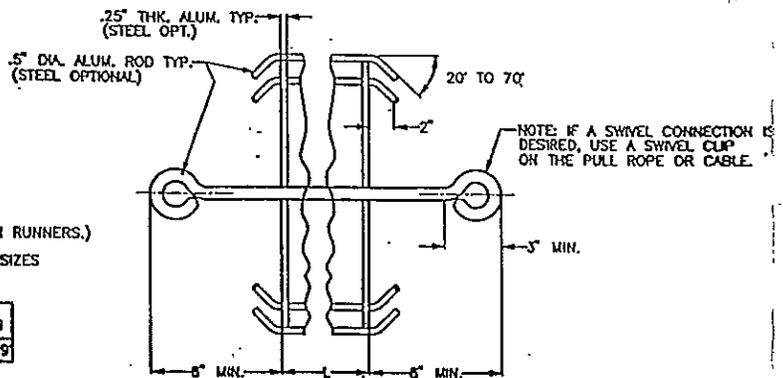


FIGURE 3.04.B



B. Testing Pressure Sewers For Leakage. All pressure sewers shall be tested for leakage with a hydrostatic test to be completed in the presence of the Director of Public Works or his representative. Leaks demonstrated by the tests are to be repaired at the expense of the Contractor.

1. Performance. Newly laid pipe or any valved section of piping shall be subjected for one (1) hour to a hydrostatic pressure test of twenty-five (25) pounds per square inch gauge or 1.5 times the

maximum force main design pressure, whichever is larger. The following formula shall be used to determine the permissible leakage that shall not be exceeded:

$$L = (S)(D)(P^{0.5}) / 133,200$$

Where, L = leakage in gallons per hour
 S = length of pipe in feet
 D = inside diameter of pipe in inches
 P = pressure in pounds per square inch

2. Execution. Fill test section of pipe with water and expel the air from the pipe. Apply the specified test pressure by means of a pump connected to the pipe. The Contractor shall furnish the necessary pump, pipe connections, gauge and meter and shall conduct the test. If force main is tapped to perform test, plug taps with brass fittings upon completion of test.
 - a. Inspect the route of the pipe during the test period to locate any leaks or breaks. The Contractor shall replace any cracked or defective pipe, fittings or valves disclosed in the pressure test.
 - b. When the one (1) hour test period is completed, bring the pressure in the pipe up to the specified test pressure and determine the amount of water lost during the test. No piping installation shall be accepted until the leakage amount is less than that specified. Should any test of combined sections or individual sections of pipe show leakage greater than the specified limit, the Contractor shall locate and repair the defective joints or defective pipe until the test proves that the leakage is within the specified allowance.
- C. Testing Gravity Sanitary Sewers For Leakage. The Contractor shall test all gravity sewer lines using either the infiltration method, exfiltration method, or the low pressure air test, in the presence of the Director of Public Works or his representative. Additionally, all new manholes shall be tested. The Director of Public Works or his representative shall be notified no later than the preceding day, of the date and approximate time the tests will be made. Sewers shall not show leakage of more than fifty (50) gallons per inch diameter per mile of pipe per twenty-four (24) hours at a minimum test head of two (2) feet above the crown of

pipes at the upstream manhole using the infiltration or exfiltration test except for pipes installed in the 25 year flood plain, which shall show leakage less than 10 gallons per inch diameter per mile of pipe per twenty four (24) hours. For the air test, leakage shall not exceed the amount specified herein for the length and diameter of the pipe tested. The Director of Public Works may vary the procedures for "Infiltration Test," "Exfiltration Test," and "Air Test" provided the methods used give an accurate measurement of the leakage.

1. Preparation for Testing. The Contractor shall supply all water for the tests, all equipment and labor necessary to convey the water into the sewer, and all labor and equipment to install test plugs, and other incidental work in conducting the tests and the cost thereof shall be included in the price for constructing the sewer. The Contractor shall supply the test plugs and the risers for the tests and will conduct the tests.
 - a. Before testing is observed by the Director of Public Works, sewers shall be completely backfilled, except for the stacks, but not necessarily water tamped. The Contractor may make preliminary tests with a minimum of eighteen (18) inches of backfill over the pipe to determine if any repairs are necessary. These tests are for the Contractor's information and shall not be performed in lieu of the tests to be observed by the Director of Public Works. These line tests will be made between the inlet side of the downstream manhole and the outlet side of the next upstream manhole.
 - b. Unless the Contractor has been notified that the tests will be made by the infiltration method, he shall leave the tops of stacks exposed and unplugged until after the leak test has been made. If a stack terminates below the test level, they shall be temporarily extended upward by installing an additional length of pipe in the top.
 - c. The Contractor shall provide suitable means to determine the groundwater level at any time until the testing is completed. As an example, a pipe not less than three (3) inches in diameter, such as a downspout pipe, closed at the bottom and perforated for at least the lower three (3) feet, with the perforations wrapped with at least two (2) thicknesses of filter fabric, set in the trench prior to backfilling. These pipes shall than be removed or cut off at

least two (2) feet below the ground after testing has been completed. Prior to removal, the pipes shall be protected against damage and earth or other material excluded therefrom. Generally one pipe shall be installed in each run of pipeline between manholes.

- d. Stubs or house connections connected to the section being tested for leakage which are below the test water level, will be considered in computing the allowable leakage but the Contractor will not be held responsible for excess leakage in sewers not laid by him which have been connected to the lines being tested. The Director of Public Works may request individual stubs or house connections in the system that were constructed under this contract to be tested. Prior arrangements for access to the ends of the pipe will be made for these tests.

2. Infiltration Test. For the Infiltration Test, all pumps must be stopped and the groundwater allowed to return to its normal level and to remain so for at least 24 hours. Before the test is started, the pipe will be filled with water to a depth that will cause leakage to flow at a uniform rate through an opening in the plug in the downstream end of the section of sewer being tested. Leakage will be determined by measuring the flow through the opening in the downstream plug during a given time. Five measurements will be taken. The average of the measurements will be used. If one of the five measurements varies by more than fifty percent (50%) of the other four, then that measurement will be discarded, except for the last measurement taken. If the results of the tests are satisfactory, but the last of the five measurements shows leakage in excess of that permitted, tests shall be continued to determine if additional leaks may have developed during testing.

<u>Size of Pipe</u>	<u>Allowable Leakage*, Gal. Per Minute Per 100 Ft.</u>
6"	0.0039
8"	0.0053
10"	0.0066
12"	0.0079
15"	0.0099
18"	0.0118
21"	0.0138
24"	0.0158
27"	0.0178
30"	0.0197
36"	0.0237

*Equivalent to 50 gal. per inch diameter per mile per 24 hours

For other diameters, multiply square of diameter by value for 1" diameter.

3. Exfiltration Test. In order to permit absorption by the pipe, the Contractor may keep the pipe full of water for 24 hours prior to the test. The Director of Public Works shall be notified by the Contractor before backfilling is completed that the pipe will be filled and will be given 48 hours before the test to allow time for filling and soaking the pipe. At least two (2) hours before the tests start, the water will be bled off below the level of the top of the pipe at its lower end and allowed to remain so until the water level remains static at this level or continues to fall. The test shall be made in the following manner.
 - a. A watertight plug, equipped with a pipe riser will be inserted and braced in the inlet opening in the downstream manhole and a similar plug equipped with a suitable vent pipe that will permit the escape of air in the pipe at its upper end, will be inserted and braced in the outlet in the upstream manhole. Fill the sewer and riser with water up to a level either four (4) feet above the crown of the sewer pipe at its lower end or two (2) foot above the crown of the sewer pipe at its upper end, whichever is higher, plus the vertical distance from the invert of the sewer at its lower end up to the level of the groundwater where such groundwater exists above the invert of the sewer.

- b. The sewer will be filled with water as a continuous operation, as rapidly as the supply will permit, and the test measurement will be started as soon as the water is at the required level. This will be completed in not less than two (2) hours for sewers twelve (12) inches or smaller, not less than three (3) hours for sewers fifteen (15) inches through twenty-four (24) inches and not less than four (4) hours for larger sewers. A measurement of the water level will be recorded at each minute for five (5) minutes or until the level has dropped twelve (12) inches, whichever occurs first. The water will then be brought back to the required level and the test shall be repeated until five (5) such tests have been performed. Use the average of these results, discarding any of the five (5) observations that varies by more than fifty percent (50%) from the average of the other four (4) except for the last one. If the results of the tests are otherwise satisfactory, but the last of the five (5) measurements shows leakage in excess of that permitted, the tests will be continued to determine if additional leaks may have developed during testing.
- c. The total leakage in cubic inches shall be the total cross-sectional area in square inches of the inside of the two (2) risers and of any stacks in the sewer multiplied by the drop in water level in inches.

Table For Measuring Leakage in Sewers

Diameter of Riser Or Stack	Volume Per Inch of Depth	
	Cu. Inch	Gallons
1"	0.7854	0.0034
2"	3.1416	0.0136
2-1/2"	4.9087	0.0212
3"	7.0686	0.0306
4"	12.5664	0.0544
5"	19.6350	0.0850
6"	28.2743	0.1224
8"	50.2655	0.2176

4. Air Test. The air test shall be performed as follows.
- a. To perform the air test, all the water should be flushed and drained from the line being tested prior to beginning the

test. All pipe outlets, especially laterals and services, shall be plugged. Air shall be added until the internal air pressure of the sewer line is 4.0 psi greater than the pressure exerted on the pipe by the groundwater above the pipe. Allow the air pressure to stabilize after it has reached 4 psig. As the air temperature stabilizes, the air pressure will normally drop. When the pressure has stabilized at 3.5 psig, allow the pressure to drop to 2.5 psig. The time it takes the pressure to drop from 3.5 psig to 2.5 psig shall be recorded. If the time it takes the pressure to drop exceeds the time permitted, the line has passed. If the time is less than allowable, the line has failed.

