SPECIFICATIONS

Bidder shall ensure that all the work for the **Project** will be performed in accordance and compliance with the terms, conditions and technical requirements included in: Subcontract Agreement, **Contract** and its Technical Requirements.

Construction, Quality, Safety and Environmental requirements are defined by the **Contract** between **Contractor** and **TxDOT**, and are considered part of the Subcontract Documents and this solicitation package. Subcontractor shall guarantee compliance with requirements of the CDA: sections 10.3 and 10.1.1, 10.1.2, 10.1.3.

Subcontractor shall comply with the **TxDOT Specifications, Line Items Numbers 1-9, 103, 104, 105, 110, 112, 160, 400, 402, 403, 424, 429, 438, 440, 462, 464, 465, 466, 467, 471, 472, 474, 476, 479, 480, 481, 496, 500, 556, TxDOT Bridge Standards- Culvert and Drainage** and **Departmental Materials Specifications 7300 and 7310** and **abide by Technical Provisions for the US 181 Harbor Bridge Project with Special attention to Drainage 2.1 thru 2.5**

Bidder shall be responsible for fully complying with all applicable laws, statutes, ordinances, rules, regulations and/or orders of any public authority (federal, state, local) as they relate to safety of persons, environment, public, or property.

Bidder shall ensure that his proposal is in accordance and comply with ALL requirements detailed in the following documents: 1. This Solicitation for Bid, 2. Subcontract Agreement, 3. **Prime Contract** and 4. Technical Requirements.

1. PERFORMANCE, DESIGN AND CONSTRUCTION STANDARDS

As per section 3.2 "Performance, Design and Construction Standards; Deviations" of the **Prime Contract**, bidder shall perform the construction work as designed, free from defects, and in accordance with:

a) Good industry practice
b) The requirements, terms and conditions set forth I the **Contract**
c) The **Project** schedule
d) All Laws
e) The requirements, terms and conditions set forth in all governmental approvals
f) The approved **Project** Management Plan and all component plans prepared or to be prepared thereunder
g) Safety compliance, the Safety and Health Plan and Safety Standards
h) All other applicable Safety, environmental and other requirements

2. QUALITY REQUIREMENTS

As per section 2.2 "Quality Management Plan" of the Technical Provisions for the **Contract**, all work performed for the **Project**, must be in compliance with ISO 9001.

SPECIFICATIONS

Bidder shall submit their Quality Management Plan (QMP) as part of their proposal. The QMP shall describe the system, policies and procedures that ensure the Work meets the requirements of the Prime Contract and provides documented evidence of same, while fulfilling the requirements of ISO 9001.

Bidder shall ensure that all the Work performed for the **Project** will be consistent with the applicable procedures contained in the current **TxDOT** Contract Administration Handbook for Construction.

Bidder shall ensure all the necessary availability to allow **Contractor's** inspections during the execution of the Work.

Review and approval of drawings and any document generated as part of the execution of the Work, shall follow the procedure included in the Technical Requirements of the **Contract**.

DMS-7300

Precast Concrete Fabrication Plants

Effective Date: April 2015

1. DESCRIPTION

This Specification, in conjunction with Item 424, "Precast Concrete Structural Members (Fabrication)," of the Department's *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*, governs for fabrication of precast prestressed and precast nonstressed members.

2. UNITS OF MEASUREMENTS

The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

3. DEFINITIONS AND ABBREVIATIONS

The following definitions apply to this Specification.

- **Multi-Project Fabrication Plant—**a facility at an offsite location that fabricates precast prestressed or precast nonstressed members. This definition also applies to single-Contract offsite facilities.
- **Project-Specific Fabrication Plant—**a temporary facility at or near the project location that fabricates precast prestressed or precast nonstressed members for only one Contract. (This definition may be applied to temporary facilities that fabricate for multiple adjacent Contracts, if approved by CST/M&P.)
- **Nonstressed Members—**precast concrete members that have not been pre-tensioned or post-tensioned.
- **Prestressed Members—**precast concrete members fabricated by the process of pre-tensioning, post-tensioning, or a combination of both methods.
- **Minor Prestressed Members—**includes piling (non-voided), bridge deck panels, pavement panels, retaining wall panels, and sound wall panels.
- **Major Prestressed Members—**includes all other prestressed members not listed as minor prestressed members, including but not limited to I-beams, U-beams, box beams, slab beams, cylindrical piling, bent caps, and abutments.
- **I-Beams—**for this Specification, all I-girders and bulb-tee beams are referred to as I-beams.
- **Temperature Probe—**thermocouple for measuring concrete temperature or air temperature.
- **Temperature Recording Device—**data logger for recording temperatures from the temperature probes.
- **PCI—**Precast/Prestressed Concrete Institute.
- **ACI—**American Concrete Institute.
- **NPCA—**National Precast Concrete Association.
- **MOH—**material on hand.
- **Commercial Laboratory Criteria.**
  - Laboratory must be AASHTO-accredited in the specific test(s) to be conducted, and the technician must possess the ACI Aggregate Testing Technician – Level 1 for performing aggregate testing and ACI Concrete Strength Testing Technician for performing Tex-418-A.
  - Technician from commercial laboratory possessing the ACI Aggregate Testing Technician – Level 1 for performing aggregate testing and ACI Concrete Strength Testing Technician for performing

Tex-418-A certification(s) may conduct the required test(s) at the fabrication plant laboratory provided that facility is in compliance with applicable sections of Tex-237-F and Tex-498-A.

4. MATERIAL PRODUCER LIST

The Materials and Pavements Section of the Construction Division (CST/M&P) maintains the Material Producer Lists (MPLs) of fabrication plants that have demonstrated the ability to conform to the requirements of this Specification. When using precast concrete produced by multi-project fabrication plants, it must be listed on the following MPLs in order to be used on Department projects.

- Prestressed Member Fabrication Plants (Multi-Project)
  - Major Prestressed Member Fabrication Plants (Multi-Project)
  - Minor Prestressed Member Fabrication Plants (Multi-Project)
- Nonstressed Member Fabrication Plants (Multi-Project)

Submit all documents referenced in this Specification electronically to CST/M&P. Include date and highlight any changes from previous documents.

5. BIDDERS' AND SUPPLIERS' REQUIREMENTS

The Department will only purchase or allow on projects those products listed by producer and product code or designation shown on the MPL.

Use of pre-qualified product does not relieve the Contractor of the responsibility to provide product that meets this Specification. The Department may inspect or test material at any time and reject any material that does not meet the specifications.

6. QUALIFICATION PROCESS FOR MULTI-PROJECT FABRICATION PLANTS

6.1. **Qualification Request.** Submit a request for plant approval under DMS-7300 to DMS_Prequal@txdot.gov. For plants producing precast concrete structural members, requests must include the following information, in PDF format:

- company and fabrication plant name;
- physical and mailing addresses;
- list of precast concrete products to be evaluated for qualification purposes;
- contact names, titles, phone numbers, and email addresses; and
- additional documents requested throughout this Specification, dependent on plant and product type.

6.2. **Evaluation.** CST/M&P will review the qualification request documentation. If the qualification request includes the required information, CST/M&P will perform an initial Department-directed plant audit in accordance with Article 8, "Plant Approval," to ensure compliance with this Specification. The Department will evaluate all fabrication plants for adequate equipment, processes, organization, experience, knowledge, and competent personnel to produce acceptable work.

6.2.1. **Qualification.** If the required submittals and audit(s) verify compliance with this Specification, the Department will list the fabrication plant on the MPL. CST/M&P reserves the right to perform additional audits (announced or unannounced) at its discretion for the plant to remain on the MPL as an approved fabrication plant for precast concrete structural members.

Fabrication plants must continue successful completion of any additional Department-directed audits and any follow-up plant audits by adequately implementing corrective actions for all deficiencies.

6.2.2. **Failure.** Fabrication plants not qualified under this Specification may not furnish materials for Department projects and must show evidence of correction of all deficiencies before reconsideration for qualification.

6.3. **Random Inspection.** The Department reserves the right to inspect, sample, test, conduct random audits of plants, and perform random audits of required paperwork, test reports, and shipping records at any time to ensure compliance with Item 424, Item 9.6, "Payments for Material on Hand (MOH)", and this Specification. Provide facilities and access to allow for inspection of materials, the process of fabrication, and the finished precast members.

6.4. **Disqualification.** Any fabrication plant that deliberately fails to comply with the requirements of this Specification is subject to disqualification, which includes removal from the MPL. A disqualified fabricator is prohibited from furnishing product to Department projects and may not bid any work let during the disqualification period. The disqualification period will be a minimum of 30 days or as determined by CST/M&P.

Causes for disqualification and removal from the MPL may include, but are not limited to:

- repetitive poor quality and workmanship,
- falsification of or incomplete documentation,
- lack of certified or qualified QC personnel, or
- certifying or furnishing product that does not meet the specifications.

If a fabricator has been disqualified, all previously produced products will be subject to review and possible removal from assigned projects. If the Department disqualifies a fabricator, the Department may permit subcontracting pending product quantities for active projects to another Department-approved fabrication plant for the specific product.

Before issuing a letter removing a fabricator from the MPL, a fabricator may request issue escalation; however, the Department reserves the right to immediately remove from the MPL or suspend acceptance of product from a supplier in order to protect the public and the Department from further harm. Timely corrective action by the fabrication plant suspends MPL removal action and the need for escalation. If needed, the Department will notify Contractors of an impending MPL removal action, through the authority of the Contract.

6.5. **Re-Qualification.** Once the disqualification period established by CST/M&P has elapsed, the fabricator may begin the re-qualification process by providing the Department with an implemented reconciliation plan that includes at a minimum:

- evidence of corrected deficiencies,
- passing an additional Department-directed audit, and
- ensuring compliance with all requirements in this Specification.

The fabricator must bear all Department expenses associated with requalification.

6.6. **Inactive Fabricator.** If a precast fabricator does not furnish any precast concrete product to projects inspected by the Department for a period of 2 years, CST/M&P will remove the fabricator from the MPL due to inactivity.

CST/M&P will consider future qualification when the producer indicates it will furnish precast concrete product to Department projects and is in compliance with this Specification.

7. EQUIPMENT REQUIREMENTS

Field office and inspection laboratory, furnishings, and equipment will be subject to Department approval. As directed, maintain, repair, or replace the building and equipment immediately if either the building or

equipment becomes inadequate for its intended use. Provide building janitorial service acceptable to the Engineer.

7.1. **Field Office and Inspection Laboratory.**

7.1.1. **Multi-Project Fabrication Plant.** Provide a field office and an inspection laboratory before casting any prestressed or nonstressed members required by the Contract. Submit the proposed field office and inspection laboratory floor plan drawings for approval.

Provide a laboratory and office with:

- controlled access with security measures controlled by the Engineer (office only),
- ceilings at least 8 ft. high
- at least 300 sq. ft. of laboratory space,
- at least 200 sq. ft. of office space for plant operations requiring up to two inspection personnel, and
- at least 400 sq. ft. of office space for operations requiring three or more inspection personnel.

If the office and laboratory are in the same building, partition the building to separate them. Building must be weatherproof and adequately lighted, heated, air conditioned, and ventilated.

Furnish the following:

- adequate electrical outlets,
- windows,
- impervious floor covering, and
- rest room facilities, which must include:
  - a flush toilet,
  - a sink with hot and cold running water,
  - a sewer or septic tank with connections, and
  - adequate rest room supplies (paper towels, toilet paper, hand soap, etc.)

Solar screens, blinds, or shades may be required. Furnish potable drinking water acceptable to the Engineer.

Provide broadband internet service via an Internet Service Provider (ISP) capable of accessing the Department's Citrix® Metaframe Server at Austin Headquarters using Department-furnished Citrix® client software.

High-speed broadband connection may be through digital subscriber line (DSL), cable, satellite, fiber-optic (FiOS), or wireless (WISP-hotspot). Provide connections in the quantity needed to provide simultaneous connection of the Contractor and the Inspectors. Connection and download speeds must be commensurate with current industry standards for accessing and downloading large Contract Plans and specifications.

Provide all equipment to connect the desktop or laptop microcomputer to the ISP. Because of problems connecting to the Citrix® Metaframe server, the Department will not permit integrated services digital network (ISDN) service. Validate that the chosen ISP can establish a connection. ISPs that use TCP/IP protocol should be capable of accessing the Citrix® server. Immediately resolve all firewall and technical issues.

Provide adequate ventilation for capping equipment. Locate curing, capping, and testing facilities for concrete cylinders and capping ventilation equipment in a space convenient to the office and laboratory. If housing curing, capping, and testing facilities in the same building as the laboratory, the space required for these facilities will be in addition to the above requirements for laboratory space.

Locate the office and laboratory to provide visibility to plant operations unless otherwise approved. Provide adequate parking space for Department vehicles adjacent to the field office.

Do not house Department and Contractor personnel in the same office. If the Contractor uses a portion of the structure, do not place the field office adjacent to Contractor-used rooms unless otherwise approved. Laboratory space may be shared; however, Contractor access must only be for business purposes, and use of the laboratory and testing equipment must be coordinated with the Department. If the office and laboratory are adjacent to each other, provide a locking, soundproof door between them. The Contractor must enter the laboratory from an alternate door and not through the field office.

7.1.2. **Project-Specific Fabrication Plant.** Provide a field office and inspection laboratory before casting any prestressed or nonstressed members required by the Contract. Provide a Type C structure as specified in Item 504 "Field Office and Laboratory."

7.2. **Furnishings and Laboratory Equipment.** Laboratory must comply with applicable sections of Tex-237-F and Tex-498-A. Calibrate all equipment and house it in a weatherproof enclosure. Recalibrate equipment at the Contractor's expense as follows:

- as required by the manufacturer;
- when suspect results, malfunction, or repair work occurs; or
- as directed by the Engineer.

7.2.1. **Multi-Project Fabrication Plant.** Furnish the following:

- a sink with running hot and cold water;
- worktables, file cabinets, plan file racks, bulletin boards, desks, and chairs as needed;
- a compression machine meeting the requirements of Tex-418-A;
  - The compression machine must be able to test cylinders to their full strength while operating within 90% of full capacity.
  - Nonstressed member fabrication plants may have test cylinders tested by an approved commercial laboratory, at the Contractor's expense, instead of furnishing a compression machine. A licensed professional engineer must seal the test results from a commercial laboratory.
- a video monitoring and digital recording system approved by the Department prior to use for the testing of cylindrical concrete specimens (digital video recorder and monitor to be placed in TxDOT office or laboratory if the Department has full-time access);
- a scale or balance as specified in Tex-401-A;
- equipment as specified in Tex-409-A or ASTM C566 for checking moisture content of aggregates;
- a calcium carbide pressure tester as specified in Tex-425-A;
- equipment as specified in Tex-403-A for determining specific gravity of aggregates;
- a complete set of sieves as specified in Tex-401-A;
- an electrically powered mechanical sieve shaker, to accommodate the sieves furnished above, housed in a soundproof enclosure (Mount the sieve shaker on a rigid platform that extends through the floor and firmly fix it to the ground when a portable structure is used.);
- a thermostatically controlled electric or gas oven capable of maintaining a temperature of 230°F ± 9°F at loaded capacity, or a minimum 1,000-watt microwave oven with interior floor dimensions of at least 14 in. × 14 in.;
- equipment as specified in Tex-447-A for making cylinder test specimens;
- six 10-in. round aggregate pans (microwave safe, if necessary);
- capping equipment meeting the requirements of Tex-450-A or Tex-418-A (unless test cylinders are tested by a commercial laboratory);
- equipment for determining the diameter of test cylinders to the nearest 0.01 in. (unless test cylinders are tested by a commercial laboratory);
- curing tank meeting the requirements of Tex-447-A and large enough to accommodate the required number of test cylinders during production;
- equipment as specified in Tex-404-A and Tex-417-A for determining unit weight;

- equipment as specified in Tex-415-A for determining concrete slump or ASTM C 1611 for determining concrete slump flow, VSI rating, and T-50 test;
- equipment as specified in ASTM C 1610 to determine concrete segregation;
- equipment as specified in ASTM C 232 to determine concrete bleeding;
- equipment as specified in Tex-203-F for performing the sand equivalent test;
- equipment as specified in Tex-422-A for determining temperature of fresh concrete (with thermometers calibrated to at least two points including 50° and 95°F annually or when there is a question of accuracy);
- concrete temperature probes, curing enclosure air temperature probes, and temperature recording devices per Item 424;
  - Provide a minimum of one standby temperature recording device in the plant for emergency use.
  - Temperature recording devices must be able to generate a graph displaying the temperature profile of the entire curing period at intervals not to exceed 15 min.
  - Calibrate temperature recording devices at least once per year, or more frequently, if recommended by the manufacturer. Temperature recording devices must be accurate to within ± 2°F in the range of 0–200°F. The graph generated by the temperature recording device must be readable to within 5°F.
- equipment as specified in Tex-715-I, when match-cure technology is used to cure release-of-tension strength cylinders;
- equipment as specified in Tex-414-A or Tex-416-A for determining air content;
- equipment as specified in Tex-440-A for determining initial set of concrete; and
- equipment to perform inspection duties, including but not limited to:
  - beam length measuring tape,
  - custom squares and straight edges, and
  - measuring jigs.

