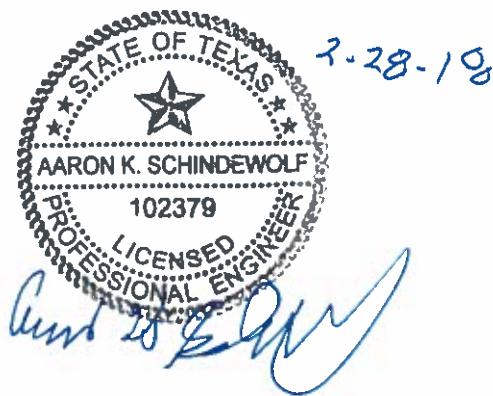




SAN JACINTO RIVER AUTHORITY

**WOODLANDS DIVISION
ON-CALL REPAIR PROJECT**

ATTACHMENT A



SECTION 01 35 05

ENVIRONMENTAL PROTECTION AND SPECIAL CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Addresses:

1. Minimizing the pollution of air, water, or land; control of noise, the disposal of solid waste materials, and protection of deposits of historical or archaeological interest.

1.2 MEASUREMENT AND PAYMENT

- ###### **A. Unit Prices.** No separate payment will be made for this item. Include the cost of same in associated items for this project.

1.3 ENVIRONMENTAL CONTROLS

- ###### **A.** Provide and maintain methods, equipment, and temporary construction as necessary for controls over environmental conditions at construction site and adjacent areas.
- ###### **B.** Work to minimize impact to surrounding environment. Adopt construction procedures that do not cause unnecessary excavation and filling of terrain, indiscriminate destruction of vegetation, air or stream pollution, nor harassment or destruction of wildlife.
- ###### **C.** Recognize and adhere to environmental requirements of Project. Limit disturbed areas to boundaries established by Contract. Avoid pollution of “on-site” streams, sewers, wells, or other water sources.
- ###### **D.** Burning of rubbish, debris, or waste materials is not permitted.

1.4 POLLUTION CONTROL

- ###### **A.** Provide methods, means, and facilities required to prevent contamination of soil, water, or atmosphere by discharge of noxious substances from construction operations.
- ###### **B.** Provide equipment and personnel to perform required emergency measures to contain spillage, and to remove contaminated soils or liquids. Excavate and

dispose of contaminated earth off-site, and replace with suitable compacted fill and topsoil.

C. Provide systems for control of atmospheric pollutants.

1. Prevent toxic concentrations of chemicals.
2. Prevent harmful dispersal of pollutants into atmosphere.

D. Use equipment that conforms to current Federal, State, and local laws and regulations.

E. Install or otherwise implement positive controls to prevent hazardous materials migrating from Work area.

1.5 NOISE CONTROL

M. Provide vehicles, equipment, and construction activities that minimize noise to greatest degree practicable. Conform noise levels to latest OSHA standards. Do not permit noise levels to interfere with Work or create nuisance in surrounding areas.

N. Conduct construction operations during daylight hours except as approved by Owner's Representative.

O. Select construction equipment to operate with minimum noise and vibration. When in opinion of Owner's Representative, objectionable noise or vibration is produced by equipment, rectify conditions without additional cost to Owner. Sound Power Level (PWL) of equipment shall not exceed 85 dbA (re: 10-12 watts) measured 5 feet from piece of equipment. Explicit equipment noise requirements are specified with equipment specifications.

1.6 DUST CONTROL

A. Control objectionable dust caused by operation of vehicles and equipment. Apply water or use other methods, subject to approval of Owner's Representative, to control amount of dust generated.

1.7 QUALITY ASSURANCE

A. Person conducting visual examination for pollutant shall be fully knowledgeable about the TPDES Construction General Permit, detecting sources of storm water contaminants, inspection of aboveground storage tank and appurtenances for

leakage, and the day-to-day operations that may cause unexpected pollutant releases.

PART 2 - PRODUCTS

2.1 ABOVEGROUND FUEL STORAGE TANK

- A. Tank Assembly: Must be listed with UL 1709 and UL 2085.
- B. Inner Steel Storage Tank: Follow UL 142, with minimum thickness of 1/8-inch welded construction.
- C. Tank Encasement: Either concrete or steel to provide minimum of 110 percent containment of inner tank capacity. Provide 5-gallon overspill containment pan for tank refueling.
- D. Dispenser Pump: For submersible pump, UL listed emergency shut-off valve to be installed at each dispenser. For suction pump, UL listed vacuum-activated shut-off valve, with shear section, is to be installed at each dispenser. Fuel may not be dispensed from tank by gravity flow or by pressurization of tank. Means must be provided to prevent release of fuel by siphon flow.
- E. Representative Manufacturers: Convault, Fireguard, Ecovault, SuperVault, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Employ and utilize environmental protection methods, obtain all necessary permits, and fully observe all local, state, and federal regulations.
- B. No clearing and grubbing or rough cutting permitted until erosion and sediment control systems are in place, other than site Work specifically directed by Owner's Representative to allow soil testing and surveying.
- C. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damage caused by construction traffic to erosion and sediment control systems.
- D. Maintain existing erosion and sediment control systems located within project site until acceptance of Project or until directed by Owner's Representative to remove and discard existing system.
- E. Regularly inspect and repair or replace damaged components of erosion and sediment control systems as specified in this Section. Unless otherwise directed, maintain erosion and sediment control systems until project area stabilization is accepted by the Owner. Remove erosion and sediment control

systems promptly when directed by Owner's Representative. Discard removed materials off site.

- F. Remove and dispose sediment deposits at designated spoil site for Project. If a project spoil site is not designated on Drawings, dispose of sediment off site at location not in or adjacent to stream or flood plain. Assume responsibility for off-site disposal. Spread sediment evenly throughout site, compacted and stabilized. Prevent sediment from flushing into a stream or drainage way. If sediment has been contaminated, dispose of in accordance with existing federal, state, and local rules and regulations.
- G. Assume responsibility for collecting, storing, hauling, and disposing of spoil, silt, and waste materials as specified in this or other Specifications and in compliance with applicable federal, state, and local rules and regulations.
- H. Employ protective measures to avoid damage to existing trees to be retained on project site. Conduct construction operations under this Contract in conformance with erosion control practices described in Drawings and this or other Specifications.
- I. Prepare spill response and containment procedures to be implemented in event of significant materials spill. Significant materials include but are not limited to: raw materials; fuels; materials such as solvent, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under Section 101(14) of CERCLA; chemical required to be reported pursuant to Section 313 of Title III of SARA; fertilizers; pesticides, and waste products such as slag, ashes and sludge that have potential to be released with storm water discharges. Spill containment procedures shall be kept on-site or in construction field office.
- J. Spill containment equipment appropriate to size of operation is to be located in close proximity of fueling area. Such equipment includes, but not limited to,

suitable waste containers for significant materials, drip pans, booms, inlet covers, or absorbent.

- K. Properly label significant materials or waste containers used for construction activities and stored on-site overnight.
- L. Install, maintain, and inspect erosion, sediment control measures and practices as specified in Drawings and in this or other Specifications
- M. Land Protection:
 - 1. Except for any work or storage area and access routes specifically assigned for the use of the Contractor, the land areas outside the limits of construction shall be preserved in their present condition.
 - a. Contractor shall confine his construction activities to areas defined for work within the Contract Documents.
 - 2. Manage and control all borrow areas, work or storage areas, access routes and embankments to prevent sediment from entering nearby water or land adjacent to the work site.
 - 3. Restore all disturbed areas including borrow and haul areas and establish permanent type of locally adaptable vegetative cover.
 - 4. Unless earthwork is immediately paved or surfaced, protect all side slopes and backslopes immediately upon completion of final grading.
 - 5. Plan and execute earthwork in a manner to minimize duration of exposure of unprotected soils.
 - 6. Except for areas designated by the Contract Documents to be cleared and grubbed, the Contractor shall not deface, injure or destroy trees and

vegetation, nor remove, cut, or disturb them without approval of the Owner's Representative.

- a. Any damage caused by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition at the Contractor's expense.
7. Utilize, as necessary, erosion control methods to protect side and backslopes, minimize and the discharge of sediment to the surface water leaving the construction site as soon as rough grading is complete.
- a. These controls shall be maintained until the site is ready for final grading and landscaping or until they are no longer warranted and concurrence is received from the Owner's Representative.
 - b. Physically retard the rate and volume of run-on and runoff by:
 - 1) Implementing structural practices such as diversion swales, terraces, straw bales, silt fences, berms, storm drain inlet protection, rocked outlet protection, sediment traps and temporary basins.
 - 2) Implementing vegetative practices such as temporary seeding, permanent seeding, mulching, sod stabilization, vegetative buffers,

hydroseeding, anchored erosion control blankets, sodding, vegetated swales or a combination of these methods.

- 3) Providing Construction sites with graveled or rocked access entrance and exit drives and parking areas to reduce the tracking of sediment onto public or private roads.
8. Discharges from the construction site shall not contain pollutants at concentrations that produce objectionable films, colors, turbidity, deposits or noxious odors in the receiving stream or waterway.

N. Solid Waste Disposal:

1. Collect solid waste on a daily basis.
2. Provide disposal of degradable solid waste to an approved solid waste disposal site.
3. Provide disposal of nondegradable solid waste to an approved solid waste disposal site or in an alternate manner approved by Owner's Representative and regulatory agencies.
4. No building materials wastes or unused building materials shall be buried, dumped, or disposed of on the site.

O. Fuel and Chemical Handling:

1. Store and dispose of chemical wastes in a manner approved by regulatory agencies.
2. Take special measures to prevent chemicals, fuels, oils, greases, herbicides, and insecticides from entering drainage ways.
3. Do not allow water used in onsite material processing, concrete curing, cleanup, and other waste waters to enter a drainage way(s) or stream.
4. The Contractor shall provide containment around fueling and chemical storage areas to ensure that spills in these areas do not reach waters of the state.

P. Control of Dust:

1. The control of dust shall mean that no construction activity shall take place without applying all such reasonable measures as may be required to

prevent particulate matter from becoming airborne so that it remains visible beyond the limits of construction.

- a. Reasonable measures may include paving, frequent road cleaning, planting vegetative groundcover, application of water or application of chemical dust suppressants.
 - b. The use of chemical agents such as calcium chloride must be approved by the State of Texas DOT.
2. Utilize methods and practices of construction to eliminate dust in full observance of agency regulations.
 3. The Owner's Representative will determine the effectiveness of the dust control program and may request the Contractor to provide additional measures, at no additional cost to Owner.

Q. Burning:

1. Do not burn material on the site.
2. If the Contractor elects to dispose of waste materials by burning, make arrangements for an off-site burning area and conform to all agency regulations.

R. Control of Noise:

1. Control noise by fitting equipment with appropriate mufflers.

S. Completion of Work:

1. Upon completion of work, leave area in a clean, natural looking condition.
2. Ensure all signs of temporary construction and activities incidental to construction of required permanent work are removed.

T. Historical Protection:

1. If during the course of construction, evidence of deposits of historical or archaeological interests is found, cease work affecting find and notify Owner's Representative.
 - a. Do not disturb deposits until written notice from Owner's Representative is given to proceed.
2. The Contractor will be compensated for lost time or changes in construction to avoid the find based upon normal change order procedures.

3.2 DUST CONTROL

- A. Implement dust control methods to control dust creation and movement on construction sites and roads and to prevent airborne sediment from reaching

receiving streams or storm water conveyance systems, to reduce on-site and off-site damage, to prevent health hazards, and to improve traffic safety.

- B. Control blowing dust by using one or more of following methods:
 - 1. Mulches bound with chemical binders such as Carasol, Terratack, or equal.
 - 2. Temporary vegetative cover.
 - 3. Spray-on adhesives on mineral soils when not used by traffic.
 - 4. Tillage to roughen surface and bring clods to surface.
 - 5. Irrigation by water sprinkling.
 - 6. Barriers using solid board fences, snow fences, burlap fences, crate walls, bales of hay, or similar materials.
- C. Implement dust control methods immediately whenever dust can be observed blowing on project site.

3.3 KEEPING STREETS CLEAN

- A. Keep streets clean of construction debris and mud carried by construction vehicles and equipment. If necessary, install stabilized construction exits at construction, staging, storage, and disposal areas. Vehicle/equipment wash area (stabilized with coarse aggregate) may be installed adjacent to stabilized construction exit, as needed. Release wash water into a drainage swale or inlet protected by erosion and sediment control measures.
- B. In addition to stabilized construction exits, shovel or sweep pavement to extent necessary to keep street clean. Water hosing or sweeping of debris and mud off of street into adjacent areas is not allowed.

3.4 EQUIPMENT MAINTENANCE AND REPAIR

- A. Confine maintenance and repair of construction machinery and equipment to areas specifically designated for that purpose. Locate areas so that oils, gasoline, grease, solvents, and other potential pollutants cannot be washed directly into receiving streams or storm water conveyance systems. Provide these areas with adequate waste disposal receptacles for liquid as well as solid waste. Clean and inspect maintenance areas daily.
- B. On construction site where designated equipment maintenance areas are not feasible, take precautions during each individual repair or maintenance operation to prevent potential pollutants from washing into streams or conveyance systems. Provide temporary waste disposal receptacles.

3.5 WASTE COLLECTION AND DISPOSAL

- A. Formulate and implement a plan for collection and disposal of waste materials on construction site. In plan, designate locations for trash and waste receptacles and establish a collection schedule. Specify and carry out methods for ultimate disposal of waste in accordance with applicable local, state, and federal health

and safety regulations. Make special provisions for collection and disposal of liquid wastes and toxic or hazardous materials.

- B. Keep receptacles and waste collection areas neat and orderly to extent possible. Waste shall not be allowed to overflow its container or accumulate from day-to-day. Locate trash collection points where they shall least likely be affected by concentrated storm water runoff.

3.6 WASHING AREAS

- A. Avoid washing concrete delivery trucks or dump trucks and other construction equipment at locations where runoff shall flow directly into a watercourse or storm water conveyance system. Designate special areas for washing vehicles. Locate these areas where wash water shall spread out and evaporate or infiltrate directly into ground, or where runoff can be collected in temporary holding or seepage basin. Beneath wash areas construct a gravel or rock base to minimize mud production.

3.7 STORAGE OF CONSTRUCTION MATERIALS AND CHEMICALS

- A. Isolate sites where chemicals, cements, solvents, paints, or other potential water pollutants are stored in areas where they shall not cause runoff pollution.
- B. Store toxic chemicals, materials, pesticides, paints, and acids in accordance with manufacturers' guidelines. Protect groundwater resources from leaching by placing a plastic mat, packed clay, tar paper, or other impervious materials on areas where toxic liquids are to be opened and stored.

3.8 SANITARY FACILITIES

- A. Provide construction sites with adequate portable toilets for workers in accordance with applicable health regulations.

3.9 CONSTRUCTION METHODS

- A. Provide fuel tank protection area and driveway as shown on Drawings.
- B. Do not locate fueling area in or near channelized flow area or close to storm sewer conveyance system. Provide sufficient space to allow installation of other erosion and sediment controls to protect those areas.
- C. Clear and grub fueling area to remove unsuitable materials. Place geotextile fabric as permeable separator to prevent mixing of coarse aggregate with underlying soil. Overlap fabric minimum of 6 inches. Place coarse aggregate on top of geotextile fabric to minimum depth of 8 inches.
- D. Grade protection area and driveway to provide sufficient drainage away from stabilized areas. Use sandbags, gravel, boards, or similar methods to prevent sediment from entering public right-of-way, receiving stream or storm water

conveyance system. Provide driveway to fuel tank area with minimum width of 15 feet for one-way traffic and 30 feet for two-way traffic.

3.10 MAINTENANCE

- A. Inspections shall be conducted by designated health and safety officer qualified to conduct health and safety inspections.
- B. Inspect stabilized areas after every storm event and at least once a week. Provide periodic top dressing with additional coarse aggregate to maintain required depth. Repair and clean out damaged control measures used to trap sediment.

3.11 TEMPORARY FUELING AREA CLOSURE

- A. Dispose of temporary vehicle and equipment fueling area by removal of sediment and erosion controls properly off site. Owner's Representative will inspect top soils in fueling area and immediate vicinity for evidence of fuel leaks. If Owner's Representative determines that sufficient pollutants have been released, remove soil and properly dispose off site. Other remediation methods may be required.

END OF SECTION

SECTION 01 45 29
TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing laboratory services
2. Requirements of this section apply to testing laboratories employed by the Owner for approval of materials and the constructed Work on site.

1.2 MEASUREMENT AND PAYMENT

A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project

1.3 QUALITY ASSURANCE

A. Reference Standards

1. ASTM C 1077 – Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
2. ASTM D 3666 – Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials.
3. ASTM D 3740 – Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
4. ASTM E 329 – Standard Specification for Minimum Requirements for Agencies Engaged the Testing and/or Inspection of Materials Used in Construction.
5. ISO/IEC 17025 – General Requirements for the Competence of Calibration and Testing Laboratories.

1.4 RELATED REQUIREMENTS

- A. Owner will select, employ, and pay for services of an independent testing laboratory to perform inspection and testing identified in Part 3 of individual Specification sections.
- B. Employment of testing laboratory by Owner does not relieve the Contractor of obligation to perform the Work in accordance with requirements of Contract Documents.
- C. Owner's Representative schedules and monitors Owner's testing laboratory. Provide minimum 24 hours notice of testing to Owner's Representative to avoid delay of the Work.

1.5 QUALIFICATION OF LABORATORY

- A. Meet laboratory qualification requirements of ASTM E 329 and applicable requirements of ASTM C 1077, ASTM D 3666, and ASTM D 3740.
- B. Meet ISO/IEC 17025 conditions for accreditation by the American Association for Laboratory Accreditation (A2LA) in specific fields of testing required in individual Specification sections.
- C. If laboratory subcontracts are part of testing services, such work will be placed with laboratory complying with requirements of this Section.

1.6 LABORATORY

- A. Owner's testing laboratory will provide and distribute copies of laboratory reports to the distribution list provided by Owner's Representative at the preconstruction conference.
- B. Laboratories will email material supplier, Contractor, and Owner's Representative no later than close of business on working day following test completion and review, reports which indicate failing test results.

1.7 LIMITS ON TESTING LABORATORY AUTHORITY

- A. Laboratory may not release, revoke, alter, or enlarge requirements of Contract.
- B. Laboratory may not approve or accept any portion of the Work.
- C. Laboratory may not assume duties of Contractor or the Owner
- D. Laboratory has no authority to stop the Work.

1.8 SUBMITTALS (NOT USED)

1.9 CONTRACTOR RESPONSIBILITIES

- A. Provide safe access to the Work and to manufacturer's facilities for Owner's Representative, and for testing laboratory personnel.
- B. Provide testing laboratory with copy of construction schedule and copy of each update to construction schedule.
- C. Notify Owner's Representative and testing laboratory during normal working hours of the day previous to expected time for operations requiring inspection and testing services. When Contractor fails to make timely prior notification, then do not proceed with operations requiring inspection and testing services.
- D. Notify Owner's Representative 24 hours in advance when Specification requires presence of Owner's Representative for sampling or testing.
- E. Request and monitor testing as required to provide timely results and avoid delay to the Work. Where specified, provide samples to laboratory in sufficient time to allow required test to be performed in accordance with specified test methods before intended use of material.
- F. Cooperate with laboratory personnel in collecting samples on site. Provide incidental labor and facilities for safe access to the Work to be tested; to obtain

and handle samples at site or at source of products to be tested; and to facilitate tests and inspections including storage and curing of test samples.

- G. Arrange with laboratory through Owner's Representative. Payment for additional testing will be made for:
1. Retesting required for failed tests
 2. Retesting for nonconforming Work
 3. Additional sampling and tests requested beyond specified requirements
 4. Insufficient notification of cancellation of tests for Work scheduled but not performed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONDUCTING TESTING

- A. Conform laboratory sampling and testing specified in individual Specification sections to latest issues of ASTM standards, TxDOT methods, or other recognized test standards as approved by Owner's Representative.
- B. Requirements of this section also apply to those tests for approval of materials, for mix designs and for quality control of materials as performed by employed testing laboratories.

END OF SECTION

SECTION 01 51 36.01

PROCEDURE FOR WATER VALVE ASSISTANCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

Operation of valves. Owner employees will operate existing valves.
Contractor's employees may operate new valves included in the Project prior to acceptance by the Owner.

1.2 MEASUREMENT AND PAYMENT

A. No separate payment will be made for this item. Include the cost of valve operation and valve assistance in Unit Price bid for valves and water mains.

1.3 PROCEDURE

A. Contractor to coordinate with Owner's Representative for valve assistance.

1.4 SUBMITTALS (NOT USED)

1.5 CANCELLATION

A. The Owner may cancel a scheduled valve assistance appointment at no extra cost to either party. Cancellation may be caused by bad weather, preparation work taking longer than anticipated or unforeseen delays by one or more of the three parties.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 55 26
TRAFFIC CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes traffic control requirements for signs, signals, control devices, flares, lights, as well as construction parking control, English-speaking flagpersons, peace officers, designated haul routes and bridging of trenches and excavations.

1.2 MEASUREMENT AND PAYMENT

- A. Traffic Control and Regulation. No separate payment. Include in payment for associated items.
 - 1. Flagmen. No separate payment. Include in price for Traffic Control.

1.3 SUBMITTALS

- A. Traffic control plan responsive to the current Texas Manual on Uniform Traffic Control Devices (TMUTCD) sealed by Registered Professional Engineer is incorporated into Drawings. If Contractor proposes to implement traffic control without modification to plan provided, submit a letter confirming decision. If Contractor proposes to implement traffic control different than plan provided, submit a traffic control plan in conformance with TMUTCD sealed by Registered Professional Engineer.
- B. Submit copies of approved lane closure permits.
- C. Provide information and records regarding use of qualified flagmen to verify use of “peace officers” as flagmen in compliance with Contract and Texas law, including but not limited to, Article 4413 (29bb), commonly referred to as Private Investigators and Private Security Agencies Act, and Article 2.12, Texas Code of Criminal Procedure.
- D. Provide information and records regarding use of qualified flagmen to verify Contractor’s use of “certified flagmen” as flagmen is in compliance with Contract.

1.4 FLAGMEN

- A. Use flagmen, qualified as described under Paragraph 1.4.B, Uniformed Peace Officers, and Paragraph 1.4.C, Certified Flagmen, to control, regulate, and direct even flow and movement of vehicular and pedestrian traffic when construction operations encroach on public traffic lanes.
- B. Uniformed Peace Officer: Individual who has full-time employment as peace officer and receives compensation as flagman for private employment as individual employee or independent contractor. Private employment may be either employee-employer relationship or on an individual basis. Flagman may

not be in employ of another peace officer and may not be a reserve peace officer.

1. Peace officer is defined as:
 - a. Sheriffs and their deputies
 - b. Constables and deputy constables
 - c. Marshals or police officers of an incorporated city, town, or village
 - d. As otherwise provided by Article 2.12, Texas Code of Criminal Procedure, as amended
 2. Individual who has full-time employment as a peace officer is one who is actively employed in a full-time capacity as a peace officer working, on average, a minimum of 32 paid hours per week, being paid a rate of pay not less than prevailing minimum hourly wage rate set by federal Wage and Hour Act and entitled to full benefits of participation in retirement plan, vacation, holidays, and insurance benefits. A reserve peace officer does not qualify, under this definition, as a peace officer.
- C. Certified Flagman: Individual who receives compensation as flagman and meets the following qualifications and requirements:
1. Formally trained and certified in traffic control procedures.
 2. Required to wear distinctive uniform, bright-colored vest, and be equipped with appropriate flagging and communication devices
 3. English speaking, with Spanish as advantageous, but not required, primary, or secondary language.
 4. Required to carry proof of training/certification and photographic identification card issued by training institute to allow Owner's Representative to easily determine necessary full-time traffic control is actually provided when and where construction work encroaches upon traffic lanes.

PART 2 - PRODUCTS

2.1 SIGNS, SIGNALS, AND DEVICES

- A. Comply with Texas State Manual on Uniform Traffic Control Devices.
- B. Traffic Barriers, Cones and Drums, Flares and Lights: As approved by local jurisdictions.

PART 3 - EXECUTION

3.1 PUBLIC ROADS

- A. Abide by laws and regulations of governing authorities when using public roads. If Work requires public roads be temporarily impeded or closed, obtain

approvals from governing authorities and pay permits before starting any Work. Coordinate activities with Owner's Representative.

- B. Maintain 10-foot-wide, all-weather lane adjacent to Work areas for use of emergency vehicles. Keep all-weather lane free of construction equipment and debris.
- C. Cover or remove the permanent signs and construction signs that are incorrect or that do not apply to the current situation for a particular phase. Do not mount signs on drums or barricades, except those listed in the latest Barricades and Construction standard sheets.
- D. Place positive barriers to protect drop-off conditions greater than 1 FT within the clear zones that remain overnight.
- E. Maintain local driveway access to residential and commercial properties adjacent to Work areas at all times. Use all-weather materials as approved by

Owner's Representative when maintaining temporary driveway access to commercial and residential driveways.

- F. Provide safe access for pedestrians along major cross streets.

3.2 CONSTRUCTION PARKING CONTROL

- A. Control vehicular parking to prevent interference with public traffic and parking, and access by emergency vehicles.
- B. Monitor parking of construction personnel's vehicles in existing facilities. Maintain vehicular access to and through parking areas.
- C. Prevent parking on or adjacent to access roads or in non-designated areas.

3.3 FLARES AND LIGHTS

- A. Provide flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.

3.4 REMOVAL

- A. Remove equipment and devices when no longer required.
- B. Repair damage caused by installation.

3.5 TRAFFIC CONTROL, REGULATION, AND DIRECTION

- A. Use flagmen to control, regulate, and direct even flow and movement of vehicular and pedestrian traffic including but not limited to the following conditions:
 - 1. Where multi-lane vehicular traffic must be diverted into single lane vehicular traffic
 - 2. Where vehicular traffic must change lanes abruptly
 - 3. Where construction equipment must enter or cross vehicular traffic lanes and walks
 - 4. Where construction equipment may intermittently encroach on vehicular traffic lanes and unprotected walks and crosswalks
 - 5. Where traffic regulation is needed due to rerouting of vehicular traffic around Work site.
 - 6. Other areas of Work where construction activities might affect public safety and convenience.
- B. Use and maintain flagmen at points for periods of time as may be required to provide for public safety and convenience of travel.
- C. Use of flagmen is for purpose of assisting in regulation of traffic flow and movement and does not relieve Contractor of full responsibility for taking other

steps and providing other flaggers or personnel as Contractor may deem necessary to protect Work and public.

3.6 MAINTENANCE OF EQUIPMENT AND MATERIAL

- A. Designate individual to be responsible for maintenance of traffic handling around construction area. Individual must be accessible at all times to immediately correct any deficiencies in equipment and materials used to handle traffic including missing, damaged, or obscured signs, drums, barricades, or pavement markings. Give name, address, and telephone number of designated individual to Owner's Representative.
- B. Make daily inspections of signs, barricades, drums, lamps, and temporary pavement markings to verify that these are visible, in good working order, and conform with traffic handling plans and directions of Owner's Representative. When not in compliance, immediately bring equipment and materials into compliance by replacement, repair, cleaning, relocation, and realignment.
- C. Keep equipment and materials, especially signs and pavement markings, clean and free of dust, dirt, grime, oil, mud, or debris.
- D. Owner's Representative shall decide if damaged or vandalized signs, drums, and barricades can be reused.

END OF SECTION

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SECTION 01 56 39

TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for tree and plant protection.

1.2 MEASUREMENT AND PAYMENT

- A. Unless a separate bid item has been established, no separate payment will be made for tree and plant protection specified herein. Include cost in price bid for related work items.

1.3 PROJECT CONDITIONS WHEN TREES AND PLANTS ARE IDENTIFIED TO REMAIN

- A. Preserve and protect existing trees and plants from foliage, branch, trunk, or root damage that could result from construction operations when trees and plants are identified to remain.
- B. Do not allow any vehicular traffic, construction equipment, parking of vehicles or stockpiling of excavated material or construction materials within protected tree

root zone areas. Refer to Section 1.6 DEFINITIONS, for Dripline/Root Zone Area definition.

C. Prevent the following types of damage:

1. Compaction of root zone area by equipment, vehicles, foot traffic or materials storage.
2. Suffocating roots by placing soil in excess of three inches (3") within root zone areas, including placement of any select fill or soil with high clay content.
3. Trunk and limb damage resulting from contact with equipment and vehicles.
4. Poisoning by pouring solvents, fuel, and other injurious materials on or near root zone areas or in areas where such materials will leak or wash into root zone areas.
5. Changing soil pH within root zones by depositing concrete, powdered lime or other materials used to stabilize or dehydrate soils.
6. Cutting roots measuring one inch (1") in diameter and larger within protected areas unless required for root pruning.
7. Scorching of foliage, twigs and limbs caused by direct contact with expulsion of hot exhaust from equipment or vehicles.
8. Branch damage due to improper pruning or trimming.
9. Damage from permanently altering drainage patterns near root zones.
10. Trunk and branch damage resulting from nailing or bolting.

1.4 DAMAGE ASSESSMENT

- A. When trees other than those designated for removal are destroyed or badly damaged as result of construction operations, remove and replace with same size, species, and variety up to and including 8 inches in trunk diameter. Any tree larger than 8 inches in diameter shall be replaced with 8-inch diameter tree of same species and variety and total contract amount shall be reduced by amount determined from following International Shade Tree Conference formula: $0.7854 \times D^2 \times \$38.00$ where D is diameter in inches of tree or shrub trunk measured 12 inches above grade.

1.5 DEFINITIONS

- A. Dripline/Root Zone Area - The ground area delineated by the branch spread of a single plant or group of plants. This area is considered the most critical area

of roots and should be protected, excluding the area within the street located between curbs.

- B. Zero Curb Cut - The process in which required street work is conducted without cutting or otherwise disturbing soil located immediately behind the existing curb.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Protection Fencing - Orange, plastic mesh fencing, four feet (4') in height with six feet (6') high steel T-bar posts. Set posts eighteen inches (18") into ground. Stretch fencing material taut prior to securing.
- B. Fertilizer - A low salt, slow release fertilizer containing twenty-seven percent (27%) nitrogen, nine percent (9%) phosphorus and nine percent (9%) potassium (potash) or similar.
- C. Plastic Vapor Barrier - Polyethylene sheeting at least 6-mil thickness and three feet width to prevent leaching of stabilized material into native soil.
- D. Tree Replacements - Shall be as approved by Owner's Representative as necessary.

PART 3 - EXECUTION

3.1 PROTECTION AND MAINTENANCE OF EXISTING TREES AND SHRUBS

- A. Except for trees shown on Drawings or determined by Owner's Representative to be removed or relocated, trees within Project area are to remain in place, protected from damage and maintained by Contractor.
- B. If required by the Project specifications, employ a qualified Arborist. The Arborist must be approved by Owner's Representative and shall have a minimum of 5 (five) years of experience in the field of tree protection.
- C. Perform the following services as required by construction activities for trees that remain:
 - 1. Trimming
 - a. Trees shall be pruned in accordance ANSI A300 (Part 1) - 2001 Pruning Revision of ANSI A300-1995 Tree, Shrub and Other Woody Plant Maintenance - Standard Practices. Pruning shall be done by a

professional arborist who has received training in proper pruning techniques.

- b. Pruning shall not alter the natural shape or character of the tree or leave holes in the canopy. Trees and shrubs should be pruned for balance as well as to maintain proper form and branching habit.
- c. Cut limbs at branch collar. No stubs should remain on trees. Branch cuts should not gouge outer layer of tree structure or trunk.

2. Root Pruning

- a. When excavating with equipment within the root zone area is unavoidable and roots cannot be preserved, root prune prior to excavation to minimize damage to the portion of the root system that will remain.
 - b. Prune roots using a conventional trenching machine. Trench along the proposed edge of excavation limits to a depth of three feet (3'). Do not allow ripping of roots with a backhoe or other equipment.
 - c. Following trenching with the machine, re-cut roots measuring one inch (1") in diameter and larger using appropriate sharpened, pruning shears or pruning saws to make a clean, smooth-cut surface. Cut roots flush with edge of soil to limit root exposure.
 - d. Backfill trench in a manner that will not allow settling using clean, native soil.
3. Contractor's option with Owner's Representative's permission, shrubs to remain may be temporarily transplanted and returned to original positions under supervision of professional horticulturist.

3.2 PROTECTION

A. Construction Methods

1. General

- a. Contractor shall attend a pre-construction meeting conducted by the Owner's Representative to review tree preservation requirements and sequence of services for the construction process.
- b. Protect tree limbs, trunks and foliage from direct exposure to hot exhaust from equipment and vehicles by providing adequate exhaust pipe deflectors.
- c. Cover exposed roots within 24 hours to reduce damage caused by desiccation. Roots may be covered with soil or mulch to help protect them from drying.
- d. Protect root zone areas from damage that may result from soil compaction or from noxious materials in solution caused by run-off or

spillage during mixing and placement of construction materials, or drainage from stored materials.

- e. Minimize cut to two inches (2") below grade when installing silt fence within tree root zones or anchor base of fabric on grade using gravel or staples. Do not cut roots 1" in diameter or larger.
- f. Site preparation work and/or construction work shall not begin in any area where tree preservation measures have not been completed and approved by the Owner's Representative.

2. Preparation

- a. Contractor shall not allow any vehicular traffic, parking of vehicles or stockpiling of excavated material or construction material within the root zone area of trees to be preserved.
- b. When access within protected root zone areas by equipment traffic or frequent foot traffic cannot be avoided, contact Owner's Representative for review prior to entrance. Place a three-quarter inch (3/4") thick layer of plywood on natural grade within root zones to minimize soil compaction. Overlap edges of plywood by six inches (6") to twelve inches (12") to ensure adequate coverage. This is not acceptable bridging for driving over exposed tree roots. Exposed roots should not be driven over.
- c. Contractor shall notify Owner's Representative if existing tree locations differ from locations represented on construction drawings. The tree location and dripline/root zone area as observed in the field shall supersede that outlined on construction plans.

3. Tree Protection Fencing

- a. Each tree located adjacent to proposed soil excavation shall be protected with a tree protection fence or as designated on the plans. Fence locations shall be approved by Owner's Representative.
- b. Contractor shall not remove or relocate tree protection fencing and shall not operate within the limits shown without approval of the Owner's Representative.
- c. Fences shall be placed in continuous alignment to protect a tree or group of trees.
- d. Posts shall be installed on eight-foot (8') centers at eighteen inches (18") below grade. The fencing shall be continuous between posts, shall be

pulled taut prior to securing to posts, and shall be firmly attached to the posts with a minimum of three (3) wire ties.

- e. Place fencing in a manner that will not obstruct traffic sight lines at curbs, intersections or driveways.
- f. Fencing shall be removed only after all work within the immediate area is complete.
- g. Contractor shall immediately repair fences if damage occurs at no additional charge to client.

4. Excavation within Root Zone Areas

- a. For excavation within root zone areas, where required for personal safety, provide excavation protection by using vertical-wall-shoring techniques at excavations to minimize excavation width. Do not bench cut or step cut edge where such techniques will encroach on root zone areas.
- b. If roots are encountered and must be severed, roots measuring one inch (1") in diameter and larger shall be cut using a sharpened pruning instrument to leave a smooth, clean-cut surface.

5. Trunk Barricading

- a. Install trunk barricading to protect trees in close proximity of moving or mechanical equipment and construction work when work is required within the tree protection fencing as shown on the plans.
- b. Place trunk barricading around entire tree trunks to protect tree trunks located within five feet (5') of construction activities.
- c. Install 2x4's or 2x6's (5-foot to 6-foot lengths) spaced 3 inches (3") apart around the circumference of the tree trunk.
- d. Tie in place with 9 to 12 gauge steel wire.

B. Accidental Spills of Toxic Materials

- 1. Concrete, lime or other chemicals placed or accidentally spilled within root zone protection areas shall be completely removed. Contaminated soil shall be completely removed at the time of the spill and removed by hand shovel. Fresh soil shall be added as necessary to bring the soil level to that of natural grade.

3.3 MAINTENANCE OF NEWLY PLANTED TREES AND REPLANTED TREES

- A. Guarantee trees planted for this Project shall remain alive and healthy at least until end of 1-year warranty period.

- 1. Within 4 weeks notice from Owner's Representative, replace dead trees or trees that in opinion of Owner's Representative have become unhealthy,

unsightly or have lost their natural shape as result of additional growth, improper pruning, maintenance or weather conditions.

2. When tree must be replaced, guarantee period begins on date of tree replacement, subject to Owner's Representative's inspection, for no less than 1 year.
3. Straighten leaning trees and bear entire cost.
4. Dispose of trees rejected by Owner's Representative and bear entire cost.

END OF SECTION

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SECTION 01 57 23

TEMPORARY STORM WATER POLLUTION AND EROSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Construction and maintenance of temporary storm water protection and erosion control devices.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Reference Standards:

1. ASTM International (ASTM):
 - a. A36 – Standard Specification for Carbon Structural Steel.
 - b. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - c. D3786 – Standard Test Method for Hydraulic Bursting Strength for Knitted Goods and Nonwoven Fabrics.
 - d. D4355 – Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
 - e. D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - f. D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - g. D4833 – Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
 - h. D6382 – Standard Practice for Dynamic Mechanical Analysis and Thermogravimetry of Roofing and Waterproofing Membrane Material.

1.4 DEFINITIONS

- A. Filter Fabric Fence and Reinforced Filter Fabric Fence: Installed to allow surface or channel runoff percolation through fabric in sheet-flow manner and to retain and accumulate sediment.
- B. Straw Bale Fence: Installed to allow surface runoff percolation through straw in sheet-flow manner and to retain and accumulate sediment.