- b. The air pressure test should not be used when the pipe is submerged in groundwater, because the static water pressure will greatly affect the results. The water infiltration test will be used in this case.
- c. For sections of pipe less than 36-inch average inside diameter, the minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be computed from the following equation:

$$T = 0.085(D)(K)/(Q)$$

where,

T = time for pressure to drop 1.0 pound per square inch gauge in seconds

K = $0.000419(D)(L)$, but not less than 1.0

D = average inside diameter in inches

L = length of line in feet of same pipe size being tested

Q = rate of loss, 0.0015 cubic feet per minute per square foot internal surface shall be used

- d. Since a K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter as follows:

Air Test Table

Pipe Diameter (inches)	Minimum Time (seconds)	Length for Minimum Time (feet)	Time for Longer Length (seconds)
6	340	398	0.855(L)
8	454	298	1.520(L)
10	567	239	2.374(L)
12	680	199	3.419(L)
15	850	159	5.342(L)
18	1020	133	7.693(L)
21	1190	114	10.471(L)
24	1360	100	13.676(L)
27	1530	88	17.309(L)
30	1700	80	21.369(L)
33	1870	72	25.856(L)

- e. For sections of pipe with an average inside diameter less than thirty-six (36) inches, the test may be stopped if no pressure loss has occurred during the first twenty-five percent (25%) of the calculated testing time. If any pressure loss has occurred during the first twenty-five percent (25%) of the testing period, then the test shall be continued for the entire required time.
 - f. Lines with an average inside diameter of twenty-seven (27) inches or larger may be air tested at each joint. Pipe with an inside diameter greater than thirty-six (36) inches shall be tested for leakage at each joint. A visual inspection of the line between the joints shall be performed immediately after an air test. Regardless of pipe size there shall be a minimum of ten (10) seconds allowable for the pressure to drop from 3.5 psig to 2.5 psig during a joint test.
5. Retests. Sewers which fail to meet the requirements of the leak test will be tested again for leakage, after repairs have been completed by the Contractor. If a sewer fails to pass the requirements of the leak test a second time, and additional repairs and retests are performed, then the sum of fifty dollars (\$50.00) will be deducted from the amounts due the Contractor to compensate the City of Brenham for the costs of making additional retests.

6. Manhole Test. All manholes shall be tested for leakage by plugging the lines entering the manhole and completely filling the manhole with water. If leakage exceeds 0.025 gallons per foot of diameter per foot of head per hour, repairs shall be made to make the manhole water tight, and a retest shall be performed. Concrete manholes may be filled for 24 hours before the test.

END OF SECTION

TABLE 3.04.A

Go / No Go Mandrel Sizing Guide for Deflection Testing of Installed Sewer Pipe

All Dimensions are in Inches

Stamped Identification	Average Pipe O.D.	Min. Wall Thickness of Pipe	I.D. of Pipe for Mandrel Sizing	O.D. of Mandrel C	Length of Mandrel L
6" ASTM D-3034, SDR 35	6.275	0.180	5.915	5.619	4.436
8" ASTM D-3034, SDR 35	8.400	0.240	7.920	7.524	5.940
10" ASTM D-3034, SDR 35	10.500	0.300	9.900	9.405	7.425
12" ASTM D-3034, SDR 35	12.500	0.360	11.780	11.191	8.835
15" ASTM D-3034, SDR 35	15.300	0.437	14.426	13.705	10.820
18" ASTM F-679, SDR 26	18.701	0.719	17.263	16.400	12.947
21" ASTM F-679, SDR 26	22.047	0.848	20.351	19.333	15.263
24" ASTM F-679, SDR 26	24.803	0.954	22.895	21.750	17.171
27" ASTM F-679, SDR 26	27.953	1.075	25.803	24.513	19.352
6" ASTM D-3034, SDR 26	6.275	0.241	5.793	5.503	4.345
8" ASTM D-3034, SDR 26	8.400	0.323	7.754	7.366	5.816
10" ASTM D-3034, SDR 26	10.500	0.404	9.692	9.207	7.269
12" ASTM D-3034, SDR 26	12.500	0.481	11.538	10.961	8.654
15" ASTM D-3034, SDR 26	15.300	0.588	14.124	13.418	10.593
12" ASTM D-2241, SDR 26	12.750	0.490	11.770	11.182	8.828
10" ASTM D-2241, SDR 26	10.750	0.413	9.924	9.428	7.443
8" ASTM D-2241, SDR 26	8.625	0.332	7.961	7.563	5.971
6" ASTM D-2241, SDR 26	6.625	0.255	6.115	5.809	4.586
12" ASTM D-2241, SDR 21	12.750	0.606	11.538	10.961	8.654
10" ASTM D-2241, SDR 21	10.750	0.511	9.728	9.242	7.296
8" ASTM D-2241, SDR 21	8.625	0.410	7.805	7.415	5.854
6" ASTM D-2241, SDR 21	6.625	0.316	5.993	5.693	4.495
12" ASTM D-1785, Sch. 40	12.750	0.406	11.938	11.341	8.954
10" ASTM D-1785, Sch. 40	10.750	0.365	10.020	9.519	7.515
8" ASTM D-1785, Sch. 40	8.625	0.322	7.981	7.582	5.986
6" ASTM D-1785, Sch. 40	6.625	0.280	6.065	5.762	4.459

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SECTION 03100
CONCRETE FORMWORK

PART 1 GENERAL

1.01 SUMMARY

This section defines the requirements and limitations for the design, construction, erection, and removal of concrete formwork.

1.02 RELATED SECTIONS

Section 03300 CAST-IN-PLACE CONCRETE

1.03 MEASUREMENT AND PAYMENT

There will be no separate measurement and payment for work performed under this section unless otherwise indicated in the bid form.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

ACI 347 American Concrete Institute, " Recommended Practice for
Concrete Formwork"

1.06 SYSTEM DESCRIPTION

All formwork shall be designed for the loads, lateral pressure, and allowable stresses described in the reference standard (ACI 347) and the applicable requirements of local building codes. The maximum allowable deflection for concrete surfaces exposed to view is 1/240 of the span between structural members.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

- A. Forms. Full size, moisture resistant, three-fourths (3/4) inch thick, 5-ply Douglas fir form plywood shall be used as form lumber. Joints in forms shall be horizontal or vertical. Metal or other types of forms are allowed

only with the prior approval of the City Engineer and shall produce surfaces equal to those by the specified wood forms.

1. Exposed Surfaces. Form lumber for exposed surfaces shall meet the above size and type requirements and be faced Grade B, or better, plywood. Do not use material with raised grain, torn surfaces, patches, dents, warps, knots, or other defects.
 2. Unexposed Surfaces. Undressed lumber may be used for forming unexposed surfaces.
- B. Form Ties. Form ties for exposed surfaces shall be threaded rod type or snap tie type and shall be of sufficient strength to withstand the pressure resulting from the placement of the concrete. Form ties shall be at least one and one-half (1-1/2) inches shorter than the wall thickness. Form ties shall be such that when forms are removed, no metal is closer than three-quarters (3/4) inch from the surface and shall leave a small, clean hole to be grouted. Securing forms with wire is strictly prohibited.
- C. Form Coating. Use commercial formulation of form oil or form-release agent having proven satisfactory performance. Coating must not bond with, stain, or adversely effect the concrete surfaces and shall not impair the use of bonding agents and curing compounds. If form oil is used, all excess oil shall be wiped off leaving the surface just oily to the touch.
- D. Chamfer Strips. Provide chamfer strips in corners of forms to produce beveled edges on permanently exposed surfaces. Size of chamfer shall be three-quarters (3/4) inch unless shown otherwise on the plans. Interior corners and edges of formed joints do not require any beveling unless shown otherwise on the plans.
- E. Earth Cuts for Forms. Use earth cut forms for beams under slabs on grade when the beam has sloped sides and is integral with the slab. Earth cut forms are allowable for sides of footings if the sides of the excavation are stable such that there is no caving or sloughing.
- F. Slip Forms. Slip forming is not permitted.

PART 3 EXECUTION

3.01 PREPARATION

- A. General. At least 24 hours prior to scheduled concrete placement, notify the City Engineer that formwork may be inspected. Do not place concrete until forms have been inspected and approved by the City Engineer.
- B. Preparation of Form Surfaces. Clean all surfaces of forms and embedded objects before placement of concrete. Remove accumulated mortar, grout, rust, debris and any other foreign material. Coat forms for exposed or painted surfaces with form oil or other form-release agent before placing concrete. Form oil, or other form-release agent, shall be used in strict accordance with the manufacturer's printed instructions. Do not allow excess form coating material to accumulate in forms or come in to contact with previously placed hardened concrete against which fresh concrete will be placed. No form coating material shall be placed on the reinforcement. Other than retained-in-place metal forms, forms for unexposed concrete surfaces may be wetted with water immediately prior to placement of concrete in lieu of using a form coating material. Such wetting of forms with water is not allowed when the possibility of freezing temperatures exists.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. General. Construct forms to the shape, lines and dimensions of the members as shown on the plans. Forms shall be sufficiently tight to prevent the leakage of mortar. Temporary openings shall be provided at the base of column and wall forms or at other required points to facilitate the cleaning and inspection immediately before placement of concrete.
- B. Facing Material. Facing material for exposed surfaces shall be placed in an orderly and symmetrical fashion. Full size pieces shall be used except where small pieces will cover an entire area. Facing material shall be adequately supported to prevent deflection. Facing material for exposed surfaces shall be installed in such a manner that will allow the City Engineer access to inspect the exposed surface forms before the back form is in place.
- C. Bracing of Forms. Anchor, brace, and tie all formwork to shores, members, or other supporting surfaces to prevent the upward movement of the forms during the placement of concrete. Tighten forms to close joints and insure conformance to the specified lines and shapes. All

forms that cannot be properly tightened shall be removed and rebuilt. All forms shall be securely braced to prevent lateral deflections during placement of concrete. Use wedges or jacks to provide positive adjustment of shores and struts. For wall openings, construct wood forms that facilitate loosening to counteract swelling of forms.