7.2.2. **Project-Specific Fabrication Plant.** Furnish the following:

- a sink with running hot and cold water;
- a compression machine meeting the requirements of Tex-418-A;
  - The compression machine must be able to test cylinders to their full strength while operating within 90% of full capacity.
  - Nonstressed member fabrication plants may have test cylinders tested by an approved commercial laboratory, at the Contractor's expense, instead of furnishing a compression machine. A licensed professional engineer must seal the test results from a commercial laboratory.
- equipment as specified in Tex-447-A for making cylinder test specimens;
- capping equipment meeting the requirements of Tex-450-A or Tex-418-A (unless test cylinders are tested by a commercial laboratory);
- equipment for determining the diameter of test cylinders to the nearest 0.01 in. (unless test cylinders tested by a commercial laboratory);
- curing tank meeting the requirements of Tex-447-A and large enough to accommodate the required number of test cylinders during production;
- equipment as specified in Tex-415-A for determining concrete slump;
- equipment as specified in Tex-422-A for determining temperature of fresh concrete (with thermometers calibrated to at least two points including 50° and 95°F annually or when there is a question of accuracy);
- concrete temperature probes, curing enclosure air temperature probes, and temperature recording devices per Item 424;
  - Provide a minimum of one standby temperature recording device in the plant for emergency use.
  - Temperature recording devices must be able to generate a graph displaying the temperature profile of the entire curing period at intervals not to exceed 15 min.

- Calibrate temperature recording devices at least once per year, or more frequently, if recommended by the manufacturer. Temperature recording devices must be accurate to within ± 2°F in the range of 0–200°F. The graph generated by the temperature recording device must be readable to within 5°F.

- equipment as specified in Tex-715-I, when match-cure technology is used to cure release-of-tension strength cylinders;
- equipment as specified in Tex-440-A for determining initial set of concrete; and
- equipment to perform inspection duties, including but not limited to:
  - beam length measuring tape,
  - custom squares and straight edges, and
  - measuring jigs.

7.3. **Plant Facilities.** Provide safe access in all prestressed and nonstressed plants around casting lines, batch plants, and the storage area for Department personnel to perform inspection.

7.3.1. **Multi-Project and Project-Specific Prestressed Member Fabrication Plants.** Before casting members, furnish detailed drawings of each stressing line used in prestressed pretensioned concrete fabrication. Provide permanent identification marks, to remain visible at all times when installed, on each load-carrying component to match the stressing line plan details. A licensed professional engineer must seal the plans, specifications, and design calculations for each stressing line. Furnish certification, sealed by a licensed professional engineer, stating that construction of the facilities, including each stressing line, are in accordance with the plans and specifications. Submit the drawings and calculations to the Engineer for approval before beginning work.

On the plans for each stressing line, specify the maximum loading capacity of each permanently identified load-carrying component and the maximum allowable design load and ultimate capacity (load, overturning moment, and uplift force) of each stressing line. Changes to the stressing lines that modify the load-carrying capacity of any component are subject to the same requirements stated above in this section. Provide revised drawings, sealed by a licensed professional engineer, for any changes to the stressing line plans to the Engineer.

Proof-load new and modified stressing lines and, when directed, any existing stressing line, to a minimum 10% overload (10% greater than maximum anticipated working load, overturning moment, and uplift force) for 8 hr. to establish approved working loads. Submit proof-loading procedures, sealed by a licensed professional engineer, 7 days before scheduled proof-loading, that include:

- stressing line designation,
- stressing line hardware configuration,
- load capacity and actual load during proof-loading for each permanently identified load-carrying component,
- strand pattern,
- total load,
- load eccentricity with respect to the same reference point shown on the stressing line plans, and
- certification that the proof-loading procedure does not exceed the maximum allowable design load, overturning moment, or uplift force of the stressing line by more than 10%.

For changes in facilities considered minor by the Engineer, which do not require proof-loading, submit revised drawings sealed by a licensed professional engineer. Submit written certification by a licensed professional engineer or the quality control supervisor (as defined in Article 9, “Personnel Qualifications”) that the modifications were performed in accordance with the revised facility drawings.

When facilities are reassembled, submit written certification by a licensed professional engineer or the quality control supervisor that the reassembly was performed in accordance with approved facility drawings.

Verify that load-carrying components are properly positioned and are adequately supported under load. If damage occurs to the facilities, have qualified personnel review and ensure structural adequacy and safety before subsequent use.

8. PLANT APPROVAL

8.1. **Plant Submittals.** Provide the following submittals to the Engineer for approval for each particular plant operation. Do not begin Department work until the Engineer approves these submittals.

- **Multi-Project Fabrication Plants**—proposed field office and inspection laboratory floor plan drawings per Section 7.1.1., "Multi-Project Fabrication Plant;"
- **Multi-Project Prestressed Member Fabrication Plants and Project-Specific Prestressed Member Fabrication Plants**—stressing line plans, specifications, and design calculations for prestressed pretensioned member production per Section 7.3, "Plant Facilities;"
- **Multi-Project Fabrication Plants and Project-Specific Major Prestressed Member Fabrication Plants**—designated licensed professional engineer (if required), quality control supervisor, and quality control technicians and their required certifications or licenses per Article 9, "Personnel Qualifications;" and
- **Multi-Project Fabrication Plants and Project-Specific Major Prestressed Member Fabrication Plants**—written Production and Quality Control Procedures per Section 10.1.1.1. or Section 10.2.1.1., "Quality Control Procedures," and documentation forms for production processes per Section 10.1.1.5. or Section 10.2.1.5., "Documentation."

8.2. **Plant Audits.** The following applies to both Multi-Project and Project-Specific Major Prestressed Member Fabrication Plants.

8.2.1. **Initial Plant Audits.** Plants must pass an initial Department-directed plant audit. The Department will evaluate fabrication plants for competence of the plant, equipment, organization, experience, knowledge, and personnel to produce acceptable product. This audit will verify plant compliance with this specification in order to be placed on the MPL. Discrepancies identified in the audit must be adequately addressed in a manner acceptable to the Department prior to being placed on the MPL.

8.2.2. **Periodic Plant Audits.** Plants must pass periodic, unannounced, Department-directed plant audits. These additional audits will be performed as determined by the Department for the plant to remain on the MPL as an approved Multi-project Fabrication Plant. Discrepancies identified in the audit must be adequately addressed in a manner acceptable to the Department in order to remain on the MPL.

9. PERSONNEL QUALIFICATIONS

9.1. **Multi-Project Prestressed Member Fabrication Plant.** Provide qualified personnel as follows, unless otherwise approved only on a temporary basis.

9.1.1. **Licensed Professional Engineer.** Have readily available access to the services of a licensed professional engineer experienced in precast prestressed concrete fabrication. This Engineer will be responsible for the design, modification, proof-load procedure development, and review of stressing facilities as stated in Section 7.3., "Plant Facilities," will review potentially structurally deficient members; and will develop flame release sequence procedures as specified in Item 424 when strands are individually detensioned.

9.1.2. **Quality Control Personnel.** Provide an adequate number of qualified personnel to perform the duties listed in Section 10.1.1., "Contractor." QC personnel must be independent of production personnel and proficient in utilizing Department specifications and test methods (if performing or overseeing any concrete or aggregate tests), as determined by the Engineer. QC personnel must have current certifications as follows for the duties listed in Section 10.1.1. Personnel performing these duties are subject to Department approval.

9.1.2.1. **Quality Control Supervisor (On Site).**

- PCI Level III Quality Control Technician (for major prestressed member production),
- PCI Level II Quality Control Technician (for minor prestressed member production),
- ACI Concrete Field Testing Technician – Grade I,
- ACI Aggregate Testing Technician – Level 1, and
- ACI Concrete Strength Testing Technician.

9.1.2.2. **Quality Control Technicians (On Site).**

- PCI Level II Quality Control Technician, for QC personnel performing any tasks listed under Section 10.1.1.3., "Inspection,"
- ACI Concrete Field Testing Technician – Grade I, for QC personnel performing fresh concrete testing per Table 1, (PCI Level II QC technician is required for inspection of concrete batching, placing, consolidating, finishing, and curing),
- ACI Aggregate Testing Technician – Level 1, for QC personnel performing aggregate testing per Table 1, and
- ACI Concrete Strength Testing Technician, for QC personnel performing Tex-418-A.

9.1.3. **Fabricator Safety Point of Contact.** Designate a safety point of contact. Fabricator must adhere to applicable safety regulations and own safety program.

9.2. **Multi-Project Nonstressed Member Fabrication Plant.** Provide qualified personnel as follows, unless otherwise approved only on a temporary basis.

Provide an adequate number of qualified QC personnel to perform the applicable duties listed in Section 10.1.1., "Contractor." QC personnel must be independent of production personnel and proficient in utilizing Department specifications and test methods (if performing or overseeing any concrete or aggregate tests), as determined by the Engineer. QC personnel must have current certifications as follows for the duties listed in Section 10.1.1. Personnel performing these duties are subject to Department approval.

9.2.1. **Quality Control Supervisor (On Site).**

- PCI Level I Quality Control Technician or ACI – Concrete Construction Special Inspector,
- ACI Concrete Field Testing Technician - Grade I,
- ACI Aggregate Testing Technician – Level 1, and
- ACI Concrete Strength Testing Technician.

9.2.2. **Quality Control Technicians (On Site).**

- PCI Level I Quality Control Technician, or ACI Concrete Construction Special Inspector, or NPCA Production and Quality School Level I (recertification required every five years);
- ACI Concrete Field Testing Technician – Grade I, for QC personnel performing fresh concrete testing per Table 1; (PCI Level I QC technician, or ACI Concrete Construction Special Inspector, or NPCA Production and Quality School Level I is required for inspection of concrete batching, placing, consolidating, finishing, and curing);
- ACI Aggregate Testing Technician – Level 1, for QC personnel performing aggregate testing per Table 1; and
- ACI Concrete Strength Testing Technician, for QC personnel performing Tex-418-A.

9.2.3. **Fabricator Safety Point of Contact.** Designate a safety point of contact. Fabricator must adhere to applicable safety regulations and own safety program.

9.3. **Project-Specific Major Prestressed Member Fabrication Plant.** Provide qualified personnel as follows.

9.3.1. **Licensed Professional Engineer.** Have readily available access to the services of a licensed professional engineer experienced in precast prestressed concrete fabrication. This Engineer will be responsible for the design, modification, proof-load procedure development, and review of stressing facilities as stated in Section 7.3., "Plant Facilities"; will review potentially structurally deficient members; and will develop flame release sequence procedures as specified in Item 424 when strands are individually detensioned.

9.3.2. **Quality Control Personnel.** Provide an adequate number of qualified personnel to perform the duties listed in Section 10.2.1., "Contractor." QC personnel must be independent of production personnel and hold current certifications as follows for the duties listed in Section 10.2.1. Personnel performing these duties are subject to Department approval.

9.3.2.1. **Quality Control Supervisor (On Site).**

- PCI Level III Quality Control Technician;
- ACI Concrete Field Testing Technician – Grade I;
- ACI Aggregate Testing Technician – Level 1, for QC personnel performing aggregate testing per Table 1; and
- ACI Concrete Strength Testing Technician, for QC personnel performing Tex-418-A.

9.3.2.2. **Quality Control Technicians (On Site).**

- PCI Level II Quality Control Technician, for QC personnel performing any tasks listed under Section 10.2.1.3., " Inspection";
- ACI Concrete Field Testing Technician – Grade I, for QC personnel performing fresh concrete testing per Table 1 (PCI Level II QC technician is required for inspection of concrete batching, placing, consolidating, finishing, and curing);
- ACI Aggregate Testing Technician – Level 1, for QC personnel performing aggregate testing per Table 1; and
- ACI Concrete Strength Testing Technician, for QC personnel performing Tex-418-A.

9.3.3. **Fabricator Safety Point of Contact.** Designate a safety point of contact. Fabricator must adhere to applicable safety regulations and own safety program.

9.4. **Project-Specific Minor Prestressed Member and Project-Specific Nonstressed Member Fabrication Plants.** Provide qualified personnel as follows, unless otherwise approved only on a temporary basis.

9.4.1. **Licensed Professional Engineer (for Minor Prestressed Member Production).** Have readily available access to the services of a licensed professional engineer experienced in precast prestressed concrete fabrication. This Engineer will be responsible for the design, modification, proof-load procedure development, and review of stressing facilities as stated in Section 7.3., "Plant Facilities"; will review potentially structurally deficient members; and will develop flame release sequence procedures as specified in Item 424 when strands are individually detensioned.

9.4.2. **Quality Control Personnel (On Site).** Provide an adequate number of qualified personnel to perform the duties listed in Section 10.1.1., "Contractor." QC personnel must be independent of production personnel and proficient in utilizing Department specifications and test methods (if performing or overseeing any concrete or aggregate tests), as determined by the Engineer. QC personnel must have current certifications as follows for the duties listed in Section 10.1.1. Personnel performing these duties are subject to Department approval.

- PCI Level II Quality Control Technician (for minor prestressed member production);
- PCI Level I Quality Control Technician, ACI – Concrete Construction Special Inspector, or NPCA Production and Quality School Level I (recertification required every 5 years) (for nonstressed member production);

- ACI Concrete Field Testing Technician – Grade I, for QC personnel performing fresh concrete testing per Table 1;

NOTE: PCI Level II QC technician for minor prestressed member production or the choice of either PCI Level I QC technician, ACI Concrete Construction Special Inspector, or NPCA Production and Quality School Level I for nonstressed member production is required for inspection of concrete batching, placing, consolidating, finishing, and curing.

- ACI Aggregate Testing Technician – Level 1, for QC personnel performing aggregate testing per Table 1; and
- ACI Concrete Strength Testing Technician, for QC personnel performing Tex-418-A.

9.4.3. **Fabricator Safety Point of Contact.** Designate a safety point of contact. Fabricator must adhere to applicable safety regulations and own safety program.

10. QUALITY RESPONSIBILITIES

10.1. **Multi-Project Fabrication Plant.** Quality control is solely the responsibility of the Contractor. The Department will not perform QC for the Contractor.

10.1.1. **Contractor.** Perform, at minimum, the following activities to ensure the quality and acceptability of fabricated products.

10.1.1.1. **Quality Control Procedures.** Submit written production and QC procedures for Department approval that include at least the following:

- work plan for concrete mix designs per Tex-703-I;
- form maintenance and cleaning;
- placement of prestressing strand, reinforcing steel, and embedments;
- weather protection;
- concrete placement and consolidation;
- concrete finishing;
- concrete curing;
- product and applicable component materials handling and storage; and
- finished product inspection and marking of (stamping) approved product.

For prestressed member production, include additional written QC procedures for the following:

- chuck maintenance and cleaning;
- straight and deflected strand stressing;
- partial and full-length strand debonding methods;
- straight and deflected strand detensioning; and
- internal void form hold-down devices and placement measuring methods for voided Box Beams, etc.