- C. Drop Inlet Baskets: Installed to allow runoff percolation through the basket and to retain and accumulate sediment.
- D. Sediment Traps: Constructed to pool surface runoff from construction area to allow sediment to settle onto the bottom of trap.

1.5 SUBMITTALS (NOT USED)**1.6 WARRANTY (NOT USED)****PART 2 - PRODUCTS****2.1 AGGREGATE MATERIALS**

- A. Stone: Use open graded aggregates with minimum diameter of 3 inches, and maximum 5 inches in diameter and less than ½ cubic foot in volume unless otherwise specified. Use clean, hard crushed concrete or stone free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic and injurious matter.
- B. Provide gravel lining in accordance with Specification Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities, or as shown on the Drawings.
- C. Provide clean cobbles and gravel consisting of crushed concrete or stone. Use clean, hard crushed concrete or stone free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic matter.
- D. Sediment Pump Pit Aggregate: Use nominal 2-inch diameter river gravel.

2.2 GEOTEXTILE FILTER FABRIC

- A. Woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material, in continuous rolls of longest practical length.
- B. Grab Strength: 100 psi in any principal direction (ASTM D4632), Mullen burst strength greater than 200 psi (ASTM D3786), and equivalent opening size between 50 and 140 for soils with more than 15 percent by weight passing No. 200 sieve and between 20 and 50 for soils with less than 15 percent by weight passing No. 200 sieve; and maximum water flow rate of 40 gallons per minute per square foot (ASTM D4491).
- C. Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a

temperature range of 0°F to 120°F. Ultraviolet stability exceed shall exceed 70% after 500 hours of exposure (ASTM D4355).

D. Acceptable Manufacturers: Mirafi, Inc., Synthetic Industries, or approved equal.

2.3 FENCING

- A. Wire Fencing: Woven galvanized steel wire, 12½ gauge by 2 inch by 4 inch mesh spacing, minimum 24-inch roll or sheet width of longest practical length.
- B. Fence Stakes: Nominal 2 by 2 inch moisture-resistant treated wood or steel posts (min. of 1.25 lbs. per linear foot and Brinell Hardness greater than 140) with safety caps on top; length as required for minimum 8 inch bury and full height of filter fabric.

2.4 SANDBAGS

- A. Provide woven material made of polypropylene, polyethylene, or polyamide material.
- B. Minimum unit weight of 4 ounces per square yard.
- C. Minimum grab strength of 100 psi in any principal direction (ASTM D4632)
- D. Mullen burst strength exceeding 300 psi (ASTM D3786).
- E. Ultraviolet stability exceeding 70 percent (ASTM D4355).
- F. Size: Length: 18 to 24 inches. Width: 12 to 18 inches. Thickness: 6 to 8 inches. Weight: 50 to 125 pounds.

2.5 DROP INLET BASKET

- A. Provide steel frame members in accordance with ASTM A36.
- B. Construct top frame of basket with two short sides of 2-inch by 2-inch and single long side of 1-inch by 1-inch, 1/8 inch angle iron. Construct basket hangers of 2 inch by 1/4 inch iron bars. Construct bottom frame of 1-inch by 1/4 inch iron bar or 1/4 inch plate with center 3 inches removed. Use minimum 1/4 inch diameter iron rods or equivalent for sides of inlet basket. Weld minimum of 14 rods in place between top frame/basket hanger and bottom frame. Exact

dimensions for top frame and insert basket will be determined based on dimensions of type of inlet being protected.

2.6 STRAW BALE

- A. Straw: Standard-baled agricultural hay bound by wire, nylon, or polypropylene rope. Do not use jute or cotton binding.
- B. Straw Bale Stakes (applicable where bales are on soil): No. 3 (3/8 diameter) reinforcing bars, deformed or smooth at Contractor's option, length as required for minimum 18-inch bury and full height bales.

PART 3 - EXECUTION

3.1 PREPARATION, INSTALLATION AND MAINTENANCE

- A. Provide erosion and sedimentation control systems at the locations shown on Drawings. Construct in accordance with the requirements shown on the Drawings and as specified in this Section.
- B. Control fill, grading and ditching to direct water away from excavations, pits, tunnels, and other construction areas, and to direct drainage to proper runoff courses to prevent erosion, sedimentation or damage.
- C. Maintain erosion and sediment control systems located within project site until acceptance of project or until directed by Owner's Representative to remove and discard existing system.
- D. Regularly inspect and repair or replace damaged components of erosion and sediment control structures. Unless otherwise directed, maintain erosion and sediment control structure until project area stabilization is accepted. Redress and replace granular fill at outlets as needed to replenish depleted granular fill. Remove erosion and sediment control structures promptly when directed by Owner's Representative. Dispose of materials in accordance with Specification Section 01 74 19 – Construction Waste Management and Disposal.
- E. Remove and dispose sediment deposits at the designated spoil site for the Project. If a project spoil site is not designated on Drawings, dispose of sediment off site at approved location in accordance with Specification Section 01 74 19 – Construction Waste Management and Disposal. Off-site disposal shall be the responsibility of the Contractor. Sediment to be placed at the project site should be spread, compacted and stabilized in accordance with the Owner's Representative directions. Sediment shall not be allowed to flush into streams or drainage ways. If sediment has been contaminated, it needs to be disposed of in accordance with existing federal, state and local regulations.
- F. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated right of way and easements for construction. Immediately repair

damage caused by construction traffic to erosion and sediment control structures.

- G. Protect existing trees and plants in accordance with Specification Section 01 56 39 – Temporary Tree and Plant Protection.
- H. Conduct all construction operations under this Contract in conformance with the erosion control practices required by State and local law.

3.2 CONSTRUCTION METHODS

A. Filter Fabric Fence (Type 1):

1. Provide filter fabric fence systems at locations specified on the Drawings in accordance with the Drawing detail. Filter fabric fence systems shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.
2. Attach the filter fabric to 2-inch by 2-inch wooden stakes or equivalent steel posts spaced a maximum of 6 feet apart and embedded a minimum of 1 foot. If filter fabric is factory pre-assembled with support netting, then maximum spacing allowable is 8 feet. The wooden stakes shall be installed at a slight angle toward the source of anticipated runoff.
3. Trench in the toe of the filter fabric fence with a spade or mechanical trencher so that the downward face of the trench is flat and perpendicular to the direction of flow or for V-trench configuration as shown on Drawings. Lay filter fabric along the edges of the trench. Backfill and compact trench.
4. Securely fasten filter fabric to stakes using staples or wire ties at 3 inches on center maximum. Filter fabric fence shall have a minimum height of 18 inches and a maximum height of 36 inches above natural ground.
5. The filter fabric should be provided in continuous rolls and cut to the length of the required to minimize the use of joints. When joints are necessary, the fabric should be spliced together only at a support post with a minimum 6-inch overlap, and sealed securely.
6. Inspect sediment filter barrier systems after each rainfall, daily during periods of prolonged rainfall, and at a minimum once a week. Repair or replace damaged section immediately to restore the requirements of this Item. Remove sediment deposits when silt reaches a depth one-third of the height of the fence or 6 inches, whichever is less.

B. Reinforced Filter Fabric Fence (Type 2):

1. Attach the filter fabric to 2-inch by 2-inch wooden stakes or equivalent steel posts spaced a maximum of 6 feet apart and embedded a minimum of 1 foot. If filter fabric is factory pre-assembled with support netting, then

maximum spacing allowable is 8 feet. The wooden stakes shall be installed at a slight angle toward the source of anticipated runoff.

2. Trench in the toe of the filter fabric fence with a spade or mechanical trencher so that the downward face of the trench is flat and perpendicular to the direction of flow or for V-trench configuration as shown on Drawings. Lay filter fabric along the edges of the trench. Backfill and compact trench.
3. Use galvanized 2-inch by 4-inch welded fabric for woven wire securely fasten filter fabric material to woven wire fence with tie wires.
4. Securely fasten filter fabric to stakes using staples or wire ties at 3 inches on center maximum. Filter fabric fence shall have a minimum height of 18 inches and a maximum height of 36 inches above natural ground.
5. The filter fabric should be provided in continuous rolls and cut to the length of the required to minimize the use of joints. When joints are necessary, the fabric should be spliced together only at a support post with a minimum 6-inch overlap, and sealed securely.
6. Inspect sediment filter barrier systems after each rainfall, daily during periods of prolonged rainfall, and at a minimum once a week. Repair or replace damaged section immediately to restore the requirements of this Item. Remove sediment deposits when silt reaches a depth one-third of the height of the fence or 6-inches, whichever is less.
7. When used in swales, ditches or diversions, elevation of barrier at top of filter fabric at flow line location in channel shall be lower than bottom elevation of filter fabric at ends of barrier or top of bank, whichever is less, in order to keep storm water discharge in channel from overtopping bank.

C. Sediment Traps:

1. Use fill material for embankment free of roots, woody vegetation, oversized stones or rocks, or organic or other objectionable matter. Clear, grub, and strip area under embankment of vegetation and root material.
2. Limit of excavation and outlet length and height shall be as specified on Drawings. Use side slopes of 2H:1V or flatter.
3. Maintain minimum of 6-inches between top of core material and top of stone outlet, minimum of 4-inches between bottom of core material and existing ground and minimum of 1-foot between top of stone outlet and top of embankment.
4. Embed rock minimum of 4-inches into existing ground for stone outlet.
5. For stone outlet, core shall be minimum of 1-foot in height and 1-foot in width and wrapped in triple layer of geotextile fabric.
6. Install stone outlet or outlet pipe and riser as shown on Drawings.
7. Repair or replace damaged trap components. Redress and replace stone as needed to replenish depleted stone. Remove sediment deposit and restore

traps to original dimensions when sediment has accumulated to one-half design depth of the trap or 1-foot, whichever is less.

D. Inlet Protection Barriers:

1. Place sandbags and filter fabric fences at locations shown on Drawings.
2. Maintain to allow minimal inlet inflow restrictions/blockages during storm events.

E. Drop Inlet Baskets:

1. Fit inlet insert basket into inlet without gaps around insert at locations shown on Drawings.
2. Support for inlet insert basket shall consist of fabricated metal as shown on Drawings.
3. Construct top frame of basket with two short sides of 2-inch by 2-inch and single long side of 1-inch by 1-inch, 1/8-inch angle iron. Construct basket hangers of 2-inch by 1/4-inch iron bars. Construct bottom frame of 1-inch by 1/4-inch iron bar or 1/4-inch plate with center 3-inches removed. Use minimum 1/4-inch diameter iron rods or equivalent for sides of inlet basket. Weld minimum of 14 rods in place between top frame/basket hanger and bottom frame. Exact dimensions for top frame and insert basket will be determined based on dimensions of type of inlet being protected.
4. Push down and form filter fabric to shape of basket. Use sheet of fabric large enough to be supported by basket frame when holding sediment and

extend at least 6-inches past frame. Place inlet grates over basket/frame to serve as fabric anchor.

5. Remove sediment deposit after each storm event and whenever accumulation exceeds 1-inch depth during weekly inspections.

F. Straw Bale Fences:

1. Place bales in row with ends tightly abutting adjacent bales. Place bales with bindings parallel to ground surface.
2. Embed bale in soil a minimum of 4-inches.
3. Securely anchor bales in place with Straw Bale Stakes driven through bales a minimum of 18-inches into ground. Angle first stake in each bale toward previously laid bale to force bales together.
4. Fill gaps between bales with straw to prevent water from channeling between bales. Wedge carefully in order not to separate bales.
5. Replace with new straw bale fence every two months or as required by Owner's Representative.

3.3 STREET AND SIDEWALK CLEANING

- A. Keep areas clean of construction debris and mud carried by construction vehicles and equipment.
- B. In lieu of or in addition to stabilized construction exits, shovel or sweep pavements as required to keep areas clean. Do not hose or sweep debris and mud off street into adjacent areas, except, hose sidewalks during off-peak hours, after sweeping.

3.4 WASTE COLLECTION AREAS

- A. Prevent water runoff from passing through waste collection areas, and prevent water runoff from waste collection areas migrating outside collection areas.

3.5 EQUIPMENT MAINTENANCE AND REPAIR

- A. Confine maintenance and repair of construction machinery and equipment to areas specifically designated for that purpose, so fuels, lubricants, solvents, and other potential pollutants are not washed directly into receiving streams or storm water conveyance systems. Provide these areas with adequate waste disposal receptacles for liquid and solid waste. Clean and inspect maintenance areas daily.
- B. Where designated equipment maintenance areas are not feasible, take precautions during each individual repair or maintenance operation to prevent

potential pollutants from washing into streams or conveyance systems. Provide temporary waste disposal receptacles.

3.6 REMOVAL OF CONTROLS

- A. Remove erosion and sediment controls when the site is finally stabilized, as directed by Owner's Representative.
- B. Dispose of sediments and waste products following Specification Section 01 35 05 – Environmental Protection and Special Controls.

3.7 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 01 57 23.02

CONTROL OF GROUND WATER AND SURFACE WATER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

Control of ground water and surface water.

1.2 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for control of ground water or surface water for construction of pipe size diameters less than 30 IN. Include cost to control ground water and surface water in unit price for Work requiring control for these pipe sizes. If Contract is a Stipulated Price Contract, payment for this Work is included in the total Stipulated Price
- B. Measure and payment for control of ground and surface water shall be made on a per linear foot basis for construction of pipe size diameters 30 IN and greater. Payment includes full compensation for all materials, labor, and services to complete the Work. If Contract is a Stipulated Price Contract, payment for this Work is included in the total Stipulated Price

1.3 REFERENCES

- A. ASTM D698 – Standard Test Methods for Laboratory Compaction of Soils Using Standard Effort (12,400 ft-lbf/ft³ (600kN-m/m³).
- B. Federal Regulations 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).

1.4 DEFINITIONS

- A. Ground water control includes both dewatering and depressurization of water-bearing soil layers.
1. Dewatering includes lowering water table and intercepting seepage that would otherwise emerge from slopes or bottoms of excavations, or into tunnels and shafts, and disposing of removed water. Intent of dewatering is to increase stability of tunnel excavations and excavated slopes, prevent dislocation of material from slopes or bottoms of excavations, reduce lateral loads on sheeting and bracing, improve excavating and hauling characteristics of excavated material, prevent failure or heaving of bottom of

excavations, and to provide suitable conditions for placement of backfill materials and construction of structures and other installations.

2. Depressurization includes reduction in piezometric pressure within strata not controlled by dewatering alone, as required to prevent failure or heaving of excavation bottom or instability of tunnel excavations.
- B. Excavation drainage includes keeping excavations free of surface and seepage water.
- C. Surface drainage includes use of temporary drainage ditches and dikes and installation of temporary culverts and sump pumps with discharge lines as required to protect work from any source of surface water.
- D. Equipment and instrumentation for monitoring and control of ground water control system includes piezometers, monitoring wells and flow meters for observing and recording flow rates.

1.5 PERFORMANCE REQUIREMENTS

- A. Conduct subsurface investigations to identify groundwater conditions and to provide parameters for design, installation, and operation of groundwater control systems. Submit prepared method and spacing of readings for review prior to obtaining water level readings.
- B. Design ground water control system, compatible with requirements of Federal Regulations 29 CFR Part 1926 and Section 31 41 00 – Trench Safety System to produce following results:
 1. Effectively reduce hydrostatic pressure affecting:
 - a. Excavations
 2. Develop substantially dry and stable subgrade for subsequent construction operations
 3. Preclude damage to adjacent properties, buildings, structures, utilities, installed facilities, and other work
 4. Prevent loss of fines, seepage, boils, quick condition, or softening of foundation strata
 5. Maintain stability of sides and bottom of excavations
- C. Provide ground water control systems that include single-stage or multiple-stage well point systems, eductor and ejector-type systems, deep wells, or combinations of these equipment types, as appropriate.
- D. Provide drainage of seepage water and surface water, as well as water from any other source entering excavation. Excavation drainage may include

placement of drainage materials, crushed stone and filter fabric, together with ditches and sump pumping.

- E. Provide ditches, berms, pumps, and other methods necessary to divert and drain surface water from excavation and other work areas.
- F. Locate ground water control and drainage systems so as not to interfere with utilities, construction operations, adjacent properties, or adjacent water wells.
- G. Assume sole responsibility for ground water control systems and for any loss or damage resulting from partial or complete failure of protective measures and any settlement or resultant damage caused by ground water control operations. Modify ground water control systems or operations if they cause or threaten to cause damage to new construction, existing site improvements, adjacent property, or adjacent water wells, or affect potentially contaminated areas. Repair damage caused by ground water control systems or resulting from failure of system to protect property as required.

1.6 SUBMITTALS (NOT USED)

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Comply with requirements of agencies having jurisdiction.
- B. Comply with Texas Commission on Environmental Quality regulations and Texas Water Well Drillers Association for development, drilling, and abandonment of wells used in dewatering system.
- C. Obtain necessary permits from agencies with control over use of groundwater and matters affecting well installation, water discharge, and use of existing storm drains and natural water sources. Because review and permitting process may be lengthy, take early action to pursue and submit for required approvals.
- D. Monitor ground water discharge for contamination while performing pumping in vicinity of potentially contaminated sites.
- E. Filter water discharged from dewatering systems prior to entering drainage ways.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. Use optional equipment and materials as necessary to achieve desired results for dewatering. Selected equipment and materials are subject to review of

Owner's Representative through submittals required in Paragraph 1.6, Submittals.

- B. Eductors, well points, or deep wells, where used, must be furnished, installed and operated by experienced contractor regularly engaged in ground water control system design, installation, and operation.
- C. Equipment must be in good repair and operating order.
- D. Keep sufficient standby equipment and materials available to ensure continuous operation, where required.

PART 3 - EXECUTION

3.1 GROUND WATER CONTROL

- A. Provide labor, material, equipment, techniques and methods to lower, control and handle ground water in manner compatible with construction methods and site conditions. Monitor effectiveness of installed system and its effect on adjacent property.
- B. Install, operate, and maintain ground water control systems in accordance with Ground Water and Surface Water Control Plan.
- C. Provide for continuous system operation, including nights, weekends, and holidays. Arrange for appropriate backup if electrical power is primary energy source for dewatering system.
- D. Remove ground water control installations.
 - 1. Remove pumping system components and piping when ground water control is no longer required
- E. During backfilling, dewatering may be reduced to maintain water level minimum of 5 feet below prevailing level of backfill. However, do not allow that water level to result in uplift pressures in excess of 80 percent of downward pressure produced by weight of structure or backfill in place. Do not allow water levels to rise into cement stabilized sand until at least 48 hours after placement.
- F. Remove system upon completion of construction or when dewatering and control of surface or ground water is no longer required.
- G. Foundation Beds: Maintain saturation line at least 3 feet below lowest elevations where concrete is to be placed. Drain foundations in areas where concrete is to be placed before placing reinforcing steel. Keep free from water for 3 days after concrete is placed.

3.2 EXCAVATION DRAINAGE

- A. May use excavation drainage methods if necessary to achieve well drained conditions. Excavation drainage may consist of layer of crushed stone and filter

fabric, and sump pumping in combination with sufficient wells for ground water control to maintain stable excavation and backfill conditions.

3.3 SURFACE WATER CONTROL

- A. Intercept surface water and divert it away from excavations through use of dikes, ditches, curb walls, pipes, sumps or other approved means.
Requirement includes temporary works required to protect adjoining properties from surface drainage caused by construction operations.
- B. Divert surface water and seepage water into sumps and pump it into drainage channels or storm drains, when approved by agencies having jurisdiction.
Provide settling basins when required by agencies.

END OF SECTION

SECTION 01 74 13

CLEANING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes intermediate and final cleaning of Work, not including special cleaning of closed systems specified elsewhere.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 – Bidding Requirements, Contract Forms, and Conditions of the Contract.
 - 2. Division 01 – General Requirements.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 SUBMITTALS (NOT USED)

1.4 STORAGE AND HANDLING

- A. Store cleaning products and cleaning wastes in containers specifically designed for those materials.

1.5 SCHEDULING

- A. Schedule cleaning operations so that dust and other contaminants disturbed by cleaning process will not fall on newly painted surfaces.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents:
 - 1. Compatible with surface being cleaned.
 - 2. New and uncontaminated.
 - 3. For Manufactured Surfaces: Material recommended by manufacturer.

PART 3 - EXECUTION

3.1 CLEANING - GENERAL

- A. Prevent accumulation of wastes that create hazardous conditions.
- B. Conduct cleaning and disposal operations to comply with laws and safety orders of governing authorities.

- C. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains or sewers.
- D. Dispose of degradable debris at an approved solid waste disposal site.
- E. Dispose of nondegradable debris at an approved solid waste disposal site or in an alternate manner approved by regulatory agencies.
- F. Handle materials in a controlled manner with as few handlings as possible.
- G. Do not drop or throw materials from heights greater than 4 FT or less than 4 FT if conditions warrant greater care.
- H. On completion of work, leave area in a clean, natural looking condition.
 - 1. Remove all signs of temporary construction and activities incidental to construction of required permanent Work.
- I. Do not burn on-site.

3.2 EXTERIOR (SITE) CLEANING

A. Cleaning During Construction:

- 1. Construction debris:
 - a. Remove from work area to container daily.
 - b. Site clean-up prior to storm events. Thoroughly clean site of all loose or unsecured items which may become airborne or transported by flowing water during storm events.
- 2. Soils, sand, and gravel deposited on paved areas and walks:
 - a. Remove as required to prevent muddy or dusty conditions.
 - b. Do not flush into storm sewer system.

B. Final Cleaning:

- 1. Remove trash and debris containers from site.
 - a. Repair areas disturbed by location of trash and debris containers to Owner's satisfaction including but not limited to re-seeding, sod placement, pavement repair, asphalt repair, sidewalk repair, and rut removal and/or fill placement.
- 2. Clean paved roadways.

3.3 FIELD QUALITY CONTROL (NOT USED)

END OF SECTION

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SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for construction waste management and disposal.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 – Bidding Requirements, Contract Forms, and Conditions of the Contract.
 - 2. Division 01 – General Requirements.

1.2 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for waste material disposal under this Section. Include payment in unit price for related sections.

1.3 SUBMITTALS

- A. Obtain and submit disposal permits for proposed disposal sites if required by local ordinances. Submit a copy of all disposal permits to the Owner's Representative.
- B. Submit copy of written permission from property owner(s) outside limits of Project, with description of property, prior to disposal of excess material. Submit written and signed release from property owner upon completion of

disposal work. Copies of the permission and release documents are to be submitted to the Owner's Representative.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SALVAGEABLE MATERIAL

- A. Other Salvageable Materials: Conform to requirements of individual Specification Sections.
- B. Coordinate with the Owner's Representative the loading of salvageable material.

3.2 EXCESS MATERIAL

- A. Remove and legally dispose of vegetation, rubble, broken concrete, debris, asphaltic concrete pavement, excess soil, and other materials not designated for salvage from job site.
- B. Excess soil may be deposited on private property outside the Project limits when written permission is obtained from property owner. See Paragraph 1.3C above.
- C. Verify flood plain status of any proposed disposal site. Do not dispose of excavated materials in area designated as within 100-year Flood Hazard Area unless the proper permit has been obtained. Remove excess material placed in "100-year Flood Hazard Area" at no additional cost to the Owner.
- D. Remove waste materials from site daily, in order to maintain site in neat and orderly condition, unless otherwise authorized by the Owner.

END OF SECTION

SECTION 01 74 23
RESTORATION OF SITE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for the restoration of sites affected by Utility Work, Roadway Reconstruction or Widening, or Facilities Work. Section does not apply to roadway extension projects.

1.2 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for site restoration under this Section. Include with payment for associated work.

1.3 REFERENCES

- A. ANSI Z60.1 – American Standard for Nursery Stock.

1.4 DEFINITIONS

- A. Site Restoration is replacement or reconstruction of site improvements to rights-of-way, easements, public property, and private property that are affected or altered by construction operations, with improvements to restore to a condition which is equal to, or better than, that which existed prior to construction operations.
- B. Site Improvement includes but is not limited to pavement, curb and gutter, esplanades, sidewalks, driveways, culverts, headwalls, mail boxes, lighting, signage, fences, lawns, irrigation systems, and landscaping.
- C. Line Segment. Length of water line or sewer from center line to center line of manholes, in line junction structure and bends as designated on Drawings, and to end of stubs or termination of pipe.
- D. Minimum Trench Width. Allowable trench width for corresponding pipe outside diameter as defined in Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities, unless otherwise indicated on the Drawings.

1.5 SUBMITTALS (NOT USED)

1.6 QUALITY ASSURANCE

- A. Have trees, landscape shrubs, and plantings performed by qualified personnel.

1.7 SCHEDULING

- A. After paving or utility work is completed on line segment and segment is submitted on monthly estimate for payment, complete site restoration for that

segment in accordance with 3.1 of this Section, unless extended in writing by Owner's Representative.

- B. For utility work requiring testing or post-installation TV inspection, completion of segment is not considered to include testing or TV inspection. Schedule for completion of site restoration is not determined by completion of testing or TV inspection.

1.8 WARRANTY

- A. Provide 2-week warranty on plants and sod grasses that die due to shock or damage only.
- B. Replace plants that fail during warranty period according to specifications governing original plants.
- C. Damage caused by natural hazards including hail, high winds or storm is not covered by warranty.
- D. Existing plant material required to be moved on site are covered under warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pavement, Sidewalks, and Driveways. Use materials as specified in Section 32 01 17 - Pavement Repair and Resurfacing and as shown on Drawings.
- B. Seeding and Sodding.
 - 1. Provide sod and mechanically seed as specified in Section 32 90 00 – Seeding, Sodding, and Landscaping. For areas to be seeded, conform to
- C. Trees, Shrubs, and Plantings.
 - 1. Provide trees, shrubs, and plants of quantity, size, genus, species, and variety of those being replaced and conforming to recommendations and requirements of ANSI Z60.1 and Section 32 90 00 – Seeding, Sodding and Landscaping.
 - 2. Use balled-and-burlapped nursery stock for tree replacement.
 - 3. Within availability of standard nursery stock, replace each removed tree with one of an equivalent species and size, but with not less than 2½-inch diameter trunk, as measured 1½ feet above natural ground.

PART 3 - EXECUTION

3.1 COORDINATION

- A. For water main and sanitary sewer and roadway reconstruction and widening, construction cannot exceed site restoration by more than 50% of total Project

length or 1,000 lineal feet, whichever is less., unless otherwise approved by the Owner's Representative. Site restoration must proceed continuously and be sequentially completed in order of work progress. When utility work and reconstruction or widening work occurs within same limits of right-of-way, utility installation cannot exceed pavement improvements by more than 1,000 linear feet, unless otherwise approved by the Owner's Representative. No intermediate areas can be skipped or left to be completed at a future date, unless otherwise approved by the Owner.

- B. For water main and sanitary sewer construction, site restoration associated with wet connections, cut and plugs, salvaging of fire hydrants and sewer reconnections which needs to occur after line is tested, can be restored after 45 days provided site is restored immediately after accomplishing such work. Payment may be withheld for such wet connections, cut and plugs, salvaging of fire hydrants and sewer reconnection work until site restoration is complete.

3.2 PREPARATION

A. Removing Pavements and Structures.

1. Remove minimum pavement, curb and gutter, and other structures as required to perform Work. Perform removals in accordance with Section 02 41 13 13 – Removing Existing Pavements and Structures.
2. Remove concrete and asphaltic concrete material using sawed joints in accordance with Section 32 13 13 – Concrete Pavement, Curb, Sidewalks, and Steps.
3. Remove curb and gutter a distance of 2 feet outside excavation, unless otherwise approved by the Owner's Representative.

3.3 INSTALLATION

A. Pavement, Sidewalk, and Driveway Restoration.

1. Replace pavement, curb and gutter, culverts, headwalls, sidewalks, and driveways removed or damaged as result of construction operations.
2. Where replacement sidewalks terminate at street curb radius, construct wheel chair ramp that meets current Texas Accessibility Standards.

B. Seeding and Sodding.

1. Clean up construction debris and level area with bank sand so that resulting surface of new grass matches level of existing grass and maintains pre-

construction drainage patterns. Level minor ruts or depressions caused by construction operations where grass is still viable by filling with bank sand.

2. Restore previously existing turfed areas with sod and fertilize in accordance with Section 32 90 00 – Seeding, Sodding, and Landscaping. Sod to match existing turf.

C. Trees, Shrubbery, and Plants.

1. Take extra care in removing and replanting trees, shrubbery, and plants. Remove trees, shrubbery, and plants, leaving soil around roots. Place trees, shrubbery, and plants outside of excavation area.
2. Replace in kind any trees, shrubbery, and plants removed or damaged by construction operations.
3. Have nursery or landscape firm make tree replacements using balled-and-burlapped nursery stock.

3.4 CLEANING

- A. Remove debris and trash to maintain clean and orderly site as described in General Conditions and Section 01 74 19 – Construction Waste Management and Disposal.

3.5 MAINTENANCE

- A. Maintain shrubs, plantings, sodded areas and seeded areas through warranty period.
- B. Replace shrubs, plantings, and seeded or sodded areas that fail to become established through warranty period.
- C. Maintain newly planted trees, shrubs, and plantings as follows:
 1. Water as often as necessary to keep ground and backfill moist until plantings have become established.
 2. Repair or replace bracing as necessary.
 3. Prune as necessary.
 4. Treat plants in accordance with approved methods of horticultural practices where insects or disease affect plants after planting.
- D. Refer to Section 01 56 39 – Temporary Tree and Plant Protection, and Section 32 90 00 – Seeding, Sodding, and Landscaping for additional maintenance requirements.

END OF SECTION

SECTION 02 41 13.13

REMOVING EXISTING PAVEMENTS AND STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Removing concrete pavement, asphaltic concrete pavement, brick pavement, and base courses.
2. Removing concrete curbs, concrete curbs and gutters, sidewalks, and driveways.
3. Removing pipe culverts, sewers, and sewer leads.
4. Removing existing inlets and manholes.
5. Removing miscellaneous structures of concrete or masonry.
6. Regulatory Requirements

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Including all types and thicknesses of concrete pavement, asphaltic concrete pavement, brick pavement, asphalt overlays, base courses for roads, parking areas, curbs, curbs and gutters, sidewalks and driveways, culverts, headwalls, ditch liners, storm and sanitary sewers and sewer leads, manholes, inlets, pipe replacement, timber structures, steel structures, handling of hazardous materials and other miscellaneous structures of concrete and masonry.

1.3 SUBMITTALS (NOT USED)

1.4 WORK INCLUDED

- A. Furnish labor, materials, equipment and incidentals necessary for every type of required demolition.
- B. Furnish equipment of every type required to demolish and transport construction debris away from the Site.

1.5 STANDARDS

- A. Work shall be performed in accordance with the codes and ordinances of the agency having jurisdiction over the Place of Record.
- B. Coordinate removal work with utility companies.
- C. Occupational Safety and Health Association (OSHA), 29CFR Parts 1010 and 1926, "Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite", 40 CFR Part 61 - "National Emission Standard for Hazardous Air Pollutants"

1.6 DELIVERY AND STORAGE

- A. Stockpile construction debris at the Site only as long as necessary to haul to a disposal site. Stack materials neatly and handle in an orderly manner until removed from the Site.

1.7 JOB CONDITIONS

- A. Contractor shall visit the Site and determine the extent of demolition required and the Site conditions that might affect his proposal. Include costs of covering all aspects of the demolition as part of the proposal.
- B. The Drawings shall be carefully reviewed to determine the extent of necessary demolition and to identify elements of the existing construction which are to remain in place. Report any discrepancies to Owner and Engineer before disturbing existing conditions. Property lines and limits of demolition shall be accurately located prior to beginning site demolition. Start of demolition activities shall represent confirmation by Contractor that existing conditions are as presented in the Contract Documents. Demolition outside the limits indicated on the Drawings, or outside the property lines shall not be performed.
- C. Material removed during demolition, and any equipment not otherwise designated to remain the property of the Owner, shall become the property of the Contractor and shall be promptly removed from the Site.
- D. Equipment and material designated as remaining the property of the Owner shall be removed from the structure and transported to a designated location on the Site and stored for the Owner's use. Store on wood runners raised above the surrounding grade and cover with weather resistant covering that is tied securely in place.

PART 2 - PRODUCTS

- A. New materials and equipment for patching and extending work shall meet the requirements of the individual Sections in these Contract Documents. For materials not addressed in these documents, materials used shall meet or exceed the dimensions and quality of the existing work.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Obtain advance approval from Owner's Representative for dimensions and limits of removal work.

- B. Contractor shall be responsible for obtaining location of underground utilities at the Site and stake and flag locations. Known existing underground utilities as shown in Construction Drawings are based on best available information at the time of preparation of these construction documents. Arrange for all applicable utility companies to accurately locate underground piping and set color-coded flags along the project limits. Investigate utility company's records to ascertain depths and sizes of piping and other ancillary features.
1. In the event that exact location of utility cannot be obtained, dig test holes as necessary to establish location of utility. Contractor shall not use mechanical digging machines within 6 feet of any active buried utility. For a distance of 4 feet on either side of buried utility, all digging shall be by hand excavation. If the utility is not active, or is to be abandoned or removed, any form of excavation may be used.

3.2 PROTECTION

- A. Protect following from damage or displacement:
1. Adjacent public and private property.
 2. Trees, plants, and other landscape features designated to remain.
 3. Utilities designated to remain.
 4. Pavement and utility structures designated to remain.
 5. Bench marks, monuments, and existing structures designated to remain.

3.3 REMOVALS

- A. Remove pavements and structures by methods that will not damage underground utilities. Do not use drop hammer near existing underground utilities.
- B. Minimize amount of earth loaded during removal operations.
- C. Where existing pavement is to remain, make straight saw cuts in existing pavement to provide clean breaks prior to removal. Do not break concrete pavement or base with drop hammer unless concrete or base has been saw cut to minimum depth of 2 inches.
- D. Unless otherwise shown and detailed on the plans, when street and driveway saw cut location is greater than one-half of a pavement lane width, remove pavement for full lane width or to nearest longitudinal joint as directed by Owner's Representative.
- E. Remove sidewalks and curbs to nearest existing dummy, expansion, or construction joint.
- F. Removal of Concrete Slabs

1. Remove parts of the existing concrete floor slab as indicated on the Drawings. Saw-cut the existing slab with two parallel lines around the area to be removed to the depth of the reinforcing. Do not cut reinforcing. Break out the remainder of the slab using jackhammers or by manual means. Cut reinforcing at a distance of 24 inches from the cut edge of the slab and bend back out of the way. Perform the remainder of the demolition, removing underground piping, or installing new Work.

G. Removal of Pipe

1. Remove pipe designated for salvage by carefully excavating surrounding backfill material. Remove pipe using protective measures which prevent damage. Piping shall be disconnected at joints, allowing removal in one piece. Salvaged pipe determined unsatisfactory for re-use by the Engineer may be removed in any manner. Suspended or supported pipe shall be disassembled at joints. Remove in sections without cutting. Welded pipe sections may be cut with a torch, but cuts shall be along a welded joint.

3.4 BACKFILL

- A. Backfill cavities resulting from demolition. Backfill and compact cavities outside the construction limits to the same density as the surrounding earth. No testing is required for backfill outside the limits of new construction.

3.5 DISPOSAL

- A. Disposal shall be in accordance with requirements of Section 01 74 19 – Construction Waste Management and Disposal.
- B. Remove from site, debris resulting from work under this section in accordance with requirements of Specification Section 01 74 19 – Construction Waste Management and Disposal.

3.6 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 03 05 05

TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contractor requirements for testing of concrete.
2. Definition of Owner provided testing.
3. Acceptance criteria for concrete.

1.2 MEASUREMENT AND PAYMENT

A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 RESPONSIBILITY AND PAYMENT

A. Owner will hire an independent Testing Agency/Service Provider to perform the following testing and inspection and provide test results to the Owner's Representative and Contractor.

1. Testing and inspection of concrete and grout produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
2. Additional testing or retesting of materials occasioned by their failure, be by test or inspection, to meet requirements of the Contract Documents.
3. Strength testing on concrete required by the Owner's Representative when the water-cement ratio exceeds the water-cement ratio of the typical test cylinders.
4. In-place testing of concrete as may be required by Owner's Representative when strength of structure is considered potentially deficient.
5. Other testing services needed or required by Contractor such as field curing of test specimens and testing of additional specimens for determining when forms, form shoring or reshoring may be removed.
6. Owner will pay for services defined in this paragraph.

1.4 QUALITY ASSURANCE

A. Referenced Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T260 – Standard Method of Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials.

2. American Concrete Institute (ACI):
 - a. 318 – Building Code Requirements for Structural Concrete.
3. ASTM International (ASTM):
 - a. C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - b. C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - c. C42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - d. C143 – Standard Test Method for Slump of Hydraulic Cement.
 - e. C172 – Standard Practice for Sampling Freshly Mixed Concrete.

E329 – Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
- B. Qualifications:
 1. Testing Agency:
 - a. Meeting requirements of ASTM E329.
 - b. Provide evidence of recent inspection by Cement and Concrete Reference Laboratory (CCRL) of National Bureau of Standards (NBS), and correction of deficiencies noted.
- C. Use of Testing Agency and approval by Owner's Representative of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

1.5 DEFINITIONS

- A. Testing Agency/Service Provider: An independent professional testing/inspection firm or service hired by Owner to perform testing, inspection or analysis services as directed, and as provided in the Contract Documents.

1.6 SUBMITTALS

- A. Shop Drawings:
 1. Product technical data including:
 - a. Concrete materials and concrete mix designs proposed for use.
 - 1) Include results of all testing performed to qualify materials and to establish mix designs.
 - 2) Place no concrete until approval of mix designs has been received in writing.
 - 3) Submittal for each concrete mix design to include:
 - a) Sieve analysis and source of fine and coarse aggregates.