- D. Shoring of Forms. When shoring is permitted or required, construction shall follow a planned sequenced. Such plan shall be provided by the Contractor and shall be approved by the City Engineer prior to construction.
- E. Removal of Forms. Forms for structural slabs and beam bottoms shall remain in place for a period of fourteen (14) days or until cylinder tests have shown that the concrete has reached eighty (80) percent of 28-day design strength as evidenced by laboratory test reports. In no case shall forms be removed in less than four (4) days.
- F. Form Reuse. Approval is required before reusing any forms. Do not reuse forms that are worn or damaged beyond repair. Thoroughly clean and recoat forms before reuse. For wood forms to be used for exposed surfaces, sand or otherwise dress the surface to be in contact with the concrete to the original condition or provide form liner facing material. Before reusing metal forms, straighten, remove dents and clean such that the forms are returned to original condition.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SUMMARY

This section gives the requirements for the concrete reinforcement to be used in cast-in-place concrete.

1.02 RELATED SECTIONS

Section 03300 Cast-In-Place Concrete

1.03 MEASUREMENT AND PAYMENT

There will be no separate measurement and payment for work performed under this section unless otherwise indicated in the bid form.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

A. American Society for Testing and Materials.

ASTM A-615, "Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"

ASTM A-185, "Specification for Welded Steel Wire Fabric for Concrete Reinforcement"

ASTM A-306, "Specification for Carbon Steel Bars Subject to Mechanical Property Requirements"

B. American Concrete Institute.

ACI 315, "Manual of Standard Practice for Detailing Reinforced Concrete Structures"

ACI 318, "Building Code Requirements for Reinforced Concrete"

C. Concrete Reinforcing Steel Institute.

CRSI 163, "Recommended Practice for Placing Reinforcing Bars"

CRSI 165, "Recommended Practice for Placing Bar Supports, Specifications and Nomenclature"

1.05 SUBMITTALS

When required by the City Engineer, submit detailed shop drawings showing the bar locations, splices, sizes, length, type and spacing. Detailing of reinforcement shall be in accordance with the applicable American Concrete Institute (ACI) reference standard.

1.06 QUALITY ASSURANCE

When required by the City Engineer, submit the manufacturer's certificates showing the properties of the steel proposed for use. The certificates shall show the manufacturer's test and heat number, chemical analysis, yield point, tensile strength and percent elongation.

1.07 DELIVERY, STORAGE, AND HANDLING

All steel reinforcement shall be stored above the ground on platforms, skids or other supports as approved by the City Engineer. Reinforcement shall be stored in a location such that it is protected from mechanical injury and rust. When placed in the work, steel reinforcement shall be free from dirt, scale, dust, oil, paint and other material. Store steel reinforcement in an orderly fashion so that bars may be easily identified.

1.08 SCHEDULING

Schedule the delivery of materials to the site and the installation of the reinforcement such that a minimum time of site storage is maintained for the reinforcement during the entire duration of the project.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. Steel Reinforcing Bars. All steel reinforcing bars shall be open hearth new billet steel conforming to ASTM A615. All bars shall be deformed

and be Grade 60 with a minimum yield strength of 60,000 psi.

- B. **Welded Wire Fabric.** Wire for fabric reinforcement shall be cold drawn from rods hot rolled from open hearth billets and shall conform to ASTM A82 and be fabricated in accordance with ASTM A185. Unless otherwise shown on plans, wire for fabric reinforcement shall be #4 gauge or have a nominal diameter of 0.2253-inch. Welded wire fabric shall be supplied in flat mats. Rolled fabric will not be accepted.
- C. **Supports.** Supports for reinforcing bars shall be the correct type as intended and represented by the manufacturer. Bar supports shall be uniform high density polyethylene or fiberglass reinforced plastic and conform to CRSI Class 1, Maximum Protection.
- D. **Spacers.** Reinforcing bars shall be spaced the proper distance from the face of the forms by means of approved galvanized metal spacers or approved mortar or concrete blocks. Precast mortar or concrete blocks shall be cast in individual molds, in the form of a frustrum of a cone or pyramid, with suitable tie wire to be used for anchoring the block to the steel. The precast blocks shall be properly cured and aged before use in spacing the steel.
- E. **Tie Wire.** Use 18-gauge annealed steel for tie wire.
- F. **Bar Splices.** Splicing of bars will not be permitted without the written approval of the City Engineer. When splicing of bars is unavoidable, the number of splices shall be kept to a minimum and shall be located at points of minimum stress. When practicable, splices in adjacent bars shall be staggered. Lap splices shall have a minimum splice length of not less than twenty-four (24) bar diameters when being used in 3,000 psi concrete and shall be in accordance with ACI 318. Mechanical splices shall be installed in strict accordance with the manufacturer's instructions and recommendations and shall be as follows:
 - 1. **Mechanical Bar Splices.** Use Cadweld splices manufactured by Erico Products, Inc., or preapproved equal. Splices must develop a minimum of 125% of specified yield strength of the spliced bars.
 - 2. **Threaded Bar Splices.** Use a metal coupling sleeve with internal threads which receive the threaded ends of the bars to be splice. Splices must develop a minimum of 125% of specified yield strength of the spliced bars.

2.02 FABRICATION

Reinforcement shall be bent cold to the shapes indicated on the plan details. Bends shall be true to the shapes indicated and any irregularities shall be cause for rejection. Unless otherwise shown, bends for stirrups or ties shall be made around a pin having a diameter of not less than two (2) times the bar size. Hooks shall be a complete semi-circular turn of a diameter equal to six (6) times the bar diameter, plus an extension of at least four (4) bar diameters at the free end of the bar.

PART 3 EXECUTION

3.01 PREPARATION

Notify the City Engineer at least 24-hours before concrete placement so that reinforcement may be inspected and errors corrected without delaying the work.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. General. Carefully and accurately place the reinforcement in the positions indicated on the plan details. All reinforcing steel shall be securely wired together at all intersections and be held securely in place during the pouring of concrete.
- B. Vertical Stirrups. Vertical stirrups shall always pass around the main tension members and be securely attached thereto.
- C. Spacers. No galvanized spacers shall be installed in concrete which will be exposed to the weather.
- D. Welded Wire Fabric. Where welded wire fabric is used as reinforcement, the mesh shall be placed in the longest practical lengths and shall be overlapped and securely fastened at the ends to maintain a uniform strength. A minimum of one (1) mesh overlap is required.
- E. Construction Joints. Reinforcing shall extend through construction joints.
- F. Welding of Reinforcing. No welding of reinforcing steel or splices shall be allowed without the prior approval of the City Engineer.
- G. Conflicts with the Reinforcement. Where there are conflicts between the location of reinforcing steel and other concrete embedded items, the Contractor shall immediately notify the City Engineer so that revisions

can be made before placing the concrete. Cutting of any reinforcement is strictly prohibited without the prior approval of the City Engineer.

3.03 FIELD QUALITY CONTROL

Place all reinforcing steel within the specified tolerances as outlined in the referenced standards. Variations from these tolerances will be cause for rejection of the work.

END OF SECTION

SECTION 03250

CONCRETE JOINTS AND EMBEDDED ITEMS

PART 1 GENERAL

1.01 SUMMARY

This section specifies requirements for construction joints, expansion joints and embedded items for concrete. Review drawings and specifications for additional requirements for joints and embedded items.

1.02 RELATED SECTIONS

Section 03300 Cast-In-Place Concrete

1.03 MEASUREMENT AND PAYMENT

There will be no separate measurement and payment for work covered under this section unless otherwise indicated in the bid form.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

- A. American Society for Testing and Materials (ASTM).
1. ASTM A-120, "Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses."
 2. ASTM A-306, "Carbon Steel Bars Subject to Mechanical Property Requirements."
 3. ASTM D-994, "Preformed Expansion Joint Filler for Concrete (Bituminous Type)."
 4. ASTM D-1751, "Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextending and Resilient Bituminous Types)."
 5. ASTM D-1752, "Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction."

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

- A. Expansion Joint Filler. Use 3/4-inch thick asphalt impregnated fiberboard or redwood in accordance with ASTM D-1751.
- B. Expansion Joint Sealer. Use joint sealing compound conforming to ASTM C920, Type S, Grade P or NS.
- C. Expansion Joint Dowels. Use plain steel bars conforming to ASTM A-306, grade 70. Cut Dowels to length at shop or mill before delivery to the site. Dowels must be straight and clean, free of rust and scale.
- D. Sleeves. Provide sleeves which are 26-gauge steel or PVC tubes and are capped at one end. Sleeves shall be in accordance with ASTM A-120.
- E. Waterstops. Waterstops shall be polyvinylchloride and be Seal-Tight, Type No. 6DS, as manufactured by W.R. Meadows, Inc.; Type No. 6, wide flange (PVC), as manufactured by Duro-Wal; Type CB 1-1/8, as manufactured by Williams Products; or a preapproved equal.

PART 3 EXECUTION

3.01 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. General. Place embedded items as shown on the plan details and in such a manner that will not impair the strength of the structure. Should locations of embedded items conflict with reinforcement or be detrimental to strength of the structure, notify the City Engineer so the items can be relocated. Notification shall be such that the scheduled concrete placement is not delayed and there is adequate time to relocate the embedded items. Adequately secure all embedded items to prevent displacement during concrete placement.
- B. Conflicts with Reinforcement. Do not cut or reposition reinforcing steel to facilitate the installation of inserts, conduits, sleeves, anchor bolts, mechanical openings and similar items without the prior approval of the City Engineer.