Submit updated procedures for approval when requesting changes to the approved procedures, such as QC personnel, products produced, and procedural changes. Include date of revision and highlighted changes for each submittal.

10.1.1.2. **Material Sampling and Testing.** Perform material QC sampling and testing as specified on the Plans and in Table 1. A third party (commercial laboratory, consultant, etc.) may perform material sampling and testing provided the commercial laboratory meets the criteria defined in Article 3, “Definitions and Abbreviations.”

10.1.1.3. **Inspection.** QC personnel will follow approved procedures and verify correct fabrication processes before requesting Department fabrication inspection and will inspect all finished products before requesting Department finished product inspection. QC personnel must ensure, at minimum:

- proper preparation or evaluation of mix designs per Tex-703-I;
- proper form dimensions, condition, cleanliness, and placement;
- strand stressing per approved QC procedures (including written certification);
- proper placement of reinforcing steel, embedments, and strand (including written certification);
- proper placement and measuring methods for Box Beam internal void forms during casting (including written certification);
- proper procedures for batching, mixing, placing, consolidating, finishing, and curing of concrete;
- proper procedures for detensioning (including written certification) and form removal;
- proper procedures for final inspection of product;
- proper procedures for repairs in accordance with the Department's *Concrete Repair Manual*;
- proper procedures for storage of applicable component materials;
- proper procedures for handling, storage, and loading of members; and
- proper procedures for verifying product is marked with approval stamp, is properly identified, and is not damaged or in need of repair at time of shipping.

10.1.1.4. **Certification of Product.** QC personnel must, at minimum, within 14 days of the product cast date:

- track product deficiencies on the Department-supplied spreadsheet, certifying that the repairs and corrective measures were performed and inspected properly by initialing the spreadsheet and placing QC stamp on repair;
- verify product conformance with the shop drawings and all Contract requirements (including written certification);
- mark completed and approved precast concrete products by placing fabricator's monogram stamp including a protective clear coating over the stamp on each member, unless the member is submitted on NCR or has not attained the required design strength. NCRs must be received within 14 days of the cast date. If product on NCR is accepted, repair and mark within 14 days of approval. The monogram stamp must be Department-approved prior to use. Approved fabricator monogram stamps will be listed on the MPL; and
- mark unacceptable precast concrete products with a permanent mark, acceptable to the Engineer, near the product identification marks or remove all project information including county, project number, and CSJ. If the Engineer has approved the marking of product with a fabricator job number instead of the required project information, also remove the fabricator job number.

10.1.1.5. **Documentation.** The Department must receive the following documentation before approving members. Maintain all documentation, available upon Department request. Record and submit information on Department-approved forms as follows:

- aggregate test results submitted immediately after completion of required tests (retention—6 months);
- casting schedule submitted before fabrication that includes, when used, full-length debonding strand patterns for each member;
- printout or manual record of the actual stressing operation (strand load and elongation) with certification that it was performed in accordance with approved QC procedures, submitted immediately after stressing (retention—until final acceptance of project);
- certification that placement of reinforcing steel, embedments, and strand are in conformance with the specifications;
- Box Beam internal void form placement measurements with certification that placement and measuring methods were performed in accordance with approved QC procedures, submitted immediately after casting (retention—until final acceptance of project);
- casting information recorded and available upon request immediately after casting;

- certification that strand detensioning was performed in accordance with approved QC procedures, submitted immediately after strand detensioning;
- certification that repairs were performed in accordance with the Department's *Concrete Repair Manual*;
- certification that finished product conforms with shop drawing and other plan requirements;
- completed Department form PC-2 or PC-7, submitted electronically after product meets all specification requirements (retention—until final acceptance of project); and
- completed Department form PC-2 or PC-7, copy of shop drawing, and concrete mix design worksheet for products allowed to be placed in unassigned stock inventory.

Maintain the following documentation in addition, available upon Department request:

- summary of proof load data (retention—until superseded);
- calibration certifications (retention—until superseded);
- plant laboratory qualification documentation, as required in the applicable sections of Tex-237-F and Tex-498-A (retention—until superseded);
- material test reports (retention—1 year);
- personnel certifications (retention—until superseded);
- cement invoices / material test reports (retention—90 days);
- fresh concrete test results worksheets for required tests (retention—1 year);
- moisture correlation test results for moisture probes (retention—6 months);
- concrete batch plant certification / mixer correspondence (retention—until superseded);
- concrete batch tickets (retention—90 days); and
- Department-supplied product deficiencies spreadsheet and NCRs (retention—7-years).

10.1.2. **Department.** The Department will perform, at minimum, the following activities to ensure the quality and acceptability of fabricated products and will verify acceptable fabrication processes used by the Contractor. The Contractor must provide assistance to Department personnel as needed during sampling and inspection. Inspection or lack of inspection by the Department will not relieve the Contractor from the obligation to provide materials or perform the work in accordance with the Contract.

10.1.2.1. **Quality Control Procedures.** The Department will review for approval the Contractor's written production and QC procedures.

10.1.2.2. **Material Sampling and Testing.** The Department will perform material sampling and testing as needed to verify specification compliance.

10.1.2.3. **Inspection.** The Department will monitor QC performance and perform fabrication and finished product inspection as needed to verify specification compliance.

10.1.2.4. **Documentation.** The Department will verify that the Contractor provides proper documentation.

Table 1
Contractor Minimum Material QC Sampling and Testing Frequencies

Material	Test Method	Frequency
Fine Aggregate	Sieve Analysis[1] Tex-401-A	1 per 2,000 cu. yd. of concrete, minimum 1 per week for each source[2]
	Fineness Modulus[1] Tex-402-A	1 per 2,000 cu. yd. of concrete, minimum 1 per week for each source[2]
	Sand Equivalent[3] Tex-203-F	1 per 2,000 cu. yd. of concrete, minimum 1 per week for each source[2]
	Specific Gravity and Absorption[1 or 9] Tex-403-A	1 per 6 months and when the material source changes
	Unit Weight[1 or 9] Tex-404-A	1 per 6 months and when the material source changes
	Moisture Content[1 or 4] Tex-409-A, Tex-425-A, or ASTM C 566	1 before the first batch of concrete placed each day and when there is an apparent change[5]
Coarse Aggregate	Sieve Analysis[1] Tex-401-A	1 per 2,000 cu. yd. of concrete, minimum 1 per week for each source[2]
	Decantation[1] Tex-406-A	1 per 2,000 cu. yd. of concrete, minimum 1 per week for each source[2]
	Specific Gravity and Absorption[1 or 9] Tex-403-A	1 per 6 months and when the material source changes
	Unit Weight[1 or 9] Tex-404-A	1 per 6 months and when the material source changes
	Moisture Content[1 or 4] Tex-409-A or ASTM C 566	1 before the first batch of concrete placed each day and when there is an apparent change[5]
Conventional Concrete	Slump[6] Tex-415-A	1 for the first batch of concrete placed and 1 for each set of compressive strength cylinders[7]
	Air Content (for air-entrained concrete)[6] Tex-414-A or Tex-416-A	Test in accordance with Item 421
	Temperature[6] Tex-422-A	1 for the first batch of concrete placed and 1 for each set of compressive strength cylinders[7]
	Unit Weight[6] Tex-417-A	1 per month and when a new mix design is established[8]
	Making Test Cylinders[6] Tex-447-A	In accordance with Tex-704-I, and as directed
	Initial Time of Set[6] Tex-440-A	When a new mix design with accelerating admixture is established or accelerated curing will be used, and as directed
	Compressive Strength[1] Tex-418-A	In accordance with Tex-704-I, and as directed
Self-Consolidating Concrete (SCC)	Slump Flow and VSI Rating[6] ASTM C 1611	1 for each of the first 2 batches of concrete placed, 1 for every 5th continuous batch (not delivered load) thereafter, and 1 for each set of compressive strength cylinders[7]
	Air Content (for air-entrained concrete)[6,10] Tex-414-A or Tex-416-A	Test in accordance with Item 421
	Temperature[6] Tex-422-A	1 for the first batch of concrete placed and 1 for each set of compressive strength cylinders[7]

Material	Test Method	Frequency
Self-Consolidating Concrete (SCC) (continued)	Unit Weight[6,10] Tex-417-A	1 per month and when a new mix design is established[8]
	Making Test Cylinders[6,10] Tex-447-A	In accordance with Tex-704-I, and as directed
	Initial Time of Set[6,10] Tex-440-A	When a new mix design with accelerating admixture is established or accelerated curing will be used, and as directed
	Compressive Strength[1] Tex-418-A	In accordance with Tex-704-I, and as directed
	T-50[6] ASTM C 1611	2 per year (summer and winter) and when a new mix design is established
	Passing Ability (J-ring)[6] ASTM C 1621	2 per year (summer and winter) and when a new mix design is established
	Segregation Column[6] ASTM C 1610	2 per year (summer and winter) and when a new mix design is established
	Bleeding[6,10] ASTM C 232	2 per year (summer and winter) and when a new mix design is established
	Modulus of Elasticity ASTM C 469	as directed by the Engineer based on material characteristics

1. QC personnel with current ACI Aggregate Testing Technician – Level 1 certification will perform aggregate test or QC personnel with current ACI Concrete Strength Testing Technician certification will perform concrete compressive strength test.
2. For new aggregate sources and after a failing test for existing sources, increase the testing frequency to 1 per 500 cu. yd. of concrete production, tested prior to use, until obtaining 3 consecutive passing tests. Do not use failed aggregate in the concrete without approval.
3. QC personnel qualified by the Department for this particular test will perform this test.
4. Fabricator personnel qualified by the QC Supervisor for this particular test may perform this test.
5. When aggregate weighing hoppers or storage bins are equipped with properly maintained electric moisture probes for continuous moisture determination, moisture tests are not required daily. Electric moisture probes, however, must be verified weekly against Tex-409-A or ASTM C 566 and be accurate to within 0.3% of the actual free moisture content. Electric moisture probes are required for SCC unless approved by the Engineer. If approved, test moisture content every 4 hours or when there is an apparent change while SCC is being produced.
6. QC personnel with current ACI Concrete Field Testing Technician – Grade I certification will perform the test.
7. For prestressed members, at least 3 total tests per casting line. For nonstressed members, at least 2 total tests per casting lot. If a test fails, test every delivered load until 3 consecutive tests pass. Perform additional tests when directed.
8. When the fresh unit weight of concrete varies from the established value by more than ± 2 lb. per cu. ft., check the air content first to determine if air content has changed from the initial mix design. If the air content is correct, check the aggregate unit weight, gradation, moisture content, and specific gravity. Also, check that the mix proportions have not changed. Verify the fresh unit weight of concrete after making adjustments.
9. Aggregate material supplier may perform the test and provide certified test results.
10. Follow ASTM C 1758 for filling of the test specimens.

10.2. **Project-Specific Major Prestressed Member Fabrication Plant.** Quality control is solely the responsibility of the Contractor, and the Department will not perform QC for the Contractor.

10.2.1. **Contractor.** Perform, at minimum, the following activities to ensure the quality and acceptability of fabricated products.

10.2.1.1. **Quality Control Procedures.** Submit written production and QC procedures for Department approval that include at least the following:

- work plan for concrete mix designs per Tex-703-I;
- form maintenance and cleaning;
- placement of prestressing stand, reinforcing steel, and embedments;

- weather protection;
- concrete placement and consolidation;
- concrete finishing;
- concrete curing;
- product and applicable component materials handling and storage;
- chuck maintenance and cleaning;
- straight and deflected strand stressing;
- partial and full-length strand debonding methods;
- straight and deflected strand detensioning;
- internal void form hold-down devices and placement measuring methods for voided Box Beams, etc.; and
- finished product inspection.

Submit updated procedures for approval when requesting changes to the approved procedures, such as QC personnel, products produced, and procedural changes. Include date of revision and highlighted changes for each submittal.

10.2.1.2. **Material Sampling and Testing.** Perform material QC sampling and testing as specified on the Plans and for the Conventional Concrete tests listed in Table 1. For Contractor job control testing, perform compressive strength testing to verify Handling Strength and Partial Tensioning Strength (release strength) requirements when specified on the Plans.

10.2.1.3. **Inspection.** QC personnel will verify correct fabrication processes before requesting Department fabrication inspection and will inspect all finished products before requesting Department finished product inspection. QC personnel must ensure, at minimum:

- proper preparation or evaluation of mix designs per Tex-703-I;
- proper form dimensions, condition, cleanliness, and placement;
- strand stressing per approved QC procedures (including written certification);;
- proper placement of reinforcing steel, embedments, and strand (including written certification);
- proper placement and measuring methods for Box Beam internal void forms during casting (including written certification);
- proper procedures for batching, mixing, placing, consolidating, finishing, and curing of concrete;
- proper procedures for detensioning (including written certification) and form removal;
- proper procedures for final inspection of product;
- proper procedures for repairs in accordance with the Department's *Concrete Repair Manual*;
- proper procedures for storage of applicable component materials;
- proper procedures for handling, storage, and loading of members; and
- proper procedures for verifying product is marked with approval stamp, is properly identified, and is not damaged or in need of repair at time of shipping.

10.2.1.4. **Certification of Product.** QC personnel must, at minimum, within 14 days of the product cast date:

- track all product deficiencies on the Department-supplied spreadsheet, certifying that the repairs and corrective measures were performed and inspected properly by initialing the spreadsheet and placing QC stamp on repair;
- verify product conformance with the shop drawings and all Contract requirements (including written certification);
- mark completed and approved precast concrete products, in a manner acceptable to the Engineer, unless the member is submitted on NCR or has not attained the required design strength. NCRs must

be received within 14 days of the cast date. If product on NCR is accepted, repair and mark within 14 days of approval; and

- mark unacceptable precast concrete products with a permanent mark, acceptable to the Engineer, near the product identification marks.

10.2.1.5. **Documentation.** The Department must receive the following documentation before approving members. Maintain, at a minimum, the following documentation until final acceptance of the project, available upon Department request. Record and submit this information on Department-approved forms as follows:

- casting schedule submitted before fabrication that includes, when used, full-length debonding strand patterns for each member;
- printout or manual record of the actual stressing operation (strand load and elongation) with certification that it was performed in accordance with approved QC procedures, submitted immediately after stressing;
- certification that placement of reinforcing steel, embedments, and strand are in conformance with the specifications;
- Box Beam internal void form placement measurements with certification that placement and measuring methods were performed in accordance with approved QC procedures, submitted immediately after casting;
- casting information recorded and available upon request immediately after casting;
- certification that strand detensioning was performed in accordance with approved QC procedures, submitted immediately after strand detensioning;
- certification that repairs were performed in accordance with the Department's *Concrete Repair Manual*;
- certification that finished product conforms with shop drawing and other plan requirements; and
- completed Department form PC-2 or PC-7, submitted electronically after product meets all specification requirements.

Maintain the following documentation in addition, available upon Department request:

- summary of proof load data (retention—until superseded);
- calibration certifications (retention—until superseded);
- plant laboratory qualification documentation, as required in the applicable sections of Tex-498-A (retention—until superseded);
- material test reports (retention—1 year);
- personnel certifications (retention—until superseded);
- cement invoices / material test reports (retention—90 days);
- fresh concrete unit weight worksheets (retention—6 months);
- moisture correlation test results for moisture probes (retention—6 months);
- concrete batch plant certification / mixer correspondence (retention—until superseded);
- Concrete batch tickets (retention—90 days); and
- Department-supplied product deficiencies spreadsheet and NCRs (retention—7 years).

10.2.2. **Department.** The Department will perform, at minimum, the following activities to ensure the quality and acceptability of fabricated products and will verify acceptable fabrication processes used by the Contractor. The Contractor must provide assistance to Department personnel as needed during sampling and inspection. Inspection or lack of inspection by the Department will not relieve the Contractor from the obligation to provide materials or perform the work in accordance with the Contract.

10.2.2.1. **Quality Control Procedures.** The Department will review for approval the Contractor's written production and QC procedures.

10.2.2.2. **Material Sampling and Testing.** The Department will perform material sampling and testing as needed to verify specification compliance.