- b) Test for aggregate organic impurities.
 - c) Proportioning of all materials.
 - d) Type of cement with mill certificate for the cement.
 - e) Brand, quantity and class of fly ash proposed for use along with other submittal data as required for fly ash by Specification Section 03 31 30 – Concrete, Materials, and Proportioning.
 - f) Slump.
 - g) Brand, type and quantity of air entrainment and any other proposed admixtures.
 - h) Shrinkage test results.
 - i) Total chloride ion content per cubic yard of concrete determined in accordance with AASHTO T260.
 - j) 28-day compression test results and any other data required by Specification Section 03 31 30 – Concrete, Materials, and Proportioning to establish concrete mix design.
2. Certifications:
- a. Testing Agency qualifications.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 TESTING SERVICES TO BE PERFORMED BY OWNER

- A. The following concrete testing will be performed by the Owner's Service Provider:
- 1. Concrete strength testing:
 - a. Secure concrete samples in accordance with ASTM C172.
 - 1) Obtain each sample from a different batch of concrete on a random basis, avoiding selection of test batch other than by a number selected at random before commencement of concrete placement.
 - b. For each strength test mold and cure four (4) 6-IN x 12-IN, or five (5) 4-IN x 8-IN cylinders from each sample in accordance with ASTM C31.
 - 1) Record any deviations from requirements on test report.
 - 2) Cylinder size: Per ASTM C31.
 - c. Field cure one cylinder for the seven (7) day test, laboratory cure the remaining.
 - d. Test cylinders in accordance with ASTM C39.

- 1) Test two (2) 6-IN x 12-IN, or three (3) 4-IN x 8-IN cylinders at 28 days for strength test result and one (1) at seven (7) days for information.
- 2) Hold remaining cylinder in reserve.
- e. Strength test result:
 - 1) Average of strengths of two (2) 6-IN x 12-IN, or three (3) 4-IN x 8-IN cylinders from the same sample tested at 28 days.
 - 2) If one (1) cylinder in a test manifests evidence of improper sampling, molding, handling, curing, or testing, discard and test reserve cylinder; average strength of remaining cylinders shall be considered strength test result.
 - 3) Should all cylinders in a test show any of above defects, discard entire test.
- f. Frequency of tests:
 - 1) Concrete sand cement grout: One (1) strength test for each 4 HR period of grout placement or fraction thereof.
 - 2) Precast concrete, concrete topping, concrete fill and lean concrete: One (1) strength test for each 10 CY of each type of concrete or fraction thereof placed.
 - 3) All other concrete:
 - a) One (1) strength test to be taken not less than once a day, nor less than once for each 10 CY or fraction thereof placed in any one (1) day.
2. Slump testing:
 - a. Determine slump of concrete sample for each strength test.
 - 1) Determine slump in accordance with ASTM C143.
 - b. If consistency of concrete appears to vary, the Owner's Representative shall be authorized to require a slump test for each concrete truck.
 - 1) This practice shall continue until the Owner's Representative deems it no longer necessary.

3.2 SAMPLING ASSISTANCE AND NOTIFICATION FOR OWNER

- A. To facilitate testing and inspection, perform the following:
 1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
 2. Owner to provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 HRS as required by ASTM C31.

- B. Notify Owner's Representative and Owner's Testing Agency sufficiently in advance of operations (minimum of 24 HRS) to allow completion of quality tests for assignment of personnel and for scheduled completion of quality tests.

3.3 ACCEPTANCE

- A. Completed concrete work which meets applicable requirements will be accepted without qualification.
- B. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.
- C. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents.
 - 1. In this event, modifications may be required to assure that concrete work complies with requirements.
 - 2. Modifications, as directed by Owner's Representative, to be made at no additional cost to Owner.
- D. Dimensional Tolerances:
 - 1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Owner's Representative.
 - 2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal.
 - a. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.
 - 3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.
 - 4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected.
 - a. Repair or remove and replace if required.
 - 5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected.
 - a. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.
- E. Appearance:

1. Concrete surfaces exposed to view with defects which, in opinion of Owner's Representative, adversely affect appearance as required by specified finish shall be repaired by approved methods.
2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Owner's Representative, the defects impair the strength or function of the member.

F. High Water-Cement Ratio:

1. Concrete with water in excess of the specified maximum water-cement ratio will be considered potentially deficient in durability.
2. Remove and replace concrete with high water-cement ratio or make other corrections as directed by Owner's Representative.

G. Strength of Structure:

1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure, including but not necessarily limited to following:
 - a. Low concrete strength:
 - 1) Test results for standard molded and cured test cylinders to be evaluated separately for each mix design.
 - a) Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards.
 - b) A strength test shall be the average of two (2) cylinders from the same sample tested at 28 days.
 - 2) Acceptance:
 - a) Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:
 - (1) Average of all strength tests equal or exceed the required specified 28 day compressive strength.
 - (2) No individual strength test falls below the required specified 28 day compressive strength by more than 500 psi.
 - b. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Specification Section 03 21 00 – Reinforcement or requirements of the Contract Drawings or approved Shop Drawings.
- c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
- d. Curing time and procedure not meeting requirements of this Specification Section.

- e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
 - f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
 - g. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength or durability.
- 2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.
 - 3. In-place testing of concrete may be required when strength of concrete in place is considered potentially deficient.
 - a. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Owner's Representative to determine relative strengths at various locations in the structure or for selecting areas to be cored.
 - 1) Such tests shall not be used as a basis for acceptance or rejection.
 - b. Core tests:
 - 1) Where required, test cores will be obtained in accordance with ASTM C42.
 - a) If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 DegF, relative humidity less than 60 percent) for seven (7) days before test then test dry.
 - b) If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 HRS and test wet.
 - c) Testing wet or dry to be determined by Owner's Representative.
 - 2) Three (3) representative cores may be taken from each member or area of concrete in place that is considered potentially deficient.
 - a) Location of cores shall be determined by Owner's Representative so as least to impair strength of structure.
 - b) If, before testing, one (1) or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.
 - 3) Concrete in area represented by a core test will be considered adequate if average strength of three (3) cores is equal to at least 85 percent of specified strength and no single core is less than 75 percent of specified strength.
 - 4) Fill core holes with nonshrink grout and finish to match surrounding surface when exposed in a finished area.

4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with ACI 318, Chapter 20.
5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Owner's Representative, at Contractor's expense.
6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

3.4 OWNER TRAINING (NOT USED)

END OF SECTION

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SECTION 03 09 00

CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place concrete and grout.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
 - a. 116R, Cement and Concrete Terminology.
 - b. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
 - c. 212.3R, Chemical Admixtures for Concrete.
 - d. 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 - e. 304.2R, Placing Concrete by Pumping Methods.
 - f. 305R, Hot Weather Concreting.
 - g. 306R, Cold Weather Concreting.
 - h. 318, Building Code Requirements for Structural Concrete.
 - i. 347R, Recommended Practice for Concrete Formwork.
2. ASTM International (ASTM):
 - a. A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - b. A185, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - d. A775, Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
 - e. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.

- f. C33, Standard Specification for Concrete Aggregates.
- g. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- h. C94, Standard Specification for Ready-Mixed Concrete.
- i. C138, Standard Method of Test for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
- j. C143, Standard Test Method for Slump of Hydraulic Cement Concrete.
- k. C150, Standard Specification for Portland Cement.
- l. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.
- m. C172, Standard Practice for Sampling Freshly Mixed Concrete.
- n. C173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
- o. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- p. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
- q. C289, Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
- r. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- s. C494, Standard Specification for Chemical Admixtures for Concrete.
- t. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- u. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
- v. D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
- w. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- x. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
- y. D1709, Standard Test Methods for Impact Resistance of Plastic Film by the Free-Falling Dart Method.
- z. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- aa. E96, Standard Test Methods for Water Vapor Transmission of Materials.

- bb. E329, Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
- cc. E1745, Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
- 3. Corps of Engineers (COE):
 - a. CRD-C572, Specifications for Polyvinylchloride Waterstops.
 - b. CRD-C621, Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (Nonshrink).
- B. Quality Control:
 - 1. Do not begin concrete production until proposed concrete mix design has been approved by Owner's Representative.
 - a. Approval of concrete mix design by Owner's Representative does not relieve Contractor of his responsibility to provide concrete that meets the requirements of this Specification.
 - 2. Adjust concrete mix designs when material characteristics, job conditions, weather, strength test results or other circumstances warrant.
 - a. Do not use revised concrete mixes until submitted to and approved by Owner's Representative.
- C. Qualifications:
 - 1. Ready mixed concrete batch plant certified by National Ready Mixed Concrete Association (NRMCA).

1.4 DEFINITIONS

- A. Per ACI 116R except as modified herein:
 - 1. Concrete fill: Non-structural concrete.
 - 2. Exposed concrete: Exposed to view after construction is complete.
 - 3. Indicated: Indicated by Contract Documents.
 - 4. Lean concrete: Concrete with low cement content.
 - 5. Nonexposed concrete: Not exposed to view after construction is complete.
 - 6. Required: Required by Contract Documents.
 - 7. Specified strength: Specified compressive strength at 28 days.
 - 8. Submitted: Submitted to Owner's Representative.

1.5 SUBMITTALS

- A. Shop Drawings:
 - 1. Concrete mix designs proposed for use.
 - a. Concrete mix design submittal to include the following information:

- 1) Sieve analysis and source of fine and coarse aggregates.
 - 2) Test for aggregate organic impurities.
 - 3) Test for deleterious aggregate per ASTM C289.
 - 4) Proportioning of all materials.
 - 5) Type of cement with mill certificate for cement.
 - 6) Type of fly ash with certificate of conformance to specification requirements.
 - 7) Slump.
 - 8) Air content.
 - 9) Brand, type, ASTM designation, and quantity of each admixture proposed for use.
 - 10) 28-day cylinder compressive test results of trial mixes per ACI 318 and as indicated herein.
 - 11) Shrinkage test results.
 - 12) Standard deviation value for concrete production facility.
2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Manufacturers and types:
 - 1) Joint fillers.
 - 2) Curing agents.
 - 3) Chemical sealer.
 - 4) Bonding and patching mortar.
 - 5) Construction joint bonding adhesive.
 - 6) Non-shrink grout with cure/seal compound.
 - 7) Waterstops.
 3. Reinforcing steel:
 - a. Show grade, sizes, number, and all fabrication and placement details.
 - b. Mill certificates.
 4. Strength test results of in place concrete including slump, air content and concrete temperature.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage of Material:

1. Cement and fly ash:
 - a. Store in moistureproof, weathertight enclosures.
 - b. Do not use if caked or lumpy.
 2. Aggregate:
 - a. Store to prevent segregation and contamination with other sizes or foreign materials.
 - b. Obtain samples for testing from aggregates at point of batching.
 - c. Do not use frozen or partially frozen aggregates.
 - d. Do not use bottom 6 IN of stockpiles in contact with ground.
 - e. Allow sand to drain until moisture content is uniform prior to use.
 3. Admixtures:
 - a. Protect from contamination, evaporation, freezing, or damage.
 - b. Maintain within temperature range recommended by manufacturer.
 - c. Completely mix solutions and suspensions prior to use.
 4. Reinforcing steel: Support and store all rebars above ground.
- B. Delivery:
1. Concrete:
 - a. Prepare a delivery ticket for each load for ready-mixed concrete.
 - b. Truck operator shall hand ticket to Owner's Representative at the time of delivery.
 - c. Ticket to show:
 - 1) Mix identification mark.
 - 2) Quantity delivered.
 - 3) Amount of each material in batch.
 - 4) Outdoor temp in the shade.
 - 5) Time at which cement was added.
 - 6) Numerical sequence of the delivery.
 - 7) Amount of water added.

1.7 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
1. Nonshrink, nonmetallic grout:
 - a. Sika "SikaGrout 212."
 - b. Euclid Chemical "NS Grout."
 - c. BASF Admixtures, Inc. "Masterflow 713."
 2. Epoxy grout:
 - a. BASF Admixtures, Inc. "Brutem MPG."
 - b. Euclid Chemical Company, "E3-G."
 - c. Fosroc, "Conbextra EPHF".
 3. Expansion joint fillers:
 - a. Permaglaze Co.
 - b. Rubatex Corp.
 - c. Williams Products, Inc.
 4. Waterstops, PVC:
 - a. Greenstreak Plastic Products, Inc.
 - b. W.R.Meadows, Inc.
 - c. Burke Company.
 5. Form coating:
 - a. Richmond "Rich Cote."
 - b. Industrial Lubricants "Nox-Crete Form Coating."
 - c. Euclid Chemical "Eucoslip VOX."
 6. Prefabricated forms:
 - a. Simplex "Industrial Steel Frame Forms."
 - b. Symons "Steel Ply."
 - c. Universal "Uniform."
 7. Chemical sealer:
 - a. L&M Construction Chemicals, Inc.
 - b. Euclid Chemical Company.
 - c. Dayton Superior.

8. Bonding agent:
 - a. Euclid Chemical Co.
 - b. BASF Admixtures, Inc.
 - c. L&M Construction Chemicals Inc.
- B. Submit request for substitution in accordance with Specification Section 01 25 13 – Product Substitutions.

2.2 MATERIALS

- A. Portland Cement: Conform to ASTM C150 Type I/Type II.
- B. Fly Ash:
 1. ASTM C618, Class F or Class C.
 2. Nonstaining.
 - a. Hardened concrete containing fly ash to be uniform light gray color.
 3. Maximum loss on ignition: 4 percent.
 4. Compatible with other concrete ingredients.
 5. Obtain proposed fly ash from a source approved by the State Highway Department in the state where the Project is located for use in concrete for bridges.
- C. Admixtures:
 1. Air entraining admixtures: ASTM C260.
 2. Water reducing, retarding, and accelerating admixtures:
 - a. ASTM C494 Type A through E.
 - b. Conform to provisions of ACI 212.3R.
 - c. Do not use retarding or accelerating admixtures unless specifically approved in writing by Owner's Representative and at no cost to Owner.
 - d. Follow manufacturer's instructions.
 - e. Use chloride free admixtures only.
 3. Maximum total water soluble chloride ion content contributed from all ingredients of concrete including water, aggregates, cementitious materials and admixtures by weight percent of cement:
 - a. 0.10 all concrete.
 4. Do not use calcium chloride.
 5. Pozzolanic admixtures: ASTM C618.
 6. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.

- D. Water: Potable, clean, free of oils, acids and organic matter.
- E. Aggregates:
 - 1. Normal weight concrete: ASTM C33, except as modified below.
 - 2. Fine aggregate:
 - a. Clean natural sand.
 - b. No manufactured or artificial sand.
 - 3. Coarse aggregate:
 - a. Crushed rock, natural gravel, or other inert granular material.
 - b. Maximum amount of clay or shale particles: 1 percent.
 - 4. Gradation of coarse aggregate:
 - a. Lean concrete and concrete topping: Size #7.
 - b. All other concrete: Size #57 or #67.
- F. Concrete Grout:
 - 1. Nonshrink nonmetallic grout:
 - a. Nonmetallic, noncorrosive, nonstaining, premixed with only water to be added.
 - b. Grout to produce a positive but controlled expansion.
 - c. Mass expansion not to be created by gas liberation.
 - d. Minimum compressive strength of nonshrink grout at 28 days: 6500 psi.
 - e. In accordance with COE CRD-C621.
 - 2. Epoxy grout:
 - a. 3-component epoxy resin system.
 - 1) Two liquid epoxy components.
 - 2) One inert aggregate filler component.
 - b. Each component packaged separately for mixing at jobsite.
- G. Reinforcing Steel:
 - 1. Reinforcing bars: ASTM A615, Grade 60.
 - 2. Welded wire reinforcement: ASTM A185.
 - a. Minimum yield strength: 60,000 psi.
 - 3. Column spirals: ASTM A82.
- H. Forms:
 - 1. Prefabricated or job built.
 - 2. Wood forms:

- a. New 5/8 or 3/4 IN 5-ply structural plywood of concrete form grade.
 - b. Built-in-place or prefabricated type panel.
 - c. 4 x 8 FT sheets for built-in-place type except where smaller pieces will cover entire area.
 - d. When approved, plywood may be reused.
3. Metal forms:
 - a. Metal forms excluding aluminum may be used.
 - b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.
4. Chamfer strips: Clear white pine, surface against concrete planed.
5. Form ties:
 - a. Removable end, permanently embedded body type with cones on outer ends not requiring auxiliary spreaders.
 - b. Cone diameter: 3/4 IN minimum to 1 IN maximum.
 - c. Embedded portion 1-1/2 IN minimum back from concrete face.
 - d. If not provided with threaded ends, constructed for breaking off ends without damage to concrete.
 - e. Provide ties with built-in waterstops at all walls that will be in contact with process liquid during plant operation.
6. Form release: Nonstaining and shall not prevent bonding of future finishes to concrete surface.
- I. Waterstops:
 1. Plastic: COE CRD-C572.
 2. Serrated with center bulb.
 3. Thickness: 3/8 IN.
 4. Length (general use): 6 IN unless indicated otherwise.
 5. Expansion joints:
 - a. Length: 9 IN.
 - b. Center bulb: 1 IN OD x 1/2 IN ID.
 6. Provide hog rings or grommets spaced at maximum 12 IN OC along the length of the water stop.
 7. Provide factory made waterstop fabrications at all changes of direction, intersections and transitions leaving only straight butt splices for the field.
- J. Chairs, Runners, Bolsters, Spacers, and Hangers:
 1. Stainless steel, epoxy coated, plastic, brick, or plastic coated metal.

- a. Plastic coated: Rebar support tips in contact with the forms only.
- K. Chemical Floor Sealer:
 - 1. Colorless low VOC water-based solution containing acrylic copolymers.
 - a. ASTM C1315, Class B, minimum 30 percent solids.
 - 2. L&M Construction Chemicals Inc. Dress & Seal WB 30.
- L. Vapor Retarder:
 - 1. ASTM E1745, Class A, minimum 15 mil thickness.
 - 2. Water vapor permeance: 0.03 maximum per ASTM E96.
 - 3. Puncture resistance: ASTM D1709, Method B, 2200 grams.
 - 4. Minimum tensile strength: 45 LBS/IN, ASTM D882.
 - 5. Vapor retarder tape: As recommended by vapor retarder manufacturer.
- M. Membrane Curing Compound:
 - 1. ASTM C309, Type I-D.
 - 2. Resin based, dissipates upon exposure to UV light.
 - 3. Curing compound shall not prevent bonding of any future coverings, coatings or finishes.
 - 4. Curing compounds used in water treatment plant construction to be nontoxic and taste and odor free.
- N. Bonding Agent:
 - 1. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
 - 2. Euclid Chemical Co. "Flex-Con."
 - 3. BASF Admixtures, Inc. "Acryl-Set."
 - 4. L&M Construction Chemicals "Everbond."
 - 5. Thoro System Products "Acryl 60."
- O. Expansion Joint Filler:
 - 1. In contact with water or sewage:
 - a. Closed cell neoprene.
 - b. ASTM D1056, Class SC (oil resistant and medium swell) of 2 to 5 psi compression deflection (Grade SCE41).
 - 2. Exterior driveways, curbs and sidewalks:
 - a. Asphalt expansion joint filler.
 - b. ASTM D994.

3. Other use:
 - a. Fiber expansion joint filler.
 - b. ASTM D1751.

2.3 CONCRETE MIXES

A. General:

1. All concrete to be ready mixed concrete conforming to ASTM C94.
2. Provide concrete of specified quality capable of being placed without segregation and, when cured, of developing all properties required.
3. All concrete to be normal weight concrete.

B. Strength:

1. Provide specified strength and type of concrete for each use in structure(s) as follows:

TYPE	WEIGHT	SPECIFIED STRENGTH*
Concrete fill	Normal weight	3000 psi
Lean concrete	Normal weight	3000 psi
Concrete topping	Normal weight	4000 psi
Precast concrete	Normal weight and lightweight	5000 psi
All other general use concrete	Normal weight	4000 psi

* Minimum 28-day compressive strength.

C. Air Entrainment:

1. Provide air entrainment in all concrete resulting in a total air content percent by volume as follows:

MAX AGGREGATE SIZE	TOTAL AIR CONTENT PERCENT
1 IN or 3/4 IN	5 to 7
1/2 IN	5 1/2 to 8

2. Air content to be measured in accordance with ASTM C231, ASTM C173, or ASTM C138.

D. Slump - 4 IN maximum, 1 IN minimum:

1. Measured at point of discharge of the concrete into the concrete construction member.

2. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
 3. Pumped concrete:
 - a. Provide additional water at batch plant to allow for slump loss due to pumping.
 - b. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified above.
 4. Determine slump per ASTM C143.
- E. Selection of Proportions:
1. General:
 - a. Proportion ingredients to:
 - 1) Produce proper workability, durability, strength, and other required properties.
 - 2) Prevent segregation and collection of excessive free water on surface.
 2. Minimum cement contents and maximum water cement ratios for concrete to be as follows:

SPECIFIED STRENGTH	MINIMUM CEMENT, LB/CY MAXIMUM AGGREGATE SIZE			MAXIMUM WATER CEMENT RATIO BY WEIGHT
	1/2 IN	3/4 IN	1 IN	
3000	---	517	517	0.45
4000	611	611	611	0.45
5000	---	686	665	0.40

3. Substitution of fly ash: Maximum of 25 percent by weight of cement at rate of 1 LB fly ash for 1 LB of cement.
4. Sand cement grout:
 - a. Three parts sand.
 - b. One part Portland cement.
 - c. Entrained air: Six percent plus or minus one percent.
 - d. Sufficient water for required workability.
 - e. Minimum 28-day compressive strength: 3,000 psi.
5. Pan stair fill:
 - a. Coarse aggregate: 100 percent passing a 1/2 IN sieve.

- b. Proportions:
 - 1) 1 sack cement.
 - 2) 150 LBS coarse aggregate.
 - 3) 150 LBS fine aggregate (sand).
- c. Adjust mix to obtain satisfactory finishing.
- 6. Normal weight concrete:
 - a. Proportion mixture to provide desired characteristics using one of methods described below:
 - 1) Method 1 (Trial Mix): Per ACI 318, Chapter 5, except as modified herein.
 - a) Air content within range specified above.
 - b) Record and report temperature of trial mixes.
 - c) Proportion trial mixes per ACI 211.1.
 - 2) Method 2 (Field Experience): Per ACI 318, Chapter 5, except as modified herein:
 - a) Field test records must be acceptable to Owner's Representative to use this method.
 - b) Test records shall represent materials, proportions and conditions similar to those specified.
- 7. Required average strength to exceed the specified 28-day compressive strength by the amount determined or calculated in accordance with the requirements of Paragraph 5.3 of ACI 318 using the standard deviation of the proposed concrete production facility as described in Paragraph 5.3.1 of ACI 318.
- F. Allowable Shrinkage: 0.048 percent per ASTM C157.

PART 3 - EXECUTION

3.1 FORMING AND PLACING CONCRETE

- A. Formwork:
 - 1. Contractor is responsible for design and erection of formwork.
 - 2. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position.
 - a. Allowable tolerances: As recommended in ACI 347R.
 - 3. Provide slabs and beams of minimum indicated depth when sloping foundation base slabs or elevated floor slabs to drains.

- a. For slabs on grade, slope top of subgrade to provide floor slabs of minimum uniform indicated depth.
 - b. Do not place floor drains through beams.
 4. Openings: Provide openings in formwork to accommodate work of other trades.
 - a. Accurately place and securely support items built into forms.
 5. Chamfer strips: Place 3/4 IN chamfer strips in forms to produce 3/4 IN wide beveled edges on permanently exposed corners of members.
 6. Clean and adjust forms prior to concrete placement.
 7. Tighten forms to prevent mortar leakage.
 8. Coat form surfaces with form release agents prior to placing reinforcing bars in forms.
- B. Reinforcement:
1. Position, support and secure reinforcement against displacement.
 2. Locate and support with chairs, runners, bolsters, spacers and hangers, as required.
 3. Set wire ties so ends do not touch forms and are directed into concrete, not toward exposed concrete surfaces.
 4. Lap splice lengths: ACI 318 Class B top bar tension splices unless indicated otherwise on the Drawings.
 5. Extend reinforcement to within 2 IN of concrete perimeter edges.
 - a. If perimeter edge is earth formed, extend reinforcement to within 3 IN of the edge.
 6. Minimum concrete protective covering for reinforcement: As shown on Drawings.
 7. Do not weld reinforcing bars.
 8. Welded wire reinforcement:
 - a. Install welded wire reinforcement in maximum practical sizes.
 - b. Splice sides and ends with a splice lap length measured between outermost cross wires of each fabric sheet not less than:
 - 1) One spacing of cross wires plus 2 IN.
 - 2) 1.5 x development length.
 - 3) 6 IN.
 - c. Development length: ACI 318 basic development length for the specified fabric yield strength.
 9. Provide at locations indicated.

10. Locate wall vertical construction joints at 30 FT maximum centers and wall horizontal construction joints at 10 FT maximum centers.
11. Locate construction joints in floor slabs and foundation base slabs so that concrete placements are approximately square and do not exceed 2500 SF.
12. Locate construction joints in columns and walls:
 - a. At the underside of beams, girders, haunches, drop panels, column capitals, and at floor panels.
 - b. Haunches, drop panels, and column capitals are considered part of the supported floor or roof and shall be placed monolithically therewith.
 - c. Column based need not be placed monolithically with the floor below.
13. Locate construction joints in beams and girders:
 - a. At the middle of the span, unless a beam intersects a girder at that point.
 - b. If the middle of the span is at an intersection of a beam and girder, offset the joint in the girder a distance equal to twice the beam width.
 - c. Provide satisfactory means for transferring shear and other forces through the construction joint.
14. Locate construction joints in suspended slabs:
 - a. At or near the center of span in flat slab or T-beam construction.
 - b. Do not locate a joint between a slab and a concrete beam or girder unless so indicated on Drawings.
15. In pan-formed joists:
 - a. At or near span center when perpendicular to the joists.
 - b. Centered in the slab, midway between joists, when parallel to the joists.
16. Install construction joints perpendicular to main reinforcement with all reinforcement continued across construction joints.
17. At least 48 HRS shall elapse between placing of adjoining concrete construction.
18. Thoroughly clean and remove all laitance and loose and foreign particles from construction joints.
19. Before new concrete is placed, coat all construction joints with an approved bonding adhesive used and applied in accordance with manufacturer's instructions.

C. Embedments:

1. Set and build in anchorage devices and other embedded items required for other work that is attached to, or supported by concrete.
2. Use setting diagrams, templates and instructions for locating and setting.

3. Secure waterstops in correct position using hog rings or grommets spaced along the length of the waterstop and wire tie to adjacent reinforcing steel.
- D. Placing Concrete:
1. Place concrete in compliance with ACI 304R and ACI 304.2R.
 2. Place in a continuous operation within planned joints or sections.
 3. Begin placement when work of other trades affecting concrete is completed.
 4. Place concrete by methods which prevent aggregate segregation.
 5. Do not allow concrete to free fall more than 4 FT.
 6. Where free fall of concrete will exceed 4 FT, place concrete by means of tremie pipe or chute.
- E. Consolidation: Consolidate all concrete using mechanical vibrators supplemented with hand rodding and tamping, so that concrete is worked around reinforcement and embedded items into all parts of forms.
- F. Protection:
1. Protect concrete from physical damage or reduced strength due to weather extremes.
 2. In cold weather comply with ACI 306R except as modified herein.
 - a. Do not place concrete on frozen ground or in contact with forms or reinforcing bars coated with frost, ice or snow.
 - b. Minimum concrete temperature at the time of mixing:

OUTDOOR TEMPERATURE AT PLACEMENT (IN SHADE)	CONCRETE TEMPERATURE AT MIXING
Below 30 DegF	70 DegF
Between 30-45 DegF	60 DegF
Above 45 DegF	50 DegF

- c. Do not place heated concrete that is warmer than 80 DegF.
 - d. If freezing temperatures are expected during curing, maintain the concrete temperature at or above 50 DegF for 7 days or 70 DegF for 3 days.
 - e. Do not allow concrete to cool suddenly.
3. In hot weather comply with ACI 305R except as modified herein.
 - a. At air temperature of 95 DegF and above, keep concrete as cool as possible during placement and curing.
 - b. Do not allow concrete temperature to exceed 95 DegF at placement.

- c. Prevent plastic shrinkage cracking due to rapid evaporation of moisture.
- d. Do not place concrete when the actual or anticipated evaporation rate equals or exceeds 0.2 LBS/SF/HR as determined from ACI 305R, Figure 2.1.5.

G. Curing:

- 1. Begin curing concrete as soon as free water has disappeared from exposed surfaces.
- 2. Cure concrete by use of moisture retaining cover, burlap kept continuously wet or by membrane curing compound.
- 3. Provide protection as required to prevent damage to concrete and to prevent moisture loss from concrete during curing period.
- 4. Provide curing for minimum of 7 days.
- 5. Form materials left in place may be considered as curing materials for surfaces in contact with the form materials except in periods of hot weather.
- 6. In hot weather follow curing procedures outlined in ACI 305R.
- 7. In cold weather follow curing procedures outlined in ACI 306R.
- 8. If forms are removed before 7 days have elapsed, finish curing of formed surfaces by one of above methods for the remainder of the curing period.
- 9. Curing vertical surfaces with a curing compound:
 - a. Cover vertical surfaces with a minimum of two coats of the curing compound.
 - b. Allow the preceding coat to completely dry prior to applying the next coat.
 - c. Apply the first coat of curing compound immediately after form removal.
 - d. Vertical surface at the time of receiving the first coat shall be damp with no free water on the surface.
 - e. A vertical surface is defined as any surface steeper than 1 vertical to 4 horizontal.

H. Form Removal:

- 1. Remove forms after concrete has hardened sufficiently to resist damage from removal operations or lack of support.
- 2. Where no reshoring is planned, leave forms and shoring used to support concrete until it has reached its specified 28-day compressive strength.
- 3. Where reshoring is planned, supporting formwork may be removed when concrete has sufficient strength to safely support its own weight and loads placed thereon.
 - a. While reshoring is underway, no superimposed loads shall be permitted on the new construction.

- b. Place reshores as soon as practicable after stripping operations are complete but in no case later than the end of working day on which stripping occurs.
- c. Tighten reshores to carry their required loads.
- d. Leave reshores in place until concrete being supported has reached its specified 28-day compressive strength.

3.2 CONCRETE FINISHES

A. Tolerances:

- 1. Class A: 1/8 IN in 10 FT.
- 2. Class B: 1/4 IN in 10 FT.

B. Surfaces Exposed to View:

- 1. Provide a smooth finish for exposed concrete surfaces and surfaces that are:
 - a. To be covered with a coating or covering material applied directly to concrete.
 - b. Scheduled for grout cleaned finish.
- 2. Remove fins and projections, and patch voids, air pockets, and honeycomb areas with cement grout.
- 3. Fill tie holes with nonshrink nonmetallic grout.

C. Surfaces Not Exposed to View:

- 1. Patch voids, air pockets and honeycomb areas with cement grout.
- 2. Fill tie holes with nonshrink nonmetallic grout.

D. Grout Cleaned Finish:

- 1. Mix one part Portland cement and 1-1/2 parts fine sand with sufficient bonding agent/water mixture to produce a grout with the consistency of thick paint.
 - a. White Portland cement shall be substituted for gray Portland cement to produce a color that matches color of surrounding concrete as determined by trial patch for areas not to be painted.
- 2. Wet surface of concrete to prevent absorption of water by grout and uniformly apply grout with brushes or spray gun.
- 3. Immediately scrub the surface with a cork float or stone to coat and fill air bubbles and holes.
- 4. While grout is still plastic, remove all excess grout by working surface with rubber float, sack or other approved means.
- 5. After the surface whitens from drying, rub vigorously with clean burlap.

6. Keep final finish damp for a minimum of 36 HRS after final rubbing.

E. Slab Float Finish:

1. After concrete has been placed, consolidated, struck off, and leveled, do no further work until ready for floating.
2. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operation.
3. During or after first floating, check planeness of entire surface with a 10 FT straightedge applied at not less than two different angles.
4. Cut down all high spots and fill all low spots during this procedure to produce a surface within Class B tolerance throughout.
5. Refloat slab immediately to a uniform sandy texture.

F. Troweled Finish:

1. Float finish surface.
2. Next power trowel, and finally hand trowel.
3. Produce a smooth surface which is relatively free of defects with first hand troweling.
4. Perform additional trowelings by hand after surface has hardened sufficiently.
5. Final trowel when a ringing sound is produced as trowel is moved over surface.
6. Thoroughly consolidate surface by hand troweling.
7. Leave finished surface essentially free of trowel marks, uniform in texture and appearance and plane to a Class A tolerance.
8. On surfaces intended to support floor coverings remove any defects of sufficient magnitude that would show through floor covering by grinding.

G. Broom Finish: Immediately after concrete has received a float finish as specified, give it a transverse scored texture by drawing a broom across surface.

H. Apply chemical floor hardener to permanently exposed interior concrete floor slab surfaces where indicated.

1. Apply in accordance with manufacturer's instructions.

3.3 GROUT

A. Preparation:

1. Nonshrinking nonmetallic grout:
 - a. Clean concrete surface to receive grout.
 - b. Saturate concrete with water for 24 HRS prior to grouting.

2. Rock anchors:
 - a. Clean rock anchors of all loose material.
 - b. Orient hook or bends in anchor bars to clear anchor bolts, reinforcements, and other embedments to be installed later.
 3. Epoxy grout: Apply only to clean, dry, roughened, sound surface.
- B. Application:
1. Nonshrinking nonmetallic grout:
 - a. Mix in a mechanical mixer.
 - b. Use no more water than necessary to produce flowable grout.
 - c. Place in accordance with manufacturer's instructions.
 - d. Completely fill all spaces and cavities below the bottom of baseplates.
 - e. Provide forms where baseplates and bedplates do not confine grout.
 - f. Where exposed to view, finish grout edges smooth.
 - g. Except where a slope is indicated on Drawings, finish edges flush at the baseplate, bedplate, member, or piece of equipment.
 - h. Protect against rapid moisture loss by covering with wet rags or polyethylene sheets.
 - i. Wet cure grout for seven (7) days, minimum.
 2. Rock anchors:
 - a. See Item 1 above.
 - b. If rodded:
 - 1) Fill each hole so that it overflows when anchor bar is inserted.
 - 2) Force anchor bars into place.
 - c. If pressure placed, set anchor bar before grouting.
 - d. Take special care to avoid any movement of anchors that have been placed.
 3. Epoxy grout:
 - a. Mix and place in accordance with manufacturer's instructions.
 - b. Completely fill all cavities and spaces around dowels and anchors without voids.
 - c. Obtain manufacturer's field technical assistance as required to ensure proper placement.

3.4 FIELD QUALITY CONTROL

- A. Owner will employ and pay for services of a concrete testing laboratory to perform testing of concrete placed during construction.
 - 1. Contractor to cooperate with Owner in obtaining and testing samples.
- B. Tests During Construction:
 - 1. Strength test - procedure:
 - a. Three cylinders, 6 IN DIA x 12 IN high, will be taken from each sample per ASTM C172 and ASTM C31.
 - b. Cylinders will be tested per ASTM C39:
 - 1) One at 7 days.
 - 2) Two at 28 days.
 - 2. Strength test - frequency:
 - a. Not less than one test each day concrete placed.
 - b. Not less than one test for each 50 CY or major fraction thereof placed in one day.
 - c. Not less than one test for each type of concrete poured.
 - d. Not less than one test for each concrete structure exceeding 2 CY volume.
 - 3. Slump test:
 - a. Per ASTM C143.
 - b. Determined for each strength test sample.
 - c. Additional slump tests may be taken.
 - 4. Air content:
 - a. Per ASTM C231, ASTM C173, and ASTM C138.
 - b. Determined for each strength test sample.
 - 5. Temperature: Determined for each strength test sample.
- C. Evaluation of Tests:
 - 1. Strength test results:
 - a. Average of 28-day strength of two cylinders from each sample.
 - 1) If one cylinder manifests evidence of improper sampling, molding, handling, curing or testing, strength of remaining cylinder will be test result.
 - 2) If both cylinders show any of above defects, test will be discarded.
- D. Acceptance of Concrete:

1. Strength level of each type of concrete shall be considered satisfactory if both of the following requirements are met:
 - a. Average of all sets of three consecutive strength tests equals or exceeds the required specified 28-day compressive strength.
 - b. No individual strength test falls below the required specified 28-day compressive strength by more than 500 psi.
2. If tests fail to indicate satisfactory strength level, perform additional tests and/or corrective measures as directed by Owner's Representative.
 - a. Perform additional tests and/or corrective measures at no additional cost to Owner.

3.5 SCHEDULES

A. Form Types:

1. Surfaces exposed to view:
 - a. Prefabricated or job-built wood forms.
 - b. Laid out in a regular and uniform pattern with long dimensions vertical and joints aligned.
 - c. Produce finished surfaces free from offsets, ridges, waves, and concave or convex areas.
 - d. Construct forms sufficiently tight to prevent leakage of mortar.
2. Surfaces normally submerged or not normally exposed to view: Wood or steel forms sufficiently tight to prevent leakage of mortar.
3. Other types of forms may be used:
 - a. For surfaces not restricted to plywood or lined forms.
 - b. As backing for form lining.

B. Grout:

1. Nonshrinking nonmetallic grout: General use.
2. Epoxy grout:
 - a. Grouting of dowels and anchor bolts into existing concrete.
 - b. Other uses indicated on Drawings.
3. Sand cement grout: Keyways of precast members.

C. Concrete:

1. Precast concrete: Where indicated on Drawings.
2. Lean concrete: Where indicated on Drawings.
3. Concrete fill: Where indicated on Drawings.
4. Lightweight concrete: Where indicated on Drawings.

5. Normal weight concrete: All concrete.
6. Concrete pan fill: Stair and landings where indicated on Drawings.
7. General use concrete: All other locations.