- C. Construction Joints. Make construction joints only at locations shown the plan details or as specified in these specifications. Relocation of construction joints is strictly prohibited without the prior approval of the City Engineer. Install construction joints in compliance with the following procedures:
1. Locate joints in such a manner that will least impair the strength of the structure being constructed.
 2. Place all joints perpendicular to main reinforcement. Reinforcing shall be extended through all joints unless otherwise directed.
 3. Prepare joints by removing loosened particles of aggregates or damaged concrete at the surface.
 4. Install any joint filler on expansion joints to full depth of the concrete section with the top held down 3/4-inch to provide recess for sealant.
- D. Waterstops. Install waterstops in the locations shown and in a manner that will develop effective watertightness. Position and support waterstops against any displacement during placement of concrete.

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SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

This section gives requirements for normal weight structural concrete, concrete riprap, and pneumatically placed concrete.

1.02 RELATED SECTIONS

Section 03100	Concrete Formwork
Section 03200	Concrete Reinforcement
Section 03250	Concrete Joints and Embedded Items

1.03 MEASUREMENT AND PAYMENT

There will be no separate measurement and payment for work performed under this section unless otherwise indicated in the bid form.

1.04 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

ACI	American Concrete Institute
ASTM	American Society for Testing of Materials

1.05 SYSTEM DESCRIPTION

Four (4) classes of concrete designated by the minimum seven (7) day and twenty-eight (28) day compressive strength in pounds per square inch (psi) are covered by this specification and are as follows:

Class	Compressive Strength (psi)	
	7 days	28 days
A	1,350	2,000
B	1,700	2,500
C	2,000	3,000
D	2,350	3,500

1.06 SUBMITTALS

Submit four (4) copies of the following information for the review and approval of the City Engineer:

- A. Cement. Submit certified test reports for the cement to be used on the project.
- B. Aggregate. Submit certified test reports for the aggregate to be used on the project. Testing of aggregate shall be conformance with ASTM C33.
- C. Admixtures. Submit brochures, manufacturers instructions for use, and performance data on all proposed admixtures.
- D. Design Mix. Submit test data on proposed design mixes for each class of concrete to be used on the project. Test data shall include both the 7-day and 28-day compressive strength tests results to establish a quality control standard for use during the construction period. No concrete shall be placed before the design mix is submitted and approved. An analysis showing the relationship between the water-cement ratio and the compressive strength of the concrete mix shall be submitted with the design mix.

1.07 QUALITY ASSURANCE

It shall be the responsibility of the Contractor to produce concrete of the strength, durability, workability and specified finish; furnish representative materials for specimens in quantities required by the testing laboratory; take samples of materials for testing; check proportions of mix and immediately notify the City Engineer if proportions appear improper in any respect. The Contractor shall comply with all testing laboratory findings and the City Engineer's decisions in reference to these findings. The Contractor shall pay for the redesign of the concrete mix due to a change in the source of materials.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Cement. Store cement in weathertight buildings, bins or silos to provide protection from dampness and contamination and to minimize warehouse set.
- B. Aggregate. Arrange and use aggregate stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Do not use frozen or partially frozen aggregates.

- C. Sand. Sand shall be stored such that it maintains a uniform moisture content.
- D. Admixtures. Store and handle admixtures in accordance with manufacturer's instructions.
- E. Batch Tickets. Batch tickets shall be delivered with each load of concrete and shall include the weights of each ingredient for the batched load of concrete and the date and time the load was batched. The testing agency representative shall keep at least one (1) copy of the batch ticket.

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

- A. Portland Cement. Portland cement shall be Type I or Type III and be in accordance with the current specifications for Portland cement in ASTM C150. Type IA or Type IIIA Portland cement shall be used when air entrainment is specified and shall conform to the current specifications for Portland cement in ASTM C175. Fly ash will not be accepted as a substitute for a portion of the Portland Cement.
- B. Water. Water used for mixing in concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement. Water which is suitable for drinking or ordinary household uses is acceptable. Nonpotable water shall not be used for mixing in concrete.
- C. Admixtures. Calcium chloride or admixtures containing chloride are strictly prohibited. Provide admixtures in accordance with the following:
 - 1. Air-entraining Admixtures. Use admixture which conforms to the requirements of ASTM C260.
 - 2. Chemical Admixtures. Chemical admixtures used as retarders, accelerators, water-reducing agents, or a combination of these, shall conform to the applicable provisions of ASTM C494 and/or ASTM C1017.
- D. Aggregates. Use coarse aggregate from only one (1) source and fine aggregate from only one (1) source for all exposed concrete in a single structure. Use of pit run gravel as an aggregate will not be permitted.

Both fine and course aggregates in normal weight concrete shall conform to the requirements of ASTM C33 and shall be as follows:

1. Coarse Aggregate. Course aggregates shall consist of crushed stone, gravel, crushed gravel or a combination of these. Gravel and crushed gravel shall consist of clean, hard, durable particles, free from adherent coating, thin or elongated pieces, soft or disintegrated particles, dirt, organic or injurious matter. Crushed stone shall consist of the clean, dustless product resulting from crushing stone. There shall be no adherent coatings, clay, loam, organic or injurious matter.
 2. Fine Aggregate. Fine aggregate shall consist of a sand or mixture of sand with or without a mineral filler. The sand or mixture of sand in fine aggregate shall be clean, hard, durable, uncoated grains which are free from lumps.
- E. Curing Compound. When required, provide commercial curing compound which will not permanently discolor the concrete and is in accordance with the provisions set forth in ASTM C309.
- F. Sheet Material for Curing Concrete. When required, provide waterproof paper, polyethylene film or white burlap-polyethylene sheeting in accordance with provisions set forth in ASTM C171.
- G. Patching Grout. Provide a non-shrink, non-slump, quick-setting patching mortar to repair small defects in concrete work. Master Builders' "Embeco 153," or preapproved equal, is acceptable for use as a patching grout. Sand used in patching grout shall be in accordance with the provisions set forth in ASTM C144.
- H. Proportioning and Mixing of Concrete. Proportion and mix ingredients in a manner that will produce a concrete having the proper placability, durability, strength, appearance, and other specified properties. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement when placed and consolidated and will not segregate or have excessive water collect on the surface. Proportion materials in accordance with the procedures outlined in ACI 613, "Recommended Practice for Selecting Proportions for Concrete." All materials will be proportioned and mixed with the intention of producing a concrete with the minimum specified twenty-eight (28) day compressive strength, or greater. Unless noted or specified otherwise, all concrete shall be Class "C" with a minimum twenty-eight (28) day compressive strength of 3,000 psi.

1. Normal Weight Structural Concrete. In addition to the above requirements for proportioning and mixing concrete, normal weight structural concrete shall be mixed in accordance with the provisions of ASTM C94, "Standard Specification for Ready-Mixed Concrete." The use of an on site batch plant is strictly prohibited without the prior approval of the City Engineer. Any specified or approved admixtures shall be mixed and proportioned in the concrete in accordance with the manufacturer's instructions and the applicable reference standards.
2. Concrete Riprap. Concrete riprap shall be proportioned and mixed in accordance with the provisions for normal weight concrete.
3. Pneumatically Placed Concrete. In addition to any of the following requirements, the cement, sand, admixtures, and water to be used for pneumatically placed concrete shall conform to the requirements previously outlined in this specification. Pneumatically placed concrete shall be proportioned as follows:
 - a. Type I. One (1) part cement (minimum) to four (4) parts sand (by volume).
 - b. Type II. One (1) part cement (minimum) to five (5) parts sand (by volume).

The type to be used shall be designated on the plans. At the time of mixing, the sand shall contain from three (3) to six (6) percent moisture. When visual inspection indicates that lumps or oversized particles are going into the machine, all materials shall be thoroughly mixed and passed through a 1/4-inch sieve before being placed in the machine. The minimum mixing time for each batch shall not be less than 1-1/2 minutes after the sand and cement are in the drum when the drum rotates at a peripheral speed of two-hundred (200) feet per minute. Completely discharge each batch before recharging. Clean the mixer at regular intervals to remove all adherent material from the mixing vanes and from the drum. No water shall be added to the mix after mixing and before application. Discard any mixed material which has exceeded the forty-five (45) minute maximum time to placement.

PART 3 EXECUTION

3.01 PREPARATION

- A. General. Mix concrete only in quantities for immediate use and discard any concrete which has set or is not completely discharged at the site within the maximum time allowed for placement. Retempering of any set concrete is strictly prohibited.
- B. Notification. The placement of concrete without the prior approval of the City Engineer is strictly prohibited. The Contractor shall notify the City Engineer a minimum of twenty-four (24) hours before placing concrete.
- C. Protection from Adverse Weather. Unless adequate protection is provided, or approval is obtained, do not place concrete during rain, sleet, snow or freezing weather. Do not permit rainwater to increase the amount of mixing water or to damage the surface finish. If rainfall occurs after placing operations begin, provide adequate covering to protect the work from any adverse damage.
- D. Placing Temperatures. All concrete shall be placed in accordance with the following provisions:
 - 1. Cold Weather Placement. Unless special provisions are made for heating the concrete mix and the concrete in forms, do not place any concrete when the air temperature is below 40° F or is predicted to be below 40° F within forty-eight (48) hours of placement.
 - 2. Hot Weather Placement. When the air temperature is above 85°F, use an approved retarding agent in all concrete. Concrete temperature prior to placement shall not exceed 95° F.
- E. Maximum Time to Placement. Any concrete that has attained its initial set or has contained its mixing water or cement for more than forty-five (45) minutes shall not be placed in the work. The addition of an approved retarding agent may be proposed by the Contractor to increase the maximum time to placement. The increase of time to placement shall be proposed the Contractor and approved by the City Engineer when the design mix is submitted for approval.