10.2.2.3. **Inspection.** The Department will monitor QC performance and perform fabrication and finished product inspection as needed to verify specification compliance.

10.2.2.4. **Documentation.** The Department will verify that the Contractor provides proper documentation.

10.3. **Project-Specific Minor Prestressed Member and Project-Specific Nonstressed Member Fabrication Plants.** Quality control is solely the responsibility of the Contractor, and the Department will not perform QC for the Contractor.

10.3.1. **Contractor.** Perform, at minimum, the following activities to ensure the quality and acceptability of fabricated products.

10.3.1.1. **Quality Control Procedures.** Submit written production and QC procedures for Department approval that include at least the following:

- work plan for concrete mix designs per Tex-703-I;
- proper procedures for maintaining concrete quality in accordance with Item 424.4.2.4 and Item 424.4.2.5;
- straight strand stressing and detensioning;
- chuck maintenance and cleaning; and
- finished product inspection.

Submit updated procedures for approval when requesting changes to the approved procedures, such as QC personnel, products produced, and procedural changes. Include date of revision and highlighted changes for each submittal.

10.3.1.2. **Material Sampling and Testing.** Perform material QC sampling and testing as specified on the Plans and for the Conventional Concrete tests listed in Table 1. For Contractor job control testing, perform compressive strength testing to verify "Handling Strength" and "Partial Tensioning Strength" (release strength) requirements when specified on the plans.

10.3.1.3. **Inspection.** QC personnel will verify correct fabrication processes before requesting Department fabrication inspection and will inspect all finished products before requesting Department finished product inspection. QC personnel must ensure, at minimum:

- proper preparation or evaluation of mix designs per Tex-703-I;
- proper form dimensions, condition, cleanliness, and placement;
- strand stressing per approved QC procedures (including written certification);
- proper placement of reinforcing steel, embedments, and strand (including written certification);
- proper procedures for batching, mixing, placing, consolidating, finishing, and curing of concrete;
- proper procedures for detensioning (including written certification) and form removal;
- proper procedures for final inspection of product;
- proper procedures for repairs in accordance with the Department's *Concrete Repair Manual*;
- proper procedures for storage of applicable component materials;
- proper procedures for handling, storage, and loading of member; and
- proper procedures for verifying product is marked with approval stamp, is properly identified, and is not damaged or in need of repair at time of shipping.

10.3.1.4. **Certification of Product.** QC personnel, at minimum, must within 14 days of the product cast date:

- track all product deficiencies on the Department-supplied spreadsheet, certifying that the repairs and corrective measures were performed and inspected properly by initialing the spreadsheet and placing QC stamp on repair;
- verify product conformance with the shop drawings and all Contract requirements (including written certification);
- mark completed and approved precast concrete products, in a manner acceptable to the Engineer, unless the member is submitted on NCR or has not attained the required design strength. NCRs must be received within 14 days of the cast date. If product on NCR is accepted, repair and mark within 14 days of approval; and
- mark unacceptable precast concrete products with a permanent mark, acceptable to the Engineer, near the product identification marks.

10.3.1.5. **Documentation.** The Department must receive the following documentation before approving members. Maintain, at a minimum, the following documentation until final acceptance of the project, available upon Department request. Record and submit this information on Department-approved forms as follows:

- printout or manual record of the actual stressing operation (strand load and elongation) with certification that it was performed in accordance with approved QC procedures, submitted immediately after stressing;
- certification that placement of reinforcing steel, embedments, and strand are in conformance with the specifications;
- casting information recorded and available upon request immediately after casting;
- certification that strand detensioning was performed in accordance with approved QC procedures, submitted immediately after strand detensioning;
- certification that repairs were performed in accordance with the Department's *Concrete Repair Manual*;
- certification that finished product conforms with shop drawing and other plan requirements; and
- completed Department form PC-2 or PC-7, submitted electronically after product meets all specification requirements.

Maintain the following documentation in addition, available upon Department request:

- Summary of Proof Load Data (retention—until superseded);
- Calibration certifications (retention—until superseded);
- Material test reports (retention—1 year);
- Personnel certifications (retention—until superseded);
- Cement invoices / material test reports (retention—90 days);
- Moisture correlation test results for moisture probes (retention—6 months);
- Concrete batch tickets (retention—90 days); and
- Department-supplied product deficiencies spreadsheet and NCRs (retention—7 years).

10.3.2. **Department.** The Department will perform, at minimum, the following activities to ensure the quality and acceptability of fabricated products and will verify acceptable fabrication processes used by the Contractor. The Contractor must provide assistance to Department personnel as needed during sampling and inspection. Inspection or lack of inspection by the Department will not relieve the Contractor from the obligation to provide materials or perform the work in accordance with the Contract.

10.3.2.1. **Quality Control Procedures.** The Department will review for approval the Contractor's written production and QC procedures.

10.3.2.2. **Material Sampling and Testing.** The Department will perform material sampling and testing as needed to verify specification compliance.

10.3.2.3. **Inspection.** The Department will monitor QC performance and perform fabrication and finished product inspection as needed to verify specification compliance.

10.3.2.4. **Documentation.** The Department will verify that the Contractor provides proper documentation.

11. ARCHIVED VERSIONS

Archived versions are available.

Reinforced Concrete Pipe and Machine-Made Precast Box Culvert Fabrication Plants

NOTE: Refresh the page to view the most current list.

Reference

Refer to the Spec Book for information on the following:

- ♦ Item 462, "Concrete Box Culverts and Storm Drains," and
- ♦ Item 464, "Reinforced Concrete Pipe"

Fabrication Plants

The following fabrication plants have been approved in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification," which is referenced in Items 462 & 464.

Reinforced Concrete Pipe and Machine-Made Precast Box Culvert Fabrication Plants

Producer Code	Fabricator	Location
98371	AmeriTex Pipe & Products, LLC	Conroe, TX
98183	AmeriTex Pipe & Products, LLC	Seguin, TX
99231	CAPA - Rio Valley Pipe, LLC	Penitas, TX
98131	Del Zotto Products of Texas, Inc. (♦)	Gladewater, TX
99742	Forterra (formerly Hanson Pipe and Precast, Inc.)	Austin, TX
99747	Forterra (formerly Hanson Pipe and Precast, Inc.)	Cedar Hill, TX
99726	Forterra (formerly Hanson Pipe and Precast, Inc.)	Grand Prairie, TX
99759	Forterra – Jersey Village Plant (formerly Hanson Pipe and Precast, Inc. – Jersey Village Plant)	Houston, TX
98140	Forterra (formerly South Plains Concrete Products)	Lubbock, TX
99003	Forterra (formerly Hanson Pipe and Precast, Inc.)	Robstown, TX
99730	Forterra (formerly Hanson Pipe and Precast, Inc.)	San Antonio, TX
99556	Forterra (formerly J&G Concrete Products)	Waxahachie, TX
98187	Rinker Materials – Alexandria Plant	Alexandria, LA
99727	Rinker Materials – Dallas/Fort Worth Plant	Roanoke, TX
99745	Rinker Materials – El Paso Plant	Santa Teresa, NM
99758	Rinker Materials – Langfield Plant	Houston, TX
99748	Rinker Materials – San Antonio Plant	Castroville, TX
98012	Thompson Pipe Group Dallas (formerly Johnson County Pipe, Inc.)	Alvarado, TX
99184	Thompson Pipe Group Houston (formerly Conroe Pipe, Inc.)	Conroe, TX

(♦) denotes - Fabricator is approved to produce and certify only RC pipe to Department projects.

NOTE: Precast products will have either a TxDOT monogram stamp or the fabricator's designated approval stamp as shown on the following pages.

For more information, contact CST/M&P's Structural Materials Branch at (512) 506-5924.

General

The Department reserves the right to conduct random sampling and testing and visual inspections of materials from approved fabrication plants. Department representatives may sample and inspect material from the fabrication plant or the project site. CST/M&P reserves the right to test samples to verify compliance with Items 462 and 464.

Designated Fabricator Approval Stamps
(For RC Pipe and Machine-Made Precast Box Culverts unless otherwise noted.)

AmeriTex Pipe & Products, 98183 (Seguin, TX) AmeriTex Pipe AmeriTex Pipe & Products LLC CERTIFIES SPECIFICATION COMPLIANCE SEGUIN, TX or AmeriTex Pipe AmeriTex Pipe & Products LLC CERTIFIES SPECIFICATION COMPLIANCE	**CAPA - Rio Valley Pipe, LLC 99231** (Penitas, TX) CAPA CONCRETE ▲ ASPHALT ▲ PIPE ▲ AGGREGATES CAPA RIO VALLEY PIPE, LLC. CERTIFIES SPECIFICATIONS COMPLIANCE or RIO VALLEY PIPE, LLC. RIO VALLEY PIPE, LLC. CERTIFIES SPECIFICATIONS COMPLIANCE
AmeriTex Pipe & Products, 98371 (Conroe, TX) AmeriTex Pipe AmeriTex Pipe & Products LLC CERTIFIES SPECIFICATION COMPLIANCE CONROE, TX	**Del Zotto Products of Texas, Inc., 98131** (Gladewater, TX) DZ AMERICAN OWNED CO. DEL ZOTTO CERTIFIES SPECIFICATION COMPLIANCE This Fabricator is approved to produce and certify only RC Pipe for Department projects.

Forterra, 99742
(formerly Hanson Pipe and Precast, Inc.)
(Austin, TX)

FORTERRA
AUSTIN
01 CERTIFIES SPECIFICATION COMPLIANCE

Note: 2-Digit No. designates Q.C. person's I.D. No

or

Hanson
AUSTIN
CERTIFIES SPECIFICATION COMPLIANCE
01

Forterra, 99726
(formerly Hanson Pipe and Precast, Inc.)
(Grand Prairie, TX)

FORTERRA
GRAND PRAIRIE
01 CERTIFIES SPECIFICATION COMPLIANCE

Note: 2-Digit No. designates Q.C. person's I.D. No.

or

Hanson
GRAND PRAIRIE
CERTIFIES SPECIFICATION COMPLIANCE
01

Forterra, 99747
(formerly Hanson Pipe and Precast, Inc.)
(Cedar Hill, TX)

FORTERRA
CEDAR HILL
01 CERTIFIES SPECIFICATION COMPLIANCE

Note: 2-Digit No. designates Q.C. person's I.D. No.

or

Hanson
CEDAR HILL
CERTIFIES SPECIFICATION COMPLIANCE
01

Forterra – Jersey Village, 99759
(formerly Hanson Pipe and Precast, Inc.)
(Houston, TX)

FORTERRA
JERSEY VILLAGE
01 CERTIFIES SPECIFICATION COMPLIANCE

Note: 2-Digit No. designates Q.C. person's I.D. No.

or

Hanson
JERSEY VILLAGE
CERTIFIES SPECIFICATION COMPLIANCE
01

Forterra, 98140
(formerly South Plains Concrete Products)
(Lubbock, TX)

FORTERRA
LUBBOCK
01 CERTIFIES SPECIFICATION COMPLIANCE

or

SOUTH PLAINS CONCRETE PRODUCTS
SP
CERTIFIES SPECIFICATION COMPLIANCE

Forterra, 99730
(formerly Hanson Pipe and Precast, Inc.)
(San Antonio, TX)

FORTERRA
SAN ANTONIO
01 CERTIFIES SPECIFICATION COMPLIANCE

Note: 2-Digit No. designates Q.C. person's I.D. No.

or

Hanson
SAN ANTONIO
CERTIFIES SPECIFICATION COMPLIANCE
01

Forterra, 99003
(formerly Hanson Pipe and Precast, Inc.)
(Robstown, TX)

FORTERRA
ROBSTOWN
01 CERTIFIES SPECIFICATION COMPLIANCE

or

Hanson
ROBSTOWN
CERTIFIES SPECIFICATION COMPLIANCE
01

Forterra, 99556
(formerly J&G Concrete Products)
(Waxahachie, TX)

FORTERRA
WAXAHACHIE
01 CERTIFIES SPECIFICATION COMPLIANCE

or

J&G CONCRETE PRODUCTS
J+G
CERTIFIES SPECIFICATION COMPLIANCE

Rinker Materials – Alexandria, LA Plant, 98187
(Alexandria, LA)

Rinker
RINKER MATERIALS
ALEXANDRIA CERTIFIES SPECIFICATION COMPLIANCE
01

Note: 2-Digit No. designates Q.C. person's I.D. No.

Rinker Materials – Dallas/Fort Worth Plant, 99727
(Roanoke, TX)

Rinker
RINKER MATERIALS
DFW CERTIFIES SPECIFICATION COMPLIANCE
01

Note: 2-Digit No. designates Q.C. person's I.D. No.

Rinker Materials – El Paso Plant, 99745
(Santa Teresa, NM)

Rinker
RINKER MATERIALS
EL PASO CERTIFIES SPECIFICATION COMPLIANCE

Rinker Materials – Langfield Plant, 99758
(Houston, TX)

Rinker
RINKER MATERIALS
HOUSTON CERTIFIES SPECIFICATION COMPLIANCE
03

Note: 2-Digit No. designates Q.C. person's I.D. No.

Thompson Pipe Group Dallas, 98012
(formerly Johnson County Pipe)
(Alvarado, TX)

THOMPSON PIPEGROUP DALLAS
CERTIFIES SPECIFICATION COMPLIANCE

or

Johnson County Pipe
American Owned
JCP
Certifies Specification Compliance

Thompson Pipe Group, 99184
(formerly Conroe Pipe, Inc.)
(Conroe, TX)

THOMPSON PIPEGROUP HOUSTON
CERTIFIES SPECIFICATION COMPLIANCE

or

CONROE PIPE, INC.
An American Owned Company
CONROE PIPE, INC.
CERTIFIES SPECIFICATIONS COMPLIANCE

Rinker Materials – San Antonio Plant, 99748 (San Antonio, TX) Note: 2-Digit No. designates Q.C. person's I.D. No.	

Item 462
Concrete Box Culverts and Drains

1. DESCRIPTION

Furnish, construct, and install concrete box culverts and drains.

2. MATERIALS

2.1. **General.** Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures,"
- Item 421, "Hydraulic Cement Concrete,"
- Item 440, "Reinforcement for Concrete," and
- Item 464, "Reinforced Concrete Pipe."

Provide cast-in-place or precast, formed or machine-made, box culverts, and drains. Use Class S concrete for top slabs of cast-in-place concrete culverts for culverts with overlay, a 1- to 2-course surface treatment or a top slab that is the final riding surface unless otherwise shown on the plans. Use Class C concrete for the rest of the culvert and for all other cast-in-place boxes. Culverts with fill do not require Class S concrete.

Furnish material for machine-made precast boxes in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.2. **Fabrication.**

2.2.1. **Cast-in-Place.** Meet Item 420, "Concrete Substructures" and Item 422, "Concrete Superstructures."

2.2.2. **Formed Precast.** Meet Item 424, "Precast Concrete Structural Members (Fabrication)."

2.2.3. **Machine-Made Precast.** Machine-made precast box culvert fabrication plants must be approved in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification." The Department's MPL shows approved machine-made precast box culvert plants. Fabricate machine-made precast boxes in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.3. **Testing.**

2.3.1. **Cast-in-Place.** Provide test specimens that meet Item 421, "Hydraulic Cement Concrete."

2.3.2. **Formed Precast.** Make, cure, and test compressive test specimens in accordance with Tex-704-I.

2.3.3. **Machine-Made Precast.** Make, cure, and test compressive test specimens in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.3.4. **Testing Equipment.** The producer must furnish all equipment required for testing concrete for boxes produced in a precasting plant.

2.4. **Lifting Holes.** Provide no more than 4 lifting holes in each section for precast boxes. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate

lifting devices based on the size and weight of the box section. Use lifting holes no larger than 3 in. in diameter. Cut no more than 5 in. in any direction of reinforcement per layer for lifting holes.