D. Concrete Finishes:

1. Grout cleaned finish: Where indicated on Drawings.
2. Slab finishes:
 - a. Use following finishes as applicable, unless otherwise indicated:
 - 1) Floated finish: Surfaces intended to receive roofing, concrete topping, lean concrete, concrete fill and waterproofing.
 - 2) Troweled finish: Interior floor slabs, exposed roof slabs and base slabs of structures, equipment bases, and column bases.
 - 3) Broom finish: Sidewalks, docks, concrete stairs, and ramps.

3.6 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 03 31 30

CONCRETE, MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete materials, strengths and proportioning for concrete work.
2. Grouting:
 - a. Base plates for columns and equipment.
 - b. Dowels and anchors into concrete.
 - c. Patching cavities in concrete.
 - d. As specified and indicated in the Contract Document.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
 - a. 116R – Cement and Concrete Terminology.
 - b. 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - c. 212.3R – Chemical Admixtures for Concrete.
 - d. 318 – Building Code Requirements for Structural Concrete.
 - e. 350 – Code Requirements for Environmental Engineering Concrete Structures.
2. ASTM International (ASTM):
 - a. C33 – Standard Specification for Concrete Aggregates.
 - b. C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - c. C94 – Standard Specification for Ready-Mixed Concrete.
 - d. C150 – Standard Specification for Portland Cement.
 - e. C157 – Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.

- f. C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
 - g. C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
 - h. C494 – Standard Specification for Chemical Admixtures for Concrete.
 - i. C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
3. Corps of Engineers (USACE):
- a. CRD-C621 – Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (NonShrink).

1.4 DEFINITIONS

- A. Words and terms used in these Specifications are defined in ACI 116R.

1.5 SUBMITTALS

- A. Shop Drawings:
- 1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's instructions.
 - c. Concrete mix designs as required by Specification Section 03 05 05.
 - d. Manufacturer and type of proposed admixtures.
 - e. Manufacturer and type of proposed non-shrink grout and grout cure/seal compound.
 - 2. Certifications:
 - a. Certification of standard deviation value in psi for ready mix plant supplying the concrete.
 - b. Certification that the fly ash meets the quality requirements stated in this Specification Section, and fly ash supplier's certified test reports for each shipment of fly ash delivered to concrete supplier.
 - c. Certification that the class of coarse aggregate meets the requirements of ASTM C33 for type and location of concrete construction.
 - d. Certification of aggregate gradation.
 - 3. Test reports: Cement mill reports for all cement to be supplied.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Storage of Materials:
- 1. Store cement and pozzolan in weathertight buildings, bins, or silos which will exclude moisture and contaminants.

2. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
3. Allow natural sand to drain until it has reached a relatively uniform moisture content before use.
4. Store admixtures in such a manner as to avoid contamination, evaporation, or damage.
 - a. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure thorough distribution of ingredients.
 - b. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics and performance.

1.7 WARRANTY

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement:

1. ASTM C150, Type I/II.
2. Cement type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

B. Fly Ash:

1. ASTM C618, Class F or Class C.
2. Non-staining.
3. Suited to provide hardened concrete of uniform light gray color.
4. Maximum loss on ignition: 4 percent.
5. Compatible with other concrete ingredients and having no deleterious effects on the hardened concrete.
6. Produced by source approved by the governing jurisdiction where the Project is located for use in concrete for bridges.
7. Cement and fly ash type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

C. Admixtures:

1. Air entraining: ASTM C260.
2. Water reducing, retarding, and accelerating: Conform to ASTM C494, Types A through E, and provisions of ACI 212.3R.
3. High range water reducers (superplasticizers): Conform to ASTM C494, Types F or G.

4. Admixtures to be chloride free.
 - a. Do not use calcium chloride.
 5. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.
- D. Water:
1. Potable.
 2. Clean and free from deleterious substances.
 3. Free of oils, acids and organic matter.
- E. Aggregates for Normal Weight Concrete:
1. ASTM C33.
 2. Fine and coarse aggregates to be regarded as separate ingredients.
 3. Fine aggregates to be natural, not manufactured.
 4. Coarse aggregate sieve analysis:
 - a. For lean concrete, concrete topping, and integral wearing course: ASTM C33, size number 7 (maximum 1/2 IN).
 - b. For all other concrete: ASTM C33, size number 57 (maximum 1 IN) or size number 67 (maximum 3/4 IN).
 5. Provide aggregates approved for bridge construction by the governing jurisdiction where the Project is located.
 6. Pozzolan or other additives shall not be used to compensate for alkali reactivity of aggregates.
- F. Maximum total chloride ion content for concrete mix including all ingredients measured as a weight percent of cement:
1. Prestressed concrete: 0.06.
 2. All other concrete: 0.10.
- G. Sand Cement Grout:
1. Approximately three (3) parts sand, one (1) part Portland cement, 6 ± 1 percent entrained air and water to produce a slump which allows grout to completely fill required areas and surround adjacent reinforcing.
 - a. Provide sand in accordance with requirements for fine aggregate for concrete.
 2. Minimum 28 day compressive strength: 3000 psi.

H. Non-shrink Grout:

1. Non-shrink, non-metallic, non-corrosive, and non-staining.
2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.
3. Grout to produce a positive but controlled expansion.
 - a. Mass expansion shall not be created by gas liberation or by other means.
4. Minimum 28 day compressive strength: 6500 psi.
5. Acceptable manufacturers:
 - a. BASF Admixtures, Inc. "Masterflow, 713 Plus".
 - b. Euclid Chemical "NS Grout".
 - c. Sauereisen Cements "F-100 Level Fill Grout".
 - d. U. S. Grout "Five Star Grout".
 - e. Set Products, Inc. "Set Non-Shrink Grout".
 - f. The Upco Corp "Upcon".
 - g. L&M "Crystex".
 - h. Sika Corporation "Sika Grout 212".
6. In accordance with COE CRD-C621.

I. Epoxy Grout:

1. Three-component epoxy resin system:
 - a. Two (2) liquid epoxy components.
 - b. One (1) inert aggregate filler component.
2. Adhesive acceptable manufacturers:
 - a. BASF "Masterflow 648 CP".
 - b. Exxon Chemical Company "Escoweld 2505."
 - c. Sika "Sikadur Hi-Mod."
 - d. U. S. Grout "Five Start Epoxy Grout."
 - e. Euclid Chemical "E3-G."
3. Aggregate acceptable manufacturers:
 - a. BASF "Masterflow 648 CP".
 - b. Exxon Chemical Company "Escoweld 2510."
 - c. Sika aggregate.
 - d. U. S. Grout aggregate.
 - e. Euclid Chemical "Euclid aggregate."

4. Aggregate manufacturer shall be the same as the adhesive manufacturer.
5. The aggregate shall be compatible with the adhesive.
6. Each component furnished in separate package for mixing at jobsite.
7. Submit request for substitution in accordance with Specification Section 01 25 13 – Product Substitutions.

2.2 MIXES**A. General:**

1. Provide concrete capable of being placed without aggregate segregation and, when cured, of developing all properties specified.
2. Ready-mixed concrete shall conform to ASTM C94.
3. All concrete to be normal weight concrete, weighing approximately 145 to 150 LBS per cubic foot at 28 days after placement.

B. Minimum 28 Day Compressive Strengths:

Normal weight concrete fill	3000 psi
Normal weight lean concrete	1500 psi
Normal weight concrete topping	4000 psi
Normal weight concrete	4000 psi
Normal weight precast concrete	5000 psi
Normal weight concrete pavements	4000 psi
Normal weight concrete integral wearing course	6000 psi

C. Air Entrainment:

1. Provide air entrainment in all concrete resulting in a total air content percent by volume as indicated by ACI 318-08, Chapter 4:
 - a. Exposure Class: F1.
 - b. Do not air entrain and maximum entrapped air shall not exceed 3 percent total air content for the following:
 - 1) Interior slabs
 - 2) Slabs with a steel trowel finish.
 - 3) Slabs on composite metal decks.

D. Slump:

1. General: 4 IN maximum (+/- 1 IN) minimum measured at point of discharge into the concrete construction member.

- a. Walls, beams, and columns: Provide high range water reducer (HRWR) and slump shall be 8 IN maximum (+/- 1 IN).
 - b. Provide HRWR as required for placement.
 - c. Do not provide HRWR in slab and pavements.
 2. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
 3. Provide additional water or water reducing admixture at ready mix plant for concrete that is to be pumped to allow for slump loss due to pumping.
 - a. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified and the maximum specified water-cement ratio is not exceeded.
 4. Slump may be adjusted in the field through the use of water reducers.
 - a. Coordinate dosage and mixing requirements with concrete supplier.
- E. Proportioning:
1. General:
 - a. Proportion ingredients to produce a mixture which will work readily into corners and angles of forms and around reinforcement by methods of placement and consolidation employed without permitting materials to segregate or excessive free water to collect on surface.
 - b. Proportion ingredients to produce proper placability, durability, strength and other required properties.
 2. Normal weight concrete minimum cement contents and maximum water cement ratios:

SPECIFIED STRENGTH (PSI)	MINIMUM CEMENT (LBS/CY)	MAXIMUM WATER CEMENT RATIO BY WEIGHT
3000	517*	0.45
4000	564*	0.45
4000 (Drilled Shaft)	658*	0.45
4500	611*	0.42
5000	611*	0.45
6000	658*	0.45

* If fly ash is proposed for use, the weight of fly ash plus weight of Portland cement shall equal these values.

3. Fly ash:

- a. For cast-in-place concrete only, a maximum of 25 percent by weight of Portland cement content per cubic yard may be replaced with fly ash at a rate of 1 LB fly ash for 1 LB cement.
- b. If fly ash is used, the water to fly ash plus cement ratio not to exceed the maximum water cement ratio specified in this Specification Section.
- c. Concrete containing fly ash shall not be used in the construction of the precast and prestressed concrete units.
4. Water reducing, retarding, and accelerating admixtures:
 - a. Use in accordance with manufacturer's instructions.
 - b. Do not use unless required by these specifications or approved for use by Owner's Representative.
5. High range water reducers (superplasticizers):
 - a. Use in accordance with manufacturer's instructions.
 - b. Do not use unless required by these Specifications or approved for use by Owner's Representative.
6. Concrete mix proportioning methods for normal weight concrete:
 - a. Method 1:
 - 1) Used when combination of materials proposed is to be evaluated and proportions selected to be on a basis of trial mixes.
 - 2) Produce mixes having suitable proportions and consistencies based on ACI 211.1, using at least three (3) different water cement ratios or cement contents which will produce a range of compressive strengths encompassing the required average strength.
 - 3) Design trial mixes to produce a slump within 0.75 IN of maximum specified, and for air entrained concrete, air content within 0.5 percent specified.
 - 4) For each water cement ratio or cement content, make at least three (3) compression test cylinders for specified test age, and cure in accordance with ASTM C192.
 - a) Test for strength at 28 days in accordance with ASTM C39.
 - 5) From results of these tests, plot a curve showing relationship between water cement ratio or cement content and compressive strength.
 - 6) From this curve select water cement ratio or cement content to be used to produce required average strength.
 - 7) Use cement content and mixture proportions such that maximum water cement ratio is not exceeded when slump is maximum specified.

- 8) Base field control on maintenance of proper cement content, slump, air content and water cement ratio.
- 9) See paragraph hereafter for definition of required average strength.
- b. Method 2:
 - 1) In lieu of trial mixes, field test records for concrete made with similar ingredients may be used.
 - 2) Use of proposed concrete mix proportions based on field test records subject to approval by Owner's Representative based on information contained in field test records and demonstrated ability to provide the required average strength.
 - 3) Required concrete proportions may be established by interpolation between the strengths and proportions of two (2) or more test records each of which meets the requirements of this Specification Section.
7. Required average strength to exceed the specified 28 day compressive strength by the amount determined or calculated in accordance with Paragraph 5.3 of ACI 318 using the standard deviation of the proposed concrete production facility as described in Paragraphs 5.3.1 and 2 of ACI 318.
 - a. Specifier: Indicate air dry unit weight of lightweight concrete to correspond to unit weights used in structural design.
 - b. Mixture shall contain no more than 30 percent fines.
 - c. Proportioning of mixture shall be sufficient to produce a minimum unconfined compressive strength of 50 psi at 7 days.
- F. Allowable Shrinkage: 0.048 percent per ASTM C157.

2.3 SOURCE QUALITY CONTROL

- A. To assure stockpiles are not contaminated or materials are segregated, perform any test for determining conformance to requirements for cleanness and grading on samples secured from aggregates at point of batching.
- B. Do not use frozen or partially frozen aggregates.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Perform concrete tests per Specification Section 03 05 05 – Testing.
- B. Perform strength test on any concrete to which water has been added at the jobsite.

3.2 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 03 31 31

CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mixing, placing, jointing, and curing of concrete construction.

1.2 MEASUREMENT AND PAYMENT

A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
 - a. 116R – Cement and Concrete Terminology.
 - b. 304R – Guide for Measuring, Mixing, Transporting and Placing Concrete.
 - c. 304.2R – Placing Concrete by Pumping Methods.
 - d. 305R – Hot Weather Concreting.
 - e. 306R – Cold Weather Concreting.
 - f. 308 – Standard Practice for Curing Concrete.
 - g. 309R – Guide for Consolidation of Concrete.
2. ASTM International (ASTM):
 - a. C94 – Standard Specification for Ready-Mixed Concrete.
 - b. C156 – Standard Test Method for Water Loss (from a Mortar Specimen) Through Liquid Membrane-Forming Curing Compounds for Concrete.
 - c. C171 – Standard Specification for Sheet Materials for Curing Concrete.
 - d. C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - e. D994 – Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 - f. D1056 – Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
 - g. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

3. Corps of Engineers (USACE):
 - a. CRD-C572, Specifications for Polyvinylchloride Waterstops.
 4. National Ready Mixed Concrete Association (NRMCA):
 - a. Checklist for Certification of Ready Mixed Concrete Production Facilities.
 5. National Sanitation Foundation International (NSF).
- B. Qualifications:
1. Ready Mixed Concrete Batch Plant: Certified by NRMCA.

1.4 DEFINITIONS

- A. Words and terms used in this Specification Section are defined in ACI 116R.

1.5 SUBMITTALS

- A. Shop Drawings:
1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 1) Procedure for adding high-range water reducer at the jobsite.
 - c. Scaled (minimum 1/8 IN per foot) drawings showing proposed locations of construction joints and joint keyway dimensions.
 - d. Manufacturers and types:
 - 1) Joint fillers.
 - 2) Curing agents.
 - 3) Construction joint bonding adhesive.
 - 4) Pressure relief valves.
 - 5) Waterstops.
 2. Certifications:
 - a. Ready mix concrete plant certification.
 - b. Waterstops: Products shipped meet or exceed the physical properties specified.
- B. Miscellaneous Submittals:
1. Copies of concrete delivery tickets.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
1. Concrete:

- a. Prepare a delivery ticket for each load of ready mixed concrete.
- b. Truck operator shall hand ticket to Contractor at the time of delivery.
- c. Ticket to show:
 - 1) Mix identification.
 - 2) Quantity delivered.
 - 3) Amount of material in each batch.
 - 4) Outdoor temperature in the shade.
 - 5) Time at which cement was added
 - 6) Time of delivery.
 - 7) Time of discharge.
 - 8) Amount of water that may be added at the site without exceeding the specified water-cement ratio.
 - 9) Amount of water added at the site.

1.7 WARRANTY

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Neoprene Expansion Joint Fillers:

1. Acceptable manufacturers:
 - a. Permaglaze.
 - b. Rubatex.
 - c. Williams Products.
2. Materials:
 - a. Closed cell neoprene.
 - b. ASTM D1056, Class SC.
 - c. Compression deflection: As required to limit deflection to 50 percent of joint thickness under pressure from concrete pour height.

B. Asphalt Expansion Joint Fillers:

1. Acceptable manufacturers:
 - a. W R Meadows.
 - b. J and P Petroleum Products.
2. Materials: ASTM D994.

C. Fiber Expansion Joint Fillers:

1. Materials: ASTM D1751.
- D. Waterstops, PVC Type:
1. Acceptable manufacturers:
 - a. Greenstreak Plastic Products.
 - b. W R Meadows.
 - c. Paul Murphy Plastics.
 2. Materials:
 - a. Virgin polyvinyl chloride compound not containing any scrap or reclaimed materials or pigment.
 - b. Standard: COE CRD-C572.
 3. In expansion joints:
 - a. 6 IN or 9 IN wide by 3/8 IN thick tear web type waterstop as indicated in drawings.
 - b. 2 IN minimum horizontal movement without rupturing.
 - c. Greenstreak Plastic Products Style #700.
 - d. Greenstreak Plastic Products Style #701 and #705.
 4. In control joints:
 - a. 6 IN wide by 3/8 IN thick with ribs and center bulb.
 - b. Greenstreak Plastic Products Style #705.
 5. In all other joints:
 - a. 6 IN wide by 3/8 IN thick with ribs.
 - b. Greenstreak Plastic Products Style #705, #679 or #783.
 6. Provide hog rings or grommets at maximum 12 IN OC along the length of the waterstop.
 7. Provide factory-made waterstop fabrications at all changes in direction, intersections and transitions, leaving only straight butt splices for the field.
- E. Waterstops, Preformed Strip Type:
1. Acceptable manufacturers:
 - a. Hydrotite CJ by Greenstreak Plastics, Inc.
 - b. Adeka Ultra Seal USA.
 2. Materials:
 - a. Hydrophilic type waterstop manufactured solely for the purpose of preventing water from traveling through construction joints.
 - b. Hydrotite type CJ-0725-3K.

- F. Submit request for substitution in accordance with Specification Section 01 25 13 – Product Substitutions.

PART 3 - EXECUTION

3.1 PREPARATION

A. General:

1. Complete formwork.
2. Remove earth, snow, ice, water, and other foreign materials from areas that will receive concrete.
3. Secure reinforcement in place.
4. Position expansion joint material, anchors and other embedded items.
5. Obtain approval of reinforcement erection and placement prior to placing concrete.
6. Do not place concrete during rain, sleet, or snow, unless adequate protection is provided and approval is obtained.
 - a. Plan size of crews with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
 - b. Do not allow rainwater to increase mixing water nor to damage surface finish.
7. Prepare all construction joints for proper bond per the Article JOINTS AND EMBEDDED ITEMS, paragraph Construction Joints - Bonding of this Specification Section.
8. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.
9. Provide slabs and beams of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
 - a. For floor slabs on grade, slope top of subgrade to provide slab of required uniform thickness.

B. Preparation of Subgrade for Slabs On Ground:

1. Subgrade drained and of adequate and uniform load-bearing nature.
2. Obtain approval of subgrade compaction density prior to placing slabs on ground.
3. Maintain subgrade at a temperature above 32 DegF before concrete placing begins for a sufficient amount of time to remove frost.
4. Moisten subgrade to eliminate absorption.
 - a. Keep subgrade moist at time of concreting.

- b. Allow no free-standing water on subgrade or soft or muddy spots when concrete is placed.
- C. Edge Forms and Screeds:
 - 1. Set accurately to produce designated elevations and contours of finished surface.
 - 2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
 - 3. Use strike off templates, or approved vibrating type screeds, to align concrete surfaces to contours of screed strips.

3.2 CONCRETE MIXING

A. General:

- 1. Provide all concrete from a central or dry mixed plant conforming to Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
- 2. Batch, mix, and transport in accordance with ASTM C94.
- 3. Time limit for discharging concrete from mixer trucks:
 - a. Agitated:
 - 1) 90 minutes below 75 DegF.
 - 2) 60 minutes at or above 75 DegF and up to 90 DegF.
 - 3) A set-retarder may be used to extend delivery time by 30 minutes.
 - b. Non-Agitated:
 - 1) 30 minutes below 80 DegF
 - 2) 15 minutes at or above 80 DegF

B. Control of Admixtures:

- 1. Charge admixtures into mixer as solutions.
 - a. Measure by means of an approved mechanical dispensing device.
 - b. Liquid considered a part of mixing water.
 - c. Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.
- 2. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.
- 3. Complete addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.

C. Tempering and Control of Mixing Water:

1. Mix concrete only in quantities for immediate use.
2. Discard concrete which has set.
3. Discharge concrete from ready mix trucks within time limit and drum revolutions stated in ASTM C94.
4. Addition of water at the jobsite:
 - a. See Specification Section 03 31 30 – Concrete, Materials and Proportioning for specified water cement ratio and slump.
 - b. Do not exceed maximum specified water cement ratio or slump.
 - c. Incorporate water by additional mixing equal to at least half of total mixing required.
 - d. Perform strength test on any concrete to which water has been added at the jobsite.
 - 1) See Specification Section 03 05 05 – Testing for testing requirements.

3.3 PLACING OF CONCRETE**A. General:**

1. Comply with ACI 304R and ACI 304.2R.
2. Deposit concrete:
 - a. Continuously to avoid cold joints.
 - b. In layers of 12 to 18 IN.
3. Locate construction joints at locations approved by Owner's representative.
 - a. Plan size of crews with due regard for effects of concrete temperature and atmosphere conditions to avoid unplanned cold joints.
4. Place concrete at such a rate that concrete, which is being integrated with fresh concrete, is still workable.
5. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
6. Spreaders:
 - a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
 - b. Embedded:
 - 1) Obtain approval of Owner's representative.
 - 2) Materials: Concrete or metal.
 - 3) Ends of metal spreaders coated with plastic coating 2 IN from each end.

7. Do not begin placing of concrete in supported elements until concrete previously placed in supporting members is no longer plastic and has been in place at least a minimum of 2 HRS.
8. Deposit concrete as nearly as practicable in its final position to avoid segregation.
 - a. Maximum free fall: 5 FT without high range water reducer. 10 FT with high range water reducer.
 - b. Drilled shafts place in the dry do not have a free fall restriction.
 - c. Free fall exceeding limits specified: Place concrete by means of hopper, elephant trunk or tremie pipe extending down to within 1 FT of surface placed upon.
9. Perform the following operations before bleeding water has an opportunity to collect on surface:
 - a. Spread.
 - b. Consolidate.
 - c. Straightedge.
 - d. Darby or bull float.

B. Admixtures:

1. All admixtures to be introduced at the batch plant in accordance with manufacturer's recommendations.

C. Cold Weather Concrete Placement:

1. Comply with ACI 306R.
2. Do not place concrete on substrates that are below 32 DegF or contain frozen material.
3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
4. Temperature of concrete when discharged at site:

AIR TEMPERATURE DEGF	MINIMUM CONCRETE TEMPERATURE, DEGF FOR SECTIONS WITH LEAST DIMENSION LESS THAN 12 IN	MINIMUM CONCRETE TEMPERATURE, DEGF FOR SECTIONS WITH LEAST DIMENSION 12 IN OR GREATER
30 to 45	60	55
0 to 30	65	55
below 0	70	60

5. Heat subgrade, forms, and reinforcement so the temperature of the subgrade, forms, and reinforcement will be between 45 and 70 DegF, when temperature of surrounding air is 40 DegF or below at time concrete is placed.
 - a. Remove all frost from subgrade, forms and reinforcement before concrete is placed.
6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 DegF.
7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 DegF.
8. Do not place slabs on ground if temperature is below 40 DegF or if temperature surrounding the slab will be below 40 DegF before structure is enclosed and heated.

D. Hot Weather Concrete Placement:

1. Comply with ACI 305R.
2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
3. Temperature of concrete when placed:
 - a. Not to exceed 90 DegF.
 - b. The maximum temperature of concrete shall not exceed 90 F at the time the concrete is placed. The temperatures of the mixing water shall be reduced by the use of chilled water or ice.
 - c. The maximum temperature of concrete with high range water reducing admixture shall not exceed 95 F at the time concrete is placed.
 - d. Under extreme heat, wind, or humidity conditions, concreting operations may be suspended if the quality of the concrete being placed is not acceptable.
 - e. Not so high as to cause:
 - 1) Shrinkage cracks.
 - 2) Difficulty in placement due to loss of slump.
 - 3) Flash set.
4. Temperature of forms and reinforcing when placing concrete:
 - a. Not to exceed 90 DegF.
 - b. May be reduced by spraying with water to cool below 90 DegF.
 - 1) Leave no standing water to contact concrete being placed.

E. Consolidating:

1. Consolidate in accordance with ACI 309R except as modified herein.
2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
 - a. Eliminate:
 - 1) Air or stone pockets.
 - 2) Honeycombing or pitting.
 - 3) Planes of weakness.
3. Internal vibrators:
 - a. Minimum frequency of 8000 vibrations per minute.
 - b. Insert and withdraw at points approximately 18 IN apart.
 - 1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
 - c. Use in:
 - 1) Beams and girders of framed slabs.
 - 2) Columns and walls.
 - d. Size of vibrators shall be in accordance with ACI 309R, Table 5.1.5.
4. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other approved means.
5. Do not use vibrators to transport concrete within forms.
6. Provide spare vibrators on jobsite during all concrete placing operations.
7. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
8. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
9. Prevent construction equipment, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.

F. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.

1. The sum of time for transporting in agitating and non-agitating devices may not exceed the maximum agitated concrete time allowed.
2. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94.

3. Horizontal belt conveyors:
 - a. Mount at a slope which will not cause segregation or loss of ingredients.
 - b. Protect concrete against undue drying or rise in temperature.
 - c. Use an arrangement at discharge end to prevent segregation.
 - d. Do not allow mortar to adhere to return length of belt.
 - e. Discharge conveyor runs into equipment specially designed for spreading concrete.
4. Metal or metal lined chutes:
 - a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
 - b. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
 - c. Provide end of each chute with a device to prevent segregation.
5. Pumping or pneumatic conveying equipment:
 - a. Designed for concrete application and having adequate pumping capacity.
 - b. Control pneumatic placement so segregation is avoided in discharged concrete.
 - c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1-1/2 IN.
 - d. Do not convey concrete through pipe made of aluminum or aluminum alloy.
 - e. Provide pumping equipment without Y sections.
- G. Placing of Concrete on Metal Deck:
 1. Prior to concrete placement, the metal deck shall be free of soil, debris, standing water, loose mill scale, and all other foreign matter.
 2. Care shall be exercised when placing concrete so that the deck will not be subject to construction loads or impact that exceed the design capacity of the deck.
 3. Concrete shall be placed in a uniform manner and spread toward the center of the deck span.
 4. If buggies are used to place concrete, runways shall be planked, and the buggies shall only operate on planking.
 - a. Planks shall be of adequate stiffness to transfer loads to the steel supports without damaging the deck.
 5. Deck damage caused by careless placement of concrete shall be repaired or replaced.

3.4 JOINTS AND EMBEDDED ITEMS**A. Construction Joints - General:**

1. Locate joints as indicated on Contract Drawings or as shown on approved Shop Drawings.
 - a. Where construction joint spacing shown on Drawings exceeds the joint spacing indicated in the Construction Joints - Spacing paragraph below, submit proposed construction joint location in conformance with this Specification Section.
2. Unplanned construction joints will not be allowed.
 - a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
3. In general, locate joints near middle of spans of slabs, beams and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice the width of the beam.
4. Locate joints in walls and columns at underside of floors, slabs, beams, or girders, and at tops of foundations or floor slabs, unless shown otherwise.
 - a. At Contractor's option, beam pockets may be formed into concrete walls.
 - b. Size pockets to allow beam reinforcing to be placed as detailed on Drawings.
5. Place beams, girders, column capitals and drop panels at same time as slabs.
6. Place corbels monolithically with walls.
 - a. Locate wall vertical construction joints midway between corbels.
 - b. Where only a single corbel is located place it also monolithically with wall and locate wall vertical construction joint a minimum of 3 FT from face of corbel.
7. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
8. Provide roughened construction joints at all construction joints unless indicated otherwise on Drawings.
 - a. Clean the previously hardened concrete interface and remove all laitance.
 - b. Intentionally roughen the interface to a full amplitude of 1/4 IN.
 - c. Provide recessed flat surface as required to install strip type waterstops.
9. Provide continuous keyways at all construction joints.
 - a. Construction joint keyways shall have the following dimensions, unless shown otherwise on Drawings or directed otherwise by Owner's representative.

- b. Construction joint keyways in walls:
 - 1) Keyway width, not less than 1/3 and not more than 1/2 the wall thickness measured perpendicular to wall faces.
 - 2) Keyway depth to be not less than 1-1/2 IN.
 - 3) Place keyway in wall center unless shown otherwise on Drawings.
 - c. Construction joint keyways in footings, foundations, base slabs, and structural or elevated slabs:
 - 1) Keyway height not less than 1/3 and not more than 1/2 the footing or slab thickness.
 - 2) Keyway depth not less than 1-1/2 IN.
 - 3) Keyway in footing or slab center unless shown otherwise on Drawings.
 - d. Construction joint keyways in beams:
 - 1) Keyway height not less than 1/3 and not more than 1/2 the beam depth.
 - 2) Keyway depth not less than 1-1/2 IN.
 - 3) Keyway in beam center unless shown otherwise on Drawings.
10. Allow a minimum of 48 HRS before placement of adjoining concrete construction.

B. Construction Joints - Spacing:

- 1. General - Structures not intended to contain liquid:
 - a. Wall vertical construction joints, unless noted otherwise:
 - 1) 40 FT maximum centers.
 - 2) At wall intersections, 20 FT maximum from corner.
 - b. Wall horizontal construction joints: 15 FT centers.
 - c. Base slab, floor, and roof slab construction joints:
 - 1) Placements to be approximately square and not to exceed 3500 SF.
 - 2) Maximum side dimension of a slab pour to be less than:
 - a) Twice the length of the short side.
 - b) 80 FT.
- 2. Structures intended to contain liquids:
 - a. Wall vertical construction joint, unless noted otherwise:
 - 1) 30 FT maximum centers.
 - 2) At wall intersections, 15 FT maximum from corner.
 - b. Wall horizontal construction joints: 15 FT centers.

c. Base slab, floor, and roof slab construction joints:

- 1) Placements to be approximately square and not to exceed 2000 SF.
- 2) Maximum side dimension of a slab pour to be less than:
 - a) Twice the length of the short side.
 - b) 60 FT.

C. Construction Joints - Bonding:

1. General: Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance from construction joints.
 - a. Before new concrete is placed, all construction joints shall be dampened and at a saturated, surface dry condition – surface moisture weakens the joint.
2. Roughened construction joints: All joints shall be roughened unless otherwise noted. Roughen the surface of the concrete to expose the aggregate uniformly, minimum 1/4" amplitude.
3. Keyed construction joints: Provide keyed joints where indicated on the Drawings.

D. Locate control joints in slabs on grade as indicated on Drawings.

1. Time cutting properly with set of concrete, if saw cut joints are required or permitted.
 - a. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw. Approximately 1 to 2 hours after finishing operations are completed.
 - b. Complete before shrinkage stresses become sufficient to produce cracking.

E. Expansion Joints:

1. Do not permit reinforcement or other embedded metal items bonded to concrete (except smooth dowels bonded on only one side of joint) to extend continuously through an expansion joint.
2. Use neoprene expansion joint fillers, unless noted otherwise on Drawings.
3. Seal expansion joints as shown on Drawings.

F. Waterstops:

1. Preformed strip type:
 - a. Install on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.

- b. Waterstop to be continuous with splices in accordance with manufacturer's instructions.
- c. Use in joints against existing concrete and where indicated on Drawings.
- 2. PVC type:
 - a. Position waterstop accurately in forms.
 - b. Secure waterstops in correct position using hog rings or grommets spaced along the length of waterstop and tie wire to adjacent reinforcing.
 - c. Hold horizontal waterstops in place with continuous supports.
 - d. Install according to manufacturer's instructions.
 - 1) Do not displace reinforcement from required location.
 - e. Waterstops to be continuous.
 - f. Splice ends with perpendicular butt splice using electrical splicing iron in accordance with manufacturer's instructions.
 - g. Unless otherwise noted, use for all construction joints in new construction for all structures indicated on Drawings.
- G. Other Embedded Items:
 - 1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.
 - 2. Do not place electrical conduit, drains, or pipes in or thru concrete slabs, walls, columns, foundations, beams or other structural members unless approved by Owner's representative.
- H. Placing Embedded Items:
 - 1. Position expansion joint material, waterstops, and other embedded items accurately.
 - 2. Support against displacement.
 - 3. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
 - 4. Provide adequate means for anchoring waterstop in concrete.
 - a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.
 - b. Work concrete under the waterstops by hand, so as to avoid the formation of air and rock pockets, when placing roof and floor slab concrete around waterstops.

3.5 FINISHING

- A. Coordinate mixing and placing with finishing.

3.6 INSTALLATION OF GROUT**A. Grout Schedule of Use:**

1. Sand cement grout:
 - a. Fill keyways if precast HCU.
 - b. General use.
2. Non-shrinking non-metallic grout:
 - a. Filling form tie holes.
 - b. Under column and beam base plates.
 - c. Other uses indicated on the Drawings.
3. Epoxy grout:
 - a. Patching cavities in concrete.
 - b. Grouting of dowels and anchor bolts into existing concrete.
 - c. Grouting of equipment base plates where driving motor is 500 HP and above.
 - d. Other uses indicated on the Drawings.

B. Grout Installation:

1. Sand cement grout:
 - a. Fill keyways between precast concrete hollow core slabs with sand cement grout.
 - b. Consolidate grout by rodding or by other means to assure complete filling of keyways.
 - c. Cure grout by one of methods specified.
2. Non-shrink non-metallic grout:
 - a. Clean concrete surface to receive grout.
 - b. Saturate concrete with water for 24 HRS prior to grouting.
 - c. Mix in a mechanical mixer.
 - d. Use no more water than necessary to produce flowable grout.
 - e. Place in accordance with manufacturer's instructions.
 - f. Provide under beam, column, and equipment base plates, in joints between precast concrete filter slabs, and in other locations indicated on the Drawings.
 - g. Completely fill all spaces and cavities below the top of base plates.
 - h. Provide forms where base plates and bed plates do not confine grout.

- i. Where exposed to view, finish grout edges smooth.
 - j. Except where a slope is indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
 - k. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.
3. Epoxy grout:
- a. Mix and place in accordance with manufacturer's instructions.
 - b. Apply only to clean, dry, sound surface.
 - c. Completely fill all cavities and spaces around dowels and anchors without voids.
 - d. Grout base and bed plates as specified for non-shrinking, non-metallic grout.
 - e. Obtain manufacturer's field technical assistance as required to assure proper placement.

3.7 CURING AND PROTECTION

- A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
- 1. Follow recommendations of ACI 308 except as modified herein.
- B. Unless noted otherwise, apply one of the following curing procedures immediately after completion of placement and finishing, for concrete surfaces not in contact with forms.
- 1. Ponding or continuous sprinkling.
 - 2. Application of absorptive mats or fabric kept continuously wet.
 - 3. Application of sand kept continuously wet.
 - 4. Continuous application of steam (not exceeding 150 DegF) or mist spray.
 - 5. Application of waterproof sheet materials, conforming to ASTM C171.
 - 6. Application of other moisture retaining covering as approved.
 - 7. Application of a curing compound conforming to ASTM C309.
 - a. Apply curing compound in accordance with manufacturer's recommendations immediately after any water sheen which may develop after finishing has disappeared from concrete surface.
 - b. Do not use on any surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.

- c. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two (2) coats of the curing compound.
 - 1) Apply the first coat of curing compound to a vertical surface immediately after form removal.
 - 2) The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
 - 3) Allow the preceding coat to completely dry prior to applying the next coat.
 - 4) A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.
 - d. Curing compounds used in water treatment plant construction shall be non-toxic and taste and odor free.
 - 1) Curing compound to be NSF approved and have a moisture loss of not more than 0.62 kg/SQ meter per ASTM C156.
 - a) Atlas Tech Products Atlas Quantum-Cure.
 - 2) Alternately, all tank surfaces shall be sand-blasted as required to remove non-NSF approved curing compound.
- C. Curing Concrete In Contact with Forms:
- 1. Minimize moisture loss from and temperature gain of concrete placed in forms exposed to heating by sun by keeping forms wet and cool until they can be safely removed.
 - 2. After form removal, cure concrete until end of time prescribed.
 - a. Use one of methods listed above.
 - 3. Forms left in place shall not be used as a method of curing in hot weather.
 - 4. The term "hot weather," where used in these specifications, is defined in ACI 305R.
 - 5. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete.
- D. Continue curing for at least seven (7) days for all concrete except high early strength concrete for which period shall be at least three (3) days.
- 1. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is one (1) day old, provided concrete is not permitted to become surface dry during transition.
- E. Cold Weather:
- 1. Follow recommendations of ACI 306R.

2. Maintain temperature of concrete between 50 and 70 DegF for required curing period, when outdoor temperature is 40 DegF, or less.
3. Use heating, covering, insulating, or housing of the concrete work to maintain required temperature without injury due to concentration of heat.
4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.

F. Hot Weather:

1. Follow recommendations of ACI 305R.
2. Make provision for cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.

G. Rate of Temperature Change:

1. Keep changes in temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing period.
2. Do not exceed a temperature change of 5 DegF in any 1 HR or 50 DegF in any 24 HR period.

H. Protection from Mechanical Injury:

1. Protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
3. Do not load self-supporting structures in such a way as to overstress concrete.

3.8 FIELD QUALITY CONTROL

A. Tests in accordance with Specification Section 03 05 05 – Testing.

1. Perform a strength test on all concrete to which water or superplasticizer, above the amount stated in the approved concrete mix design, has been added.
 - a. Perform sampling after water or superplasticizer has been added and additional mixing has been performed.

- B. Field samples of fabricated waterstop fittings (crosses, tees, etc.) will be selected at random by the Owner's representative for testing by a laboratory at the Owner's expense.
 - 1. When tested, they shall have a tensile strength across the joints equal to at least 600 psi.