3.02 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. Placement of Concrete. The placement of concrete shall be in accordance with the following procedures:

1. Normal Weight Structural Concrete. Place concrete only upon a subgrade or surface approved by the City Engineer. All forms shall be clean of dirt, and other construction debris, and all water shall be removed or drained from the forms before concrete is placed. Concrete shall be handled from mixer to transport vehicle to final place of deposition in a continuous manner and as rapidly as possible without segregation or loss of ingredients until the approved unit of operation is completed. Placing will not be permitted when, in the opinion of the City Engineer, the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper finishing and curing of the concrete. Forms or reinforcement shall not be splashed with concrete in advance of pouring. Concrete shall be deposited in uniform layers and as close as practicable to its final position. Immediately after placing, concrete shall be compacted and consolidated by vibration, spading, rodding, or forking such that the concrete is worked around reinforcement, embedded items and into the corners of the forms. The method used to consolidate and compact concrete shall meet with the approval of the City Engineer and shall be done so as not to cause segregation of the concrete. Special care shall be taken in placing and spading concrete against forms and all the joints to prevent the formation of voids and honeycombs. Tapping or other external vibration of forms will not be permitted. Vibrators shall not be used to move concrete in the forms. Concrete shall not be placed on concrete which is sufficiently hard to cause the formation of seams and planes of weakness within the section. Concrete shall not be allowed to drop freely more than five (5) feet in unexposed work nor more than three (3) feet in exposed work. Where greater drops are required, a tremie or other approved means shall be employed. The discharge of the tremies shall be controlled so that the concrete may be effectively compacted into horizontal layers not more than twelve (12) inches thick and the spacing of the tremies shall be such that cavities do not occur. Concrete to receive other construction shall be screeded to proper level to avoid excessive shimming or grouting.
2. Concrete Riprap. Place concrete on the slopes and other areas to be protected as shown on the plan details and as approved by the City Engineer. All surfaces shall be moist when the concrete is

placed. If the surfaces are dry and not consolidated properly, the City Engineer may require the entire area to be sprinkled or sprinkled and consolidated before the concrete is placed. After the concrete has been placed, compacted and shaped to conform to the dimensions shown on the plans and after it has set sufficiently to avoid slumping, the surface shall be finished with a wooden float to secure a reasonably smooth surface. Concrete riprap which is pneumatically placed shall conform to the requirements of subparagraph 3 "Pneumatically Placed Concrete."

3. Pneumatically Placed Concrete. The compressor or blower used to supply air for placing concrete shall be capable of delivering a sufficient volume at a pressure range of thirty (30) to sixty (60) pounds per square inch (psi) as required by the size of the nozzle being used. When a hose length of one-hundred (100) feet is used, the pneumatic pressure at the nozzle shall be forty-five (45) pounds per square inch (psi), or more, as necessary to efficiently prosecute the work. For lengths over one-hundred (100) feet, the pressure shall be increased five (5) pounds per square inch (psi) for each additional fifty (50) feet of hose required. Steady pressure must be maintained throughout the placing process. The water pump shall be of sufficient size and capacity to deliver the water to the nozzle at a pressure of not less than fifteen (15) pounds per square inch (psi) in excess of the required air pressure. Proper consistency of the concrete shall be controlled at the nozzle valve by the operator and a low water-cement ratio must be maintained. The mix shall be sufficiently wet to properly adhere and sufficiently dry so that it will not sag or fall from vertical or inclined surfaces or separate in horizontal work. In covering vertical or inclined surfaces, placing of the concrete shall begin at the bottom and be completed at the top. The nozzle shall be held at such distance (2 to 4 feet) and position that the stream of flowing concrete shall impinge as nearly as possible at right angles to the surface being covered. Any deposit of loose sand shall be removed prior to placing any original or succeeding layers of pneumatically placed concrete. Should any deposit of loose sand be covered with pneumatically placed concrete, the concrete shall be removed and replaced with a new coat of pneumatically placed concrete after the receiving surface has been properly cleaned. Before channel lining or riprap is placed, the slopes shall be thoroughly and uniformly consolidated and moistened. Sprinkling or sprinkling and consolidation may be required by the City Engineer before placement of concrete. The subgrade for lining shall be excavated and fine graded to the required section.

The use of forms for lining will not be required. The surfaces of pneumatically placed concrete for both channel lining and riprap shall be accurately finished by hand floating methods before the concrete has attained its initial set. The original surface and each surface which is permitted to harden before applying succeeding layers shall be washed with water and blasted with air, or a stiff hose stream, and all loosened material removed. Sand which rebounds and does not fall clear of the work or which collects on horizontal surfaces shall be blown off from time to time to avoid leaving sand pockets. Rebound which is recovered and is clean and free of foreign matter may be reused as sand in a quantity not to exceed twenty (20) percent of the total sand requirement. Pneumatically placed concrete shall not be applied to a surface containing frost or ice. Where standing or running water is encountered, it shall be removed before pneumatically applying the concrete. Only experienced foremen, gunmen, nozzle men, and rodmen shall be employed and satisfactory written evidence of such experience shall be furnished to the City Engineer upon request.

- B. Surface Finish on Concrete. Finish the surface of concrete in accordance with the plan details or as specified herein.
- C. Curing of Concrete.
 - 1. Moist Curing. All freshly placed concrete shall be cured by keeping the exposed surfaces, edges and corners continuously moist for a minimum duration of seven (7) days by spraying, ponding or covering with waterproof paper, polyethylene film or wet burlap. The temperature of the concrete shall be maintained above 50° F for the seven (7) day curing period. All materials for protecting and curing the concrete shall be on hand and ready for use before concreting begins. Wood forms left in place will not be considered adequate for moist curing. Ceilings and inside walls may be cured by leaving the forms on for at least four (4) days.
 - 2. Curing Compound. In lieu of moist curing, a curing compound which is acceptable to the City Engineer as to color, quality, and moisture retention, may be used. Apply curing compound in accordance with manufacturer's instructions.

3.03 FIELD QUALITY CONTROL

- A. General. The City of Brenham shall obtain the services of an independent qualified testing laboratory to perform the required testing and inspection of the concrete. All construction materials necessary for tests shall be provided by the Contractor at no additional expense to the City of Brenham or the testing laboratory.
- B. Slump Test. Contractor shall perform slump tests on each batch of concrete delivered to the job site. Slump tests shall be performed under the guidance and supervision of the testing laboratory representative and/or City Engineer. The maximum permissible slump for concrete shall be as follows:

<u>Location of Concrete</u>	<u>Maximum Slump (in.)</u>
Reinforced foundation walls and footings	4"
Plain footings and piers	3"
Slabs, beams and reinforced walls	4"
Pavements	2"

- C. Field Test Cylinders. The testing laboratory shall prepare one (1) set of concrete test cylinders, consisting of a minimum of three (3) cylinders, for each one-hundred (100) cubic yards (CY) of concrete pour or major fraction thereof. If the quantity of concrete poured in a day is less than one-hundred (100) cubic yards (CY), one (1) set of concrete tests cylinders is required. Each concrete test cylinder shall be made in accordance with the provisions outlined in ASTM C31. Test cylinders shall be cured under laboratory conditions except when, in the opinion of the City Engineer, prevailing job site conditions necessitate cylinders be cured under job conditions. Testing of concrete test cylinders shall be done by the testing laboratory in accordance with the provisions outlined in ASTM C39. One (1) cylinder shall be tested for compressive strength at the age of seven (7) days and a minimum of one (1) cylinder shall be tested for compressive strength at the age of twenty-eight (28) days. If any cylinder test is below the specified strength requirements, the City Engineer shall have the right to require changes in the mix design, require additional curing time, change the batching process, or take other necessary actions to insure that the concrete being placed in the work will meet the specified strength requirements.

3.04 ADJUSTING / CLEANING

All tie holes and other surface defects shall be repaired immediately after form removal. Approved patching grout shall be used to fill the minor voids left by form ties and all protruding defects left by forms shall be removed with a rubbing stone.

END OF SECTION



SECTION 16000

GENERAL REQUIREMENTS FOR ALL ELECTRICAL WORK

PART 1 GENERAL

1.01 SUMMARY

A. GENERAL

1. The Electrical Drawings and Specifications shall be complied with in every respect. The Contractor shall examine all of the documents and shall coordinate them with all of his electrical work.
2. The work covered shall include the furnishing of all materials, labor, transportation, tools, permits, fees, utilities, and incidentals necessary for the complete installation of all required electrical work.
3. It is the intent of these specifications to provide an installation complete in every respect. In the event that additional details or special construction is required for work indicated or specified in this section or work specified in other sections, it shall be the responsibility of the Contractor to provide all material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.
4. The Contractor shall be responsible for the coordination and proper relation of his work to the existing conditions. The Contractor shall visit the premises and thoroughly familiarize himself with the existing site conditions, and all details of the work and the working conditions and to verify all dimensions in the field.
5. If any departures from the Specifications or Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the City Engineer for review. No departures shall be made without prior written acceptance.
6. Items specifically mentioned in the Specifications but not shown on the Drawings and/or items shown on the Drawings but not specifically mentioned in the Specifications shall be installed by the Contractor under the appropriate section of work as if they were

both specified and shown.

7. UTILITIES

It shall be the responsibility of the Contractor to visit the site, meet with the local City personnel in order to coordinate and confirm the exact requirements for all electrical utilities, including, but not limited to all facilities required to provide complete and operative electrical power service.

8. TEMPORARY SERVICES

- a. It shall be the responsibility of the Contractor to provide a complete system for temporary construction power and distribution.
- b. The Electrical Contractor shall provide the necessary wiring, connections, service switches, poles, wiring protective devices, lighting fixtures, lamps, outlet devices disconnect switches, etc., as required for temporary lighting. In addition, a similar system shall be provided for the distribution of single and three phase power of voltage levels and adequate ampacity as required to facilitate the construction of the project. These services shall be installed in accordance with requirements of the National Electrical Code (NEC), National Electrical Safety Code (NESC), and the Occupational Safety and Health Administration (OSHA).

B. CODES AND STANDARDS

All work shall comply with the applicable rules of the National Electrical Code, the National Electrical Safety Code, the National Fire Codes (published by National Fire Protection Association), the City Electrical Codes and Ordinances, and the terms and conditions of services of the electrical utility, as well as any other authorities that may have lawful jurisdiction pertaining to the work specified. None of the terms or provision of this specification shall be construed as waiving any of the rules, regulations, or requirements of these authorities.