2.5. **Marking**. Mark precast boxes with the following:

- name or trademark of fabricator and plant location;
- ASTM designation;
- date of manufacture;
- box size;
- minimum and maximum fill heights;
- designated fabricator's approval stamp;
- boxes to be used for jacking and boring (when applicable);
- designation "SR" for boxes meeting sulfate-resistant concrete plan requirements (when applicable); and
- match-marks for proper installation, when required under Section 462.2.6., "Tolerances."

Mark 1 end of each box section, for boxes without lifting holes, on the inside and outside walls to indicate the top or bottom as it will be installed.

Indent markings into the box section or paint them on each box with waterproof paint.

2.6. **Tolerances**. Ensure precast sections meet the permissible variations listed in ASTM C1577 and that the sides of a section at each end do not vary from being perpendicular to the top and bottom by more than 1/2 in. when measured diagonally between opposite interior corners.

Ensure wall and slab thicknesses are not less than shown on the plans except for occasional deficiencies not greater than 3/16 in. or 5%, whichever is greater. If proper jointing is not affected, thicknesses in excess of plan requirements are acceptable.

Deviations from the above tolerances will be acceptable if the sections can be fitted at the plant or jobsite and the joint opening at any point does not exceed 1 in. Use match-marks for proper installation on sections that have been accepted in this manner.

2.6.1. **Boxes for Jacking Operations**. Use boxes for jacking operations as defined in Item 476, "Jacking, Boring, or Tunneling Pipe or Box," meeting the following additional requirements:

- The box ends must be square such that no point deviates more than 3/8 in. from a plane placed on the end of the box that is perpendicular to the box sides, and
- The slab and wall thicknesses must not be less than specified on the plans and must not exceed the specified thickness by more than 1/2 in.

2.7. **Defects and Repair**. Fine cracks on the surface of the member that do not extend to the plane of the nearest reinforcement are acceptable unless the cracks are numerous and extensive. Repair cracks that extend into the plane of the reinforcing steel in an approved manner. Excessive damage, honeycomb, or cracking will be subject to structural review. The Engineer may accept boxes with repairs that are sound, properly finished, and cured in conformance with pertinent specifications. Discontinue further production of precast sections when fine cracks on the surface indicate poor curing practices until corrections are made and proper curing is provided.

Repair machine-made precast boxes in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.8. **Storage and Shipment**. Store precast sections on a level surface. Do not place any load on the sections until design strength is reached and curing is complete. Shipment of sections is permissible when the design strength and curing requirements have been met.

Store and ship machine-made precast boxes in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

3. CONSTRUCTION

3.1. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures," except where jacking, boring, or tunneling methods are shown on the plans or permitted. Jack, bore, or tunnel in accordance with Item 476, "Jacking, Boring, or Tunneling Pipe or Box." Immediate backfilling is permitted for all box structures where joints consist of materials other than mortar. Take precautions in placing and compacting the backfill to avoid any movement of the boxes or damage to the joints. Remove and replace boxes damaged by the Contractor at no expense to the Department.

3.2. **Placement of Boxes**. Place the box sections in conformance with the plans or as directed when precast boxes are used to form multiple barrel structures. Place material to be used between barrels as shown on the plans or as directed. Start the laying of boxes on the bedding at the outlet end and proceed toward the inlet end with the abutting sections properly matched unless otherwise authorized. Fit, match, and lay the boxes to form a smooth, uniform conduit true to the established lines and grades. Lower the box sections into the trench, for trench installations, without damaging the box or disturbing the bedding and the sides of the trench. Carefully clean the ends of the box before it is placed. Prevent the earth or bedding material from entering the box as it is laid. Remove and re-lay, without extra compensation, boxes that are not in alignment or show excessive settlement after laying. Form and place cast-in-place boxes in accordance with Item 420, "Concrete Substructures."

3.3. **Jointing**. Use any of the jointing materials in accordance with the joint requirements specified in Item 464, "Reinforced Concrete Pipe," unless otherwise shown on the plans. Box joints for rubber gasketed material may be substituted for tongue and groove joints, provided they meet the requirements of ASTM C1677 for design of the joints and permissible variations in dimensions.

3.4. **Connections and Stub Ends**. Make connections of boxes to existing boxes, pipes, drains, or drain appurtenances as shown on the plans. Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections. Connect boxes to any required headwalls, wingwalls, safety end treatments or riprap, or other structures as shown on the plans or as directed. Repair any damage to the existing structure resulting from making the connections. Finish stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the box.

Fill lifting holes with mortar or concrete and cure for precast boxes. Precast concrete or mortar plugs may be used.

3.5. **Extending**. Break back and extend existing culverts in accordance with Section 420.4.8 "Extending Existing Substructures," and Section 422.4.5 "Extending Existing Slabs," as applicable.

4. MEASUREMENT

This Item will be measured by the foot. Measurement will be made between the ends of the culvert or drain along the flow line, not including safety end treatments. Safety end treatments will be measured in accordance with Item 467, "Safety End Treatment." Measurement of spurs, branches, or new connection box section will be made from the intersection of the flow line with the outside surface of the structure into which it connects. Where inlets, headwalls, wingwalls, catch basins, manholes, junction chambers, or other structures are included in lines of culverts or drains, the length of box section tying into the structure wall will be included for measurement, but no other portion of the structure length or width will be included.

The measured length of multiple barrel structures will be the sum of the lengths of the barrels.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Concrete Box Culvert" of the size specified. This price is full compensation for constructing, furnishing, and transporting sections; preparation and shaping of the bed; backfill material between box sections; jointing of sections; jointing material; cutting of sections on skew or slope; connections to new or existing structures; breaking back, removing and disposing of portions of the existing structure and replacing portions of the existing structure as required to make connections; concrete and reinforcing steel; and equipment, labor, materials, tools, and incidentals.

Protection methods for excavations greater than 5 ft. deep will be measured and paid for as required under Item 402, "Trench Excavation Protection," or Item 403, "Temporary Special Shoring." Excavation, shaping, bedding, and backfill will be paid for in accordance with Item 400, "Excavation and Backfill for Structures." When jacking, boring, or tunneling is used at the Contractor's option, payment will be made under this Item. When jacking, boring, or tunneling is required, payment will be made under Item 476, "Jacking, Boring, or Tunneling Pipe or Box."

Item 464
Reinforced Concrete Pipe

1. DESCRIPTION

Furnish and install reinforced concrete pipe, materials for precast concrete pipe culverts, or precast concrete storm drain mains, laterals, stubs, and inlet leads.

2. MATERIALS

2.1. **Fabrication.** Fabrication plants must be approved by the Construction Division in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification," before furnishing precast reinforced concrete pipe for Department projects. The Department's MPL has a list of approved reinforced concrete pipe plants.

Furnish material and fabricate reinforced concrete pipe in accordance with DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.2. **Design.**

2.2.1. **General.** The class and D-load equivalents are shown in Table 1. Furnish arch pipe in accordance with ASTM C506 and the dimensions shown in Table 2. Furnish horizontal elliptical pipe in accordance with ASTM C507 and the dimensions shown in Table 3. For arch pipe and horizontal elliptical pipe the minimum height of cover required is 1 ft.

Table 1
Circular Pipe
ASTM C76 & ASTM C655

Class	D-Load
I	800
II	1,000
III	1,350
IV	2,000
V	3,000

Table 2
Arch Pipe

Design Size	Equivalent Diameter (in.)	Rise (in.)	Span (in.)
1	18	13-1/2	22
2	21	15-1/2	26
3	24	18	28-1/2
4	30	22-1/2	36-1/4
5	36	26-5/8	43-3/4
6	42	31-5/16	51-1/8
7	48	36	58-1/2
8	54	40	65
9	60	45	73
10	72	54	88

Table 3
Horizontal Elliptical Pipe

Design Size	Equivalent Diameter (in.)	Rise (in.)	Span (in.)
1	18	14	23
2	24	19	30
3	27	22	34
4	30	24	38
5	33	27	42
6	36	29	45
7	39	32	49
8	42	34	53
9	48	38	60
10	54	43	68

2.2.2. **Jacking, Boring, or Tunneling**. Design pipe for jacking, boring, or tunneling considering the specific installation conditions such as the soil conditions, installation methods, anticipated deflection angles, and jacking stresses. Provide design notes and drawings signed and sealed by a Texas licensed professional engineer when requested.

2.3. **Marking**. Furnish each section of reinforced concrete pipe marked with the following information specified in DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

- class or D-load of pipe,
- ASTM designation,
- date of manufacture,
- pipe size,
- name or trademark of fabricator and plant location,
- designated fabricator's approval stamp,
- pipe to be used for jacking and boring (when applicable), and
- designation "SR" for pipe meeting sulfate-resistant concrete plan requirements (when applicable).

Clearly mark 1 end of each section during the process of manufacture or immediately thereafter for pipe with elliptical reinforcement. Mark the pipe on the inside and outside of opposite walls to show the location of the top or bottom of the pipe as it should be installed unless the external shape of the pipe is such that the correct position of the top and bottom is obvious. Mark the pipe section by indenting or painting with waterproof paint.

2.4. **Inspection**. Provide access for inspection of the finished pipe at the project site before and during installation.

2.5. **Causes for Rejection**. Individual section of pipe may be rejected for any of the conditions stated in the Annex of DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.6. **Repairs**. Make repairs if necessary as stated in the Annex of DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification."

2.7. **Jointing Materials**. Use any of the following materials for the making of joints unless otherwise shown on the plans. Furnish a manufacturer's certificate of compliance for all jointing materials except mortar.

2.7.1. **Mortar**. Provide mortar for joints that meets the requirements of Section 464.3.3., "Jointing."

2.7.2. **Cold-Applied, Plastic Asphalt Sewer Joint Compound**. Provide a material that consists of natural or processed asphalt base, suitable volatile solvents, and inert filler. Ensure the consistency is such that the ends of the pipe can be coated with a layer of the compound up to 1/2 in. thick by means of a trowel. Provide

a joint compound that cures to a firm, stiff plastic condition after application. Provide a material of a uniform mixture. Stir any small separation found in the container into a uniform mix before using.

Provide a material that meets the requirements of Table 4 when tested in accordance with Tex-526-C.

Table 4
Cold-Applied, Plastic Asphalt Sewer Joint Compound Material Requirements

Composition	Analysis
Asphalt base, 100%–% volatiles–% ash, % by weight	28–45
Volatiles, 212°F evaporation, 24 hr., % by weight	10–26
Mineral matter, determined as ash, % by weight	30–55
Consistency, cone penetration, 150 q, 5 sec., 77°F	150–275

2.7.3. **Rubber Gaskets**. Provide gaskets that conform to ASTM C1619 Class A or C. Meet the requirements of ASTM C443 for design of the pipe joints and permissible variations in dimensions.

2.7.4. **Pre-Formed Flexible Joint Sealants**. Pre-formed flexible joint sealants may be used for sealing joints of tongue-and-groove concrete pipe. Provide flexible joint sealants that meet the requirements of ASTM C990. Use flexible joint sealants that do not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. Supply in extruded rope form of suitable cross-section. Provide a size of the pre-formed flexible joint sealant in accordance with the manufacturer's recommendations and large enough to properly seal the joint. Protect flexible joint sealants with a suitable wrapper able to maintain the integrity of the jointing material when the wrapper is removed.

3. CONSTRUCTION

3.1. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures," except where jacking, boring, or tunneling methods are permitted. Jack, bore, or tunnel the pipe in accordance with Item 476, "Jacking, Boring, or Tunneling Pipe or Box." Immediate backfilling is permitted if joints consist of materials other than mortar. Take special precautions in placing and compacting the backfill to avoid any movement of the pipe or damage to the joints. Do not use heavy earth-moving equipment to haul over the structure until a minimum of 4 ft. of permanent or temporary compacted fill has been placed over the structure unless otherwise shown on the plans or permitted in writing. Remove and replace pipe damaged by the Contractor at no expense to the Department.

3.2. **Laying Pipe**. Start the laying of pipe on the bedding at the outlet end with the spigot or tongue end pointing downstream, and proceed toward the inlet end with the abutting sections properly matched, true to the established lines and grades unless otherwise authorized. Fit, match, and lay the pipe to form a smooth, uniform conduit. Cut cross trenches in the foundation to allow the barrel of the pipe to rest firmly upon the bedding where bell-and-spigot pipe is used. Cut cross trenches no more than 2 in. larger than the bell ends of the pipe. Lower sections of pipe into the trench without damaging the pipe or disturbing the bedding and the sides of the trench. Carefully clean the ends of the pipe before the pipe is placed. Prevent the earth or bedding material from entering the pipe as it is laid. Lay the pipe in the trench, when elliptical pipe with circular reinforcing or circular pipe with elliptical reinforcing is used, so the markings for the top or bottom are not more than 5° from the vertical plane through the longitudinal axis of the pipe. Remove and re-lay, without extra compensation, pipe that is not in alignment or shows excessive settlement after laying.

Lay multiple lines of reinforced concrete pipe with the centerlines of the individual barrels parallel. Use the clear distances between outer surfaces of adjacent pipes shown in Table 5 unless otherwise shown on the plans. Use the equivalent diameter from Table 2 or Table 3 for arch pipe or horizontal elliptical pipe to determine the clear distance requirement in Table 5.

Table 5
Minimum Clear Distance between Pipes

Equivalent Diameter	Min Clear Distance
18 in.	9 in.
24 in.	11 in.
30 in.	1 ft. 1 in.
36 in.	1 ft. 3 in.
42 in.	1 ft. 5 in.
48 in.	1 ft. 7 in.
54 in.	1 ft. 11 in.
60 to 84 in.	2 ft.

3.3. **Jointing**. Make available an appropriate rolling device similar to an automobile mechanic's "creeper" for conveyance through small-size pipe structures.

3.3.1. **Joints Sealed with Hydraulic Cement Mortar**. Use Type S mortar meeting the requirements of ASTM C270. Clean and wet the pipe ends before making the joint. Plaster the lower half of the bell or groove and the upper half of the tongue or spigot with mortar. Pack mortar into the joint from both inside and outside the pipe after the pipes are tightly jointed. Finish the inside smooth and flush with adjacent joints of pipe. Form a bead of semicircular cross-section over tongue-and-groove joints outside the pipe, extending at least 1 in. on each side of the joint. Form the mortar for bell-and-spigot joints to a 45° fillet between the outer edge of the bell and the spigot. Cure mortar joints by keeping the joints wet for at least 48 hr. or until the backfill has been completed, whichever comes first. Place fill or backfill once the mortar jointing material has cured for at least 6 hr. Conduct jointing only when the atmospheric temperature is above 40°F. Protect mortared joints against freezing by backfilling or other approved methods for at least 24 hr.

Driveway culverts do not require mortar banding on the outside of the pipe.

Furnish pipes, with approval, that are large enough for a person to enter with the groove between 1/2 in. and 3/4 in. longer than the tongue. Such pipe may be laid and backfilled without mortar joints. Clean the space on the interior of the pipe between the end of the tongue and the groove of all foreign material, thoroughly wet and fill with mortar around the entire circumference of the pipe, and finish flush after the backfilling has been completed.

3.3.2. **Joints Using Cold-Applied, Plastic Asphalt Sewer Joint Compound**. Ensure both ends of the pipes are clean and dry. Trowel or otherwise place a 1/2–in. thick layer of the compound in the groove end of the pipe covering at least 2/3 of the joint face around the entire circumference. Shove home the tongue end of the next pipe with enough pressure to make a tight joint. Remove any excess mastic projecting into the pipe after the joint is made. Backfill after the joint has been inspected and approved.

3.3.3. **Joints Using Rubber Gaskets**. Make the joint assembly according to the recommendations of the gasket manufacturer. Make joints watertight when using rubber gaskets. Backfill after the joint has been inspected and approved.

3.3.4. **Joints Using Pre-Formed Flexible Joint Sealants**. Install pre-formed flexible joint sealants in accordance with the manufacturer's recommendations. Place the joint sealer so no dirt or other deleterious materials come in contact with the joint sealing material. Pull or push home the pipe with enough force to properly seal the joint. Remove any joint material pushed out into the interior of the pipe that would tend to obstruct the flow. Store pre-formed flexible joint sealants in an area warmed naturally or artificially to above 70°F in an approved manner when the atmospheric temperature is below 60°F. Apply flexible joint sealants to pipe joints immediately before placing pipe in trench, and connect pipe to previously laid pipe. Backfill after the joint has been inspected and approved.