3.9 OWNER TRAINING (NOT USE)

END OF SECTION

SECTION 31 21 33

TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavation, trenching, backfilling and compacting for all underground utilities.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost for installed underground piping, sewer, conduit or ductwork.
- B. No additional payment will be made for performing Critical Location exploratory excavation. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
 - a. C40 – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
 - b. C94 – Standard Specification for Ready-Mixed Concrete.
 - c. C123 – Standard Test Method for Lightweight Particles in Aggregate.
 - d. C131 – Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - e. C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - f. C142 – Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
 - g. D558 – Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures.
 - h. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - i. D1140 – Standard Test Methods for Amount of Material in Soils Finer than No. 200 Sieve.
 - j. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-

m/m³)).

- k. D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - l. D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - m. D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - n. D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - o. D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- 2. Texas Department of Transportation (TxDOT):
 - a. Tex-101-E – Preparing Soil and Flexible Base Materials for Testing.
 - b. Tex-110-E – Particle Size Analysis of Soils.
 - c. Tex-460-A – Determining Crushed Face Particle Count.
 - 3. Occupational Safety and Health Administration (OSHA):
 - a. Federal Regulations – 29 CFR Part 1926,
 - 4. AWWA Standards – Excavation:
 - a. AWWA M9 – Concrete Pressure Pipe
 - b. AWWA M11 – Steel Water Pipe
- B. Qualifications:
- 1. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by the Owner.
 - 2. Contractor shall provide licensed professional engineer licensed in Texas for design of trench shoring systems or other trench safety plans.

1.4 DEFINITIONS

- A. Classification of Excavation: Excavation shall be "unclassified" and involves the removing of the necessary materials to provide the trench to the required width and depth. The Contractor, prior to submitting a proposal, must satisfy himself as to the actual subsurface conditions. No extra or separate payments shall be made for rock, dewatering, or any other condition.

1.5 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit backfill material sources and product quality information in accordance with requirements of this section.

2. Submit sieve analysis reports on all granular materials.
3. Certified Test Reports for embedment material, coarse gravel, and flexbase. Certified Test Reports shall be from an independent laboratory. Test reports shall include sieve analysis, Atterburg limits, and results of an Abrasion test.

SITE CONDITIONS

- A. Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving.
 1. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property owners.
- B. Provide full access to public and private premises and fire hydrants, at street crossings, sidewalks and other points as designated by Owner's Representative to prevent serious interruption of travel.
- C. Protect and maintain bench marks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of Owner's Representative and controlling agency.
- D. Protection of Existing Structures and Utilities
 1. The Contractor shall advise the Owner's Representative of any existing utilities that are not shown on the Drawings, or are shown incorrectly, that affect the {pipe}{structure} layout. Contractor shall also propose a resolution to the utility conflict for the Owner's Representative's review. The Owner's Representative will determine whether the utility will be relocated or the proposed {pipeline}{structure} location revised. If the {pipeline}{structure} location is revised, an adjustment to the Contract price will be agreed to as described in the General Conditions. If the proposed {pipe}{structure} grade is adjusted by 2 vertical feet or less, no Contract Price adjustment will be made. If the proposed {pipe}{structure} grade is adjusted by more than 2 vertical feet, a Contract Price adjustment will be agreed to as described in the General Conditions.
 2. Utilities that affect the {pipe}{structure} layout will be interpreted by the Owner's Representative as follows:
 - a. Utilities that conflict with the grade of the proposed {pipe}{structure} will be interpreted as affecting the {pipe}{structure} layout.
 - b. Utilities that conflict with the operations and maintenance of the proposed {pipe}{structure} will be interpreted as affecting the {pipe}{structure} layout.
- E. Where excavation endangers adjacent structures and utilities, the Contractor shall, at his own expense, carefully support and protect such structures and/or utilities so that there shall be no damage. In the case where the structure cannot be protected and must be temporarily or permanently relocated, Contractor will be compensated for actual cost only once approved by the Owner's Representative.

- F. If in the opinion of the Owner's Representative, concrete backfill is necessary for the support of utility lines crossing trenches, the Owner's Representative may direct 2000 psi concrete backfill to be used. Payment shall be made to the Contractor at the unit price bid for the installation of such quantity of the concrete backfill as directed by the Owner's Representative.

1.7 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 MATERIAL CLASSIFICATIONS

- A. Classify materials for backfill for purpose of quality control in accordance with Unified Soil Classification Symbols as defined in ASTM D 2487. Material use and application is defined in utility installation specifications and Drawings either by class, as described in Paragraph 2.01B, or by product descriptions, as given in Paragraph 2.02.
- B. Class Designations Based on Laboratory Testing:
1. Class I: Well-graded gravels and sands, gravel-sand mixtures, crushed well-graded rock, little or no fines (GW, SW):
 - a. Plasticity index: non-plastic.
 - b. Gradation: D_{60}/D_{10} - greater than 4 percent; amount passing No. 200 sieve - less than or equal to 5 percent.
 2. Class II: Poorly graded gravels and sands, silty gravels and sands, little to moderate fines (GM, GP, SP, SM):
 - a. Plasticity index: non-plastic to 4.
 - b. Gradations:
 - 1) Gradation (GP, SP): amount passing No. 200 sieve - less than 5 percent.
 - 2) Gradation (GM, SM): amount passing No. 200 sieve - between 12 percent and 50 percent.
 - 3) Borderline gradations with dual classifications (e.g., SP-SM): amount passing No. 200 sieve - between 5 percent and 12 percent.
 3. Class III: Clayey gravels and sands, poorly graded mixtures of gravel, sand, silt, and clay (GC, SC, and dual classifications, e.g., SP-SC):
 - a. Plasticity index: greater than 7.
 - b. Gradation: amount passing No. 200 sieve - between 12 percent and 50 percent.
 4. Class IVA: Lean clays (CL).
 - a. Plasticity Indexes:

- 1) Plasticity index: greater than 7, and above A line.
- 2) Borderline plasticity with dual classifications (CL-ML): PI between 4 and 7.
- b. Liquid limit: less than 50.
- c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
- d. Inorganic.
5. Class IVB: Fat clays (CH).
 - a. Plasticity index: above A line.
 - b. Liquid limit: 50 or greater.
 - c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
 - d. Inorganic.
6. Use soils with dual class designation according to ASTM D 2487, and which are not defined above, according to more restrictive class.

2.2 MATERIALS

- A. Soils classified as silt (ML), elastic silt (MH), organic clay and organic silt (OL, OH), and organic matter (PT) are not acceptable as backfill materials.
 1. These soils may be used for site grading and restoration in unimproved areas as approved by the Owner's representative.
 2. Soils in Class IVB, fat clay (CH) may only be used as backfill materials outside of roadways and where otherwise allowed by this Specification Section.
- B. Provide backfill material that is free of stones greater than 2 IN, free of roots, waste, debris, trash, organic material, unstable material, non-soil matter, hydrocarbon or other contamination, conforming to the following limits for deleterious materials:
 1. Clay lumps: Less than 0.5 percent for Class I, and less than 2.0 percent for Class II, when tested in accordance with ASTM C142.
 2. Lightweight pieces: Less than 5 percent when tested in accordance with ASTM C123.
 3. Organic impurities: No color darker than standard color when tested in accordance with ASTM C40.
 4. Clay Clods: Less than 4 inches in least dimension.
- C. Manufactured materials, such as crushed concrete, may be substituted for natural soil or rock products where indicated in the product specification, and approved by the Owner's representative, provided that the physical property criteria are determined to be satisfactory by testing.

- D. Bank Run Sand: Durable bank run sand classified as SP, or SW by the Unified Soil Classification System (ASTM D2487) meeting the following requirements:
1. Less than 15 percent passing the number 200 sieve when tested in accordance with ASTM D 1140.
 - a. The amount of clay lumps or balls not exceeding 2 percent.
 2. Material passing the number 40 sieve shall meet the following requirements when tested in accordance with ASTM D4318:
 - a. Liquid limit: not exceeding 25 percent.
 - b. Plasticity index: not exceeding 7.

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- E. Concrete Sand: Natural sand, manufactured sand, or a combination of natural and manufactured sand conforming to the requirements of ASTM C33 and graded within the following limits when tested in accordance with ASTM C136:

Sieve	Percent Passing
3/8 IN	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

- F. Gem Sand: Sand conforming to the requirements of ASTM C33 for course aggregates specified for number 8 size and graded within the following limits when tested in accordance with ASTM C136:

Sieve	Percent Passing
3/8 IN	95 to 100
No. 4	60 to 80
No. 8	15 to 40

- G. Pea Gravel: Durable particles composed of angular gravels and graded within the following limits when tested in accordance with ASTM C136:

Sieve	Percent Passing
1/2 IN	100
3/8 IN	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

- H. Crushed Aggregates: Crushed aggregates consist of durable particles obtained from an approved source and meeting the following requirements:

1. Materials of one product delivered for the same construction activity from a single source.
2. Non-plastic fines.
3. Los Angeles abrasion test wear not exceeding 45 percent when tested in accordance with ASTM C131.
4. Crushed aggregate shall have a minimum of 90 percent of the particles retained on the No. 4 sieve with 2 or more crushed faces as determined by Test Method TxDOT Tex-460-A, Part I.

5. Crushed stone:

- a. Produced from oversize plant processed stone or gravel, sized by crushing to predominantly angular particles from a naturally occurring single source.
- b. Uncrushed gravel are not acceptable materials for embedment where crushed stone is shown on the applicable utility embedment drawing details.
- c. Where coarse gravel is required for water drainage, restoration of trench foundation, or other uses, it shall be crushed stone in compliance with ASTM C33 for Coarse Concrete Aggregate. Gradation shall be ASTM C33 No. 57, No. 67, or as follows:

Sieve Size Sq. Openings	Amount Passing Percent by Weight
1"	95-100
3/4"	55-85
1/2"	25-50
No. 4	0-5

6. Crushed Concrete:

- a. The Owner's Representative will make a determination as to whether crushed concrete can be allowed and what the acceptable gradation is.
- b. Gradation and quality control test requirements are the same as crushed stone.
- c. Provide crushed concrete produced from normal weight concrete of uniform quality; containing particles of aggregate and cement material, free from other substances such as asphalt, reinforcing steel fragments, soil, waste gypsum (calcium sulfate), or debris.

7. Gradations, as determined in accordance with TxDOT Tex-110-E.

Sieve	Percent Passing by Weight for Pipe Embedment by Ranges of Nominal Pipes Sizes		
	>15 IN	15 IN - 8 IN	<8 IN
1 IN	95 - 100	100	-
3/4 IN	60 - 90	90 - 100	100
1/2 IN	25 - 60	-	90 - 100
3/8 IN	-	20 - 55	40 - 70
No. 4	0 - 5	0 - 10	0 - 15
No. 8	-	0 - 5	0 - 5

- I. Select Backfill: Class III clayey gravel or sand or Class IV lean clay with a plasticity index between 7 and 20 or clayey soils treated with lime to meet plasticity criteria.
- J. Native Backfill: Any suitable soil or mixture of soils initially excavated during trench excavation, meeting the requirements of section 2.2 B of this Specification, and within Classes I, II, III and IV; or fat clay (CH) where allowed by this Specification Section.
- K. Cement Stabilized Sand:
 - 1. Sand-cement mixture shall produce a minimum unconfined compressive strength of at least 100 pounds per square inch in 48 hours and contain not less than 2.0 sacks of cement per ton of dry sand.
 - a. Design will be based on strength specimens molded in accordance with ASTM D558 at a moisture content within 2 percent of optimum and within 4 hours of batching.
 - b. Determine minimum cement content from production data and statistical history.
 - c. Granular material to be used as cement stabilized sand should be well graded and have the grain size characteristics as listed below:

Sieve	Percent Passing
No. 4	55 to 100
No. 10	37 to 100
No. 40	24 to 100
No. 200	10 to 20

- 2. Cement: Type I Portland cement conforming to ASTM C150.
- 3. Sand: Clean, durable sand meeting grading requirements for fine aggregates of ASTM C33, or requirements for Bank Run Sand of this Specification Section and the following requirements:
 - a. Classified as SW, SP, SW-SM, SP-SM, or SM by the United Soil Classification System of ASTM D2487.
 - b. Deleterious materials:
 - 1) Clay lumps, ASTM C142; less than 0.5 percent.
 - 2) Lightweight pieces, ASTM C123; less than 5.0 percent.
 - 3) Organic impurities, ASTM C40, color no darker than the standard color.
 - c. Plasticity index of 4 or less when tested in accordance with ASTM D4318.
 - 1) Water: Potable water, free of oils, acids, alkalies, organic matter, or other deleterious substances, meeting requirements of ASTM C94.

- L. Concrete Backfill: Conform to Class B concrete as specified in Division 03 – Concrete.
- M. Subgrade Stabilization Materials: Provide subgrade stabilization material per Specification Section 32 11 13.02 – Portland Cement Stabilized Subgrade.
- N. Granular Embedment Material: Granular embedment material may be pea gravel or bank run sand as defined in sections 2.2 G and 2.2 D, respectively. Additionally, granular embedment material shall be free from large stones, clay, and organic material. Granular embedment material shall be a soil classification of GW, GP, SW, or SP as determined by ASTM D2487. The granular embedment material shall be such that when wet, the fine material shall not form mud or muck. The granular embedment material shall be composed of angular, tough durable particles, free from thin, flat and elongated pieces, of suitable quality to insure permanence in the trench and have a percentage of wear of not more than 40 percent when tested in accordance with ASTM C131 or ASTM C535. The P.I. of the fines shall not exceed 3. Light weight aggregate is not acceptable for granular embedment. Material used for granular embedment shall have a resistivity of not less than 5000 ohms/cm as measured by ASTM G57.
- O. Well-graded Crushed Stone Bedding Material:
 - 1. ASTM C33, gradation 67 (3/4 IN to No. 4 sieve) defined below:

Sieve	Percent
1"	100
3/4"	90 to 100
3/8"	20 to 55
No. 4	0 to 10

- P. Lime Stabilized Clay Backfill.
 - 1. Clayey material hydrated lime or quicklime to achieve a pH of 12.4 and a plasticity index (PI) of less than 20 in accordance with ASTM D 4318.
 - 2. The optimum lime content to be determined by lime optimization curve using specific soil sample and proposed lime additive.
- Q. Flowable fill: Provide Flowable Fill in accordance with Specification Section 03 31 31 – Concrete Mixing, Placing, Jointing, and Curing as required.

PART 3 - EXECUTION

3.1 GENERAL

- A. Remove and dispose of unsuitable materials as directed by Owner's Representative to site provided by Contractor.

- B. Establish traffic control when working within the public right of way per applicable specifications. Maintain barricades and warning lights for streets and intersections affected by Work, and are considered hazardous to traffic movements.
- C. Perform work to conform to applicable safety standards and regulations. Employ trench safety system as designed by the Contractor's engineer licensed in the State of Texas.
- D. Immediately notify agency or company owning any existing utility line which is damaged, broken or disturbed. Obtain approval from Owner's Representative and agency for any repairs or relocations, either temporary or permanent.
- E. Maintain permanent benchmarks, monumentation and other reference points. Unless otherwise directed in writing, replace those which are damaged or destroyed.
- F. Limit pavement removal to less than five pipe laying days in advance of pipe laying.

3.2 EXCAVATION

- A. Unclassified Excavation: Remove rock excavation, clay, silt, sand, gravel, hard pan, loose shale, and loose stone to required lines and grades, or as directed by Owner's Representative.
- B. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify Owner's Representative and obtain instructions before proceeding.
- C. Excavation for Appurtenances:
 - 1. 12 IN (minimum) clear distance between outer surface and embankment.
 - 2. See Specification Section 31 23 00 – Earthwork for applicable requirements.
 - 3. See Specification Section 33 05 16 – Precast Concrete Manhole Structures for applicable requirements.
- D. Groundwater Dewatering:
 - 1. Where groundwater is, or is expected to be, encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade, to allow subgrade stabilization, pipe, bedding, embedment, and backfill material to be placed in a dry, stable trench.
 - 2. Keep dewatering system in operation until dead load of pipe, structure and backfill exceeds possible buoyant uplift force on pipe or structure.
 - 3. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
 - 4. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.
 - 5. No additional payment for groundwater dewatering.

E. Critical Location Investigation

1. The contractor shall properly locate and identify all existing utilities in proximity to the water or sewer line.

F. Protection

1. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings, and in accordance with requirements of Section 01 56 39 – Temporary Tree and Plant Protection.
2. Protect and support above-grade and below-grade utilities which are to remain.
3. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.
4. Take measures to minimize erosion of trenches. Do not allow water to pond in trenches. Where slides, washouts, settlements, or areas with loss of density or pavement failures or potholes occur, repair, recompact, and pave those areas at no additional cost to Owner.

G. Trench Excavation:

1. Excavate trenches by open cut method to depth shown on Drawings and necessary to accommodate work.
 - a. Support existing utility lines and yard piping where proposed work crosses at a lower elevation.
 - 1) Stabilize excavation to prevent undermining of existing utility and yard piping.

H. Pipe Trench:

1. The “pipe zone” shall be defined as the zone from 12 inches below the bottom of the pipe to 12 inches above the top of the pipe, unless otherwise noted on Drawings.
2. The trench walls in the pipe zone shall be vertical. Trench widths shall be as shown on the Drawings.
3. Trench walls above the pipe zone may be laid back or benched where room permits as necessary to meet the requirements of OSHA.
4. For semi-rigid pipe or flexible pipe (including AWWA C200 steel pipe, AWWA C303 bar-wrapped concrete cylinder pipe, PVC, Ductile Iron, and other pipe materials as listed in appropriate specifications), where the character of the trench walls is loose, unstable, saturated soft clays, quicksand or otherwise unable to provide adequate side support to maintain the required pipe deflection, the Contractor shall modify the backfill to keep the pipe within the limits of the specified pipe deflection.

- a. Contractor shall widen the trench excavation to accommodate modified backfill procedure.
- b. Contractor shall protect exterior pipe coating, and shall repair any damage caused by backfilling.
- c. Concrete encasement, soil cement, flowable fill or some other method approved by the Owner's Representative may be used in lieu of this procedure.

I. Pipe Foundation:

1. Excavate the trench to an even grade so that the full length of the pipe barrel is supported and joints make up properly. Excavate the trench to the line and grade indicated and as directed by the Owner's Representative. Grades shall be uniform between high points and low points to eliminate intermediate "highs and lows."
2. The trench shall be "rough cut" a minimum of 12 inches below the bottom of the pipe, unless otherwise noted on drawings. The "rough cut" dimension shall be increased as necessary to provide a minimum clearance of 2 inches from the bottom of the trench to the bottom of the bells, flanges, valves, fittings, etc.
3. The entire foundation area in the bottom of all excavations shall be firm, stable material. Loose material shall be removed, leaving a clean, flat trench bottom, and material shall not be disturbed below required sub grade except as hereinafter described. If the subgrade is soft, spongy, disintegrated, or where the character of the foundation materials is such that a proper foundation cannot be obtained at the elevation specified, then when directed by the Owner's Representative the Contractor shall deepen the excavation to a depth where a satisfactory foundation can be obtained. The subgrade shall then be brought back to the required grade with the well-graded crushed stone bedding materials and construction methods specified in section 3.3 and 3.4 of this specification. Payment for additional excavation and backfill shall be made at the unit price bid in the Proposal.
4. Remove soft, loose or spongy foundation soil caused by Contractor failure to dewater, rainfall, or Contractor operations. Replace with well-graded crushed stone bedding material, as noted above, with no additional compensation.
5. If over excavation does not yield satisfactory foundation conditions, then construct the foundation in accordance with section 3.3 J. of this specification.

J. Correcting Faulty Grade:

1. If the trench is excavated to a faulty grade (at a lower elevation than indicated), correct the faulty grade as specified below:

- a. In uniform, stable dry soils, correct the faulty grade with embedment material thoroughly compacted, as defined in sections 3.3 and 3.4 of this specification.
 - b. In soft spongy disintegrated soils or where necessary to allow proper drainage, correct the faulty grade using well-graded crushed stone bedding in accordance with section 3.3 J. of this specification.
 - c. Maximum allowable loose lift thickness for embedment or well-graded crushed stone bedding material shall be 8 inches.
- K. Pipe Clearance in Rock: Remove ledge rock, rock fragments, or unyielding shale or marl to provide a clearance of at least 12 inches below the parts of the pipe, valves or fittings. Provide adequate clearance for properly jointing pipe laid in rock trenches at bell holes. Refill the excavation to grade with embedment material.
- L. Blasting Procedure: Blasting shall not be allowed.
- M. Bell Holes Required:
- 1. Bell holes of ample dimension shall be dug in trenches at each joint of pipe to permit the jointing to be made properly, visually inspected, and so that the pipe will rest on the full length of the barrel.
 - 2. Pipe with field-applied exterior coatings shall have the joints excavated to sufficient depth to allow proper cleaning, application, testing and inspection of the field-applied coating system.
- N. Care of Surface Material for Reuse: Surface materials such as topsoil in its natural state, suitable for reuse in restoring the excavated surface, shall be kept separate from the general excavation material. The top 12 inches of the trench backfill shall be considered topsoil. Save the topsoil to be used as backfill of the top 12 inches of the trench after pipe laying.
- O. Manner of Piling Excavated Material: Place excavated material so that Work is not endangered or interferes with public traffic, or the stability of excavations and open trenches. Do not place excavated material over buried pipelines or existing utilities unless adequate provisions are made to protect those pipelines and/or utilities. Roads and driveways must be kept open in every case. Keep drainage channels clear of obstructions or make other satisfactory provisions for drainage.
- P. Trenching by Machine or by Hand: The use of trench digging machinery is approved except in places where operations of same will cause damage to existing structures above or below ground, in which case employ hand methods.

3.3 BACKFILLING OF TRENCHES OUTSIDE ROADWAYS

- A. General: This Section is intended to cover the requirements for trench backfill where trench is in open fields, unimproved alleys, fields, and other similar open areas, except public and private roadways.

- B. Time of Backfilling: Backfill operations shall immediately follow pipe jointing, joint coating application, and curing.
- C. Braced and Sheeted Trenches: Remove sheeting and shoring as backfilling operations progress. Incorporate methods so that a good bond is obtained between the backfill material and the undisturbed trench walls.
- D. Protection of Pipe during Backfilling Operations: Take the necessary precautions to protect the pipe during backfilling operations. Take care to prevent damage to the pipe or to the pipe coating, and repair any damaged pipe before being “covered up”. Backfill the trench to prevent the deformation or otherwise deflection of the cylindrical shape of the pipe by more than the allowable pipe deflection as specified elsewhere. Use methods such as stulling or ellipsing as necessary.
- E. Site and Preparation: In addition to clearing and grubbing of brush and trees along the right of way for this Project, alteration to the topography shall be done if indicated on the Drawings, at the locations and to the extent shown.
- F. Compaction: All compaction shall be in accordance with specification 3.6 of this specification. See specification section 3.6 for density and testing requirements.
- G. Backfill Procedure for {Water Lines}{Structures}:
 - 1. Embedment material for {water lines}{structures} shall granular embedment material as specified in section 2.2 N. Place the first lift of granular embedment material (bedding layer) to a depth slightly above the bottom of pipe grade and compact. Lay pipe on this material to the indicated grade. Provide bell holes to permit the pipe to rest on the full length of the barrel and to permit joint make-up.
 - 2. Place subsequent lifts of granular embedment uniformly on both sides of the pipe to a depth of 12 inches above the {pipe}{structures}. Compact using low ground pressure vibration or mechanical tamping in 6 to 8 inch loose lifts. Contractor shall take precautions to ensure no voids occur under the haunches of the pipe and to prevent disturbance of the pipe alignment. The Contractor shall be responsible for any damage that may occur to the pipe.
 - 3. Backfill above {pipe zone}{structure}:
 - a. Under unimproved areas: After placement and compaction of the granular embedment, place native backfill in the trench for the full width of the trench to the top of the trench. Consolidate this material by mechanical compaction in 6 to 8 inch loose lifts. The Contractor shall be responsible for any damage that may occur to the pipe.

- b. Under proposed paving: After placement and compaction of the granular embedment, deposit native backfill in the trench for the full width of the trench to within 3 feet of pavement subgrade then place lime stabilized clay or cement stabilized sand or Owner approved select backfill to immediately below pavement subgrade. Consolidate this material by mechanical compaction in 6 to 8 inch loose lifts. The Contractor shall be responsible for any damage that may occur to the pipe.

H. Backfill Procedure for Storm and Sanitary Lines:

- 1. Embedment material for storm and sanitary sewer lines shall cement stabilized sand as defined in section 2.2 K. Place the first lift of cement stabilized sand to the bottom of pipe grade and compact. Lay pipe on this material to the indicated grade. Provide bell holes to permit the pipe to rest on the full length of the barrel and to permit joint make-up.
- 2. Place subsequent lifts of cement stabilized sand uniformly on both sides of the pipe to 12 inches above the top of the pipe. Compact using low ground pressure vibration or mechanical tamping in 6 to 8 inch loose lifts. Contractor shall take precautions to ensure no voids occur under the haunches of the pipe and to prevent disturbance of the pipe alignment.
- 3. Backfill above pipe zone:
 - a. Under unimproved areas: Place the native material above the pipe zone in lifts not exceeding 8 inches loose depth. Mechanical compaction shall be utilized. The Contractor shall be responsible for any damage that may occur to the pipe.
 - b. Under proposed paving: Continue placement and compaction of the cement stabilized sand in the trench for the full width above. Consolidate this material by mechanical compaction in 6 to 8 inch loose lifts. The Contractor shall be responsible for any damage that may occur to the pipe.

I. Surface Material Replacement:

- 1. The top 12 inches of the trench backfill shall be composed of the original surface material or topsoil excavated from the trench. Place the topsoil over the consolidated trench backfill material and neatly round over the trench to a sufficient height to allow settlement to grade after consolidation. Grade the surface to allow drainage in the same manner as existed prior to construction.
- 2. Top soil shall not contain rocks or clods larger than those adjacent to the trench in the undisturbed condition.

J. Backfill in Wet Conditions:

- 1. If wet conditions are encountered, backfill utilities lines in accordance with details provided in the Drawings for wet trench construction.

3.4 BACKFILL PROCEDURE FOR UTILITIES UNDER EXISTING PUBLIC AND PRIVATE ROADS OR UNDER OTHER UTILITIES

- A. Compact backfill material within the pipe zone as described in 3.3.
- B. For trench excavation above the pipe zone, fill the excavation to the pavement subgrade with cement stabilized sand compacted to 95 percent standard density at plus 2 to minus 1 percent optimum moisture in maximum 6 to 8 inch lifts.

3.5 TRENCH SHORING AND BACKFILL

- A. Shoring of Trench Walls.
 - 1. Install Special Shoring in advance of trench excavation or simultaneously with trench excavation, so that soils within full height of trench excavation walls will remain laterally supported at all times.
 - 2. For all types of shoring, support trench walls in pipe embedment zone throughout installation. Provide trench wall supports sufficiently tight to prevent washing trench wall soil out from behind trench wall support.
 - 3. Leave sheeting driven into or below pipe embedment zone in place to preclude loss of support of foundation and embedment materials, unless otherwise directed by Owner's Representative. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and trench wall in vicinity of pipe zone.
 - 4. Employ special methods for maintaining integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.
 - 5. If sheeting or other shoring is used below top of pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into embedment zone shall be equivalent of 1-inch-thick steel plate. As sheeting is removed, fill in voids left with grouting material.
- B. Use of Trench Shields. When trench shield (trench box) is used as worker safety device, the following requirements apply:
 - 1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to trench sidewalls.
 - 2. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged nor disturbed, nor degree of compaction reduced. Recompect after shield is moved if soil is disturbed.

3. When required, place, spread, and compact pipe foundation and bedding materials beneath shield. For backfill above bedding, lift shield as each layer of backfill is placed and spread. Place and compact backfill materials against undisturbed trench walls and foundation.
 4. Maintain trench shield in position to allow sampling and testing to be performed in safe manner.
 5. Conform to applicable Government regulations.
- C. Voids under paving area outside shield caused by Contractor's work will require removal of pavement, consolidation and replacement of pavement in accordance with Contract Documents. Repair damage resulting from failure to provide adequate supports.
- D. Place sand or soil behind shoring or trench shield to prevent soil outside shoring from collapsing and causing voids under pavement. Immediately pack suitable material in outside voids following excavation to avoid caving of trench walls.
- E. Coordinate excavation within 15 feet of pipeline with company's representative. Support pipeline with methods agreed to by pipeline company's representative. Use small, rubber-tired excavator, such as backhoe, to do exploratory excavation. Bucket that is used to dig in close proximity to pipelines shall not have teeth or shall have guard installed over teeth to approximate bucket without teeth. Excavate by hand within 1 foot of pipeline company's line. Do not use larger excavation equipment than normally used to dig trench in vicinity of pipeline until pipelines have been uncovered and fully exposed. Do not place large excavation and hauling equipment directly over pipelines unless approved by pipeline company's representative.

3.6 COMPACTION

A. General:

1. Place and assure bedding, backfill, and fill materials achieve an equal or higher degree of compaction than undisturbed materials adjacent to the work.
2. In no case shall degree of compaction below minimum compactions specified be accepted.

B. Compaction Requirements:

1. Unless noted otherwise on Drawings or more stringently by other Specification Sections, comply with following minimum trench compaction criteria.

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LOCATION	MATERIAL	COMPACTION DENSITY
All applicable areas	Bank sand	95 percent of standard proctor density, +2 to -1% optimum density, by ASTM D698 and ASTM D2922
	Pea gravel	95 percent of maximum relative density by ASTM D4253 and ASTM D4254
	Well-graded crushed stone	95 percent of maximum relative density by ASTM D4253 and ASTM D4254
	Native backfill	95 percent of standard proctor density, +2 to -1% optimum density, by ASTM D698 and ASTM D2922
	Cement stabilized sand	95 percent of standard proctor density, +2 to -1% optimum density, by ASTM D558 and ASTM D2992

3.7 FIELD QUALITY CONTROL

A. Testing:

1. In-place density tests of compacted materials will be performed by Owner's Representative according to the standards provided in section 3.6, and at the following frequencies and conditions.
2. Owner will provide a recognized testing laboratory capable of performing a full range of testing procedures complying with the standards or testing procedures specified. The testing lab shall provide certified technicians that are trained and knowledgeable in, in-trench nuclear density testing, sand cone, concrete sampling and testing, ASTM D698 and D1557 proctors at a minimum.
3. Testing Frequency: Accommodate the Owner's Representative in performing the following:
 - a. Owner's Representative shall take a minimum of three in-trench/pipe zone nuclear density test and a minimum of three above pipe zone nuclear density test at all open cut road crossings.
4. Special care should be taken by the Contractor to ensure the backfill material flows under the pipe haunches. The Contractor's method and procedures used to accomplish this will be observed to confirm that adequate results are being achieved. This may require the removal of pipe joints to observe the results and make density tests. Pipe laying shall not begin until satisfactory results are achieved by the Contractor's proposed method. Perform additional tests as directed until compaction meets or exceeds requirements.
 - a. Cost associated with "Failing" tests shall be paid by Contractor.
5. Assure Owner's representative has immediate access for testing of all soils related work.
6. Ensure excavations are safe for testing personnel.

3.8 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 31 23 23.33

FLOWABLE FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

- a. Furnish labor, materials, equipment, and incidentals necessary to place and mix a flowable mortar fill consisting of Portland cement, fine aggregate, fly ash, and water in the proper proportions as specified within this specification. Controlled Low-Strength Material (Flowable Fill) shall be used to bed and backfill around piping and utilities where indicated.

B. Related Specification Sections include, but are not necessarily limited to:

1. Section 03 05 05 – Testing.
2. Section 03 31 30 Concrete, Materials and Proportioning.
3. Section 31 21 33 – Trenching Backfilling and Compacting for Utilities.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
 - a. C 31 – Making and Curing Concrete Test Specimens in the field.
 - b. C 33 – Standard Specification for Concrete Aggregates (Fine Aggregate).
 - c. C 39 – Compressive Strength of Cylindrical Concrete Specimens.
 - d. C 40 – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
 - e. C 94 – Ready-Mixed Concrete.
 - f. C 150 – Standard Specification for Portland Cement.
 - g. C 192 – Making and Curing Concrete Test Specimens in the Laboratory.
 - h. C 292 – Air-Entraining Admixtures for Concrete.
 - i. C 494 – Chemical Admixtures for Concrete.
 - j. C 618 – Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as Mineral Admixture in Portland Cement Concrete.
 - k. C 4318 – Liquid Limit, Plastic Limit and Plasticity Index of Soils.
2. Corps of Engineers (COE):

- a. CRD-C611 – Test Method for Flow of Grout Mixtures (Flow-Cone Method)
- B. Factory Testing: The Contractor shall be responsible for the design of the material. A trial mix shall be designed by an independent testing laboratory, retained by the Contractor. The testing laboratory shall submit verification that the materials and proportions of the trial mix design meet the requirement given in the specifications. Concrete mix additives such as “Darafill” manufactured by Grace Construction Products or approved equal products may be required to achieve the minimum strength and flowability requirements. In lieu of trial mix design, Contractor may submit a mix design used successfully in previous similar work, for similar applications, for approval by Principal Architect/Engineer. The Contractor shall not make changes in materials, either in gradation, source, or brand, or proportions of the mixture after having been approved, except by specific approval of the Principal Architect/Engineer.
- C. Owner Testing: It is the responsibility of the Contractor to achieve and maintain the quality of material required by this Section of the specifications. However, the Owner may secure the services of an independent testing laboratory to verify the quality of the material. The Owner shall have the right to require additional testing, strengthening, or replacement of material which has failed to meet the minimum requirements of this Section.

1.4 SUBMITTALS

- A. Submit a copy of delivery tickets accompanied by batch tickets to Owner’s Representative at the time of delivery.

1.5 DESIGN REQUIREMENTS

- A. Design Criteria; Concrete Proportions and Consistency:
 - 1. Concrete shall be proportioned to provide necessary workability and strength and shall conform to the following governing requirements:

28-Day Compressive Strength-psi	Min. Cement Pounds Per Cu. Yd.	Fine Aggregate Pounds Per Cu. Yd.	Max. Water Pounds Per Cu. Yd.	Max. Fly Ash Pounds per Cu. Yd.
100-150	50	2720	290	150

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cement: Portland cement conforming to the specifications and test for Type I Portland cement of the American Society for Testing and Materials, Designation C150 (ASTM C150).

- B. Fine Aggregate: Fine aggregate consisting of natural, washed and screened sand having clean, hard, strong, durable, uncoated grains complying with the requirements for ASTM C33. The sand shall generally be of such size that 100 percent will pass a 3/8-inch sieve, at least 95 percent will pass a 1/4-inch sieve, at least 80 percent will pass a No. 8 sieve, and 0 – 10 percent will pass a No. 200 sieve. Aggregate shall not contain strong alkali, or organic material which gives a color darker than the standard color when tested in accordance with ASTM C40.
- C. Fly Ash/Pozzolans: Fly ash shall be an ASTM C618, Class “C” fly ash. The fly ash may be used in controlled low-strength material.
- D. Water: Water for material shall be clean and free from oil, acid, alkali, organic matter, or other harmful impurities. Water which is suitable for drinking or for ordinary household use will be acceptable for material. Where available, water shall be obtained from mains of a waterworks system.
- E. Additives: As required to meet specification requirements:
 - 1. “Darafill” by Grace Construction Products.
 - 2. Rheocell Rheofill by BASF The Chemical Company.
 - 3. Sika Lightcrete Powder by Sika Corporation.
 - 4. Or approved equal.

2.2 MIXES

- A. In the determination of the amount of water required for mix, consideration shall be given to the moisture content of the aggregate. The net amount of water in the mix will be the amount added at the mixer; plus the free water in the aggregate; and minus the absorption of the aggregate, based on a 30 minute absorption period. No water allowance shall be made for evaporation after batching.
- B. The methods of measurement of materials shall be such that the proportions of water to cement can be closely controlled during the progress of the work and easily checked at any time by the Owner’s Representative. To avoid unnecessary or haphazard changes in consistency, the aggregate shall be obtained from sources which will ensure a uniform quality and grading during any single day’s operation, and shall be delivered to the work and handled in such a manner that the variation in moisture content will not interfere with the steady production of concrete of reasonable degree of uniformity. Sources of supply shall be approved by the Owner’s Representative.
- C. The proportions of the mix shall be such as to produce material that can be placed readily into the void area without spading or vibrating, and without segregation or undue accumulation of water or laitance of the surface.
- D. When additive is contained in the mixture, the additive ingredients, proportions, and placement of the additive shall be per manufacturer’s recommendations.

PART 3 - EXECUTION

3.1 PLACING

- A. Contractor shall give the Owner's Representative sufficient advance notice before starting to place material in any area, to permit inspection of the area, and preparation for pouring.
- B. Conduct the operation of depositing the material so as to form a compact, dense, impervious mass.
- C. Flowable fill shall be uniformly placed to the depth shown on the plans. The fill shall be brought up uniformly to the top of excavation elevation. Placement of flowable fill shall then cease and the fill protected from traffic for a period of 72 hours.
- D. The material shall be placed against undisturbed soil.
- E. Material shall be placed in a manner to prevent pipe flotation. If multiple lifts are used, material shall be allowed to harden before placing next lift.

3.2 FIELD QUALITY CONTROL

- A. Perform concrete tests per Specification Section 03 05 05 – Testing.
- B. Perform strength test on any concrete to which water has been added at the jobsite.

3.3 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 31 32 13.16

CEMENT STABILIZED SAND

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cement Stabilized Sand

1.2 MEASUREMENT AND PAYMENT

A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 REFERENCES

- A. C 33 – Standard Specification for Concrete Aggregates (Fine Aggregate).
- B. C 40 – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
- C. C 42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
- D. C 94 – Standard Specification for Ready-Mixed Concrete.
- E. C 123 – Standard Test Method for Lightweight Particles in Aggregate.
- F. C 142 – Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
- G. C 150 – Specification for Portland Cement.
- H. D 558 – Standard Test Method for Moisture-Density (Unit Weight) Relations of Soil Cement-Mixtures.
- I. D 1632 – Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory.
- J. D 1633 – Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders.
- K. D 2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- L. D 6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- M. D 3665 – Standard Practice for Random Sampling of Construction Materials.
- N. D 4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01 33 00 – Submittals.
- B. Submit proposed target cement content and production data for sand-cement mixture in accordance with requirements of Paragraph 2.3, Materials Qualifications.