1.02 RELATED SECTIONS

Section 1650 through 1699 except for the sections that are omitted

1.03 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

NEC	National Electrical Code
NESC	National Electrical Safety Code
IEEE	Institute of Electrical and Electronic Engineers
NEMA	National Electrical Manufacturers Association
UL	Underwriters Laboratories
JIC	Joint Industrial Counsel
NTBA	National Machine Tool Builders Assoc.
ANSI	American National Standards Institute.
ASTM	American Society of Testing and Materials
OSHA	Occupational Safety and Health Administration

PART 2 PRODUCTS

2.01 MATERIALS AND/OR EQUIPMENT

A. GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

All materials, in general, shall conform to the National Electrical Code requirements and shall be listed, inspected, and approved by the Underwriters Laboratories and shall bear the U.L. label where labeling service is available. The label or listing of the Underwriters Laboratories, Inc. will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this listing, the Contractor may submit a statement from a nationally recognized, adequately equipped testing agency, indicating that the items have been treated in accordance with required procedures, and that the materials and equipment comply with all contract requirements.

B. STANDARD PRODUCTS

Materials and equipment to be provided shall be the standard currently manufactured catalog products of manufacturers regularly engaged in the manufacture of products conforming to these Specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use for at least two years. Where custom or special items are required, these shall be fully described using Drawings, material lists, etc., which fully describe in detail the item proposed for use.

C. MANUFACTURER'S INSTRUCTIONS

The responsibility for the furnishing of the proper electrical equipment and/or material and the responsibility for seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor. If needed for proper installation, operation, or start-up, the contractor shall request advice and supervisory assistance from the representative of the specific manufacturer. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Engineer in writing of any conflict between the requirements of the contract documents and the manufacturers' directions and shall obtain the Engineer's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such instructions from the Engineer, he shall bear all costs arising in connection with the deficiencies.

D. RUST PREVENTION

All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus shall be given a rust inhibiting treatment and standard finish by the manufacturer. All parts such as boxes, bodies, fittings, guards, and miscellaneous parts shall be protected in accordance with the ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing.

E. STORAGE AT SITE

The Contractor shall not receive material or equipment at the job site until ready for installation or until there is suitable space provided to properly protect equipment from rust, weather, humidity, dust, or physical damage.

F. CONDITION OF MATERIALS AND APPURTENANCES

All conduit, fixtures, panelboards, and other material required for complete installation of these systems shall be new to conform to manufacturer's recommendations, unless otherwise specified. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage on premises, while being erected and installed, and while being tested, until time of final completion, shall be replaced by this Contractor without extra cost to Owner.

G. CAPACITIES

Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of start-up or other overload conditions. Where approved equipment requires electrical power other than those used for design purposes, the Contractor shall be responsible to adjust protective devices, starter sizes, conductors, conduits, etc. to accommodate this approved device electrically.

H. NAMEPLATES

Each major component of equipment shall have the manufacturer's name address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of final inspection.

PART 3 EXECUTION

3.01 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. SPACE AND EQUIPMENT ARRANGEMENT

1. All electrical equipment shall be installed in such a manner as to allow removal for service without disassembly of other equipment.
2. All electrical equipment shall have working clearances as required by the latest version of the National Electrical Code, and any applicable city, local, or state codes.

B. EXCAVATION

All excavation shall be done in strict accordance with current OSHA, and any other applicable agency. Compliance with these regulation and actual trench safety shall be the sole responsibility of the Contractor.

C. CLEANING

The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the site and from any street or alley adjacent to the

site.

D. HOUSEKEEPING PAD

Each piece of floor mounted equipment, such as switchboards, motor control centers, transformers, emergency generators, etc., shall be set on neat cement finished, structural grade concrete bases. Bases shall be not less than 4" high and shall be pinned to the floor, or poured monolithic.

E. IDENTIFICATION AND LABELING

1. Disconnect switches, distribution centers, new panels, shall be properly marked to identify their service. Panels shall contain an index card having all circuits identified and typed on the card.

END OF SECTION

SECTION 16050

BASIC MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

This section is a general introduction to the electrical materials and methods that are described throughout Sections 16050 through 16999 inclusive. (Some sections are omitted.)

1.02 RELATED SECTIONS

Section 1650 through 1699 except for the sections that are omitted.

PART 2 PRODUCTS

2.01 MANUFACTURERS

Refer to the individual sections.

2.02 MATERIALS AND/OR EQUIPMENT

In general all materials shall be : new, U.L. approved and listed for the specific application; as specified or as required; and properly installed.

PART 3 EXECUTION

3.01 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. All work shall be performed in accordance with acceptable industry standards of workmanship except where specific procedures are called for in these Specifications in which case they shall be followed. It is strongly suggested all procedures are reviewed with the Engineer prior to beginning the work in order to avoid costly mistakes to the Contractor.
- B. Comply with the NEC, ANSI Code C2-1978, National Electrical Safety code, all applicable state, federal and local codes. The Contractor and his employees are responsible for helping to accomplish this end.

- C. All conductors installed under this contract shall be properly tagged at each terminal point, J-box.
- D. Concrete work and pads
1. All concreting, reinforcing, and form work necessary in connection with the construction of pads, manholes and the concreting around raceway runs underground shall be provided by the Contractor. Refer to Division 3 for concrete forms, materials, and other requirements.
 2. Furnish and install reinforced concrete pads for transformer, switchgear, of size, etc., as shown on the Drawings or required. Unless otherwise noted, pads shall be 4" high for interior locations and 12" for exterior locations. They shall exceed dimensions of equipment being set on them, including future sections, by six inches (6") on all sides, except when equipment is designed to set flush against a wall, then the side or sides of the pads against the wall shall be flush with the equipment.
 3. Chamfer top edges 3/4". Trowel all surfaces smooth. Reinforce pads with 6" x 6" 6/6 welded wire fabric.

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 GENERAL

1.01 SUMMARY

Raceways (def.: "any channel for holding wires, cables, or bus bars that is designed expressly for, and used solely for, this purpose" - NEC. Raceways include rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, flexible metal conduit, electrical metallic tubing ("thinwall"), wireways, and busways.

1.02 RELATED SECTIONS

Section 16000 - General Requirements for All Electrical Work

1.03 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

NEC	National Electrical Code
IEEE	Institute of Electrical and Electronic Engineers
NEMA	National Electrical Manufacturers Association
UL	Underwriters Laboratories
JIC	Joint Industrial Counsel
NTBA	National Machine Tool Builders Assoc.
ANSI	American National Standards Institute.

1.04 SUBMITTALS

Submit manufacturer's data demonstrating compliance with this Specification including couplings, fittings, bushings, and hangers.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Handling shall assure that raceways are not crushed or damaged in any way which would restrict the cross sectional area or cause oxidation.
- B. Store in a safe dry location on the site.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Conduit:

1. Rigid metal, intermediate and EMT:
 - a. Allied Tube and Conduit Corp.
 - b. Republic Steel Corp.
 - c. Triangle PWC Inc.
 - d. Perm-a-Cote Ind.
2. Flexible and flexible water-tight:
 - a. American Flexible Conduit Co.
 - b. Anaconda Metal Hose
 - c. Triangle PWC Inc.
 - d. O.Z. Gedney
3. Plastic Rigid:
 - a. Carlon
 - b. Anaconda Metal Hose
 - c. Triangle, PWC Inc.
 - d. Allied Tube and Conduit
4. Conduit supports and hangers:
 - a. Caddy
 - b. Thomas and Betts
 - c. Appleton
 - d. Crouse-Hinds
 - e. B-Line Systems
5. Insert anchors:
 - a. Ackerman-Johnson
 - b. Paine
 - c. Phillips

C. Lay-in ducts, wireways, and troughs:

1. Square D Co.
2. Midland-Ross Corp.
3. Hoffman Engineering Co.

2.02 MATERIALS AND/OR EQUIPMENT

A. Conduit

1. Rigid metal (RMC):
 - a. Hot dipped galvanized rigid steel, meet ASTM Standard A-153 galvanized after fabrication.
 - b. Bear UL label and manufacturers name.
 - c. Meet UL Standard #6
2. Intermediate (IMC):

U.L. 1242 and Fed. Spec. WWC-581.
3. Electrical metallic tubing (EMT or Thinwall) shall:
 - a. Be of open hearth, cold rolled, strip steel tubing, of standard sizes and weights, especially selected with reference to uniformity and freedom from defects.
 - b. Have each length stamped with manufacturers name and trademark, and bear Underwriter's label.
 - c. Have inner wall of conduit coated with one or more coats of baked on enamel of such consistency that it will not become soft or sticky and prevent the free insertion or withdrawal of conductors.
 - d. Have electrically welded seams, and an outside electrically galvanized or similar finish.
 - e. Be highly resistant to the corrosive effect of moisture, alkali, dirt, dust, and other injurious agents.
 - f. Thinwall conduit fittings: All thinwall conduit fittings for damp, wet or exposed locations shall be malleable iron of the regular watertight design, with hexagonal nuts and center portions requiring the use of a wrench during installation. The use of steel compression fittings will be permitted elsewhere. Formed metal set screw and die cast fittings are not acceptable.
4. Flexible conduit: Shall:
 - a. Be flexible steel type in dry locations with squeeze type connectors.
 - b. Be flexible rubber or plastic coated type in all wet locations with watertight ferrule and sleeve type connectors.
5. PVC Conduit:

- a. All PVC conduit shall meet all NEMA, ASTM, and U.L. Standards.
- b. PVC shall be Schedule 40 or 80 and be as manufactured by Carlon or approved equal.

PART 3 EXECUTION

3.01 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

A. General

1. Sizing: All wiring shall be in NEC approved raceways sized as shown on the Drawings, or, if not sized on the Drawings, in accordance with the NEC.
2. Contractor to install raceway systems where indicated on the Drawings, complete with all J-boxes and pullboxes as necessary and noted on plans.