3.4. **Connections and Stub Ends**. Make connections of concrete pipe to existing pipes, pipe storm drains, or storm drain appurtenances as shown on the plans.

Mortar or concrete the bottom of existing structures if necessary to eliminate any drainage pockets created by the connections. Repair any damage to the existing structure resulting from making the connections.

Make connections between concrete pipe and corrugated metal pipe with a suitable concrete collar and a minimum thickness of 4 in. unless otherwise shown on the plans.

Finish stub ends for connections to future work not shown on the plans by installing watertight plugs into the free end of the pipe.

Fill lift holes with concrete, mortar, or precast concrete plugs after the pipe is in place.

4. MEASUREMENT

This Item will be measured by the foot. Measurement will be made between the ends of the pipe barrel along the flow line, not including safety end treatments. Safety end treatments will be measured in accordance with Item 467, "Safety End Treatment." Pipe that will be jacked, bored, or tunneled will be measured in accordance with Item 476, "Jacking, Boring, or Tunneling Pipe or Box." Measurement of spurs, branches, or new connecting pipe will be made from the intersection of the flow line with the outside surface of the pipe into which it connects. Where inlets, headwalls, catch basins, manholes, junction chambers, or other structures are included in lines of pipe, the length of pipe tying into the structure wall will be included for measurement, but no other portion of the structure length or width will be included.

For multiple pipes, the measured length will be the sum of the lengths of the barrels.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Reinforced Concrete Pipe," "Reinforced Concrete Pipe (Arch)," or "Reinforced Concrete Pipe (Elliptical)" of the size and D-load specified or of the size and class specified. This price is full compensation for constructing, furnishing, transporting, placing, and joining pipes; shaping the bed; cutting pipes on skew or slope; connecting to new or existing structures; breaking back, removing, and disposing of portions of the existing structure; replacing portions of the existing structure; cutting pipe ends on skew or slope; and equipment, labor, tools, and incidentals.

Protection methods for excavations greater than 5 ft. deep will be measured and paid for as required under Item 402, "Trench Excavation Protection," or Item 403, "Temporary Special Shoring." Excavation, shaping, bedding, and backfill will be paid for in accordance with Item 400, "Excavation and Backfill for Structures." When jacking, boring, or tunneling is used at the Contractor's option, payment will be made under this Item. When jacking, boring or tunneling is required, payment will be made under Item 476, "Jacking, Boring or Tunneling Pipe or Box."

Item 465
Junction Boxes, Manholes, and Inlets

1. DESCRIPTION

Construct junction boxes, manholes, and inlets, complete in place or to the stage detailed, including furnishing and installing frames, grates, rings, and covers.

2. MATERIALS

Furnish materials in accordance with the following:

- Item 420, "Concrete Substructures,"
- Item 421, "Hydraulic Cement Concrete,"
- Item 440, "Reinforcement for Concrete," and
- Item 471, "Frames, Grates, Rings, and Covers."

Cast-in-place junction boxes, manholes, inlets, risers, and appurtenances are acceptable unless otherwise shown. Alternate designs for cast-in-place items must be acceptable to the Engineer and must conform to functional dimensions and design loading. Alternate designs must be designed and sealed by a licensed professional engineer.

2.1. **Concrete**. Furnish Class H concrete as referenced in Item 421 "Hydraulic Cement Concrete," except that Mix Design Options 1–8 will be allowed for formed precast junction boxes, manholes, and inlets. Furnish concrete per DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification," for machine-made precast junctions boxes, manholes, and inlets. Furnish Class C concrete for cast-in-place manholes and inlets unless otherwise shown on the plans.

2.2. **Mortar**. Furnish mortar conforming to DMS-4675, "Cementitious Grouts and Mortars for Miscellaneous Applications."

2.3. **Timber**. Provide sound timber that is a minimum of 3 in. nominal thickness and reasonably free of knots and warps for temporary covers when used with Stage I construction (see Article 465.3., "Construction").

2.4. **Other Materials**. Use commercial-type hardware as approved.

3. CONSTRUCTION

Construct all types of junction boxes, manholes, and inlets either complete or in 2 stages, described as Stage I and Stage II.

Construct the Stage I portion of junction boxes, manholes, and inlets as shown on the plans or as specified in this Item. Furnish and install a temporary cover as approved.

Furnish and install the storm drain pipe and a temporary plug for the exposed end of the storm drain pipe from the storm drain to a point below the top of curb indicated on the plans for Stage I construction of cast iron or steel inlet units.

Construct Stage II after the pavement structure is substantially complete unless otherwise approved.

Construct the remaining wall height and top of junction box, manhole, or inlet for Stage II, and furnish and install any frames, grates, rings and covers, curb beams, or collecting basins required.

Construct cast-in-place junction boxes, manholes, and inlets in accordance with Item 420, "Concrete Substructures." Forms will be required for all concrete walls. Outside wall forms for cast-in-place concrete may be omitted with approval if the surrounding material can be trimmed to a smooth vertical face.

3.1. **Precast Junction Boxes, Manholes, and Inlets**. Construct formed precast junction boxes, manholes, and inlets in accordance with Item 420, "Concrete Substructures," except as otherwise noted in this Item. Construct machine-made precast junction boxes, manholes, and inlets in accordance with ASTM C478 except as otherwise noted in this Item. Mix and place concrete for machine-made junction boxes, manholes, and inlets per the requirements of DMS-7310, "Reinforced Concrete Pipe and Machine-Made Precast Concrete Box Culvert Fabrication and Plant Qualification." Conform to the product permissible variations and rejection criteria stated in ASTM C478 for machine-made precast junction boxes, manholes, and inlets. Cure all precast units in accordance with Item 424, "Precast Concrete Structural Members (Fabrication)."

Multi-project fabrication plants as defined in Item 424 "Precast Concrete Structural Members (Fabrication)," that produce manholes and inlets will be approved by the Construction Division in accordance with DMS-7340, "Qualification Procedure for Multi-Project Fabrication Plants of Precast Concrete Junction Boxes, Manholes and Inlets." The Department's MPL has a list of approved multi-project plants.

3.1.1. **Lifting Holes**. Provide no more than 4 lifting holes in each section for precast units. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the section. The maximum hole diameter is 3 in. at the inside surface of the wall and 4 in. at the outside surface. Cut no more than 5 in. in any direction of reinforcement per layer for lifting holes. Repair spalled areas around lifting holes.

3.1.2. **Marking**. Clearly mark each precast junction box, manhole, and inlet unit with the following information:

- name or trademark of fabricator and plant location;
- product designation;
- ASTM designation (if applicable);
- date of manufacture;
- designated fabricator's approval stamp; and
- designation "SR" for product meeting sulfate-resistant concrete plan requirements (when applicable).

3.1.3. **Storage and Shipment**. Store precast units on a level surface. Do not ship units until design strength requirements have been met.

3.2. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Immediate backfilling is permitted for all junction box, manhole, and inlet structures where joints consist of rubber boots, rubber gaskets, or bulk or preformed joint sealant. Take precautions in placing and compacting the backfill to avoid any movement of junction boxes, manholes, and inlets. Remove and replace junction boxes, manholes, and inlets damaged by the Contractor at no expense to the Department.

3.3. **Junction Boxes, Manholes, and Inlets for Precast Concrete Pipe Storm Drains**. Construct junction boxes, manholes, and inlets for precast concrete pipe storm drains before completion of storm drain lines into or through the junction box, manhole, or inlet. Neatly cut all storm drains at the inside face of the walls of the junction box, manhole, or inlet.

3.4. **Junction Boxes, Manholes, and Inlets for Box Storm Drains**. Place bases or risers of junction boxes, manholes, and inlets for box storm drains before or in conjunction with placement of the storm drain. Backfill the junction box, manhole, or inlet and storm drain as a whole.

3.5. **Inverts**. Shape and route floor inverts passing out or through the junction box, manhole, or inlet as shown on the plans. Shape by adding and shaping mortar or concrete after the base is placed or by placing the required additional material with the base.

3.6. **Finishing Complete Junction Boxes, Manholes, and Inlets.** Complete junction boxes, manholes, and inlets in accordance with the plans. Backfill to original ground elevation in accordance with Item 400, "Excavation and Backfill for Structures."

3.7. **Finishing Stage I Construction.** Complete Stage I construction by constructing the walls to the elevations shown on the plans and backfilling to required elevations in accordance with Item 400, "Excavation and Backfill for Structures."

3.8. **Stage II Construction.** Construct subgrade and base course or concrete pavement construction over Stage I junction box, manhole, or inlet construction unless otherwise approved. Excavate to expose the top of Stage I construction and complete the junction box, manhole or inlet in accordance with the plans and these Specifications, including backfill and cleaning of all debris from the bottom of the junction box, manhole, or inlet.

3.9. **Inlet Units.** Install cast iron or steel inlet units in conjunction with the construction of concrete curb and gutter. Set the inlet units securely in position before placing concrete for curb and gutter. Form openings for the inlets and recesses in curb and gutter as shown on the plans. Place and thoroughly consolidate concrete for curb and gutter adjacent to inlets and around the inlet castings and formed openings and recesses without displacing the inlet units.

4. MEASUREMENT

All junction boxes, manholes, and inlets satisfactorily completed in accordance with the plans and specifications will be measured by each junction box, manhole, or inlet, complete, or by each junction box, manhole, or inlet completed to the stage of construction required by the plans.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for as follows:

5.1. **Complete Manholes.** Payment for complete manholes will be made at the unit price bid for "Manhole (Complete)" of the type specified.

5.2. **Complete Inlets.** Payment for inlets will be made at the unit price bid for "Inlet (Complete)," of the type specified.

5.3. **Complete Junction Boxes.** Payment for junction boxes will be made at the unit price bid for "Junction Box (Complete)" of the type specified.

5.4. **Manholes Stage I.** Payment for Manholes, Stage I, will be made at the unit price bid for each "Manhole (Stage I)" of the type specified.

5.5. **Manholes Stage II.** Payment for Manholes, Stage II, will be made at the unit price bid for each "Manhole (Stage II)" of the type specified.

5.6. **Inlets Stage I.** Payment for Inlets, Stage I, will be made at the unit price bid for each "Inlet (Stage I)" of the type specified.

5.7. **Inlets Stage II.** Payment for Inlets, Stage II, will be made at the unit price bid for each "Inlet (Stage II)" of the type specified.

5.8. **Junction Boxes Stage I.** Payment for Junction Boxes, Stage I, will be made at the unit price bid for each "Junction Box (Stage I)" of the type specified.

5.9. **Junction Boxes Stage II.** Payment for Junction Boxes, Stage II, will be made at the unit price bid for each "Junction Box (Stage II)" of the type specified.

This price is full compensation for concrete, reinforcing steel, mortar, frames, grates, rings and covers, excavation, and backfill and for all other materials, tools, equipment, labor, and incidentals.

Item 466
Headwalls and Wingwalls

1. DESCRIPTION

Furnish, construct, and install concrete headwalls and wingwalls for drainage structures and underpasses.

2. MATERIALS

2.1. **General**. Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures,"
- Item 421, "Hydraulic Cement Concrete," and
- Item 440, "Reinforcement for Concrete."

Use Class C concrete for cast-in-place and precast concrete units unless otherwise shown on the plans. Furnish cast-in-place or precast headwalls and wingwalls unless otherwise shown on the plans.

2.2. **Fabrication**.

2.2.1. **General**. Fabricate cast-in-place concrete units and precast units in accordance with Item 420 "Concrete Substructures." Use the following definitions for headwalls and wingwalls:

- "Headwalls" refers to all walls, including wings, at the ends of single-barrel and multiple-barrel pipe culvert structures.
- "Wingwalls" refers to all walls at the ends of single-barrel or multiple-barrel box culvert structures.

2.2.2. **Lifting Holes**. Provide no more than 4 lifting holes in each section for precast units. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the section. The maximum hole diameter is 3 in. at the inside surface of the wall and 4 in. at the outside surface. Cut no more than 1 longitudinal wire or 2 circumferential wires per layer of reinforcing steel when locating lift holes. Repair spalled areas around lifting holes.

2.2.3. **Marking**. Clearly mark each precast unit before shipment from the casting or fabrication yard with the following:

- the date of manufacture,
- the name or trademark of the manufacturer, and
- the type and size designation.

2.2.4. **Storage and Shipment**. Store precast units on a level surface. Do not place any loads on precast concrete units until design strength is reached. Do not ship units until design strength requirements have been met.

2.2.5. **Causes for Rejection**. Precast units may be rejected for not meeting any one of the specification requirements. Individual units may also be rejected for fractures or cracks passing through the wall or surface defects indicating honeycombed or open texture surfaces. Remove rejected units from the project, and replace them with acceptable units meeting the requirements of this Item.

2.2.6. **Defects and Repairs**. Occasional imperfections in manufacture or accidental damage sustained during handling may be repaired. The repaired units will be acceptable if they conform to the requirements of this Item and the repairs are sound, properly finished, and cured in conformance with pertinent specifications.

3. CONSTRUCTION

3.1. **General**. Remove portions of existing structures and drill, dowel, and grout in accordance with Item 420, "Concrete Substructures."

3.2. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Take special precautions in placing and compacting the backfill to avoid any movement or damage to the units. Bed precast units on foundations of firm and stable material accurately shaped to conform to the bases of the units.

3.3. **Placement of Precast Units**. Provide adequate means to lift and place the precast units. Fill lifting holes with mortar or concrete and cure. Precast concrete or mortar plugs may be used.

3.4. **Connections**. Make connections to new or existing structures in accordance with the details shown on the plans. Furnish jointing material in accordance with Item 464, "Reinforced Concrete Pipe," or as shown on the plans.

Remove a length of the existing pipe from the headwall to the joint when removing existing headwalls as shown on the plans or as approved. Re-lay the removed pipe if approved, or furnish and lay a length of new pipe.

4. MEASUREMENT

This is a plans quantity measurement item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

4.1. **Headwalls**. Headwalls will be measured by each end of a structure.

4.2. **Wingwalls**. Wingwalls will be measured by one of the following methods:

4.2.1. **Square Foot**. Wingwalls will be measured by the square foot of the front surface area of the wall of each type. The area will be measured from the top of the footing or apron to the top of the wall unless otherwise shown on the plans. If there is no footing or apron, then measurement is from the bottom of the wall.

4.2.2. **Each**. Wingwalls will be measured by each end of a structure.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the price bid for "Headwalls" of the type and pipe size (diameter or design) specified, "Wingwalls" of the type specified when measurement is by the square foot, or "Wingwalls" of the type and wall height specified when measurement is by each. For payment purposes, the wingwall height will be rounded to the nearest foot. All wingwalls and headwalls of the same type will be paid for equally when skew does not affect the type. This price is full compensation for constructing, furnishing, transporting, and installing the headwalls or wingwalls; connecting to existing structure; breaking back, removing and disposing of portions of the existing structure, and replacing portions of the existing structure as required to make connections; excavation and backfill; and concrete, reinforcing steel, corrugated metal pipe or reinforced concrete pipe, equipment, labor, tools, and incidentals.

Apron concrete or riprap between or around the wingwalls of single- or multiple-barrel box culvert structures will be measured and paid for in accordance with Item 432, "Riprap."

The removal and re-laying of existing pipe or the furnishing of new pipe to replace existing pipe will not be paid for directly but will be considered subsidiary to this Item.

Item 467
Safety End Treatment

1. DESCRIPTION

Furnish, construct, and install safety end treatments for drainage structures, or install or replace pipe runners or pipe runner assemblies on existing drainage structures.

2. MATERIALS

2.1. **General.** Furnish materials in accordance with the following.

- Item 420, "Concrete Substructures,"
- Item 421, "Hydraulic Cement Concrete,"
- Item 432, "Riprap,"
- Item 440, "Reinforcement for Concrete,"
- Item 442, "Metal for Structures,"
- Item 445, "Galvanizing,"
- Item 460, "Corrugated Metal Pipe," and
- Item 464, "Reinforced Concrete Pipe."