1.5 DESIGN REQUIREMENTS

- A. Use sand-cement mixture producing minimum unconfined compressive strength of 100 pounds per square inch (psi) in 48 hours containing no less than 2.5 sacks of cement per cubic yard of mixture.
 - 1. Where potable water lines cross wastewater lines, embed wastewater line with cement stabilized sand in accordance with Texas Administrative Code §290.44(e)(4)(B):
 - a. Provide minimum of 10% cement per cubic yard of cement stabilized sand mixture, based on loose dry weight volume. Use at least 2.5 sacks of cement per cubic yard of mixture (2 sacks per ton of dry sand).
 - b. Unless otherwise shown on Drawings, embed wastewater main or lateral minimum of six inches above and below.
 - c. Use brown coloring in cement stabilized sand for wastewater main or lateral bedding for identification of pressure rated wastewater mains during future construction.
- B. Design will be based on strength specimens molded in accordance with ASTM D558 at moisture content within 3 percent of optimum and within 4 hours of batching.

1.6 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cement: Type I Portland cement conforming to ASTM C 150.
- B. Sand: Clean, durable sand meeting grading requirements for fine aggregates of ASTM C 33, or requirements for bank run sand of Section 31 23 33 – Trenching, Backfilling, and Compacting for Utilities, and the following requirements:
 - 1. Classified as SW, SP, SW-SM, SP-SM, or SM by United Soil Classification System of ASTM D 2487.
 - 2. Deleterious materials:
 - a. Clay lumps, ASTM C 142; less than 0.5 percent.
 - b. Lightweight pieces, ASTM C 123; less than 5.0 percent.

- c. Organic impurities, ASTM C 40, color no darker than standard color.
- 3. Plasticity index of 4 or less when tested in accordance with ASTM D 4318.
- C. Water: Potable water, free of oils, acids, alkalis, organic matter or other deleterious substances, meeting requirements of ASTM C 94.

2.2 MIXING MATERIALS

- A. Add required amount of water and mix thoroughly in pugmill-type mixer.
- B. Stamp batch ticket at plant with time of loading. Reject material not placed and compacted within 4 hours after mixing.

2.3 MATERIAL QUALIFICATION

- A. Determine target cement content of material as follows:
 - 1. Obtain samples of sand-cement mixtures at production facility representing range of cement content consisting of at least three points.
 - 2. Complete molding of samples within 4 hours after addition of water.
 - 3. Perform strength tests (average of two specimens) at 48 hours and 7 days.
 - 4. Perform cement content tests on each sample.
 - 5. Perform moisture content tests on each sample.
 - 6. Plot average 48-hour strength vs. cement content.
 - 7. Record scale calibration date, sample date, sample time, molding time, cement feed dial settings, and silo pressure (if applicable).
- B. Test raw sand for following properties at point of entry into pug-mill:
 - 1. Gradation
 - 2. Plasticity index
 - 3. Organic impurities
 - 4. Clay lumps and friable particles
 - 5. Lightweight pieces
 - 6. Moisture content
 - 7. Classification
- C. Present data obtained in format similar to that provided in sample data form attached to this Section.
- D. The target content may be adjusted when statistical history so indicates. For determination of minimum product performance use formula:

$f'_c + \frac{1}{2}$ standard deviation

PART 3 - EXECUTION

3.1 PLACING

- A. Place sand-cement mixture in maximum 8-inch-thick loose lifts and compact to 95 percent of maximum density as determined in accordance with ASTM D 558, unless otherwise specified. Refer to related specifications for thickness of lifts in other applications. Target moisture content during compaction is ± 3 percent of optimum. Perform and complete compaction of sand-cement mixture within 4 hours after addition of water to mix at plant.
- B. Do not place or compact sand-cement mixture in standing or free water.

3.2 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01 45 29 – Testing Laboratory Services.
- B. One sample of cement stabilized sand shall be obtained for each 150 tons of material placed per day with no less than one sample per day of production. Random samples of delivered cement stabilized sand shall be taken in the field at point of delivery in accordance with ASTM 3665. Obtain three individual samples of approximately 12 to 15 pounds each from the first, middle, and last third of the truck and composite them into one sample for test purposes.
- C. Prepare and mold four specimens (for each sample obtained) in accordance with ASTM D 558, Method A, without adjusting moisture content. Samples will be molded at approximately same time material is being used, but no later than 4 hours after water is added to mix.
- D. After molding, specimens will be removed from molds and cured in accordance with ASTM D 1632.
- E. Specimens will be tested for compressive strength in accordance with ASTM D 1633, Method A. Two specimens will be tested at 48 hours plus or minus 2 hours and two specimens will be tested at 7 days plus or minus 4 hours.
- F. A strength test will be average of strengths of two specimens molded from same sample of material and tested at same age. Average daily strength will be average of strengths of all specimens molded during one day's production and tested at same age.
- G. Precision and Bias: Test results shall meet recommended guideline for precision in ASTM D 1633 Section 9.
- H. Reporting: Test reports shall contain, as a minimum, the following information:

1. Supplier and plant number
2. Time material was batched
3. Time material was sampled
4. Test age (exact hours)
5. Average 48-hour strength
6. Average 7-day strength
7. Specification section number
8. Indication of compliance/non-compliance
9. Mixture identification
10. Truck and ticket numbers
11. The time of molding
12. Moisture content at time of molding
13. Required strength
14. Test method designations
15. Compressive strength data as required by ASTM D 1633
16. Supplier Mixture identification
17. Specimen diameter and height, in.
18. Specimen cross-sectional area, sq. in.

3.3 ACCEPTANCE

- A. Strength level of material will be considered satisfactory if:
 1. The average 48-hour strength is greater than 100 psi with no individual strength test below 70 psi.
 2. All 7-day individual strength tests (average of two specimens) are greater than or equal to 100 psi.
- B. Material will be considered deficient when 7-day individual strength test (average of two specimens) is less than 100 psi, but greater than 70 psi. See Paragraph 3.4 Adjustment for Deficient Strength.
- C. The material will be considered unacceptable and subject to removal and replacement at Contractor's expense when individual strength test (average of two specimens) have 7-day strength less than 70 psi.
- D. When moving average of three daily 48-hour averages falls below 100 psi, discontinue shipment to project until plant is capable of producing material, which exceeds 100 psi at 48 hours. Five, 48-hour strength tests shall be made in this determination with no individual strength tests less than 100 psi.

- E. Testing laboratory shall notify Contractor, Owner's Representative, and material supplier by facsimile of tests indicating results falling below specified strength requirements within 24 hours.
- F. If any strength test of laboratory cured specimen falls below the specified strength, Contractor may, at his own expense, request test of cores drilled from the area in question in accordance with ASTM C42. In such cases, three (3) cores shall be taken for each strength test that falls below the values given in 3.3A.
- G. Cement stabilized sand in an area represented by core tests shall be considered satisfactory if the average of three (3) cores is equal to at least 100 psi and if no single core is less than 70 psi. Additional testing of cores extracted from locations represented by erratic core strength results will be permitted.

3.4 ADJUSTMENT FOR DEFICIENT STRENGTH

- A. When mixture produces 7-day compressive strength greater than or equal 100 pounds per square inch, then material will be considered satisfactory and bid price will be paid in full.
- B. When mixture produces 7-day compressive strength less than 100 pounds per square inch and greater than or equal to 70 pounds per square inch, material shall be accepted contingent on credit in payment. Compute credit by the following formula:

$$\text{Credit per Cubic Yard} = \frac{\$30.00 \times 2 (100 \text{ psi} - \text{Actual psi})}{100}$$

When mixture produces 7-day compressive strength less than 70 pounds per square inch, then remove and replace cement-sand mixture and paving and other necessary work at no cost to the Owner.

3.5 WARRANTY (NOT USED)

END OF SECTION

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SECTION 31 41 00
TRENCH SAFETY SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Trench safety system for construction of trench excavations. For structural excavations which fall under provisions of State and Federal trench safety laws.

1.2 MEASUREMENT AND PAYMENT

A. Unit Price

1. If noted on the Bid Form, measurement for trench safety systems used on trench excavations is on a per linear foot basis measured along centerline of trench, including manholes and other line structures.
2. No payment will be made for Trench Safety Systems for structural excavations, tunnel shafts, auger pits, or excavation for trenchless installations under this section. Include payment for Trench Safety Systems in applicable structural or utility installation sections.

1.3 DEFINITIONS

- A. Trench. Narrow excavation (in relation to its depth) made below surface of ground. In general, depth is greater than width, but width of trench (measured at bottom) is not greater than 15 feet.
- B. Trench safety system requirements shall apply to larger open excavations if erection of structures or other installations limits space between excavation slope and installation to dimensions equivalent of a trench as defined.
- C. Trench safety systems include, but are not limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage. Trench safety system is Contractor's methods and means of construction.
- D. Trench Safety Program is the safety procedures governing the presence and activities of individuals working in and around trench excavations.

1.4 SUBMITTALS

- A. Trench safety system and special designs containing deviations from OSHA standards to be sealed by a Professional Engineer registered by State of Texas.

- B. Review of trench safety system by Owner's Representative shall only be in regards to compliance with this specification and shall not constitute approval by Owner's Representative nor relieve Contractor of obligations under State and Federal trench safety laws
- C. Submit certification that trench safety system will not be subjected to loads exceeding those which the system was designed to withstand according to the available construction and geotechnical information. When trench box is used in a manner other than what is indicated and certified in manufacturer's technical data, submit trench box manufacturer certifications of proposed usage.

1.5 REGULATORY REQUIREMENTS

- A. Install and maintain trench safety systems in accordance with detail specifications set out in provision of Excavations, Trenching, and Shoring, Federal Occupation Safety and Health Administration (OSHA) Standards, 29CFR, Part 1926, Subpart P, as amended, including Final Rule, published in Federal Register Vol. 54, No. 209 on October 31, 1989. Sections that are incorporated into these specifications by reference include Sections 1926-650 through 1926-652.
- B. Reproduction of OSHA standards included in "Subpart P - Excavations" from Federal Register Vol. 54, No. 209 is available upon request to Contractors bidding on projects. The Owner assumes no responsibility for accuracy of reproduction. Obtain copy of this section of the Federal Register.
- C. Legislation enacted by Texas Legislature with regard to Trench Safety Systems, is hereby incorporated, by reference, into these specifications. Refer to Texas Health and Safety Code Ann., §756.021 (Vernon 1991).

1.6 INDEMNIFICATION

- A. Contractor to indemnify and hold harmless the Owner and the Owner's Representative, its employees and agents, from any and all damages, costs (including, without limitation, legal fees, court costs, and cost of investigation), judgments or claims by anyone for injury or death of persons resulting from collapse or failure of trenches constructed under this Contract.
- B. Contractor acknowledges and agrees that this indemnity provision provides indemnity for the Owner and the Owner's Representative, its employees and agents, in case the Owner and the Owner's Representative is negligent either by act or omission in providing for trench safety, including, but not limited to safety program and design reviews, inspections, failures to issue stop work orders, and hiring of Contractor.

1.7 WARRANTY (NOT USED)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and maintain trench safety systems in accordance with provisions of OSHA 29 CFR.
- B. Install specially designed trench safety systems in accordance with Contractor's trench excavation safety program for locations and conditions identified in program.
- C. A competent person, as identified in Contractor's Trench Safety Program, to verify that trench boxes and other pre-manufactured systems are certified for actual installation conditions.

3.2 INSPECTION

- A. Contractor, or Contractor's independently retained consultant, to make daily inspections of trench safety systems to ensure that installed systems and operations meet OSHA 29 CFR and other personnel protection regulations requirements.
- B. If evidence of possible cave-ins or slides is apparent, immediately stop work in trench and move personnel to safe locations until necessary precautions have been taken to safeguard personnel entering trench.
- C. Maintain permanent record of daily inspections.

3.3 FIELD QUALITY CONTROL

- A. Verify specific applicability of selected or specially designed trench safety systems to each field condition encountered on project.

3.4 OWNER TRAINING (NOT USED)

END OF SECTION

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SECTION 32 12 16

ASPHALTIC CONCRETE VEHICULAR PAVEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Asphaltic concrete vehicular paving.

1.2 MEASUREMENT AND PAYMENT

A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. Federal Specifications (FS):
 - a. TT-P-115F, Paint, Traffic (Highway, White and Yellow).

B. Miscellaneous:

1. Should conflicts arise between standard specifications of government agencies mentioned herein and Contract Documents, Contract Documents shall govern.

1.4 SUBMITTALS

A. Shop Drawings:

1. Asphalt design mix.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Asphaltic Concrete:

1. TxDOT Specification – Item 300 Asphalts, Oils, & Emulsions
2. TxDOT Specification – Item 310 Prime Coat
3. TxDOT Specification – Item 340 Dense Graded Hot-Mix Asphalt.
4. TxDOT Specification – Item 247 Flexible Base

B. Line Paint:

1. Nonreflective.
2. White.
3. FS TT-P-115F.

4. Refer to Specification Section 09 91 00 – Painting and Protective Coatings.

2.2 MIXES

- A. Comply with mix design category per TxDOT Specification – Item 340, Dense Graded Hot-Mix Asphalt.
 1. Fine-Graded Surface Course, Type D

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Construct to line, grade and section as shown on Drawings and in accordance with referenced State and Federal Specifications.
- B. Install base course in accordance with TxDOT Specification – Item 247, Flexible Base, and drawings.
- C. Spread a prime coat uniformly on compacted aggregate base course at rate of 0.25 to 0.35 GAL per square yard in accordance with TxDOT Specification – Item 310, Prime Coat.
- D. Install Tack Coat in accordance with TxDOT Specification – Item 300, Asphalts, Oils, & Emulsions.
- E. Install surface course, Type D, in accordance with TxDOT Specification – Item 340, Dense Graded Hot Mix Asphalt.
- F. Tolerance of Finished Grade: +0.10 FT from required elevations.
- G. Line Painting:
 1. Thoroughly clean surfaces which are to receive paint.
 2. Make completely dry before paint is applied.
 3. Do not paint until minimum of five (5) days has elapsed from time surface is completed.
 - a. A longer period may be required if directed by Owner's Representative.
 4. Do not apply paint over wet surfaces, during wet or damp weather, or when temperature is below 40 DegF.

3.2 OWNER TRAINING (NOT USED)

END OF SECTION

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SECTION 32 13 13

CONCRETE PAVEMENT, CURB, SIDEWALKS, AND STEPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete pavement, curb, sidewalk, and steps.

1.2 MEASUREMENT AND PAYMENT

A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M153 – Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction (ASTM D1752).
 - b. M171 – Sheet Materials for Curing Concrete.
 - c. M182 – Burlap Cloth Made from Jute or Kenaf.
 - d. M213 – Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) (ASTM D1751).
 - e. M224 – Use of Protective Sealers for Portland Cement Concrete.
 - f. M233 – Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete.
2. American Concrete Institute (ACI):
 - a. 305R – Hot Weather Concreting.
 - b. 306R – Cold Weather Concreting.
3. ASTM International (ASTM):
 - a. A185 – Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - b. A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - c. C33 – Standard Specification for Concrete Aggregates.
 - d. C150 – Standard Specification for Portland Cement.

- e. C174 – Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores.
 - f. C309 – Standard Specification Liquid Membrane-Forming Compounds for Curing Concrete.
 - g. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
 - h. D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - i. D1752 – Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - j. D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - k. D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
4. Federal Specification (FS):
- a. SS-S-1614 – Sealants, Joint, Jet-Fuel-Resistant, Hot-Applied for Portland Cement and Tar Concrete Pavements.
 - b. TT-S 00227 E – Sealing Compound: Elastomeric Type, Multi-Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).

1.4 SUBMITTALS (NOT USED)

1.5 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150, Type I or II.
- B. Aggregates:
 - 1. ASTM C33, gradation size #67, 3/4 IN to #4.
 - 2. Clean, crushed gravel.
- C. Water: Clean, clear; and free from oil, acids, alkali, or vegetable matter.
- D. Admixtures: Comply with Specification Section 03 31 30 – Concrete, Materials and Proportioning.
- E. Reinforcing Bars: ASTM A615, Grade 60.
- F. Welded Wire Reinforcement:

1. ASTM A185.
 2. Flat.
 3. Clean, free from dirt, scale, rust.
- G. Preformed Joint Filler:
1. Non-extruding cork, self-expanding cork, sponge rubber or cork rubber.
 2. AASHTO M153 or AASHTO M213.
- H. Hot-Poured Joint Sealing Material: FS SS-S-1614.
- I. Sidewalk Joint Sealant:
1. Two (2) compound polyurethane.
 2. Class A, Type 1.
 3. Self-leveling.
 4. Non-tracking.
 5. FS TT-S 00227 E(3).
- J. Membrane Curing Compound: ASTM C309.
- K. Cover Materials for Curing:
1. Burlap:
 - a. AASHTO M182.
 - b. Minimum Class 2, 8 OZ material (1 YD x 42 IN).
 2. Polyethylene film, AASHTO M171.
- L. Paper Subgrade Cover: Polyethylene film, AASHTO M171.
- M. Concrete Treatment:
1. Boiled linseed oil mixture.
 2. AASHTO M233.
- N. Traffic Paint: FS TT-P-115, Type 1 - Alkyd.
- O. Forms:
1. Steel or wood.
 2. Size and strength to resist movement during concrete placement and able to retain horizontal and vertical alignment.
 3. Free of distortion and defects.
 4. Full depth.
 5. Metal side forms:
 - a. Minimum 7/32 IN thick.
 - b. Depth equal to edge thickness of concrete.

- c. Flat or rounded top minimum 1-3/4 IN wide.
- d. Base 8 IN wide or equal to height, whichever is less.
- e. Maximum deflection 1/8 IN under center load of 1,700 LBS.
- f. Use flexible spring steel forms or laminated boards to form radius bends.

2.2 MIXES

- A. Mix design to provide 4,000 psi 28-day compressive strength, 1-1/2 IN plus 1 IN slump, 6 percent air.
- B. Comply with Specification Section 03 31 30 – Concrete, Materials and Proportioning and Specification Section 03 31 31 – Concrete Mixing, Placing, Jointing, and Curing.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Subgrade Preparation:
 - 1. Prepare using methods, procedures, and equipment necessary to attain required compaction densities, elevation and section.
 - 2. Scarify and recompact top 6 IN of fills and embankments which will be under paved areas.
 - 3. Remove soft or spongy areas.
 - 4. Replace with aggregate material.
 - 5. Compact to the following densities:
 - a. Cohesive soils: 95 percent per ASTM D698.
 - b. Non-cohesive soils: 75 percent relative per ASTM D4253 and ASTM D4254.
 - 6. Assure moisture content is within limits prescribed to achieve required compaction density.
 - 7. Following compaction, trim and roll to exact cross section.
 - a. Check with approved grading template.
 - 8. Perform density tests on subgrade to determine that subgrade complies with the specification.
- B. Aggregate Course:
 - 1. Place material in not more than 6 IN thick layers.
 - 2. Spread, shape, and compact all material deposited on the subgrade during the same day.
 - 3. Compact to 75 percent relative per ASTM D4253 and ASTM D4254.

- C. Loose and Foreign Material: Remove loose and foreign material immediately before application of paving.
- D. Appurtenance Preparation:
 - 1. Block out or box out curb inlets and curb returns.
 - 2. Provide for joint construction as detailed and dimensioned on Drawings.
 - 3. Adjust manholes, inlets, valve boxes and any other utility appurtenances to design grade.
 - a. Secure to elevation with concrete.
 - b. Place concrete up to 5 IN below design grade.
 - 4. Headers:
 - a. Construct at open ends of pavements.
 - b. Use same concrete to construct headers as that used in the abutting structure.
 - c. Extend header full width of pavement and crown same as pavement.
 - 5. Clean and oil forms.

3.2 INSTALLATION

- A. Concrete Production: Comply with Specification Section 03 31 31 – Concrete Mixing, Placing, Jointing, and Curing.
- B. Forms:
 - 1. Form support:
 - a. Compact soil foundation and cut to grade to support forms and superimposed machine loads.
 - b. Use bearing stakes driven flush with bottom of form to supplement support as necessary.
 - c. Do not use earth pedestals.
 - 2. Staking forms:
 - a. Joint forms neatly and tightly.
 - b. Stake and pin securely with at least three (3) pins for each 10 FT section.
 - 3. Clean and oil forms prior to placement of concrete.
 - 4. Set forms sufficiently in advance of work (minimum of 2 HRS) to permit proper inspection.
 - 5. Previously finished concrete pavement, curb or sidewalk contiguous with new work may serve as side form when specifically approved.
- C. Reinforcing:
 - 1. Locate longitudinal edge bars between 3 IN and 6 IN from edge of slab.

2. Lap mats one (1) full space.
3. Tie end transverse member of upper mat securely to prevent curving.
4. Lap non-welded bars 12 IN minimum.
5. Support:
 - a. Place bars and heavy mats securely on chairs at called-for height.
 - b. Place other fabric on the first of a two-course pour and cover promptly with final pour, or place fabric by a fabric-placer if procedure is reviewed and approved by Owner's Representative.

D. Joints:

1. Hold joint location and alignment to within +1/4 IN.
2. Finish concrete surface adjacent to previously placed slab to within +1/8 IN, with tooled radius of 1/4 IN.
3. Metal keyway joints:
 - a. Form by installing metal joint strip left in place.
 - b. Stake and support like side form.
 - c. Provide dowels or tie bars.
4. Weakened plane joints:
 - a. Tooled joints:
 - 1) Form groove in freshly placed concrete with tooling device.
 - 2) Groove dimensions shall be 3/8 IN at surface and 1/4 IN at root.
 - b. Sawed joints:
 - 1) Saw 1/4 IN groove in green concrete.
 - 1) Commence sawing as soon as concrete is hard enough to withstand operation without chipping, spalling or tearing, regardless of nighttime or weather.
 - 2) Thoroughly wet surface to protect membrane cure and recoat afterward.
 - 3) Complete saw cutting before shrinkage stresses cause cracking.
 - c. Locate at 6 FT intervals.
5. Stake in place load transfer device for expansion joints consisting of dowels:
 - a. Supporting and spacing means and pre-molded joint filler as per Drawing details.
 - b. Located at 48 FT intervals and at all intersection curb returns.
 - c. Provide preformed joint filler at all junctions with existing curb, sidewalk, steps, or other structures.

6. Install construction joints at end of day's work or wherever concreting must be interrupted for 30 minutes or more.
7. Thoroughly clean and fill joints with joint sealing material as specified.
8. Fill joints without overflowing onto pavement surface.
9. Upper surface of filled joint to be flush to 1/8 IN below finish surface.

E. Place Concrete:

1. Comply with Specification Section 03 31 31 – Concrete Mixing, Placing, Jointing, and Curing.
2. Construct driveway openings, ramps, and other features as per Drawing details.

F. Cold and Hot Weather Concreting:

1. Cold weather:

- a. Cease concrete placing when descending air temperature in shade falls below 40 Deg F.
- b. Do not resume until ambient temperature rises to minimum 40 Deg F.
- c. If placing below 40 Deg F is authorized by Owner's Representative, maintain temperature of mix between 60 and 80 Deg F.
- d. Heat aggregates or water or both.
- e. Water temperature may not exceed 175 Deg F.
- f. Aggregate temperature may not exceed 150 Deg F.
- g. Remove and replace frost damaged concrete.
- h. Salt or other antifreeze is not permitted.
- i. Comply with ACI 306R.

2. Hot weather:

- a. Cease concrete placing when plastic mix temperature cannot be maintained under 90 Deg F.
- b. Aggregates or water or both may be cooled.
- c. Cool water with crushed ice.
- d. Cool aggregates by evaporation of water spray.
- e. Never batch cement hotter than 160 Deg F.
- f. Comply with ACI 305R.

G. Finishing:

1. As soon as placed, strike off and screed to crown and cross section, slightly above grade, so that consolidation and finishing will bring to final Drawing elevations.

2. Maintain uniform ridge full width with first pass of first screed.
3. Pavement and similar surfaces:
 - a. Float by longitudinally reciprocating float, passing gradually from edge to edge.
 - b. Assure successive advances do not exceed half the length of the float.
 - c. Test level of slab with minimum 10 FT straightedge.
 - d. Fill depressions with fresh material, consolidate and refinish.
 - e. Cut down high areas and retest.
 - f. Belt surface with two-ply canvas belt, using transverse strokes while advancing along center line.
 - g. Provide final finish by full width burlap or carpet drag, drawn longitudinally.
 - h. Keep drag clean to avoid build up and consequent scarring.
 - i. Tool pavement edges with suitable edger.
 - j. Retest with straightedge and if pavement shows deviation of more than 1/8 IN in 10 FT, remove and replace.
4. Curb and similar surfaces:
 - a. Bring curb to grade by running straightedge over steel templates with sawing motion.
 - b. Float surface with a wood float to draw cement to surface.
 - c. Broom finish after floating.
 - d. Tool edges with suitable edger.
 - e. Upon removal of forms, fill honeycombed or unevenly filled sections immediately with cement mortar.
 - f. Assure that expansion joints are cleared of concrete.
5. Sidewalk, steps, ramps, and similar surfaces:
 - a. Test with 6 FT straightedges equipped with long handles and operated from off the sidewalk.
 - b. Draw excess water and laitance off from surface.
 - c. Float finish so as to leave no disfiguring marks, but to produce a uniform granular or sandy texture.
 - d. Broom finish after floating.
 - e. Tool pavement edges with suitable edger.
 - f. Provide exposed aggregate surfaces in areas indicated on the Drawings.

- g. Provide method such as abrasive blasting, bush hammering, or surface retarder acceptable to the Owner's Representative.

H. Curing:

1. Apply membrane curing compound complying with ASTM C309, and in accordance with manufacturer's directions, but at a minimum rate of 200 SF per gallon.
2. Apply curing compound within 4 HRS after finishing or as soon as surface moisture has dissipated.
3. Cure for minimum of seven (7) days.
4. When average daily temperature is below 50 Deg F, provide insulating protection of 12 IN minimum thickness loose dry straw, or equivalent, for 10 days.
5. Linseed oil sealant:
 - a. For concrete pavement or sidewalk, seal surface with linseed oil.
 - b. Apply linseed oil to clean surface as per AASHTO M224 after concrete has cured for one (1) month.
 - c. Apply first application at minimum rate of 67 SY per gallon.
 - d. Apply second application to a dry surface at minimum rate of 40 SY per gallon.

I. Protection of Concrete:

1. Protect concrete surfaces and appurtenances from traffic for minimum of 14 days.
2. Erect and maintain warning signs, lights, watchmen to direct traffic.
3. Repair or replace parts of concrete surfaces damaged by traffic, or other causes, occurring prior to final acceptance.
4. Protect concrete pavement against public traffic, construction traffic and traffic caused by employees and agents.
5. No equipment shall be driven or moved across concrete surfaces unless such equipment is rubber-tired and only if concrete is designed for and capable of sustaining loads to be imposed by the equipment.
6. Do not drive over new or existing concrete with tracked vehicles and equipment.

J. Painting and Striping:

1. Stripe and mark pavement per the Drawings following sufficient cure time for pavement.
2. Lay out markings with guidelines, templates, and forms.

3. Apply 6 IN wide stripe with self-contained striping machine to a clean and dry pavement surface.
4. Temperature must be above 40 Deg F and precipitation should not be expected during drying period.
5. Use yellow or white paint as approved complying with FS TT-P-115.
6. Apply at 1 GAL per 105 SF.

K. Opening to Traffic:

1. After 14 days, pavement may, at Owner's discretion, be opened to traffic if job cured test cylinders have attained a compressive strength of 3,000 LBS per square inch when tested in accordance with ASTM standard methods.
2. Prior to opening to traffic, clean and refill joints as required with the specified filler material.

L. Clean Up:

1. Assure clean up work is completed within two (2) weeks after pavement has been opened to traffic.
2. No new work will begin until clean up work has been completed, or is maintained within two (2) weeks after pavement has been opened to traffic.

M. Pavement Patching:

1. Comply with material and density requirements as mentioned elsewhere in this Specification Section except provide minimum 6 IN aggregate immediately below the patch.
2. Place pavement patch providing a thickened edge.
3. Assure that patch in plane of "cold" joint has a thickness 6 IN greater than that of the existing pavement.
4. Extend patch under existing pavement for a distance of 6 IN minimum.
5. Fill void under existing pavement with concrete.
6. Undercut existing pavement 6 IN all around patch and to a depth of 6 IN.
7. Prior to placing patch, sawcut edge of existing concrete to 1/4 depth and remove to provide a vertical face for a straight and true joint.

3.3 FIELD QUALITY CONTROL

- A. Provide test cylinders in accordance with Specification Section 03 05 05 – Testing for each 10 CY of concrete placed or per Owner's direction.

B. Pavement Thickness Testing:

1. General:
 - a. Core pavement to determine the actual thickness as directed by Owner's Representative.

- b. Determine thickness by ASTM C174.
 - c. Fill holes from removal of cores with concrete of the same mixture as specified.
 - d. Cost incidental to coring of cores showing a deficiency greater than 1/4 IN shall be paid by the Contractor.
 - e. Cost of cores showing a deficiency of 1/4 IN or less shall be paid by the Owner.
 - f. If average pavement thickness, as directed by core measurement, is outside specified tolerances, payment will be reduced per PART 1 of this Specification Section.
 - g. If deficiency in pavement thickness is 1 IN or more, remove and replace pavement at Contractor's expense.
2. Core categories:
- a. In determining the average thickness of acceptable pavement for which payment will be made, utilize the following core categories:

CATEGORY NUMBER	CORE THICKNESS IN RELATION TO DESIGN	CORE LENGTH USED IN CALCULATING
1	1 IN or more deficiency	NOT USED
2	Less than 1 IN deficiency through 1/2 IN excess	Actual Core Thickness
3	More than 1/2 IN excess	Design Thickness plus 1/2 IN

- b. Core sampling:
 - 1) Take cores in each lane in each block.
- c. Take cores at locations where the cement content was found to be low when checking the quantities of cement used during the progress of the work.
- d. Each separately poured lane of the pavement to be considered as a unit.
- e. A lane shall be considered to be the pavement surface between longitudinal construction joints, between a longitudinal construction joint and the edge, or between two (2) pavement edges in cases where the entire width of the pavement is poured in one (1) operation.
- f. Should any core show a deficiency in thickness in excess of 1 IN, check cores shall be taken 5 FT on either side of this location parallel to the centerline of the pavement.
- g. If both of these cores are within the 1 IN tolerance, no further special borings for this individual zone of deficiency will be made.

- h. If either one (1) or both of these cores are not within the 1 IN tolerance, the procedure will be to cut cores in the following order on either side of the original short core parallel to the centerline of the pavement:
 - 1) 25 FT, 50 FT, the same to be measured from the location of original core found to be deficient in thickness, then at 50 FT intervals until a thickness within the 1 IN tolerance is found in both directions.
 - 2) On either side of the original deficient core, the procedure will then be to make a coring approximately half the distance within the first core which comes within the 1 IN tolerance.
 - 3) Repeat the above procedure until the station (+5 FT), at which the pavement comes within the 1 IN tolerance is located.
 - 4) If for some reason two (2) or more cores are taken at the same station and at least one (1) of them is beyond the 1 IN tolerance, the section of pavement at the station shall be considered as unacceptable.

3.4 OWNER TRAINING (NOT USED)

END OF SECTION

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SECTION 32 32 13

CAST-IN-PLACE INLETS, HEADWALLS, AND WINGWALLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place inlets for storm or sanitary sewers, including cast iron frame and plate or grate. Cast-in-place headwalls including wingwalls for storm sewers. Cast-in-place junction box with lid or grate top.

1.2 MEASUREMENT AND PAYMENT

A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 SUBMITTALS

- A. Submit shop drawings for approval of design and construction details for cast-in-place units which differ from units shown on Drawings.
- B. Submit manufacturer's data and details for frames, grates, rings, and covers.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Concrete: Class A concrete with minimum compressive strength of 4000 psi conforming to requirements of Section 03 31 30 – Concrete, Materials, and Proportioning, unless otherwise indicated on Drawings.
- B. Reinforcing Steel: Conform to requirements of Section 03 31 30 – Concrete, Materials, and Proportioning.
- C. Miscellaneous metals: Cast-iron frames, grates, rings, and covers conforming to requirements of Section 33 39 20 - Frames, Grates, Rings, and Covers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify lines and grades are correct.
- B. Verify compacted subgrade will support loads imposed by inlets.

3.2 INSTALLATION

- A. Construct units complete in place to dimensions, lines and grades as shown on Drawings.
- B. Excavate in accordance with requirements of Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities.
- C. Construct box section of inlet with Class A concrete or brick.
- D. Forms required for both outside and inside faces of concrete inlet walls, however, when nature of material excavated for inlet can be hand trimmed to smooth vertical face, outside forms may be omitted with approval of Owner's representative.
- E. Place reinforcing steel to conform to details shown on Drawings. Provide positive means for holding steel cages in place during concrete placement. Welding of reinforcing steel is not permitted unless noted on Drawings. Maximum variation in reinforcement position is plus or minus 10 percent of wall thickness or plus or minus ½ inch, whichever is less. Regardless of variation, maintain minimum cover of concrete over reinforcement as shown on Drawings.
- F. Chamfer exposed edges unless otherwise indicated on Drawings.

3.3 FINISHES

- A. Cut off inlet leads neatly at inside face of inlet wall. Point up with mortar.
- B. When box section of inlet is completed, shape floor of inlet with mortar to conform to detailed Drawings.
- C. Finish concrete surfaces in accordance with requirements of Section 03 31 30 – Concrete, Materials, and Proportioning.

3.4 QUALITY CONTROL

- A. Verify that inlets are free of leaks. Repair leaks in approved manner.

3.5 CONNECTIONS

- A. Connect inlet leads to inlets.
- B. Seal leads inside and outside with hydraulic cement.

3.6 BACKFILL

- A. Backfill area of excavation surrounding each completed inlet according to requirements of Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities.

END OF SECTION

SECTION 32 90 00

SEEDING, SODDING AND LANDSCAPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seeding, sodding and landscape planting:

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Nursery and Landscape Association/American National Standards Institute (ANLA/ANSI):
 - a. Z60.1 – American Standard for Nursery Stock.
2. AOAC International (AOAC – Association of Official Agricultural Chemists.).
3. ASTM International (ASTM):
 - a. D2028 – Standard Specification for Cutback Asphalt (Rapid-Curing Type).
 - b. D5276 – Standard Test Method for Drop Test of Loaded Containers by Free Fall.

B. Quality Control:

1. Fertilizer:
 - a. If Owner's Representative determines fertilizer requires sampling and testing to verify quality, testing will be done at Contractor's expense, in accordance with current methods of the AOAC.
 - b. Upon completion of Project, a final check of total quantities of fertilizer used will be made against total area seeded.
 - c. If minimum rates of application have not been met, Contractor will be required to distribute additional quantities to make up minimum application specified.

1.4 SUBMITTALS (NOT USED)

1.5 SEQUENCING AND SCHEDULING (NOT USED)

1.6 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND SUPPLIERS

- A. Subject to compliance with the Contract Documents, the manufacturers and suppliers listed in the applicable Articles below are acceptable.

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2.2 MATERIALS

BOTANICAL AND COMMON NAME	PERCENT BY WEIGHT (PLS)	MINIMUM PERCENT GERMINATION	MINIMUM PERCENT PURITY
Kentucky Bluegrass (Poa pratensis)	60	85	95
Fescue, Tall, KY 31 (Festura arundiancea 'KY 31')	30	85	98
Ryegrass, Perennial (Lolium perenne)	10	90	95

Pasture Seeding:

BOTANICAL AND COMMON NAME	MINIMUM PERCENT GERMINATION	MINIMUM PERCENT PURITY	LBS PLS PER ACRE
Smooth Brome Grass (Bromus inermis 'Leyss')	80	90	14
Fescue, Tall, KY 31 (Festura arundiancea 'KY 31')	90	98	2.5
Switchgrass (Panicum virgatum)	90	95	3.5

BOTANICAL AND COMMON NAME	MINIMUM PERCENT GERMINATION	MINIMUM PERCENT PURITY
Pennegift Crownvetch (Coronilla veria) (Blue-tagged certified hulled)	75	98
Ryegrass, Perennial (Lolium perenne)	90	95

A. Native Grass Seeding: Certified seed of locally adapted strains.

SEEDING, SODDING AND LANDSCAPING

GRASSES	LBS PLS PER ACRE	APPROXIMATE NUMBER OF SEEDS PER LB (PLS)
Big bluestem(<i>Andropogon gerardi</i>)	2.4	165,000
Blue grama(<i>Bouteloua gracilis</i>)	0.1	825,000
Green needlegrass(<i>Stipa viridula</i>)	0.6	181,000
Indian grass(<i>Sorghastrum nutans</i>)	1.2	175,000
Little bluestem 'Blaze' (<i>Andropogon scoparius</i> 'Blaze')	1.4	260,000
Sideoats grama(<i>Bouteloua curtipendula</i>)	0.8	191,000
Switchgrass(<i>Panicum virgatum</i>)	1.0	389,000
Western wheatgrass(<i>Agropyron smithii</i>)	1.5	110,000
Sand reedgrass(<i>Calamovilfia gigantea</i>)	1.0	273,000
Sand bluestem(<i>Andropogon hallii</i>)	2.5	113000
Sand Lovegrass(<i>Eragrostis trichodes</i>)	0.3	1300000
Reed canarygrass(<i>Phalaris arundinacea</i>)	2.0	533000

FORBS	LBS PLS PER ACRE	APPROXIMATE NUMBER OF SEEDS PER LB (PLS)
Purple prairieclover (<i>Petalostemen purpureum</i>)	0.2	278.000
Pitcher Sage		
Salvia pitcheri	0.2	149,000
Upright prairieconeflower	0.1	461,000

Buffalograss lawn: Spring seeding or dormant fall seeding.