B All Conduits:

1. All conduits shall: Have openings temporarily plugged to exclude plaster or other foreign materials; be no smaller than ½", be reamed after cutting; have joints cut square, and butt solidly into fittings; have the ends terminated in a proper bushed fitting; be rigidly supported so as to prevent undue stress or strain on the couplings and connectors.
2. Concealed conduits shall be run in a direct line with long sweep bends and offsets. All horizontal runs shall be run with a slight incline, to prevent low spots or pockets (for drawings).
3. On all conduit 1" trade size and larger, bushings shall be of the insulated type. Except service entrance conduits shall be provided with grounding type bushings.
4. All conduit systems must be installed complete before conductors are pulled in and be electrically continuous throughout.
5. Exposed conduits shall be installed at right angles to the building lines; all breaks and turns being made with cadmium or hot galvanized covers. All conduit fittings shall be as recommended by the manufacturer of the conduit. Approval of the Engineer must be obtained for location and aesthetics of each and every run of exposed raceway prior to installation.
6. No conduit shall be run above or adjacent to steam piping or under water piping, and must be individually supported.
7. No aluminum conduit shall be permitted unless approved in writing by the Engineer.

8. All threaded conduit run underground shall have all joints made up watertight using thread compound or tape.
- C. Rigid Conduit:
1. Rigid steel conduit shall be used in ground bearing floor slabs, mechanical rooms to 60" above finished floor, for all services and feeders, for all wiring in moist or hazardous areas, and for underground branch circuits, except as herein otherwise allowed. Where rigid steel conduit is run underground, it shall be protected by using 0.010 inch-thick pipe wrapping plastic tape, field applied with 50 percent overlap, or by using factory applied plastic resin, epoxy, or coal-tar coating.
 2. All rigid conduits shall be cut square, threaded, reamed smooth, and drawn tight in that order. Bends or offsets shall be made with standard conduit ells.
- D. IMC:
1. May be used in lieu of rigid, where approved by NEC.
 2. All IMC conduits shall be cut square, threaded, reamed smooth and drawn tight in that order. Bends or offsets shall be made with standard conduit ells.
- E. Electrical Metallic Tubing:
Electrical metallic tubing (EMT) or "Thinwall" (T.W.) may be used where concealed above grade and where permitted by NEC, except for feeders, sub-feeders, moist areas, or where exposed in mechanical equipment rooms below 60".
- F. PVC Conduit:
1. PVC may be used for buried branch circuits and buried services and feeders five feet outside of the building where permitted by the NEC and local codes except where rigid is specifically called for on the Drawings. PVC may be used in concrete, in slab on fill or grade construction except that all stub-ups shall transition to rigid steel. All boxes, fittings, coupling, transition fittings, adhesives, and installation procedures recommended by the manufacturer must be strictly followed.
- G. Conduit Supports and Hangers:
1. All conduits shall be securely fastened in place on maximum of 8' intervals 1" conduit or less and 5' intervals over 1", and hangers. supports or fastenings shall be provided at each elbow and at the end of each straight run terminating at a box or cabinet. The use of

- perforated iron for supporting conduits will not be permitted.
2. Where two or more conduits 1" or larger run parallel, trapeze hangers may be used consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized "L" angle iron, or P-1000 Unistrut cross members. These conduits shall be individually fastened to the cross members of every other trapeze hanger with galvanized cast one hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.
 3. Hangers shall be made of durable materials suitable for the application involved and shall be painted with two coats of lead and oil paint. Where excessive corrosive conditions are encountered, hanger assemblies shall be protected after fabrication by galvanizing, special paint or other suitable preservative methods.
 4. On concrete or brick construction, insert anchors shall be installed. In wood construction, round head screws shall be used. In brick, inserts shall be near center of brick, not near edge or in joint. Where steel members occur, same shall be drilled and tapped, and round head machine screws shall be used. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from rust-resisting metal, or approved equivalent.

H. Installation of Underground Conduits:

1. Encasement: (Where Required by the City)
Underground conduits and ducts shall be concrete encased when containing high voltage cables, and when containing low voltage cables and extending below slab-on-grade construction, roadways and parking areas.
 - a. Conduit and ducts noted to be concrete encased shall be mounted on spacers to allow a minimum of 3 inches encasement on all sides a minimum of 2 inches between parallel runs of conduit. Care shall be taken to prevent movement of conduit or duct during pouring.
 - b. Concrete shall be Class B, 2500 pound test at 28 days, consisting of a mixture of 1 part cement to 5 parts sand, having maximum aggregate size of 3/4 inches. Slump test shall measure between a 3 and 4 inch slump.
 - c. The concrete encasement shall be colored red by mixing the red coloring powder directly in with the new cement mixture.

2. Excavation and Back-filling:

- a. The ground shall be excavated in open trenches to the width, depth, and in direction necessary for the proper installation of the underground ductwork, manhole, vault, etc., and connections where shown on Drawings.
- b. Where the bottom of the trench is excavated below the necessary elevation, it shall be brought to proper grade by the use of torpedo sand or three-eighth inch gravel, well tamped into place.
- c. No extras will be allowed because of the nature of the ground in which the trench or other excavations are made. All necessary sheathing to prevent cave-ins and barricades shall be provided by the Contractor.
- d. Where permanently moist or unstable ground is encountered in the bottom of the trench, it shall be excavated to a depth of at least 12 inches below the line of the duct or slab, and replaced with coarse gravel to proper height.
- e. Where the excavation for its entire depth is in water or wet sand, pump the trench so as to drain it effectively.
- f. Where it is necessary to remove sod, it shall be removed in as large a section as possible and carefully set aside and cared for until replaced. Before replacing the sod, the backfill must be covered with not less than 4" of topsoil. The sod shall then be relaid and lightly tamped into place, and if dry, it shall be sprinkled with water. If sod is badly damaged sow lawn seed or entirely replace the sod, as directed.
- g. Backfill trenches with the excavated material unless otherwise specified. It shall be thoroughly tamped to insure a satisfactory job, or a thorough puddling with water, or both, as directed. In surfaced areas, compactions shall be 95% of surrounding undisturbed soil. Sodded areas shall be compacted to 95% up to topsoil. Topsoil shall be lightly tamped then soil mounded to allow for settling.
- h. Backfill openings around manhole, vault, ducts, etc., with fine aggregate (torpedo sand).
- i. Conduits, ducts passing under sidewalks, roads, curbs, lawns, etc.:
 - (1) Where conduits or ducts pass under existing sidewalks, roads or curbs cut and remove same in order to install the conduit or ducts. All sidewalks, roads or curbs shall be replace with material equal to those now in place. Where conduits, ducts, etc., pass under existing sidewalks, roads, or curbs, and with

the approval of the City Engineer, the Contractor may push galvanized steel conduit under said road, etc., maintaining the proper slope and drainage. The conduit shall extend at least 5' on either side of the road, etc., and the concrete envelope over the duct shall extend at least 3' beyond the end of the duct and over the conduit to fully protect the conduit to duct coupling. Reinforce at least 6' of the concrete encasement.

3. Primary Duct Banks:
 - a. Furnish all materials and construct the primary and secondary underground duct and conduit runs of rigid conduit. Bends shall have long sweep radius curves instead of standard elbows.
 - b. All conduit burial shall be minimum of 30" for over 600V system, and 24" for systems 600V and below. The depth of conduits at the manhole, vault and building shall be 30" deep or as noted on the Drawings.
 - c. Each conduit shall be provided with an approved insulated metallic bushing at manhole or vaults (if any).
 - d. Conduit or duct runs shall be pitched to drain toward manholes, and away from buildings or vaults.
 - e. All conduit runs shall be separated and supported (before pouring concrete) with plastic or precast concrete base and intermediate spacers.
 - f. The materials for concreting shall comply with Division 3.
 - g. Before the Contractor pulls any cables into the underground conduits he shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit, and if any concrete obstructions are found, the Contractor shall remove them and clear the conduits. All underground conduits shall be swabbed before cables are pulled in.
 - (1) All conduits containing cables shall be sealed with an approved duct seal around cable.
 - (2) All spare conduit shall be closed with an approved plug.
 - (3) Couplings in the duct run shall be staggered at least 1" apart.
 - (4) The concrete envelope of all duct runs shall be anchored to all buildings, manholes, vaults, etc., to prevent shear of the duct at the wall. The reinforcing shall be at least 4 #4 hooked rods not less than 24"

- long.
- (5) After duct runs are completed and set, backfill the trenches and tamp thoroughly so as to settle the fill well.
 - (6) Each duct shall be provided with a bell at manholes.
 - (7) Duct runs shall be installed deeper than the minimum depth wherever required to avoid any existing piping, tunnels, or other obstructions.
 - (8) After duct requiring encasement is in place notify the City Engineer and **NO** concrete shall be poured until approved.
 - (9) When temperature changes at the job site are more than 10 degrees F during the workday, all concrete encasement of plastic duct shall be done in the morning and before the temperature has risen 10 degrees F above the temperature at the start of the day's work.
 - (10) Provide a buried cable warning tape over all underground electrical installations which says "Caution - Buried Electrical Line Below".
4. Reinforced duct runs:
- a. Reinforcing shall consist of ½" deformed bars spaced 6" on center, paralleling the ducts on top, bottom, and sides, with ½" deformed tie bars spaced 12" on centers.
 - b. Bars shall overlap forty diameters and shall extend 5' beyond roads or drives on each side.
5. No excavation parallel to walls shall be permitted closer than 18" horizontally from footings.

END OF SECTION

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SECTION 16120

WIRES AND CABLES

PART 1 GENERAL

1.01 SUMMARY

This section describes cables and wires rated 600 volts or less.

1.02 REFERENCES

The applicable provisions of the following standards shall apply as if written here in their entirety:

NEC	National Electrical Code
UL	Underwriters Laboratories
IECA	Insulated Cable Engineers Association
NEMA	National Electrical Manufacturers' association
ASTM	American Society of Testing and Materials
ANSI	American National Standards Institute Copper Development Assoc. Inc. International Annealed Copper Standard.