Use Class C concrete for cast-in-place and precast concrete units unless otherwise shown on the plans. Furnish cast-in-place or precast safety end treatments unless otherwise shown on the plans. Furnish Class B concrete for concrete riprap unless otherwise shown on the plans. Provide galvanized steel for prefabricated metal end sections in accordance with Item 460, "Corrugated Metal Pipe."

Furnish pipe runners in accordance with the following:

- ASTM A1085;
- ASTM A53, Type E or S, Grade B;
- ASTM A500, Grade B; or
- API 5L, Grade X42.

Furnish plates and angles in accordance with ASTM A36. Furnish nuts and bolts in accordance with ASTM A307. Galvanize pipes, plates, angles, nuts, and bolts in accordance with Item 445, "Galvanizing."

2.2. **Fabrication.** Fabricate cast-in-place concrete units and precast units in accordance with Item 420, "Concrete Substructures." Provide either prefabricated metal end sections or mitered CMP when specified for the pipe structure unless otherwise shown on the plans.

Provide one of the following when reinforced concrete pipe (RCP) is specified for the pipe structure, unless otherwise shown on the plans:

- mitered RCP or
- precast safety end treatment (SET) units. Provide riprap only if the plans specifically require it for this alternative.

2.2.1. **SET Types.**

2.2.1.1. **Type I.** Provide Type I SET consisting of reinforced concrete headwalls or wingwalls and pipe runners in accordance with the details shown on the plans when required.

2.2.1.2. **Type II**. Provide Type II SET in accordance with the details shown on the plans consisting of the following:

- CMP or RCP mitered to the proper slope, concrete riprap and pipe runners, when required;
- prefabricated metal end sections, concrete riprap and pipe runners, when required; or
- precast SET units, concrete riprap, when required, and pipe runners, when required.

2.2.2. **Lifting Holes**. Provide no more than 4 lifting holes in each section for precast units. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the section. The maximum hole diameter is 3 in. at the inside surface of the wall and 4 in. at the outside surface. Cut no more than 1 longitudinal wire or 2 circumferential wires per layer of reinforcing steel when locating lift holes. Repair spalled areas around lifting holes.

2.2.3. **Marking**. Clearly mark the following on each precast unit, mitered CMP, mitered RCP, or metal end section before shipment from the casting or fabrication yard:

- the date of manufacture,
- the name or trademark of the manufacturer, and
- the type and size designation.

2.2.4. **Storage and Shipment**. Store precast units on a level surface. Do not place any loads on precast units until the design strength is reached. Do not ship units until design strength requirements have been met.

2.2.5. **Causes for Rejection**. Precast units may be rejected for not meeting any one of the specification requirements. Individual units may also be rejected for fractures or cracks passing through the wall or surface defects indicating honeycombed or open texture surfaces. Remove rejected units from the project and replace with acceptable units meeting the requirements of this Item.

2.2.6. **Defects and Repairs**. Occasional imperfections in manufacture or accidental damage sustained during handling may be repaired. The repaired units will be acceptable if they conform to the requirements of this Item and the repairs are sound and properly finished and cured in conformance with pertinent specifications. Repair damaged galvanizing in accordance with Section 445.3.5., "Repairs."

3. CONSTRUCTION

3.1. **General**. Remove portions of existing structures in accordance with Section 420.4.8., "Extending Existing Substructures." Drill, dowel, and grout in accordance with Item 420, "Concrete Substructures." Furnish concrete riprap in accordance with Item 432, "Riprap."

Provide riprap on all prefabricated metal end sections.

3.2. **Excavation, Shaping, Bedding, and Backfill**. Excavate, shape, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Take special precautions in placing and compacting the backfill to avoid any movement or damage to the units. Bed precast units on foundations of firm and stable material accurately shaped to conform to the bases of the units.

3.3. **Placement of Precast Units**. Provide adequate means to lift and place the precast units. Fill lifting holes with mortar or concrete and cure. Precast concrete or mortar plugs may be used.

3.4. **Connections**. Make connections to new or existing structures in accordance with the details shown on the plans. Furnish jointing material in accordance with Item 464, "Reinforced Concrete Pipe."

Also remove a length of the existing pipe from the headwall to the joint when removing existing headwalls as shown on the plans or as approved. Re-lay the removed pipe if approved, or furnish and lay a length of new pipe.

3.5. **Install or Replace Pipe Runners or Assemblies**. Install or replace individual pipe runners or pipe runner assemblies on existing drainage structures as indicated on the plans.

4. MEASUREMENT

SETs of all types will be measured by each barrel of each structure end.

Pipe runners or pipe runner assemblies installed or replaced on existing structure will be measured by each installed or replaced on each structure end.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the various designations of "Safety End Treatment" specified as follows:

- SET (Type I) (Barrel Span) (Wall Height) (Slope, Horizontal:Vertical) (Orientation, Cross or Parallel)
- SET (Type I) (Pipe Diameter or Design) (Slope, Horizontal:Vertical) (Orientation, Cross or Parallel)
- SET (Type II) (Pipe Diameter or Design) (Pipe Material) (Slope, Horizontal:Vertical) (Orientation, Cross or Parallel)
- SET (Pipe Runner)
- SET (Pipe Runner Assembly)

For payment purposes, the wingwall heights of Type I SETs for box culverts will be rounded to the nearest foot.

This price is full compensation for constructing, furnishing, transporting, and installing the end treatments; pipe runners, or pipe runner assemblies, connecting to existing structure; breaking back, removing and disposing of portions of the existing structure, removing and disposing of existng pipe runner or pipe runner assemblies, and replacing portions of the existing structure as required to make connections; excavation and backfill; furnishing concrete, reinforcing steel, corrugated metal pipe or reinforced concrete pipe, and pipe runners; and concrete riprap, nuts, bolts, plates, angles, equipment, labor, tools, and incidentals.

The removal and re-laying of existing pipe or the furnishing of new pipe to replace existing pipe will not be paid for directly but will be considered subsidiary to this Item.

The mitered length of CMP or RCP that is a part of the SET (Type II) will not be paid for directly but will be considered subsidiary to this Item. The limits for payment for pipe will be as shown on the plans and paid for in accordance with the pertinent bid item.

The limits of riprap to be included in the price bid for each SET will be shown on the plans. Any riprap placed beyond the limits shown will be paid in accordance with Item 432, "Riprap." Riprap between multiple precast SET units will be required as shown on the plans and is included in the price bid for SET.

When precast SETs are provided as an option to mitered RCP, riprap aprons will not be required unless the plans specifically require riprap aprons for precast SET units. The plans will show the limits of the riprap to be included with the precast SET for payment.

Item 471
Frames, Grates, Rings, and Covers

1. DESCRIPTION

Furnish and install frames, grates, rings, and covers for inlets, manholes, and other structures.

2. MATERIALS

2.1. **Frame, Grate, Ring, and Cover Castings**. Provide clean castings conforming to the shape and dimensions shown on the plans. Ensure all gray and ductile iron castings conform to the AASHTO Designation M 306. Cast or machine the bearing surfaces for traffic service castings between manhole rings and covers and between grates and frames with such precision as to prevent rocking.

Provide gray iron castings in accordance with ASTM A48 Class 35B and AASHTO M 306 for traffic service applications unless otherwise specified. Provide gray iron castings in accordance with ASTM A48 Class 35B for sidewalk or pedestrian applications unless otherwise specified. Provide ductile iron castings in accordance with ASTM A536, Grade 70-50-05, unless otherwise specified. Provide steel castings in accordance with ASTM A27, Grade 70-36, unless otherwise specified. Ensure all traffic service castings and gratings meet or exceed the H20 proof-load requirements of AASHTO M 306. Load test results and material certifications must be made available upon request.

Ensure all traffic service (heavy duty) rated castings and grating meet the proof-load testing requirements of AASHTO M 306. Ensure all load tests are conducted with a calibrated NIST certified load cell. Ensure materials are loaded with a 9 × 9-in. load block to an applied load of 40,000 lb. for one minute without deformation or failure. Load test results and material certifications must be made available upon request.

Provide castings within ±1/16 in. per foot of plan dimensions, and within ±5% of plan weight.

2.2. **Welded Steel Grates and Frames**. Provide welded steel grates and frames as an assembly in accordance with the member size, dimensions, and details shown on the plans. Fabricate these assemblies in accordance with Item 441, “Steel Structures.” Use steel that meets ASTM A36 or equivalent.

2.3. **Documentation**. Furnish a manufacturer’s certification stating the casting meets the proof-load testing requirements of AASHTO M 306 for traffic service castings.

3. CONSTRUCTION

Construct and install frames, grates, rings, and covers in accordance with the details shown on the plans. Weld in accordance with Item 448, “Structural Field Welding.” Tack weld grates and covers to the frame or ring when directed.

Galvanize steel castings, welded steel grates, and frames in accordance with Item 445, “Galvanizing.” Galvanizing is not required for iron castings unless used in conjunction with structural steel shapes or shown on the plans.

Provide galvanized bolts and nuts in accordance with Item 445, “Galvanizing.”

4. MEASUREMENT

Frames, grates, rings, and covers, when a part of the complete manhole or inlet, will not be measured for payment but will be considered subsidiary to Item 465, "Junction Boxes, Manholes, and Inlets." Frames, grates, rings, and covers, when not a part of a Manhole (complete) or Inlet (complete), will be measured by the each.

5. PAYMENT

When payment is required in accordance with "Measurement," payment for frames, grates, rings, and covers will be made at the unit price bid for "Grate," "Frame," "Grate and Frame," "Frame and Cover," or "Ring and Cover" with the type and number of grates specified, if necessary. This price is full compensation for equipment, materials, labor, tools, and incidentals.

Item 472
Removing and Re-Laying Culvert

1. DESCRIPTION

Remove, transport, clean, and re-lay existing culvert and storm drain pipe.

2. MATERIALS

Bituminous coating must meet the requirements of Section 460.2.2., "Protective Coating."

3. CONSTRUCTION

Culvert and storm drain pipe to be removed and re-laid will be shown on the plans. Remove debris and sediment within the culvert and storm drain pipe. Clean joints to facilitate proper re-laying. Install concrete pipe in accordance with Item 464, "Reinforced Concrete Pipe." Install corrugated metal pipe in accordance with Item 460, "Corrugated Metal Pipe." Excavate, bed, and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Prevent damage to the pipe and fittings. Make connections to existing structures as shown on the plans and in conformance to the requirements for connections as described in pertinent pipe specifications. Connect reinforced concrete pipe to corrugated metal pipe with a suitable concrete collar with a minimum thickness of 4 in. or as shown on the plans. Use a coating of bituminous material to insulate portions of aluminum pipe that are to be in contact with metal other than aluminum. Extend coating at least 1 ft. beyond area of contact. Mark the top and bottom of reinforced concrete pipe before removal and reinstall in the same position. Reuse headwall, aprons, or other appurtenances by severing from the culvert and moving to the new position if shown on the plans. Make connections for joining sections of pipes in accordance with pertinent Items.

Replace any items designated for reuse with new material or restore them to previous condition, as approved. The Contractor may remove and dispose of existing structures and construct new structures at no expense to the Department in accordance with pertinent specifications and designs shown on the plans or as approved.

4. MEASUREMENT

This Item will be measured by the foot between the ends of the pipe barrel along the flow line as installed. Where spurs, branches, or connections to the existing pipe lines are involved, measurement of the spur or connecting pipe will be made from the intersection at the flow line with the outside surface of the pipe into which the pipe connects. Where inlets, catch basins, manholes, safety end treatments, or other structures are included in lines of pipe, the length of pipe tying into the structure wall will be included for measurement but no other portion of the structure length or width will be included.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measurement as provided under "Measurement" will be paid for at the unit price bid for "Removing and Re-laying Pipe" of the size specified. This price is full compensation for excavating and removing pipe from its original location; loading, hauling, placing, and joining pipe; cutting pipe ends on skew or slope; moving and re-using headwalls and safety end treatments; connections to existing structures; concrete collars and reinforcing; and equipment, materials, labor, tools, and incidentals. Removal and disposal of pipe and appurtenances not reused will be subsidiary to the bid items of the Contract. Protection methods for excavations greater than 5 ft. in depth will be measured and paid for as required under Item 402, "Trench Excavation Protection," or Item 403,

"Temporary Special Shoring." Excavation, bedding, and backfill for re-laying pipe will be paid for in accordance with Item 400, "Excavation and Backfill for Structures." When jacking, boring, or tunneling is used at the Contractor's option, payment will be made under this Item. When jacking, boring, or tunneling is required, payment will be made under Item 476, "Jacking, Boring, or Tunneling Pipe or Box."

Item 474
Linear Drains

1. DESCRIPTION

Furnish and install linear drains of the sizes and descriptions shown on the plans as cast-in-place trench drain, precast trench drain, or slotted drain.

2. MATERIALS

Provide materials conforming to the pertinent requirements of the following Items:

2.1. **Cast-in-Place Trench Drain**. Provide a trench with a slope as shown on the plans. Furnish forms capable of maintaining proper alignment during the concrete placement. Ensure connections to structures do not restrict the hydraulic flow of the trench drain. Use Class C Concrete conforming to Item 421, "Hydraulic Cement Concrete."

Provide grates and frames conforming to the requirements of DMS-4370.6 (B), "Grates and Frames." Removable grates with minimum width of 12 in. and length of 36 in. are permissible. Grates with lessor dimensions will not be removable.

Provide shop drawings sealed by a licensed professional engineer stating the trench drain system meets loading requirements. Submit documents showing design loadings if using a proprietary system.

Furnish documentation in accordance with Section 471.2.3., "Documentation."

2.2. **Precast Trench Drains**. Furnish precast trench drains for the Department from pre-approved manufacturers in accordance with DMS-4370, "Precast Trench Drain." The Department's MPL is a list of approved manufacturers and their products. Unapproved precast trench drains will not be accepted.

Furnish materials conforming to the following where required.

- Item 420, "Concrete Substructures"
- Item 421, "Hydraulic Cement Concrete" (Use Class C concrete unless otherwise shown on the plans.), and
- Item 440, "Reinforcement for Concrete."

2.3. **Slotted Drains**. Fabricate and furnish materials in accordance with Item 460, "Corrugated Metal Pipe." Furnish galvanized steel or aluminized steel (AASHTO M 36, Type 2) pipe with a minimum thickness of 16 gauge.

Slotted drains consist of a drain guide assembly attached to a longitudinal opening in a corrugated metal pipe. Unless otherwise specified on the plans, fabricate slotted drains with bearing bars and crossbar spacers meeting the requirements of ASTM A36, welded to the longitudinal opening in the corrugated metal pipe. Galvanize the drain guide assembly after fabrication in accordance with Item 445, "Galvanizing." Clean and repair welded areas and heat-affected zones in accordance with Section 445.3.5, "Repairs."

2.4. **Slotted Drain Outfalls**. Slotted drain outfalls consist of the corrugated metal pipe that connects the slotted drain to the main drainage line.

2.5. **Backfill**. Provide cement-stabilized backfill in accordance with Item 400, "Excavation and Backfill for Structures," or high-slump, low-strength concrete with a minimum of 180 lb. of cement per cubic yard.

3. CONSTRUCTION OF CAST IN PLACE TRENCH DRAINS

Perform excavation in accordance with Item 400, "Excavation and Backfill for Structures." Construct trench with a slope as shown on the plans. Submit shop drawings that provide enough detail to ensure seamless installation of the trench drain adjacent to the proposed or existing pavement structure.

If using a proprietary system, provide shop drawings that contain the manufacturer's installation guidelines and any sequential order of construction. Construct the trench drain with a maximum allowable tolerance of ±1/16 in. for dimensional accuracy and rail co-planarity. Provide a smooth finish on the surface of the trench that will convey runoff. Make connections to new or existing structures as shown on the plans or as directed.

Remove trench drain forms and dispose of properly. Install grates with retaining pins on each of the 4 corners. Remove all construction debris from the trench drain.