BOTANICAL AND COMMON NAME	LBS (PLS) PER ACRE	APPROXIMATE NUMBER OF SEEDS PER POUND
Buffalograss (<i>Buchloe dactyloides</i>)	20.0	52,000
Blue Grama (<i>Bouteloua gracilis</i>)	0.1	825,000

B. Soil Amendments:

C. Asphalt Binder: Emulsified asphalt per State specifications.

D. Water:

1. Water free from substances harmful to grass or sod growth.
2. Provide water from source approved prior to use.

E. Plants:

1. Sound, healthy, vigorous, with normal top and root systems, free from disease, insect pests or their eggs, grown in same or colder climatic zone as project.
2. Nursery grown stock, freshly dug. No heeled-in, cold storage or collected stock.
 - a. Species and size as indicated on Drawings.

PART 3 - EXECUTION

3.1 SOIL PREPARATION

A. General:

1. Limit preparation to areas which will be planted soon after.
2. Provide facilities to protect and safeguard all persons on or about premises.
3. Protect existing trees designated to remain.
4. Verify location and existence of all underground utilities.
 - a. Take necessary precaution to protect existing utilities from damage due to construction activity.
 - b. Repair all damages to utility items at no cost to Owner.
5. Provide facilities such as protective fences and/or watchmen to protect work from vandalism.
 - a. Contractor to be responsible for vandalism until acceptance of work in whole or in part.

B. Preparation for Lawn-Type Seeding, Sprigging, Plugging or Sodding:

1. Loosen surface to minimum depth of 4 IN.
2. Remove stones over 1 IN in any dimension and sticks, roots, rubbish, and other extraneous matter.
3. Prior to applying fertilizer, loosen areas to be seeded with a double disc or other suitable device if the soil has become hard or compacted.
4. Correct any surface irregularities in order to prevent pocket or low areas which will allow water to stand.
5. Distribute fertilizer uniformly over areas to be seeded:
 - a. For lawn-type seeding: 30 LBS per 1000 SF.
 - b. For pasture seeding: 200 LBS per acre.
6. Incorporate fertilizer into soil to a depth of at least 2 IN by disking, harrowing, or other approved methods.

7. Remove stones or other substances from surface which will interfere with turf development or subsequent mowing operations.
8. Grade lawn areas to a smooth, even surface with a loose, uniformly fine texture.
 - a. Roll and rake, remove ridges and fill depressions, as required to meet finish grades.
 - b. Limit fine grading to areas which can be planted soon after preparation.
9. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and before planting.
10. Spread limestone uniformly over designated areas at a rate of 100 LBS per 1000 SF.
11. Distribute fertilizer as specified uniformly over areas to be seeded at a rate of 12 LBS per 1000 SF.

C. Native Grass Seeding:

3.2 INSTALLATION

A. Lawn-Type and Pasture Seeding:

1. Do not use seed which is wet, moldy, or otherwise damaged.
2. Perform seeding work from April 20 to May 15 for spring planting, and August 1 to September 15 for fall planting, unless otherwise approved by Owner's Representative.
3. Employ satisfactory methods of sowing using mechanical power-driven drills or seeders, or mechanical hand seeders, or other approved equipment.
4. Distribute seed evenly over entire area at rate of application not less than 4 LBS (PLS) of seed per 1000 SF, 50 percent sown in one direction, remainder at right angles to first sowing.
5. Stop work when work extends beyond most favorable planting season for species designated, or when satisfactory results cannot be obtained because of drought, high winds excessive moisture, or other factors.
 - a. Resume work only when favorable conditions develop.
6. Lightly rake seed into soil followed by light rolling or cultipacking.
7. Immediately protect seeded areas against erosion by mulching.
 - a. Spread mulch in continuous blanket using 1-1/2 tons per acre to a depth of 4 or 5 straws.
8. Protect seeded slopes against erosion with erosion netting or other methods approved by Owner's Representative.

- a. Protect seeded areas against traffic or other use by erecting barricades and placing warning signs.
9. Immediately following spreading mulch, anchor mulch using a rolling coulter or a wheatland land packer having wheels with V-shaped edges to force mulch into soil surface, or apply evenly distributed emulsified asphalt at rate of 10-13 GAL/1000 SF.
 - a. SS-1 emulsion in accordance with ASTM D5276 or RC-1 cutback asphalt in accordance with ASTM D2028 are acceptable.
 - b. If mulch and asphalt are applied in one treatment, use SS-1 emulsion with penetration test range between 150-200.
 - c. Use appropriate shields to protect adjacent site improvements.

3.3 PLANTING TREES, SHRUBS, AND GROUND COVERS

A. Notification:

1. Notify Owner's Representative of source of plants and plant materials at least 30 days prior to planting to permit Owner's Representative inspection of source qualifications.

B. Preparation:

1. Handle plants so that roots or balls are adequately protected from breakage of balls, from sun or drying winds.
 - a. Ensure tops or roots of plants are not permitted to dry out.
2. During transportation, protect materials from wind and sun to prevent tops and roots from drying out.
3. Protect tops of plants from damage. Plants with damaged tops will be rejected.
4. For purpose of inspection and planting identification, attach durable, legible labels to bundle or container of plant material delivered at the planting site. State correct plant name and size of each plant in weather-resistant ink on labels.
5. Do not prune trees and shrubs at nursery.

C. Planting Season:

1. Plant deciduous shade trees and shrubs any time the ground is suitable between October 15 and June 1.
2. Plant evergreen material between September 1 and June 1.
3. Plant ground covers between March 15 to June 1.

D. Planting Procedure:

1. Indicate locations of plants for approval by Owner's Representative before excavating plant locations.
2. In event underground construction, utilities, obstructions, or rock are encountered in excavation of plantings, secure alternate locations from Owner's Representative
 - a. Make said changes without additional compensation.
 - b. Where tree locations fall under existing overhead wires, or crowd existing trees, adjust locations as directed by Owner's Representative.
3. Excavate pits and beds as necessary and in accordance with ANLA/ANSI Z60.1.
 - a. Loosen bottom of pits prior to planting.
 - b. Excavation is unclassified; excavate all materials without additional cost.
4. Tree and shrub pits to be circular in shape with vertical sides at least 1 FT greater in diameter than ball diameter.
 - a. Pit to be of sufficient depth to provide 6 IN of planting soil under ball when set to natural grade.
5. Shrub and ground cover beds:
 - a. Plant shrubs used in mass plantings in individual holes of required size.
 - b. Strip all sod from among mass planting.
 - c. For ground cover beds, remove sod from within limits of bed.
 - d. Add soil amendments as specified and mix or rototill with existing topsoil to a depth of 6 IN.
6. Set plants straight or plumb, in locations when indicated and at such level that after settlement they bear same relationship to finished grade as they did in their former setting.
 - a. Carefully tamp planting soil under and around base of balls to prevent voids.
 - b. Remove burlap, rope and wires from top of balls.
 - c. Do not remove burlap from sides and bottom of balls.
7. Backfill plants with planting soil.
 - a. Tamp to 1/2 depth of pit and thoroughly water and puddle before bringing backfill to proper grade.
 - b. After planting has been completed, flood pit again so that backfill is thoroughly saturated and settled.
8. After planting is complete, form a level saucer 3 IN high around each tree extending to limit of plant pit for watering purposes.
9. Mulch plant pit after saucer has been shaped.

- a. Mulch to limits of pit and uniformly over ground cover beds to a depth of 3 IN.
 - b. In mass plantings of shrubs, mulch entire area uniformly among shrubs to a depth of 3 IN.
 - c. If mulching is delayed and soil has dried out, water plants thoroughly before spreading mulch.
10. Staking: Stake trees immediately after planting as detailed on Drawings or in accordance with Nursery Standards.
11. Wrap deciduous trees 2 IN or more in caliper by neatly overlapping wrapping material between ground line and second branch. Place ties at top and bottom of wrapping material and not more than 12 IN apart between top and bottom ties.
12. Remove dead or damaged branches.
 - a. Thin deciduous material to about two-thirds of initial branching.
 - b. Remove only dead or damaged branches from evergreens.
13. Water plants during planting operations.
 - a. Water each plant a minimum of once each week until final acceptance.
 - b. Apply sufficient water to moisten backfill about each plant so that moisture will extend into the surrounding soil.

3.4 MAINTENANCE AND REPLACEMENT

A. General:

1. Begin maintenance of planted areas immediately after each portion is planted and continue until final acceptance or for a specific time period as stated below, whichever is the longer.
2. Provide and maintain temporary piping, hoses, and watering equipment as required to convey water from water sources and to keep planted areas uniformly moist as required for proper growth.
3. Protection of new materials:
 - a. Provide barricades, coverings or other types of protection necessary to prevent damage to existing improvements indicated to remain.
 - b. Repair and pay for all damaged items.
4. Replace unacceptable materials with materials and methods identical to the original specifications unless otherwise approved by the Owner's Representative.

B. Seeded or Sodded Lawns:

1. Maintain seeded lawns: 90 days, minimum, after installation and review of entire project area to be planted.
2. Maintenance period begins at completion of planting or installation of entire area to be seeded or sodded.
3. Owner's Representative will review seeded or sodded lawn area after installation for initial acceptance.
4. Maintain lawns by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, regrading, and replanting as required to establish a smooth, uniform lawn, free of weeds and eroded or bare areas.
5. Lay out temporary lawn watering system and arrange watering schedule to avoid walking over muddy and newly seeded areas.
 - a. Use equipment and water to prevent puddling and water erosion and displacement of seed or mulch.
6. Mow lawns as soon as there is enough top growth to cut with mower set at recommended height for principal species planted.
 - a. Repeat mowing as required to maintain height.
 - b. Do not delay mowing until grass blades bend over and become matted.
 - c. Do not mow when grass is wet.
 - d. Time initial and subsequent mowings as required to maintain a height of 1-1/2 to 2 IN.
 - e. Do not mow lower than 1-1/2 IN.
7. Remulch with new mulch in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose.
 - a. Anchor as required to prevent displacement.
8. Unacceptable plantings are those areas that do not meet the quality of the specified material, produce the specified results, or were not installed to the specified methods.
9. Replant bare areas using same materials specified.
10. Owner's Representative will review final acceptability of installed areas at end of maintenance period.
11. Maintain repaired areas until remainder of maintenance period or approved by Owner's Representative, whichever is the longer period.

3.5 OWNER TRAINING (NOT USED)

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SECTION 33 05 01.07

LOW-HEAD REINFORCED CONCRETE CULVERT, STORM DRAIN, AND SEWER
PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Low-head reinforced concrete pipes (RCP), storm drains, and sewer pipes

1.2 MEASUREMENT AND PAYMENT

A. Measurement

1. Pipe will be measured in linear feet along the centerline of each size and type specified, not including safety end treatments. Measurement of spurs, branches, or new connecting pipe will be made from the intersection of the flow line of the pipe being installed with the outside surface of the existing pipe. Where inlets, headwalls, catch basins, manholes, junction chambers, or other structures are included in lines of the 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.
2. For multiple pipes, the measured length will be the sum of the lengths of the individual barrels.

B. Payment

1. Payment will be paid for at the unit price bid per linear foot, measured as provided above for "Reinforced Concrete Pipe", "Reinforced Concrete Pipe (Arch)", "Reinforced Concrete Pipe (Elliptical)" of the size and class/D-load specified. Payment shall be full compensation for furnishing and transporting the pipe; for preparation and shaping of beds; for placing and jointing of pipe; for fittings; for end finish; for all connections to existing and new structures; and for all labor, material, equipment and incidentals necessary to complete the pipe in accordance with the Contract Documents (in place complete).
2. Payment for pipe will include trench excavation, bedding material and backfill.

1.3 WORK INCLUDED

- A. Furnish labor, materials, equipment and incidentals necessary to install reinforced concrete pipe and/or conduits or drainage lines, including pipe fittings, connecting drain lines to curb inlets, joints, connections to new or existing pipe or headwalls, manholes etc., to the lines and grades indicated. Pipe and fittings shall be of the classes, sizes, and dimensions indicated.

1.4 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):

- a. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- b. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
- c. C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
- d. C497, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
- e. C655, Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe.

2. American Water Works Association (AWWA):

- a. C302, Standard for Reinforced Concrete Pressure Pipe, Noncylinder Type.
- b. C651, Standard for Disinfecting Water Mains.
- c. M9, Installation of Concrete Pipe.

B. Conduct testing methods to evaluate physical properties of pipe in full compliance with ASTM C497.

1. Report full results test showing compliance with referenced standard.

C. Protection: Protect storm drainage or sewer pipe from damage before, during, and after installation until backfill is complete. Protect the Work and materials of other trades. In event of damage, make all necessary repairs and replacements at no additional cost to the Owner.

D. Workmanship and Finish:

1. Pipe shall be free from fractures, large or deep cracks, defects that indicate imperfect manufacturing, surface defects indicating honeycombed or open texture, damaged ends that would prevent making a satisfactory joints, any continuous crack having a surface width of 0.01 inch or more and extending for a length of 12 inches or more. The ends of pipe shall be perpendicular to the walls and centerline of the pipe within the limits of variations.
2. Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements. Rejected pipe shall be plainly marked by the Engineer and shall be replaced by the Contractor with pipe which meets the requirements of these specifications. Remove rejected pipe immediately from the Site. In the event of damage, make the necessary repairs and replacements at no additional cost to the Owner.

1.5 SYSTEM DESCRIPTION

- A. Provide each pipe, fitting, special appurtenance with a plainly and permanently waterproofed, marked identification.
 - 1. Include but not necessarily limit markings to the following:
 - a. Size and class of pipe, pressure rating in compliance with referenced standards.
 - b. Date of manufacture.
 - c. Manufacturer's trademark.
 - d. Manufacturer's name.
 - e. Full details on fittings and pipe schedule regarding angles of change, reduction.
 - f. Special notations and tagging of special items in regard to line location.
 - g. Diameter of the pipe,
 - h. Where elliptical reinforcement is used, one end of each section or joint of pipe shall be clearly marked during the process of manufacture or immediately thereafter on the inside and the outside of opposite walls to show the location of the "Top or "Bottom" of the pipe as it should be installed. Markings shall be indented on the pipe section or painted thereon with waterproof paint. "Top" and "Bottom" markings are not required on pipe having such an external shape that the correct position of the top and bottom is obvious.

1.6 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Concrete materials:
 - 1) Chemical and physical properties.
 - 2) Mix design.
 - d. Joint details.
 - e. Connection details.

1.7 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

2.2 MATERIALS

- A. General: Except as modified herein, materials, manufacture, and design of concrete pipe shall conform to ASTM C76 for Circular Pipe, ASTM C506 for Arch Pipe, or ASTM C507 for Elliptical Pipe].
- B. Jointing Materials:
 - 1. Cold applied preformed plastic gaskets. The gasket sealing the joint shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes, or obnoxious odors. The gasket joint sealer shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength, and shall be supplied in extruded rope-form of suitable cross-section and size as to fill the joint space when the pipes join. The size of the plastic gasket joint sealer shall be in accordance with the manufacturer's recommendations and sufficient to squeeze out the gasket materials on the inside or outside around the complete pipe joint circumference. The gasket joint sealer shall be protected by a suitable removable two piece wrapper.
 - 2. Expanded cellular rubber gaskets shall be produced from a blend of nitrile and vinyl polymers meeting the physical requirements of ASTM D1056, Class 2C1.

2.3 MIXES

- A. Mix concrete in a central batch plant or other approved batching facility from which the quality and uniformity of the concrete can be assured. Transit-mixed concrete shall not be acceptable for use in precast concrete pipe.

2.4 FABRICATION

- A. Provide non-pressure service or gravity drainage piping meeting or exceeding ASTM C76 with varying lengths a minimum of 7 FT long.
 - 1. Each lot shall consist of a single diameter and strength designation manufactured by essentially the same process.
 - 2. Provide RCP for non-pressure service or gravity drainage with sealed joints using continuous rubber gaskets conforming to the requirements of ASTM C443 or ASTM C361.
 - 3. Type of joint shall be spigot groove type joint with O-ring gasket (R/C).
 - a. United States Bureau of Reclamation Type R/4.

- b. Ensure that the rubber gasket will perform as the sole element to make the joint watertight.
- B. Provide plant and process pressure service piping meeting or exceeding ASTM C361 where indicated.
 1. Provide sealed joints using continuous rubber gasket conforming to requirements of ASTM C361.
 2. Type of joint shall be spigot groove type joint with O-ring gasket or steel end ring joint with spigot groove and O-ring gasket.
 - a. United States Bureau of Reclamation Type R/4 and R/2, respectively.
 3. Ensure that rubber gasket joint will perform as the sole element to make the joint watertight.
- C. Provide pressure service RCP for internal hydrostatic pressures of 55 psi or less in full compliance with AWWA C302.
 1. Provide sealed joints using continuous rubber gasket conforming to requirements of ASTM C361.
 2. Type of joint shall be steel end ring joint with spigot groove and O-ring gasket.
 - a. United States Bureau of Reclamation Type R-2.
- D. Provide steel and ring joint with spigot groove and O-ring gasket designated as an R/S joint conforming to requirements of ASTM C361 for all jacked-in-place sewer pipe.
- E. Jointing Materials:
 1. The two piece wrapper shall be designed so that 1/2 may be removed longitudinally without disturbing the other 1/2 to facilitate application as noted below.
 2. The chemical composition of the gasket joint sealing compound shall meet the following requirements when tested in accordance with the test methods shown.

Composition	Test Method
Bitumen (Petroleum plastic content) (% by weight) ASTM D4	50-70
Ash-Inert Mineral Matter (% by weight) AASHTO Designation T-111	30-50
Volatile Matter at 325° F (% by weight) ASTM D6	2.0 Max.

3. The gasket joint sealing compound when immersed for 30 days at ambient room temperature separately in 5-percent solution of caustic potash, a mixture of 5-percent hydrochloric acid, a 5-percent solution of sulfuric acid, and a saturated H₂S solution shall show no visible deterioration.
4. The physical properties of the gasket joint sealing compound shall meet the following requirements:

Property	Test Method	Typical Analysis
Specific Gravity at 77° F	ASTM D71	1.20 Min. 1.35 Max.
Ductility at 77° F (cm) Min.	ASTM D113	5.0 Min.
Softening Point at 77° F Min.	ASTM D36	320° F Min.
Flashpoint C.O.C. degrees F	ASTM D92	600° F Fire Point
C.O.C. degrees F	ASTM D92	625° F
Penetration		
32 F (300 gms) 60 sec.	ASTM D217	75 Min.
77 F (150 gms) 5 sec.	ASTM D217	50 Min. 120 Max.
115 F (150 gms) 5 sec.	ASTM D217	150 Max.

2.5 COATINGS

A. Interior Pipe Coating:

1. Plastic lined RCP:

- a. Concrete pipe shall be provided with plastic linings at the location shown on the plans.
 - 1) The plastic lining shall cover 270° F of the inside diameter of the pipe with the unlined portion of the pipe centered on the bottom invert.
- b. Plastic lining shall be Amer-Plate T-Lock Liner as manufactured by Ameron, or Atlas Steuler Bekaplast.
- c. Plastic lining shown on the profile shall be considered incidental to the manufacture of the RCP and cost shall be included in the bid item to furnish and install sewer pipe.
- d. The plastic lining shall consist of a PVC compound and shall have a thickness of at least 0.065 IN and shall have integrally molded T-shaped ribs which securely anchor the lining to the pipe.

- 1) Color: White.
- e. All work in connection with the installation of the plastic lining in concrete pipe shall be performed in strict conformity with the lining manufacturer's recommendations.
 - 1) Liner sheets shall be fastened in place securely in the forms for the concrete pipe before reinforcing steel or concrete is placed.
- f. For field connections between lengths of pipe, either an extended flap of the lining or a separate joint strip of lining material wide will be acceptable.
 - 1) Field joints shall be made by heat welding.
 - 2) The flaps or joint strips for field joints shall be of the same thickness and composition as the plastic lining installed in the pipe.
 - 3) All adhesive, welding materials, separate strips of lining material for field joints, and other materials required for field jointing shall be furnished by the lining material manufacturer.
- g. The joint between sections of plastic lined pipe shall be prepared in the following manner before making the lining joint:
 - 1) The inside joint shall be filled and carefully pointed with cement mortar for the full circumference of the pipe.
 - a) The mortar shall not, at any point, extend into the pipe beyond a straight line connecting the surfaces of the adjacent pipe sections.
 - 2) No lining joint shall be made until after the trench has been backfilled.
 - a) Pipe joints must be dry before lining joints are made.
 - b) All mortar and other foreign material shall be removed from lining surfaces adjacent to the pipe joint.
- h. Field joints in the lining at pipe joints may be either of the following described types:
 - 1) The joint shall be made with a separate 4 IN wide joint strip and two
 - (2) 1 IN wide welding strips.
 - a) The 4 IN strip shall be centered over the joint, secured to the lining with an adhesive compound and welded along each edge to adjacent liner sheets.
 - b) The width of the space between the ends of pipe lining material shall not exceed 2 IN.
 - c) The 4 IN joint strip shall overlap the lining in each pipe a minimum of 1 IN.
 - 2) The joint shall be made with a lining flap extending about 3 IN beyond the spigot end of the pipe.

- a) One welding strip is required.
- b) The joint flap shall overlap the lining in the adjacent pipe a minimum of 1 IN.
- c) An adhesive compound shall be used to hold the flap in place during welding.
- d) The flap shall be protected from damage during installation.
- e) Excessive tension and distortion in bending back the strip to expose the distortion in bending back the strip to expose the pipe joint during laying and joint mortaring shall be avoided.
- i. All joints between pipe and wall fittings in manholes and between wall fitting and lining of manhole walls, where lining is required, shall be made by one (1) of the two (2) ways described above.
- j. All welding of joints shall be in strict conformity with the recommendations of the lining manufacturer.
- k. Care shall be taken in handling and transporting plastic lined pipe to prevent damage to the liner plate.
 - 1) No interior hooks or other interior lifting device shall be used in handling the pipe; all handling requiring lifting shall be done by exterior slings.
 - 2) Damaged pipe will not be installed unless repaired to the satisfaction of the Owner's representative.
- l. The manufacturer of plastic liner plate shall submit to the Owner's representative for approval, samples of each type of sheet and strip proposed for use, together with a list of all ingredients from which the sheets and strips are to be compounded.
 - 1) Said list shall show the percentage of each ingredient used in the formulation.
- m. After the pipe is installed in the trench and backfilled, all surfaces covered with plastic lining, including welds, shall be tested with an electric holiday detector.
 - 1) The voltage and specific methods of testing shall be as recommended by the manufacturer of the lining material.
 - 2) In addition, all welds shall be physically tested by nondestructive probing.
 - 3) All patches over holes, or repairs to the liner wherever damage has occurred, shall be installed in conformity with the instructions and recommendations of the lining manufacturer.
- n. The Contractor shall furnish qualified personnel and equipment to holiday test in the presence of the Owner's representative.

- o. Each transverse welding strip which extends to a lower edge of the liner shall be tested.
 - 1) The welding strip shall extend 2 IN below the liner to provide a tab.
 - 2) A 10 LB pull shall be applied to each tab.
 - 3) The force shall be applied normal to the face of the structure by means of a spring balance.
 - 4) Liner adjoining the welding strip shall be held against the concrete during application of the force.
 - 5) The 10 LB pull shall be maintained if a weld failure develops, until no further separation occurs.
 - 6) Defective welds shall be retested after repairs have been made.
 - 7) Tabs shall be trimmed away neatly after the welding strip has passed inspection.
 - 8) Inspection shall be made within two (2) days after joint has been completed.
- 2. Polymorphic resin pipe lining compound:
 - a. Polymorphic resin pipe lining compound manufactured by Quantum may be supplied as an alternative to the plastic lining above.
 - 1) The entire inside of the pipe shall be coated with the Quantum coating at the locations shown on the Plans.
 - b. The lining Contractor shall be responsible for the complete performance of the system.
 - 1) Application of lining compound.
 - a) Surface preparation:
 - (1) All interior barrel and joint surface areas will be exposed to sewer liquids and gases shall be prepared for lining by removal of laitance, form oil, loose, foreign or deleterious materials which will adversely affect the bond of the lining compound to the pipe surface.
 - (2) Removal shall be accomplished by abrasive blasting the pipe to provide a clean, open, sound surface.
 - b) Atmospheric and substrate conditions:
 - (1) The lining must be applied on a dry, frost-free, surface and shall not be applied when the ambient temperature is below 10 DegF.
 - (2) The barrel of the pipe shall be blown off with dry, clean, compressed air to remove sand, dust or other loose material immediately prior to application of the prime coat.

c) Application:

- (1) After blasting and cleaning, all joint and barrel surfaces shall be primed by applying a thin coat of thoroughly mixed clear Quantum resin extended 10 percent with styrene.
 - (a) Coverage of the primer shall be 300-500 SF per gallon.
 - (b) This will produce a dry film thickness of approximately 5 mils.
- (2) The lining compound shall then be applied to the barrel of the pipe.
 - (a) The lining compound shall be applied in one (1) or more coats to obtain a continuous and smooth integral lining with a minimum dry film thickness of 60 mils.
- (3) A top coat of clear resin shall be applied as the final seal coat to barrel and joint surfaces.
 - (a) Minimum dry film thickness shall be 5 mils.
 - (b) Minimum total dry film thickness on barrels shall be 70 mils.
- (4) The coated pipe section shall not be delivered to the site or installed until approval is obtained from the lining Contractor.

d) Holiday detection:

- (1) All interior barrel surfaces shall be thoroughly inspected for holidays (pinholes) using an electronic, low voltage instrument specifically designed for the purpose.
- (2) A high voltage detector shall not be used, i.e., in excess of 100 V.

e) The lining Contractor shall verify in writing to the Owner the coating has been applied and tested according to the manufacturer's recommendations with any repairs required being done at that time.

- (1) The lining Contractor shall warrant the pipe lining for a period of five (5) years against corrosion or deterioration of the pipe.

B. Other Protective Coatings: Coat exposed metal surfaces, steel joint rings, flange connection outlets, and other metal surfaces with self-curing inorganic zinc coating to a finished dry thickness of 2 mils.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Observe all recommendations in accordance with AWWA M9 for installation, delivery, and storage of pipe material.
- B. Furnish and place in position the necessary batter boards, string lines, plummets, graduated poles, laser equipment, targets and incidentals for establishing and maintaining the lines and grades. The batter boards and location stakes must be protected from possible damage or change of location.
 - 1. Lay pipe and fittings and joint in a dry trench. Excavate trenches to the lines, grades, and alignment indicated in accordance with Section 31 21 33 "Trenching, Backfilling and Compacting for Utilities." Unless otherwise authorized by the Owner's representative, start the laying the pipe on the prepared foundation at the outlet or downstream end with the spigot or tongue end of the pipe joint pointing downstream and proceed with laying pipe toward the inlet or upstream end with each abutting section of pipe properly matched, true to the established lines and grades. Approved facilities shall be provided for hoisting and lowering the sections of pipe into the trench without disturbing the prepared bedding foundation or the sides of the trench. Carefully clean the ends of the pipe before the pipe is placed in the trench. As each length of pipe is laid, protect the open end and prevent the entrance of earth or bedding material. Fit and match the pipe so that when laid in the prepared bedding it forms a smooth, uniform conduit. When elliptical pipe with circular reinforcing, or circular pipe with elliptical reinforcing, is used, lay the pipe in the trench so that the markings "Top" or "Bottom" are not be more than 5 degrees from the vertical plane through the longitudinal axis of the pipe. Remove and re-lay, without extra compensation, pipe that is not in alignment or that shows excessive settlement after laying.
 - 2. When conduit lines terminate at locations which do not include connection to drainage structures, plug the end of the pipe with a field cast or precast unit.

3.2 CURING

- A. Cure pipe in accordance with the applicable ASTM Specification for each type of pipe.

3.3 CONCRETE PIPE JOINING

- A. Make joints using cold-applied preformed plastic gaskets as follows:
 - 1. Apply, with brush, a suitable primer of a type recommended by the gasket joint sealer manufacturer to the tongue and groove joint surfaces and the end surfaces and allow to dry and harden. Do not apply primer over mud, sand, or dirt, or sharp cement protrusions. Clean and dry surfaces prior to application of primer.

2. Before laying the pipe in the trench, attach the plastic gasket sealer around the tapered tongue or tapered groove near the shoulder or hub of each pipe joint. Remove the paper wrapper from one side only of the two piece wrapper on the gasket and press it firmly to the clean, dry pipe joint surface. Do not remove the outside wrapper until immediately before pushing the pipe into its final position.
3. When the tongue is correctly aligned with the flare of the groove, remove the outside wrapper on the gasket and pull or push the pipe home with sufficient force and power (back hoe shovel, chain hoist, ratchet hoist, or winch) to cause the evidence of squeeze out of the gasket material on the inside or outside around the complete pipe joint circumference. Remove any joint material that pushed out into the interior of the pipe that would tend to obstruct the flow. (Pipe shall be pulled home in a straight line with all parts of the pipe on line and grade at all times.) Backfilling of pipe laid with plastic gasket joints may proceed as soon as the joint has been inspected and approved by the Engineer. Take special precautions in placing and compacting backfill to avoid damage to the joints.
4. When the atmospheric temperature is below 60° F, store plastic joint seal gaskets either in an area warmed to above 70° F, or artificially warmed to this temperature in a manner satisfactory to the Engineer. Apply gaskets to pipe joints immediately prior to placing the pipe in the trench, then make connections to previously laid pipe.

3.4 CURVES AND FITTINGS

A. Curves:

1. Observe Drawings for details regarding changes in direction.
 - a. Where changes of direction by curvature is acceptable, perform curve by deflecting pipe at each joint within the permissible joint deflection allowance recommended by the manufacturer.
2. $R = L/2(\tan 1/2 D/N)$ where R = radius of curvature, feet; L=average laid length of pipe sections measured along the centerline, feet; D = total deflection angle of curve, degrees; N = number of pipe with pulled joints; D/N = total deflection of each pipe, degrees.
 - a. Check D/N from manufacturer.
3. Employ the use of special radius (beveled or mitered) pipe where deflected straight pipe will not provide a short enough change in radius.

B. Fittings:

1. In addition to straight pipe or radius pipe, furnish bends, tees, adapters, closure pieces, and other fittings or specials shown on Drawings or required to complete the work.
 - a. Design fittings to provide same strength as the adjacent piping.

2. Fittings to be smooth or mitered providing mitered angles do not exceed 22-1/2 Degrees and fitting has an R/d greater or equal to 1, where R = radius of bend, IN; d = diameter of pipe, IN.

3.5 THRUST AND ANCHOR BLOCKING

- A. Install cast in place concrete blocking at all bends or install restrained joints.

3.6 BACKFILL

- A. After the pipe has been placed, bedded, and jointed as specified and approved by the Owner or his authorized representative, backfilling shall be done in accordance with Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities.

3.7 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 33 05 16

PRECAST CONCRETE MANHOLE STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast concrete manhole structures and appurtenant items.
 - a. Sanitary sewer manholes and appurtenances.
 - b. Drain manholes and appurtenances.
 - c. Storm sewer manholes and appurtenances.

1.2 MEASUREMENT AND PAYMENT

A. Unit Price.

1. Payment for manholes is on a unit price basis for each manhole type installed.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
 - a. A48 – Standard Specification for Gray Iron Castings.
 - b. A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - c. A615 – Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - d. C150, Standard Specification for Portland Cement.
 - e. C270 – Standard Specification for Mortar for Unit Masonry.
 - f. C443 – Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets.
 - g. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - h. C923, Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
 - i. C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
 - j. D4022, Standard Specification for Coal Tar Roof Cement, Asbestos Containing.

- k. D2665 - Standard Specification Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
Fabrication and/or layout drawings:
 - c. Include detailed diagrams of manholes showing typical components and dimensions, reinforcements and other details.
 - d. Indicate knockout elevations for all piping entering each manhole.
2. Shop drawings of manhole sections, base units and construction details, including reinforcement, jointing methods, materials and dimensions.
3. Summary of criteria used in manhole design including, as minimum, material properties, loadings, load combinations, and dimensions assumed. Include certification from manufacturer that precast manhole design is in full accordance with ASTM C478 and design criteria as established in this Specification.
4. Seal submittal drawings by Professional Engineer registered in State of Texas.

1.5 {PROJECT} {SITE} CONDITIONS (NOT USED)

1.6 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- ##### **A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:**
1. Manhole rings, covers and frames:
 - a. Neenah Foundry.
 - b. Deeter Foundry.
 2. Black mastic joint compound:
 - a. Kalktite 340.
 - b. Tufflex.
 - c. Plastico.

3. Premolded joint compound:
 - a. Ram Nec.
 - b. Kent Seal.
4. Emulsified fibrated asphalt compound:
 - a. Sonneborn Hydrocide 700B Semi-Mastic.

2.2 SANITARY SEWER, STORM AND DRAIN MANHOLE STRUCTURE COMPONENTS

A. Manhole Components:

1. Reinforcement: ASTM C478.
2. Minimum wall thickness: 5 IN.
3. Minimum base thickness: 12 IN.
4. Provide the following components for each manhole structure:
 - a. Base (precast) with integral bottom section or (cast-in-place).
 - b. Precast bottom section(s).
 - c. Precast barrel section(s).
 - d. Precast eccentric transition section.
 - e. Precast adjuster ring(s).
 - f. Precast concrete transition section.
 - g. Precast flat top.
5. Unless dimensioned or specifically noted on Drawings, provide manhole section with minimum 48 IN inside dimensions.

B. Nonpressure Type Frames and Cover:

1. Cast iron frame and covers: ASTM A48, Class 35 (minimum).
2. Ductile iron frame and covers: ASTM A536.
3. Use only cast {ductile} iron of best quality, free from imperfections and blow holes.
4. Furnish frame and cover of heavy-duty construction a minimum total weight of 450 LBS.
5. Machine all horizontal surfaces.
6. Furnish unit with solid nonventilated lid with concealed pickholes.
 - a. Letter covers "SEWER" for all collection system manholes, "DRAIN" for all gravity unit drains returning flow to the headworks, and "STORM" for storm sewer systems.
7. Ensure minimum clear opening of 24 IN DIA.

PRECAST CONCRETE MANHOLE STRUCTURES

C. Pressure Type Frame and Cover:

1. Provide covers meeting the requirements of Paragraph 2.2B and as modified below.
2. Furnish frame and bolted cover of heavy-duty construction.
 - a. Equip unit with six (6) stainless steel countersunk 3/8 IN DIA by 1-1/2 IN long bolts with stainless steel washers.
3. Provide solid lid and minimum 1/8 IN thick x 1/2 IN wide continuous strip neoprene gasket.
4. Furnish unit with a minimum of six (6) anchorage holes and six (6) 6 IN long x 3/4 IN DIA stainless steel anchor bolts.

D. Special Coatings and Joint Treatment:

1. Joints of precast sections:
 - a. Black mastic compound: ASTM D4022.
2. Aluminum components embedded in concrete:
 - a. See Specification Section 09 91 00 – Painting and Protective Coatings for protective coating for aluminum embedded in concrete.
3. Vertical wall surfaces:
 - a. Emulsified fibrated asphalt compound meeting ASTM D1227 Type I for all exterior vertical wall surfaces.

E. Sanitary Sewer Manhole Concrete:

1. Provide all sanitary manholes constructed with Portland ASTM C150, Type I or II cement with a tricalcium aluminate content not to exceed 8 percent.
2. Mix aggregate shall be a minimum of 50 percent crushed limestone.
3. Provide 3000 psi non-shrink grout.

F. Construct barrels for precast manholes from standard reinforced concrete manhole sections of diameter indicated on Drawings. Use various lengths of manhole sections in combination to provide correct height with fewest joints. Design wall sections for depth and loading conditions in this Section, with minimum thickness of 5 inches. Base section shall have minimum thickness of 12 inches under invert.

G. Provide tops to support HS-20 vehicle loading, and receive cast iron frame covers, as indicated on Drawings.

H. Where manholes larger than 48-inch diameter are indicated on Drawings, provide precast base sections with flat slab top precast sections used to transition to 48-inch diameter manhole access riser sections. Transition can be concentric or eccentric unless otherwise shown on Drawings. Locate transition to provide minimum of 7-foot head clearance from base to underside of transition unless otherwise approved by Owner's Representative.

PRECAST CONCRETE MANHOLE STRUCTURES

- I. Design Loading Criteria: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed, by manufacturer, to requirements of ASTM C 478 for depth as shown on Drawings and to resist following loads.
 - 1. AASHTO HS-20 vehicle loading applied to manhole cover and transmitted down to transition and base slabs.
 - 2. Unit soil weight of 120 pcf located above portions of manhole, including base slab projections.
 - 3. Lateral soil pressure based on saturated soil conditions producing an at-rest equivalent fluid pressure of 100 pcf.
 - 4. Internal liquid pressure based on unit weight of 63 pcf.
 - 5. Dead load of manhole sections fully supported by transition and base slabs.
- J. Design: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed according to requirements of ASTM C 478 and the following:
 - 1. Design additional reinforcing steel to transfer stresses at openings. Area of steel to be no less than shown on Drawings.
 - 2. Wall Loading Conditions:
 - a. Saturated soil pressure acting on empty manhole.
 - b. Manhole filled with liquid to a halfway depth as measured from invert to cover, with no balancing external soil pressure.
 - 3. Minimum clear distance between two wall penetrations shall be 12 inches or half diameter of smaller penetration, whichever is greater.
- K. Provide joints between sections with O-ring gaskets conforming to ASTM C 443.
- L. When base is cast monolithic with portion of vertical section, extend reinforcing in vertical section into base.
- M. Precast Concrete Base: Suitable cutouts or holes to receive pipe and connections. Lowest edge of holes or cutouts: for water line manhole, no less than 6 inches above inside surface of floor of base.