1.03 SUBMITTALS

Submit manufacturer's data demonstrating compliance with this Specification.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Collyer
- B. Triangle
- C. Brand Rex
- D. Universal
- E. Okonite
- F. Anaconda
- G. Carol
- H. Belden
- I. Southwire
- J. Rome Cable
- K. Alcan Cable

L. Kaiser

2.02 MATERIALS AND/OR EQUIPMENT

- A. Copper conductor for wire and cable shall be based on 98% Conductivity and shall be tinned or untinned in accordance with established standards for the type of insulation around the conductors. No. 10 AWG and smaller shall be solid and No. 8 AWG and larger shall be stranded. Unless indicated or specified otherwise, conductor sizes are based on copper. [ALL CONDUCTORS SHALL BE COPPER].
- B. All wire and cable shall be permanently marked approximately every two feet to indicate size, voltage, and type temperature rating in accordance with NEC.
- C. All cable or wire shall:
1. Be 600 volt.
 2. Be installed in approved raceways or conduit.
 3. Be not less than #12 AWG.
 4. #14 AWG may be used for control and low voltage wiring.
 5. Have type insulation as follows:
General Use ----- THW or THHN-THWN
Wet or Moist Locations ----- THW or THHN-THWN
Feeders to panels ----- THW, THHN-THWN, XHHW
Service Entrance ----- THW, THHN, THWN, XHHW
Buried Distribution ----- THW, THHN, THWN, XHHW
TRAY Cable----- TC
(THHN-THWN = Dual rated wire)
- D. Conduit sizes are based on THW insulated Conductors and shall not be changed regardless of insulation used.
- E. Wire pulling lubricant: When necessary to use a lubricant for pulling wires, lubricant must be listed by Underwriters' Laboratories and be of such consistency that it will leave no obstruction or tackiness that will prevent pulling out old wires or pulling in new wires, or additional wires. No soap flakes or vegetable soaps will be permitted.
- F. Cable ties: Wiring in panels, cabinets, etc. shall be neat and tied with "Ty-Rap" T&B "TY-5418" series, or Panduit Co. "Cable Wrap".
- G. All conductors installed by the Contractor shall be properly tagged and

identified at each end.

PART 3 EXECUTION

3.01 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. All wires or cables shall be installed in NEC approved raceways as described in Section 16110.
- B. All branch circuit wiring shall be installed using color coded conductors, using the same code throughout.

Mechanical Ground		- Green
Phase A	208/120	- black
Phase B	208/120	- Red
Phase C	208/120	- Blue
Neutral	208/120	- White
Phase A	480/277	- Brown
Phase B	480/277	- Purple
Phase C	480/277	- Yellow
Neutral	480/277	- Natural gray

Four Wire Delta Service:

Phase A	"Higher" phase voltage to Ground	- Orange
Phase B	Lower phase voltage to Ground	- Red
Phase C	Lower phase voltage to Ground	- Black
Neutral		- White

Single and 3-Way Return - Purple Tracer

3-Way Traveler - Yellow Tracer

- C. Colors as selected for the purpose of identifying circuits shall be applied to the wire. The colors must be fast, fadeless and capable of withstanding cleaning in the event that the wire becomes soiled.
- D. Parallel Conductors shall be terminated on multiple barrel lugs, or on a combination of multiple barrel lugs on a common bus. Following commissioning of the circuit, division of load between conductors shall be

checked. Where such variations exceed 10% of the conductor load, corrective measures must be taken to return the division to within 10%. Record of such tests, by conductor, shall be made on each feeder, along with conductor size, voltage, and location for positive location. Each test, as well as re-testing following corrective measures, shall be signed by the tester and the witness. Copies of this test shall be provided to the Engineer.

E. Pulling cables:

Wires and cables shall be carefully handled during installation. The type of lubricant to be used for drawing in wires and cables shall be approved by the Construction Manager.

END OF SECTION

identified at each end.

PART 3 EXECUTION

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END OF SECTION

SECTION 16121

WIRE CONNECTIONS AND DEVICES

PART 1 GENERAL

1.01 RELATED SECTIONS

Section 16000 - General Requirements for All Electrical Work.
Section 16120 - Wires and Cables

1.02 REFERENCES

NEMA National Electrical Manufacturers Association
NEC National Electrical code
UL Underwriters Laboratories

1.03 SUBMITTALS

Submit manufacturer's data demonstrating compliance with this Specification.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Ideal.
- B. Anderson Electric Corp.
- C. Burndy Corp.
- D. Thomas and Betts Co.
- E. Penn-Union Electric.
- F. Buchanan Electric Products Corp.
- G. O.Z. Electrical Mfg. Co.
- H. 3-M Corp.

2.02 MATERIALS AND/OR EQUIPMENT

- A. Splices and connections:

600 volts or less shall be with connecting devices designed for the conductor and application.

- B. Terminations:

600 volts or less shall be with terminating kits designed for the conductor

and application.

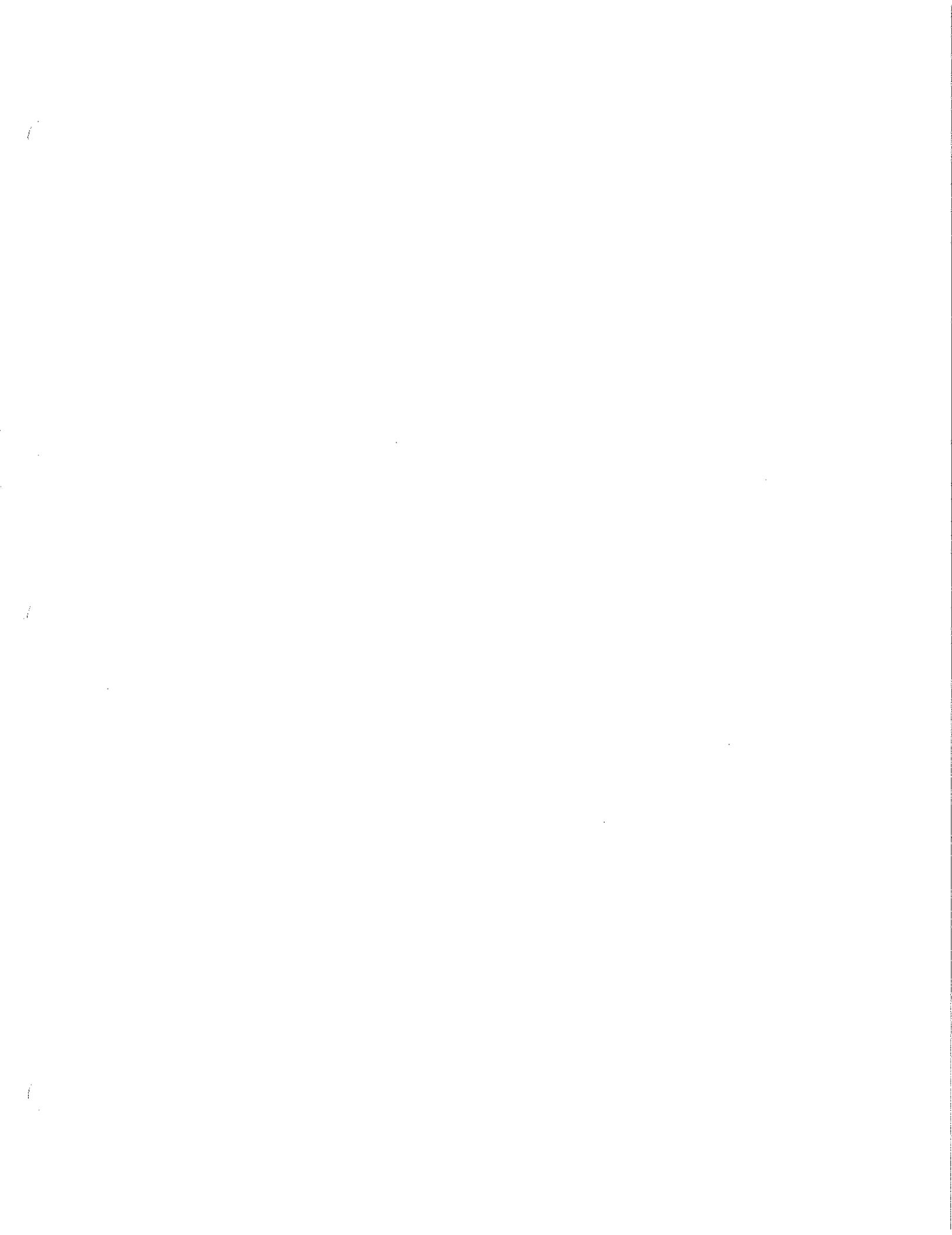
- C. All connectors shall be of material compatible with the materials of the conductors to prevent corroding, differences in coefficients of expansion or electrolysis.

PART 3 EXECUTION

3.01 ERECTION / INSTALLATION / APPLICATION AND/OR CONSTRUCTION

- A. Splices and terminations: Splices in conductors shall be as few as possible. Where joints are necessary, they shall be mechanically strong and well made so that the electrical resistance of a joint shall not exceed that of two feet of the conductor. Splices and terminations shall be made only in junction boxes and never in conduit LB's and similar fittings. Do not splice in panels!!
- B. Stranded copper cables shall be terminated onto solderless lugs. Wrapping around binding posts shall not be permitted.
- C. On 600 volt copper wire #8 and smaller, use wing nut solderless connectors, or solder; #6 and larger, use insulated parallel connectors; use tape to an equivalent insulation thickness on ALL uninsulated splices and apply an insulating coat of paint. Manufacturers recommendations as to sizing, stripping, twisting, etc., shall be strictly followed.
- D. Connections: Shall be made with screw-on, set-screw, clamp-on, split-bolt, crimp or compression-type lugs, taps and terminal fittings.
- E. Where special tools are required to properly install the particular connector the special tools shall only be used.

END OF SECTION



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