4. CONSTRUCTION OF PRECAST TRENCH DRAINS

Place precast trench drains in concrete pavement or encased in a concrete grade beam and subgrade designed to support H-20 wheel loading.

Perform excavation in accordance with Item 400, "Excavation and Backfill for Structures." Construct trench with a slope as shown on the plans. Use interconnecting end profiles on adjoining channels to maintain channel alignment within ±1/16 in. Use non-sloping sections where shown on the plans or as directed.

Assemble and install precast trench drains in accordance with approved shop drawings and manufacturer's recommendations at the locations directed on the plans. Provide shop drawings containing the manufacturer's installation guidelines.

Encase precast trench drains, not cast in concrete pavement, in concrete grade beams, as shown on the plans and suitable to support the trench drain and retain the trench grate from pull out. Ensure the grade and alignment of the installed grates matches the grade and alignment of the surrounding pavement.

Do not provide removable trench drain grates at any location where wheeled vehicles may drive over them including roadway lanes, shoulders, and driveways.

Remove all construction debris from the trench drain.

5. CONSTRUCTION OF SLOTTED DRAINS

Install slotted drains and slotted drain outfalls in accordance with details on the plans and the requirements of Item 460, "Corrugated Metal Pipe." Excavate and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Backfill trenches as shown on the plans or as directed. Furnish slotted drains in 20-ft. lengths, minimizing the number of joints required.

6. MEASUREMENT

This Item will be measured by the foot, between the ends of the linear drain along the pavement surface as installed, complete and in place. Where inlets are included in lines of linear drain, that length of drain tying into the structure wall will be included for measurements, but no other portion of the structure length or width will be included.

7. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Cast-in-Place Trench Drain," "Precast Trench Drain

(in Concrete Pavement)," "Precast Trench Drain (without Concrete Pavement)," or "Slotted Drain" of the size specified.

This price will be full compensation for structure excavation, installing the trench drain, concrete, reinforcing steel, reinforcement anchors, other connecting devices, furnishing all materials (including forms, rails, anchorages, support bars, and grates), tools, labor, equipment, and incidentals.

Item 476
Jacking, Boring, or Tunneling Pipe or Box

1. DESCRIPTION

Furnish and install pipe or box by jacking, boring, or tunneling.

2. MATERIALS

Use the following types of pipe or box:

- corrugated metal pipe meeting Item 460, "Corrugated Metal Pipe," of the size, type, design, and dimension shown on the plans;
- reinforced concrete pipe meeting the special requirements for jacking, boring, or tunneling of Item 464, "Reinforced Concrete Pipe," of the size, strength, and dimension shown on the plans;
- reinforced concrete box meeting Item 462, "Concrete Box Culverts and Drains," of the size and type shown on the plans; or
- other types specified by the plans.

3. CONSTRUCTION

Excavate suitable shafts or trenches for conducting the jacking, boring, or tunneling operations and for placing end joints of the pipe or box if the grade at the jacking, boring, or tunneling end is below the ground surface. Maintain a 3:1 slope from edge of pavement on the shaft side of the road unless otherwise shown or directed. Provide a positive barrier when the shaft location is within the clear zone of the roadway. Protect excavations deeper than 5 ft. as specified in Item 402, "Trench Excavation Protection," or Item 403, "Temporary Special Shoring."

Install pipe or box so there is no interference with the operation of street, highway, railroad, or other facility and no embankment or structure is weakened or damaged.

Repair any pipe or box damaged in jacking, boring, or tunneling. Remove and replace any pipe or box damaged beyond repair at the Contractor's expense.

Backfill shafts or trenches excavated to facilitate jacking, boring, or tunneling immediately after installation of pipe or box.

3.1. **Jacking**. Provide jacks suitable for forcing the pipe or box through the embankment. Use even pressure to all jacks during operation. Provide a suitable jacking head and suitable bracing between the jacks and the jacking head to apply uniform pressure around the ring of the pipe or circumference of the box. Use joint cushioning of plywood or other approved material. For plywood cushioning material, use 1/2-in. minimum thickness for pipe diameter 30 in. or less, and use 3/4-in. minimum thickness for pipe diameter greater than 30 in. Use 3/4-in. minimum thickness for all boxes. Use cushioning rings of single or multiple pieces. Provide a suitable jacking frame or backstop. Set the pipe or box to be jacked on guides that support the section of the pipe or box, and direct it on the proper line and grade. Place the entire jacking assembly in line with the direction and grade of the pipe or box. In general, excavate the embankment material just ahead of the pipe or box, remove the material through the pipe or box, and force the pipe or box through the embankment with jacks into the space bored or tunneled.

Furnish a plan showing the proposed method of jacking for approval. Include the design for the jacking head, jacking support or backstop (thrust block), arrangement and position of jacks, and guides in the plan.

Ensure excavation for the underside of the pipe for at least 1/3 of the circumference of the pipe conforms to the contour and grade of the pipe. Ensure the excavation for the bottom slab of the box conforms to the grade of the box. Over-excavate, if desired, to provide no more than 2 in. of clearance for the upper portion and sides of the pipe or box. Taper this clearance to zero at the point where the excavation conforms to the contour of the pipe or box. Carry out jacking without interruption to prevent the pipe from becoming firmly set in the embankment. Monitor volume of soil excavated to avoid any appreciable over excavation. Pressure-grout any over excavation of more than 1 in. Pressure-grout between the carrier pipe and casing when shown on the plans.

The distance the excavation extends beyond the end of the pipe or box must not exceed 2 ft. Decrease this distance as necessary to maintain stability of the material being excavated.

Jack the pipe or box from the low or downstream end. The final position of the pipe or box must not vary from the line and grade shown on the plans by more than 1 in. in 10 ft. Variation must be regular and in one direction, and the final flow line must be in the direction shown on the plans.

Use a shield or cutting edge of steel plate around the head end of the pipe or box extending a short distance beyond the end if desired. The minimum distance for parallel pipe or box jacking or tunneling is 3 ft. or 2 times the diameter of the pipe or width of box, whichever is greater, unless otherwise shown on the plans.

3.2. **Boring or Tunneling**. Bore from a shaft in an approved location provided for the boring equipment and workmen.

Dispose of excavated material using an approved method. Use water or other appropriate drilling fluids in connection with the boring operation only as necessary to lubricate cuttings and pipe or box; do not use jetting.

Use a gel-forming colloidal drilling fluid consisting of high-grade, carefully processed bentonite to consolidate cuttings of the bit in unconsolidated soil formations. Seal the walls of the bore hole and furnish lubrication for subsequent removal of cuttings and immediate installation of the pipe.

Allowable variations from line and grade are specified in Section 476.3.1., “Jacking.” Pressure-grout any over excavation of more than 1 in.

3.2.1. **Larger Diameter Boring Methods**. Use the pilot hole or auger method for drainage and large utility borings. Pressure-grout any over excavation of more than 1 in. Pressure-grout between the carrier pipe and casing when shown on the plans.

3.2.1.1. **Pilot Hole Method**. Bore a 2-in. pilot hole the entire length of the crossing, and check it for line and grade during the boring or tunneling operation on the opposite end of the bore from the work shaft. This pilot hole will serve as centerline for the larger diameter hole to be bored.

3.2.1.2. **Auger Method**. Use a steel encasement pipe of the appropriate diameter equipped with a cutter head to mechanically perform the excavation. Use augers of large enough diameter to convey the excavated material to the work shaft.

3.2.2. **Electrical and Communication Conduit Boring**. Limit over excavation to the dimensions shown in Table 1 for electrical and communication conduit borings. Increased boring diameters will be allowed for outer diameters of casing and couplings. Pressure-grouting will not be required for electrical and communication conduit borings.

Table 1
Allowable Bore Diameter for Electrical or Communication Conduit or Casing

Single Conduit Bores		Multiple Conduit Bores	
Conduit Size (in.)	Maximum Allowable Bore (in.)	Conduit Size (in.)[1]	Maximum Allowable Bore (in.)
2	4	4	6
3	6	5	8
4	6	6	10
6	10	7	12
		8	12

1. The diameter of multiple conduits is the sum of the outside diameter of the 2 largest conduits for placement of up to 4 conduits in one bore. Submit boring diameters for the Engineer's approval when more than 4 conduits are to be placed in a bore.

3.3. **Tunneling**. Use an approved tunneling method where the characteristics of the soil, the size of the proposed pipe, or the use of monolithic pipe would make the use of tunneling more satisfactory than jacking or boring, or when shown on the plans.

Ensure the lining of the tunnel is strong enough to support the overburden when tunneling is permitted. Submit the proposed liner method for approval. Approval does not relieve the Contractor of the responsibility for the adequacy of the liner method.

Pressure-grout the space between the liner plate and the limits of excavation.

Pressure-grout between the carrier pipe and liner plate when shown on the plans.

3.4. **Joints**. Make joints by field bolting or connecting bands, whichever is feasible if corrugated metal pipe is used. Make the joints in accordance with Item 464, "Reinforced Concrete Pipe," if reinforced concrete pipe is used. Make the joints in accordance with Item 462, "Concrete Box Culverts and Drains," if reinforced concrete box is used.

4. MEASUREMENT

This Item will be measured by the foot between the ends of the pipe or box along the flow line.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal, unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Jacking, Boring, or Tunneling Pipe" of the type, size, and class specified; or "Jacking, Boring, or Tunneling Pipe" of the type, size, and design specified; or "Jacking or Tunneling Box Culvert" of the size specified.

This price is full compensation for excavation, grouting, backfilling, and disposal of surplus material; furnishing pipe, box, and pipe liner materials required for tunnel operations; preparation, hauling, and installing of pipe, box, and pipe liner materials; and materials, tools, equipment, labor, and incidentals.

Protection methods for open excavations deeper than 5 ft. will be measured and paid for as required under Item 402, "Trench Excavation Protection," or Item 403, "Temporary Special Shoring."

Item 479
Adjusting Manholes and Inlets

1. DESCRIPTION

Adjust or cap existing manholes or inlets. Drainage junction boxes will be classified as manholes.

2. MATERIALS

Reuse removed manhole and inlet rings, plates, grates, and covers if they are in good condition as determined by the Engineer. Provide additional materials in accordance with Item 465, "Junction Boxes, Manholes, and Inlets," at no cost to the Department. Use single- or multiple-piece prefabricated metal, polymer, plastic, or rubber extension rings for the adjustment of manholes as approved. Limit the height of flexible extension rings to 3 in. Provide concrete that meets Item 421, "Hydraulic Cement Concrete."

Ensure frames and grates, or rings and covers, above grade are of single-piece cast iron manufactured in compliance with Item 471, "Frames, Grates, Rings, and Covers." Provide steel riser material compliant with ASTM A36. Provide steel adjustable risers that include a stainless steel adjustable stud with positive lock that adjusts the diameter ±3/8 in. Provide steel risers that include a minimum of 3 allen head set screws that lock the riser to the manhole or catch basin frame. Ensure seating surfaces are flat and true and provide a non-rocking seating surface.

3. CONSTRUCTION

Perform all work in accordance with Item 465, "Junction Boxes, Manholes, and Inlets." Excavate and backfill in accordance with Item 400, "Excavation and Backfill for Structures." Carefully remove manhole and inlet rings, covers, plates, and grates to be reused. Clean mortar and grease from the contact areas of all reused items. Dispose of unused removed material as directed. Use construction methods described in Section 479.3.1., "Lowering the Top of a Manhole or Inlet," and Section 479.3.2., "Raising the Top of a Manhole or Inlet," unless otherwise shown on the plans.

3.1. **Lowering the Top of a Manhole or Inlet**. Remove a sufficient depth of brick courses or concrete to permit reconstruction on a batter not exceeding 1 in. horizontal to 2 in. vertical. Clean the mortar from the top course of brick where brickwork is present. Rebuild the manhole or inlet to the original top dimensions or to the dimensions shown on the plans. Install the manhole or inlet ring and the cover, plate, or grate to conform to the proposed new surface contour.

3.2. **Raising the Top of a Manhole or Inlet**. Clean the top surface of brick or concrete. Construct to the proper new elevation using new rubber extension rings, concrete rings, or Class A concrete. Provide rubber manhole and catch basin risers of minimum 80% by weight recycled rubber and minimum 10% by volume recycled RFL coated fiber. Provide rubber manhole and catch basin adjustment risers that are of uniform quality, free from cracks, holes, and any other surface defects. Construction must be suitable for AASHTO H20 live loads. Load certifications for materials will be made available upon request. Install the manhole or inlet ring and the cover, plate, or grate to conform to the proposed new surface contour. Install prefabricated extension rings in accordance with manufacturer's instructions.

3.3. **Capping an Inlet or Manhole**. Remove the inlet or manhole to a minimum of 1 ft. below subgrade elevation or as indicated on the plans. Cap as shown on the plans.

4. MEASUREMENT

Adjusted or capped manholes or inlets will be measured as each manhole or inlet adjusted.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Adjusting Manholes," "Adjusting Inlets," or "Adjusting Manholes and Inlets." This price is full compensation for materials, including backfill as required, and for excavation, tools, equipment, labor, and incidentals.

Item 480
Cleaning Existing Culverts

1. DESCRIPTION

Remove all extraneous material from existing culvert barrels and pipes.

2. WORK METHODS

Expose all inside surfaces of the specified culverts. Do not move or damage the culvert. Dispose of material in accordance with federal, state, and local regulations. Place on roadway slopes when approved.

Perform cleaning to maintain drainage during construction. Acceptance of the cleaned culverts occurs at final acceptance of the project in accordance with Article 5.11., "Final Cleanup," unless otherwise shown on the plans.

3. MEASUREMENT

This Item will be measured by each complete culvert cleaned regardless of the number of barrels or pipes at each location or by the cubic yard. If measurement is by the cubic yard, the volume of material to be removed will be computed by the method of average end areas in its original position.

4. PAYMENT

The work performed in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Cleaning Existing Culverts." This price is full compensation for excavation, disposal of excavated material, equipment, labor, tools, and incidentals.

Item 481
Pipe for Drains

1. DESCRIPTION

Furnish and install pipe for drains.

2. MATERIALS

Furnish polyvinyl chloride (PVC) pipe meeting the requirements of ASTM D1785, Schedule 40, and furnish PVC fittings meeting the requirements of ASTM D2466. PVC pipe and fittings meeting the requirements of ASTM D3034, Type SDR 35 may be used for installations encased in concrete or buried in soil.

Furnish a manufacturer's certification stating the material meets the appropriate ASTM specification.

Furnish pipe marked with:

- manufacturer's name or trademark and code;
- nominal size;
- PVC cell classification (example: 12454-B);
- schedule, size, or other legend (example: SDR-35 PVC Sewer Pipe); and
- specification designation (example: ASTM D1785).

Furnish fittings marked with:

- manufacturer's name or trademark;
- nominal size;
- material designation (example: PVC);
- schedule, size, or other legend (example: Schedule 40); and
- specification designation (example: ASTM D3034).

Furnish solvent meeting the requirements of ASTM D2564 for solvent-welding of fittings.

Provide other types of pipe and fittings as indicated.

Provide fittings, hangers, clamps, straps, anchors, and guard plates in accordance with the details shown on the plans.

3. CONSTRUCTION

Excavate and backfill for pipe installation in accordance with Item 400, "Excavation and Backfill for Structures." Install pipe as shown on the plans or as directed. Solvent-weld all fittings, including splice fittings, to provide a watertight fit. Do not splice straight sections of pipe at intervals shorter than 20 ft. unless at the end of a run or otherwise approved.

Degrease all exposed PVC pipe and fittings, and apply an acrylic water-based primer followed by a coating of the same color used for adjacent concrete surface unless otherwise shown on the plans.

Follow manufacturer's specifications for installation of other types of pipe (material other than PVC) when indicated.

4. MEASUREMENT

This Item will be measured by the foot along the centerline of the installed pipe of the nominal size shown on the plans.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Pipe" of the sizes and types specified. This price is full compensation for furnishing and installing the pipe and for fittings, hangers, clamps, straps, anchors, guard plates, painting, equipment, labor, tools, and incidentals. Excavation and backfill will not be paid for directly but will be considered subsidiary to this Item.