2.3 CONCRETE

- A. Conform to requirements of Section 03 05 05 – Testing.
- B. Channel Inverts: Use 5 sack premix (bag) concrete or Class A concrete for inverts not integrally formed with manhole base, with minimum compressive strength of 4000 psi.
- C. Cement Stabilized Sand Foundation: Provide cement stabilized sand foundation under base section in lieu of foundation slab, as shown on Drawings, conforming to requirements of Section 31 32 13.16 – Cement Stabilized Sand.

- D. Concrete Foundation: Provide Class A concrete with minimum compressive strength of 4000 psi for concrete foundation slab under manhole base section where indicated on Drawings.

2.4 MISCELLANEOUS METALS

- A. Provide cast-iron frames, rings, and covers conforming to requirements of Section 33 39 20 – Frames, Grates, Rings, and Covers.

2.5 DROP CONNECTIONS AND STUBS

- A. Provide drop connections and stubs conforming to same pipe material requirements used in main pipe, unless otherwise indicated on Drawings.

2.6 PIPE CONNECTIONS TO MANHOLE

A. Sanitary Sewers:

1. Provide resilient connectors conforming to requirements of ASTM C 923. Use the following materials for metallic mechanical devices as defined in ASTM C 923:
 - a. External Clamps: Type 304 stainless steel.
 - b. Internal, Expandable Clamps on Standard Manholes: Type 304 stainless steel, 11 gauge minimum.
 - c. Internal, Expandable Clamps on Corrosion-Resistant Manholes:
 - 1) Type 316 stainless steel, 11 gauge minimum.
 - 2) Type 304 stainless steel, 11 gauge minimum, coated with minimum 16-mil fusion-bonded epoxy conforming to AWWA C 213.
2. Where rigid joints between pipe and cast-in-place manhole base are specified or shown on Drawings, provide polyethylene-isoprene waterstop meeting physical property requirements of ASTM C 923, such as Press-Seal WS Series, or approved equal.

B. Storm Sewer Connections

1. Provide watertight connections in accordance with ASTM 923 and ASTM F 2510 as applicable.

C. Water Lines:

1. Where smooth exterior pipes (i.e., steel, ductile iron, or PVC pipes) are connected to manhole base or barrel, seal space between pipe and manhole wall with assembly consisting of rubber gasket or links mechanically compressed to form a watertight barrier. Assemblies: Press-Wedge, Res-Seal, Thunderline Link-Seal, or approved equal. See Drawings for placement of assembly in manhole sections.

PRECAST CONCRETE MANHOLE STRUCTURES

2. When connecting concrete or cement mortar coated steel pipes, or as option for connecting smooth exterior pipes to manhole base or barrel, space between pipe and manhole wall may be sealed with an assembly consisting of a stainless steel power sleeve, stainless steel take-up clamp and a rubber gasket. Take-up clamp: minimum of 9/16-inch wide. Provide PSX positive seal gasket system by Press-Seal Gasket Corporation or approved equal.

2.7 NON-SHRINK GROUT

- A. Provide prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only addition of water.
- B. Meet requirements of ASTM C 1107 and have minimum 28-day compressive strength of 7000 psi.

2.8 VENT PIPES

- A. Provide external vent pipes for manholes where indicated on Drawings.
- B. Vent Outlet Assembly: Provide vent outlet assembly as shown on Drawings, constructed of following specified materials:
 1. Flanges: Meet bolt pattern and dimensions for ASME B16.I, 125-pound flanges. Flange bolts shall be Type 304 stainless steel or hot-dip zinc coated, conforming to ASTM A 307, Class A or B.
 2. Coating: Hot-dipped galvanized after fabrication.

2.9 PROHIBITED MATERIALS

- A. Do not use brick masonry for construction of sanitary sewer manholes, including adjustment of manholes to grade. Use only specified materials listed above.

PART 3 - EXECUTION

3.1 MANHOLE CONSTRUCTION

- A. General:
 1. Construct cast-in-place concrete base slabs.
 2. Make inverts with a semi-circular bottom conforming to the inside contour of the adjacent sewer sections.
 3. On all straight runs, lay pipe through manhole and cut out top half of pipe.
 - a. See detail on Drawings.
 - b. If pipes deflect at manhole, shape as specified in the preceding and following paragraphs.
 4. Shape inverts accurately and steel trowel finish.

PRECAST CONCRETE MANHOLE STRUCTURES

- a. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert using as large a radius as manhole inside diameter will permit.
- b. Pour base slab integral with bottom barrel section.

3.2 BUILD EACH MANHOLE TO EXAMINATION

- A. Verify that lines and grades are correct.
- B. Determine if subgrade, when scarified and recompact, can be compacted to 95 percent of maximum Standard Proctor Density according to ASTM D 698 prior to placement of foundation material and base section. When proper density is not reached, moisture-condition subgrade until that density is reached or treat as unstable subgrade.
- C. Do not build manholes in ditches, swales, or drainage paths unless approved by Owner's Representative.

3.3 PLACEMENT

- A. Install precast manholes to conform to locations and dimensions shown on Drawings and at such elevation that pipe sections built into wall of manhole will be true extensions of line of pipe.
- B. For all horizontal mating surfaces between concrete and concrete or concrete and metal, above established high groundwater elevation shown trowel apply to clean surface black mastic joint compound to a minimum wet thickness of 1/4 IN immediately prior to mating the surfaces.
- C. For horizontal joints that fall below established high groundwater elevation shown, install a resilient O-ring type gasket or pre-molded joint compound.
- D. Seal all pipe penetrations in manhole.
 1. Form pipe openings smooth and well-shaped.
 2. After installation, seal cracks with, non-shrink grout.
 3. After grout cures, wire brush smooth and apply two coats emulsified fibrated asphalt compound to minimum wet thickness of 1/8 IN to ensure complete seal.
- E. Set and adjust frame and cover final 6 IN (minimum) to 18 IN (maximum) to match finished pavement or finished grade elevation using precast adjuster rings.
- F. Place sanitary and storm manholes at points of change in alignment, grade, size, pipe intersections, and end of sewer unless otherwise shown on Drawings.

3.4 MANHOLE BASE SECTIONS AND FOUNDATIONS

- A. Place precast base on 12-inch-thick (minimum) foundation of crushed stone wrapped in filter fabric, cement stabilized sand, or concrete foundation slab. Compact cement-sand in accordance with requirements of Section 31 32 13.16 - Cement Stabilized Sand.

PRECAST CONCRETE MANHOLE STRUCTURES

- B. Unstable Subgrade Treatment: When unstable subgrade is encountered, notify Owner's Representative for examination of subgrade to determine if subgrade has heaved upwards after being excavated. When heaving has not occurred, over-excavate subgrade to allow for 24-inch-thick layer of crushed stone wrapped in filter fabric as foundation material under manhole base. When there is evidence of heaving, provide pile-supported concrete foundation, as detailed on Drawings, under manhole base.

3.5 PRECAST MANHOLE SECTIONS

- A. Install sections, joints, and gaskets in accordance with manufacturer's printed recommendations.
- B. Install precast adjustment rings above tops of cones or flat-top sections as required to adjust finished elevation and to support manhole frame.
- C. Seal any lifting holes with non-shrink grout.
- D. Place at least two precast concrete grade rings with thickness of 12 inches or less, under casting.

3.6 PIPE CONNECTIONS AT MANHOLES

- A. Install approved resilient connectors at each pipe entering and exiting manholes in accordance with manufacturer's instructions.
 - 1. Where smooth exterior pipes (i.e. steel, ductile iron or PVC pipes) are connected to manhole base or barrel, space between pipe and manhole wall shall be sealed with an assembly consisting of rubber gaskets or links mechanically compressed to form watertight barrier. Assemblies: "Press-Wedge," "Res-Seal," "Thunderline Link-Seals," or approved equal. See Drawings for placement of assembly in manhole sections.
 - 2. When connecting concrete or cement mortar coated steel pipes, or as an option for connecting smooth exterior pipes to manhole base or barrel, space between pipe and manhole wall may be sealed with an assembly consisting of stainless steel power sleeve, stainless steel take-up clamp and rubber gasket. Take-up clamp: minimum of 9/16-inch wide. Provide PSX positive seal gasket system by Press-Seal Gasket Corporation or approved equal.
- B. Grout storm sewer connections to manhole unless otherwise shown on Drawings. Grout pipe penetration in place on both inside and outside of manhole.
- C. Ensure no concrete, cement stabilized sand, fill, or other rigid material is allowed to enter space between pipe and edge of wall opening at and around resilient connector on either interior or exterior of manhole. If necessary, fill space with compressible material to ensure full flexibility provided by resilient connector.

D. Where new manhole is constructed on existing sewer, rigid joint pipe may be used. Install waterstop gasket around existing pipe at center of cast-in-place wall. Join ends of split waterstop material at pipe springline using an adhesive recommended and supplied by waterstop manufacturer.

E. Test connection for watertight seal before backfilling.

3.7 INVERTS FOR SANITARY SEWERS

A. Construct invert channels to provide smooth flow transition waterway with no disruption of flow at pipe-manhole connections. Conform to following criteria:

1. Slope of Invert Bench: 1 inch per foot minimum; 1-1/2 inches per foot maximum.
2. Depth of Bench to Invert:
 - a. Pipes smaller than 15 inches: one-half of largest pipe diameter.
 - b. Pipes 15 to 24 inches: three-fourths of largest pipe diameter.
 - c. Pipes larger than 24 inches: equal to largest pipe diameter.
3. Invert Slope through Manhole: 0.10 foot drop across manhole with smooth transition of invert through manhole, unless otherwise indicated on Drawings.

B. Form invert channels with concrete if not integral with manhole base section. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature. Provide curves for side inlets and smooth invert fillets for flow transition between pipe inverts.

3.8 DROP CONNECTIONS FOR SANITARY SEWERS

A. Backfill drop assembly with crushed stone wrapped in filter fabric, cement stabilized sand, or Class A concrete to form solid mass. Extend cement stabilized sand or concrete encasement minimum of 4 inches outside bells.

B. Install drop connection when sewer line enters manhole higher than 24 inches above invert of manhole.

3.9 STUBS FOR FUTURE CONNECTIONS

A. In manholes, where future connections are indicated on Drawings, install resilient connectors and pipe stubs with approved watertight plugs.

3.10 MANHOLE FRAME AND ADJUSTMENT RINGS

A. Combine precast concrete or HDPE adjustment rings so elevation of installed casting cover matches pavement surface. Seal between concrete adjustment ring and precast top section with non-shrink grout; do not use mortar between adjustment rings. Apply latex-based bonding agent to precast concrete surfaces joined with non-shrink grout. Set cast iron frame on adjustment ring in bed of approved sealant material. Install sealant bed consisting of two beads of sealant, each bead having minimum dimensions of 1/2-inch and 1/2-inch wide.

PRECAST CONCRETE MANHOLE STRUCTURES

- B. Wrap manhole frame and adjustment rings with external sealing material, minimum 3 inches beyond joint between ring and frame and ring and precast section.
- C. For manholes in unpaved areas, set top of frame minimum of 6 inches above existing ground line unless otherwise indicated on Drawings. In unpaved areas, encase manhole frame in mortar or non-shrink grout placed flush with face of manhole ring and top edge of frame. Provide rounded corner around perimeter.

3.11 BACKFILL

- A. Place and compact backfill materials in area of excavation surrounding manholes in accordance with the requirements of Section 31 21 33 – Trenching, Backfilling and Compacting for Utilities. Provide embedment zone backfill material, as specified for adjacent utilities, from manhole foundation up to an elevation 12 inches over each pipe connected to manhole. Provide trench zone backfill, specified for adjacent utilities, above embedment zone backfill.
- B. Where rigid joints are used for connecting existing sewers to manhole, backfill under existing sewer up to springline of pipe with Class B concrete or flowable fill.
- C. In unpaved areas, provide positive drainage away from manhole frame to natural grade.

3.12 PROTECTION

- A. Protect manholes from damage until subsequent work has been accepted. Repair or replace damaged elements of manholes at no additional cost to Owner.

3.13 OWNER TRAINING (NOT USED)

END OF SECTION

Section 33 05 16.01
CAST-IN-PLACE CONCRETE MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Cast-in-place concrete manholes and storm sewers, including box sewers. Pile-supported concrete foundation used for unstable

1.2 MEASUREMENT AND PAYMENT

A. Unit Price.

1. Payment for manholes is on a unit price basis for each manhole type installed, exclusive of water transmission line manholes.

1.3 REFERENCES

A. ASME B16.1 – Standards Pipes Fittings.

2. ASTM International (ASTM):

- a. A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- b. C270 - Standard Specification for Mortar for Unit Masonry.
- c. C443 – Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
- d. C923 - Standard Specifications for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
- e. C1107 - Standard Specification for Packaged Dry, Hydraulic - Cement Grout (Nonshrink).
- f. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³(600 kN-m/m³).
- g. D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

1.3 SUBMITTALS

A. Shop Drawings:

1. Submit proposed design mix and test data for each type and strength of concrete.

B. Submit manufacturer's data and details of following items for approval:

1. Frames, grates, rings, and covers.

2. Materials to be used in fabricating drop connections.
3. Materials to be used for pipe connections at manhole walls.
4. Materials to be used for stubs and stub plugs.
5. Plugs to be used for sanitary sewer hydrostatic testing.
6. Installation instruments for forms.

PART 2 - PRODUCTS

2.1 CONCRETE

- A. Conform to requirements of Section 03 09 00.
- B. Channel Inverts: Use 5 sack premix (bag) concrete or Class A concrete for inverts not integrally formed with manhole base, with minimum compressive strength of 4000 psi.
- C. Cement Stabilized Sand Foundation: Provide cement stabilized sand foundation under base section in lieu of foundation slab, as shown on Drawings, conforming to requirements of Section 31 32 13.16 - Cement Stabilized Sand.
- D. Concrete Foundation: Provide Class A concrete with minimum compressive strength of 4000 psi for concrete foundation slab under manhole base section where indicated on Drawings.

2.2 MORTAR

- A. Conform to requirements of ASTM C 270, Type S using Portland cement.

2.3 MISCELLANEOUS METALS

- A. Provide cast-iron frames, grates, rings, and covers conforming to requirements of Section 33 39 20 - Frames, Grates, Rings, and Covers.

2.4 DROP CONNECTIONS AND STUBS

- A. Provide drop connections and stubs conforming to same pipe material requirements used in main pipe, unless otherwise indicated on Drawings.

2.5 PIPE CONNECTIONS

- A. Sanitary Sewers:
 1. Provide resilient connectors conforming to requirements of ASTM C 923. Use the following materials for metallic mechanical devices as defined in ASTM C 923:

- a. External clamps: Type 304 stainless steel
- b. Internal, expandable clamps on Standard manholes: Type 304 stainless steel, 11 gauge minimum
- c. Internal, expandable clamps on corrosion-resistant manholes:
 - 1) Type 316 stainless steel, 11 gauge minimum
 - 2) Type 304 stainless steel, 11 gauge minimum, coated with minimum 16 mil fusion-bonded epoxy conforming to AWWA C 213
2. Where rigid joints between pipe and cast-in-place manhole base are specified or shown on Drawings, provide polyethylene-isoprene waterstop meeting physical property requirements of ASTM C 923, such as Pres-Seal WS Series, or approved equal.
- B. Storm Sewers: Use non-shrink grout for storm sewer pipe connections to concrete manholes, unless otherwise shown on Drawings. Grout pipe penetration in place on both inside and outside of manhole.
- C. Water Lines
 1. Where smooth exterior pipes, i.e., steel, ductile iron, or PVC pipes are connected to manhole base or barrel, seal space between pipe and manhole wall with assembly consisting of rubber gasket or links mechanically compressed to form a watertight barrier. Assemblies: Press-Wedge, Pres-Seal, Thunderline, Link-Seals, or approved equal. See Drawings for placement of assembly in manhole sections.
 2. When connecting concrete or cement mortar coated steel pipes, or as option for connecting smooth exterior pipes to manhole base or barrel, space between pipe and manhole wall may be sealed with an assembly consisting of a stainless steel power sleeve, stainless steel take-up clamp and a rubber gasket. Take-up clamp: Minimum of 9/16 inch wide. Provide PSX positive seal gasket system by Press-Seal Gasket Corporation or approved equal.

2.6 SEALANT MATERIALS

- A. Provide sealing materials between precast concrete adjustment ring and manhole cover frame, such as Adeka Ultraseal P 201, or approved equal.
- B. Provide external sealing material from Canusa WrapidSeal manhole encapsulation system, or approved equal.
- C. Butyl Sealant: Provide Press-Seal Gasket Corporation EZ-Stick Sealant or equal, for HDPE rings.

2.7 CORROSION-RESISTANT MANHOLE MATERIALS

- A. Where corrosion-resistant manholes or PVC-lined manholes are indicated on the Drawings, provide one of the following:
 - 1. PVC liner for precast cylindrical manhole section, base sections, and cone sections.
 - 2. Precast base sections lined with PVC and fiberglass manhole sections and cone sections.

2.8 BACKFILL MATERIALS

- A. Conform to the requirements of Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities.

2.9 NON-SHRINK GROUT

- A. Provide prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based non-shrink grout requiring only addition of water.
- B. Provide grout meeting requirements of ASTM C 1107 and having minimum 28-day compressive strength of 7,000 psi.

2.10 VENT PIPES

- A. Provide external vent pipes for manholes where indicated on Drawings.
- B. Vent Outlet Assembly: Provide vent outlet assembly as shown on Drawings, constructed of following specified materials.
 - 1. Flanges: Meet bolt pattern and dimensions for ASME B 16.1, 125-pound flanges. Use Type 304 stainless steel or hot-dip zinc coated, conforming to ASTM A 307, Class A or B flange bolts.
 - 2. Coating: Hot-dipped galvanized after fabrication.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify lines and grades are correct.
- B. Determine if subgrade, when scarified and recompact, can be compacted to 95 percent of maximum Standard Proctor Density according to ASTM D 698 prior to placement of foundation material and base section. When proper density cannot be reached, moisture condition subgrade until that density is reached or treat as an unstable subgrade.
- C. Do not build manholes in ditches, swales, or drainage paths unless approved by Owner's representative.

3.2 MANHOLES

- A. Construct manholes to dimensions shown on Drawings. Commence construction as soon as possible after pipes are laid. On monolithic sewers, construct manholes at same time sewer is being constructed.
- B. Unstable Subgrade Treatment: When unstable subgrade is encountered, notify Owner's representative for examination of subgrade to determine if subgrade has heaved upwards after being excavated. When heaving has not occurred, over-excavate subgrade to allow for 24-inch-thick layer of crushed stone wrapped in filter fabric as foundation material under manhole base. When there is evidence of heaving, provide pile-supported concrete foundation, as detailed on Drawings, under manhole base.
- C. Cast manhole foundations and walls monolithically. Use cold joint with approved waterstop when manhole flow line depth exceeds 12 feet. No other joints will be allowed unless shown on Drawings. Wrap cold joints with external sealing material, minimum 6-inch width.
- D. For concrete containing micro silica admixtures, place, finish, and cure concrete for manholes following procedures in Section 03 31 30 – Concrete, Materials, and Proportioning.
- E. Top of manhole elevations shown on Drawings are approximate, based on current pavement and natural ground conditions as determined from elevations measured on 50-foot spacings. No additional payment will be made if final elevation of manhole ring and cover is higher or lower due to requirements of finished grade or replaced pavement surface.

3.3 PIPE CONNECTIONS

- A. Install approved resilient connectors at each pipe entering and exiting water line and sanitary sewer manholes in accordance with manufacturer's instructions.
- B. Grout storm sewer connections to manhole unless otherwise shown on Drawings. Grout pipe penetrations both inside and outside of manhole.
- C. Ensure no concrete, cement stabilized sand, fill, or other solid material is allowed to enter space between pipe and edge of wall opening at and around resilient connector on interior or exterior of manhole. When necessary, fill space with compressible material to ensure resilient connector will maintain full flexibility where evidence of reduced flexibility is encountered.
- D. Where new manhole is to be constructed on existing sewer, a rigid joint pipe may be used. Install waterstop gasket around existing pipe at center of cast-in-place wall. Join ends of split waterstop material at pipe spring line using adhesive recommended and supplied by waterstop manufacturer.

- E. Do not construct joints on sanitary sewer pipe within wall sections of manholes. Use approved connection material.
- F. Construct pipe stubs with resilient connectors for future connections at locations and with material indicated on Drawings. Install approved stub plugs at interior of manhole.
- G. Test connection for watertight seal before backfilling.

3.4 INVERTS FOR SANITARY SEWERS

- A. Construct invert channels to provide smooth flow transition waterway with no disruption of flow at pipe-manhole connections. Conform to following criteria:
 - 1. Slope of invert bench: 1 inch per foot minimum; 1½ inch per foot maximum.
 - 2. Depth of bench to invert:
 - a. Pipes smaller than 15 inches: one-half of largest pipe diameter
 - b. Pipes 15 to 24 inches: three-fourths of largest pipe diameter
 - c. Pipes larger than 24 inches: equal to largest pipe diameter
 - 3. Invert slope through manhole: 0.10 foot drop across manhole with smooth transition of invert through manhole, unless otherwise indicated on Drawings.
- B. Form invert channels with Class A concrete if not integral with manhole base. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature. Provide curves for side inlets and smooth invert fillets for flow transition between pipe inverts.

3.5 DROP CONNECTIONS FOR SANITARY SEWERS

- A. Backfill drop assembly with crushed stone wrapped in filter fabric, cement-stabilized sand, or Class A concrete to form solid mass. Extend cement stabilized sand or concrete encasement minimum of 4 inches outside bells.
- B. Install connection when sewer line enters manhole higher than 24 inches above invert of manhole.

3.6 STUBS FOR FUTURE CONNECTIONS

- A. In manholes where future connections are indicated on Drawings, install resilient connectors and pipe stubs with approved watertight plugs.

3.7 ADJUSTMENT RINGS AND FRAME

- A. Combine precast concrete or HDPE adjustment rings so elevation of installed casting cover matches pavement surface. Seal between concrete adjustment ring and precast top section with non-shrink grout; do not use mortar between adjustment rings. Apply latex-based bonding agent to precast concrete surfaces to be joined with non-shrink grout. Set cast iron frame on adjustment ring in a bed of approved sealant material. Install a sealant bed consisting of two beads of sealant, each bead having minimum dimensions of ½-inch and ½-inch wide.
- B. Wrap manhole frame and adjustment rings with external sealing material, minimum 3 inches beyond joint between ring and frame, and ring and precast section.
- C. For manholes in unpaved areas, set top of frame minimum of 6 inches above existing ground line unless otherwise indicated on Drawings. Encase manhole frame in mortar or non-shrink grout placed flush with face of manhole ring and top edge of frame. Provide rounded corner around perimeter.

3.8 BACKFILL

- A. After concrete obtains adequate strength, place, and compact backfill materials in area of excavation surrounding manholes in accordance with requirements of Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities. Use embedment zone backfill material for adjacent utilities, as shown in details over each pipe connected to manhole. Provide trench zone backfill, as specified for adjacent utilities, above embedment zone backfill.
- B. Where rigid joints are used for connecting existing sewers to manhole, backfill under existing sewer up to spring line of pipe with Class B concrete or flowable fill.
- C. In unpaved areas, provide positive drainage away from manhole frame to natural grade. Provide minimum of 4 inches of topsoil conforming to requirements of Section 31 91 05 – Topsoiling and Finished Grading. Seed in accordance with Section 32 92 13 - Hydro-Mulching or sod disturbed areas in accordance with Section 32 90 00 – Seeding, Sodding, and Landscaping.

3.9 PROTECTION

- A. Protect manholes from damage until subsequent work has been accepted. Repair or replace damaged elements of manholes at no additional cost to Owner.

END OF SECTION

SECTION 33 05 23.13

WATER LINE HORIZONTAL DIRECTIONAL DRILLING

Part 1 - GENERAL

1.1 SUMMARY

- A. Section includes
 - 1. Methods and materials for installing water mains by the horizontal directional drilling (HDD).
- B. Related Specifications Sections include, but are not necessarily limited to:
 - 1. Division 00 – Proposing Requirements, Contract Forms, and conditions of
 - 2. Division 01 – General Requirements
 - 3. Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities.
 - 4. Section 33 11 12.01 – Fusible PVC Pipe.
 - 5. Section 33 11 15 – High Density Polyethylene (HDPE) Solid and Profile Wall Pipe.
 - 6. Section 33 11 13 – Water Main Construction.
 - 7. Section 33 11 13.04 – Hydrostatic Testing of Pipelines.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.
 - 1. See Section 33 11 13 – Water Main Construction for payment of waterlines constructed by trenchless methods (including horizontal directional drilling).

1.3 DEFINITIONS

- A. Work Plan: Written description, together with supporting documentation that defines plans and procedures for tunnel method operations which will allow the Owner's Representative and the Engineer to verify the proposed method will meet the requirements of the Drawings and Specifications.
- B. Contractor's Engineer: Professional Engineer licensed in the State of Texas employed or subcontracted by the Contractor to prepare designs on behalf of the Contractor

1.4 REFERENCE STANDARDS

- A. The publications listed below form a part of this specification to extent referenced. Publications are referred to in the text by abbreviations only:
 - 1. American National Standards Institute (ANSI)
 - a. ANSI B16.1 Cast-Iron Pipe Flanges and Flanged Fittings
 - 2. ASTM International (ASTM):

- a. ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate Sheet and Strip for Pressure Vessels and for General Applications
3. American Petroleum Institute
 - a. API Spec. 13A, Specification for Oil Well Drilling Fluids
4. NSF National Sanitation Foundation
 - a. NSF Standard 61 – Drinking Water System – Health Components
5. American Association of State Highway and Transportation Officials (AASHTO). Load and Resistance Factor Bridge Design Specification
6. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering

1.5 REGULATORY REQUIREMENTS

- A. Conform to TxDOT requirements for installations under State Highways.
- B. Installations Under Railroads:
 1. Secure and comply with requirements of right-of-entry for crossing railroad company's easement or right-of-way from railroad companies affected. Comply with railroad permit requirements.
 2. Damages due to delays caused by railroad requesting work to be done at hours which will not inconvenience railroad will be at no additional cost to Owner.
 3. Maintain equipment and excavations minimum 35-foot clearance from centerline of tracks.

1.6 SUBMITTALS

- A. Work Plan: Submit a work plan for work covered under this section. Work Plan shall describe common items of work for all sites on this project and specific items of work for each particular work site if substantially different conditions exist. The contractor may request changes to the proposed vertical and horizontal alignment of the installation and the location of the entry and exit points. Proposed changes shall be submitted in the Work Plan and must receive written approval prior to construction. If the proposed entry point is within an easement, it must remain wholly within the easement and the pipeline route and exit must remain in the easement shown on the construction drawings. Contractor shall not commence work on items described in Contractor's Work Plan until submittals have been reviewed. Review by the Owner's Representative and Engineer shall not be construed to relieve Contractor of any responsibilities under Contract. All structural designs and other engineered components prepared by the Contractor must be designed, signed and sealed by the Contractor's Engineer

1. Include written description identifying details of proposed method of construction and sequence of operations to be performed to demonstrate the proposed materials and procedures will meet requirements of the Drawings and Specifications
2. Include arrangement drawings and technical specifications of equipment to be used and a list of experience (projects with similar size and scope) with this type of equipment and method for both Contractor and proposed operator. Include description of method for accurately monitoring location of pilot bore throughout bore using electronic detection system. Electronic detection equipment must be capable of achieving accuracy within 0.1 feet at all points throughout bore..
3. Include Fusion Technician qualifications and fusing procedures.
4. Include Boring Technicians qualifications and experience record
5. Include a plan and profile drawing at 1"= 40' horizontal and 1"= 4' vertical scale for each trenchless location that indicates the pit/shaft or entrance and exit locations, stationing and elevation of the beginning and end of the carrier pipe and casing (if applicable). Include on the plan and profile, locations and elevations of existing utilities and lines from the Critical Location Report (See Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities) and other utilities as on the Drawings or as located in the field and the elevations of the proposed pipe or casing at each of the utility locations. The proposed vertical and horizontal clearances between the bored pipe and any existing/proposed conflicting pipes, conduits or obstructions cannot exceed the guidance system accuracy tolerance by a minimum of 100%.
6. Address the location of the drill rig setups and for multiple bores, the lengths of each bore based on soil condition, equipment used, topography, etc
7. Include layout and design details of any proposed access pits or shafts (if applicable) including dimensions and elevations with respect to the pipe and casing installation.
8. Include data on pipe materials to be used (from the specified approved options for pipe materials) and data on casing materials including diameter and thickness of casings.
 - a. Provide joining details for casings sections (if applicable).
 - b. Provide details for joining pipe used for trenchless construction to pipe used for open cut construction, if different materials are proposed.
 - c. Pipe Size.
 - d. Dimensionality.
 - e. Pressure Class per applicable standard.
 - f. Color.

- g. Recommended minimum bending radius.
- h. Recommended maximum safe pulling force and controls t help no exceed that force.
- 9. Include a drilling fluid plan which details types of drilling fluids, cleaning and recycling equipment, estimated flow rates, and procedures for minimizing drilling fluid escape.
- 10. Include description of the method of controlling line and grade of excavation and the reference points used to check line and grade for each site.
- 11. Include description of muck and fluid removal methods, including type of equipment and method of soil transportation and storage type and number and locations of disposal sites.
- 12. Include monitoring plan describing monitoring to assess and detect and record ground settlement or movement. Monitoring plans are not required for pipes or casings less 100 feet in length or less than 6 inches in diameter unless required by a railroad or TxDOT or other agency permit. Plan to indicate location of proposed monitoring points and initial survey readings,
- 13. Include any additional Geotechnical Investigation the Contractor performs at his own expense to adequately assess the sub surface conditions
- 14. Include description of any special activities at utility crossings or potentially affecting other facilities where special precautions must be taken during construction.

1.7 DESIGN CRITERIA

- A. Contractor is responsible for design of horizontal directional drilling system and meeting the minimum criteria provided in the Contract Drawings and these specifications. Contractor's Engineer to design for appropriate loading conditions, including, but not limited to: overburden and lateral earth pressures, handling and installation stresses, loads imposed by horizontal drilling operations, subsurface soil and water loads, and all other conditions of service.
- B. If HDD is permitted by the railroad, use Cooper E-80 locomotive loading distributions in accordance with AREMA specifications for criteria at railroad crossings or other loadings in accordance with permit. Account for additive loadings for multiple tracks in design, if applicable.
- C. If HDD is permitted by TxDOT, use HL93 vehicle loading distributions for truck loading criteria in accordance with AASHTO.
- D. Compatibility of Methods: Use HDD methods that are compatible with the balance of the project and restrictions on work, such as influence on existing installations or potential groundwater contamination.

1.8 QUALIFICATIONS

- A. Directional drilling and pipe installation shall be done only by an experienced personnel or subcontractor specializing in directional drilling and whose key personnel have at least five (5) years experience in HDD work. Personnel or HDD subcontractor shall have installed directionally drilled pipe at least as large as the size of pipe being installed in this contract and, have performed installations at least as long as the pipe being installed in this contract.
- B. Fusion Technician shall be fully qualified by the pipe supplier to install fusible pipe of the type and size being used. Qualification shall be current as of the actual date of fusion performance on the project.

1.9 WARRANTY (NOT USED)**Part 2 - PRODUCTS****2.1 MATERIALS****A. Pipe materials**

- 1. Unless a specific pipe material is indicated on the Drawings the Contractor shall select from the allowable pipe materials listed in the Sections below based on the requirements of the Work and his construction means and methods. Only one type of pipe material may be used from the material alternates allowed. Contractor is responsible to ensure type of pipe selected and resulting methods and means comply with requirements and limitations set forth herein and on Drawings.
 - a. Section 33 11 12.01 – Fusible Polyvinyl Chloride (PVC) Pipe
 - b. Section 33 11 15 – High Density Polyethylene (HDPE) Solid and Profile Wall Pipe
- 2. Pipe Manufacturer: Selected manufacturer performance history shall be minimum 5 years of successful field installations with proposed pipe diameter and proposed type of pipe joint.
- 3. Pipe Material standards: Conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 and have certified by an organization accredited by ANSI.
- 4. Coordinating pipe materials with other contractors and differing pipe materials:
- 5. When Contractor's selected pipe material joins to pipes of different material and/or different coatings to be constructed by others, Contractor shall request the Owner's representative to identify the type of pipe in the adjoining contract.
 - a. If the adjoining contract is scheduled to complete the adjoining waterline first, Contractor shall provide an approved connection with insulating kit and isolation test station at no additional cost to the Owner.

- b. If Contractor's pipe is scheduled to complete first the other contractor will provide the insulating kit and isolation test station.

Part 3 - EXECUTION

3.1 ALIGNMENT

- A. The proposed plan and profile installation locations are based on alignments to accommodate acquired easements, to avoid obstructions, and to properly maintain operation flow velocities.

3.2 PROCEDURES

- A. All pipe shall be cut, fabricated, and installed in strict conformance with the pipe manufacturer's recommendations.
- B. Joining, laying, and pulling of the pipe shall be accomplished by personnel experienced in working with the selected pipe material.
- C. The pipe supplier shall certify in writing that the Contractor is qualified to join the pipe or representative of the pipe manufacturer shall be on site to oversee the pipe joining. Expense for the representative shall be paid for by the Contractor.

3.3 HANDLING PIPE

- A. All of the pipe supplier's guidelines shall be followed for handling the pipe.
- B. The handling of the joined pipeline shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects.
- C. Ropes, fabric, or rubber protected slings and straps shall be used when handling pipes.
- D. Chains, cables, or hooks inserted into the pipe ends shall not be used.
- E. Two slings spread apart shall be used for lifting each length of pipe.
- F. Pipe or fittings shall not be dropped onto rocky or unprepared ground.
- G. Slings for handling the pipeline shall not be positioned at butt-fused joints
- H. Sections of the pipes with cuts and gouges exceeding 10 percent of the pipe wall thickness or kinked sections shall be removed and the ends rejoined.
- I. The open ends of all sections of joined and/or installed pipe (not in service) shall be plugged at night to prevent animals or foreign material from entering the pipe line or pipe section.
- J. Waterproof nightcaps of approved design may be used but they shall also be so constructed that they will prevent the entrance of any type of natural precipitation into the pipe and will be fastened to the pipe in such a manner that the wind cannot blow them loose.
- K. Stuffing cloth or paper in the open ends of the pipe is unacceptable.

- L. Where possible, the pipe shall be raised and supported at a suitable distance back from the open end such that the open end will be below the level of the pipe at the point of support.

3.4 INSTALLATION

- A. The Contractor shall install the pipelines by means of horizontal directional drilling. The Contractor shall assemble, support, and pretest the pipeline prior to installation in the directional drill tunnel.
- B. Horizontal directional drilling shall consist of the drilling of a small diameter pilot hole from one end of the alignment to the other, followed by enlarging the hole diameter for the pipeline insertion. The exact method and techniques for completing the directionally drilled installation shall be determined by the Contractor, subject to the requirements of these Specifications.
- C. The Contractor shall prepare and submit a plan to the Engineer for approval for insertion of the pipe into the opened bore hole. This plan shall include pullback procedure, ballasting, use of rollers, side booms and side rollers, coating protection, internal cleaning, internal gauging, hydrostatic tests, dewatering, purging, and disinfection prior to placing pipe in service.
- D. Size drilling and relief pits to provide adequate room to meet operational requirements for horizontal drilling requirements as well as structures indicated on Drawings. Provide minimum 6-inch space between pipe and walls of drilling and relief pits. Maximum allowable width of drilling and relief pits shall be 5 feet. Width of pit at surface shall not be less than at bottom. Maximum allowable length of drilling pit shall be no more than 5 feet longer than one full section of pipe and shall not exceed 25 feet. Maximum allowable length of relief pit shall be 5 feet.
- E. Do not install drilling and relief pits at street intersection between curb returns.
- F. Replace sidewalks, driveways and, pavement removed for relief pits according to local jurisdiction agency requirements and specification Section 33 11 13 – Water Main Construction.
- G. Provide tees and plugs installed in piping subject to internal hydrostatic heads with suitable anchors, joint harnesses, or other acceptable means of preventing movement of pipe caused by internal pressure. Installation shall be completed so that joints are accessible for repair.
- H. Backfill and compact excavations, including relief pits, in accordance with Specification Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities.

3.5 DRILLING OPERATIONS

- A. The Contractor shall prepare a plan to be submitted for Engineer approval which describes the noise reduction program, solids control plan, pilot hole drilling procedure, the reaming operation, and the pullback procedure. All drilling operations shall be performed by supervisors and personnel experienced in horizontal directional drilling. All required support, including drilling tool suppliers, survey system, mud cleaning, mud disposal, and other required support systems used during this operation shall be provided by the Contractor.
- B. Drill pipe shall be API steel drill pipe, Range 2, Premium Class or higher, Grade S-135 in a diameter sufficient for the torque and longitudinal loads and fluid capacities required for the work. Only drill pipe inspected under API's Recommended Practice Specification API RP 7G within 30 days prior to start and certified as double white band or better shall be used.
- C. A smooth drilled pilot hole shall follow the design centerline of the pipe profile and alignment described on the construction drawings.
- D. The position of the drill string shall be monitored by the Contractor with the downhole survey instruments. Contractor shall compute the position in the X, Y, and Z axis relative to ground surface from downhole survey data a minimum of once per length of each drilling pipe (approximately 31 foot interval). Deviations from the acceptable tolerances described in the Specifications shall be documented and immediately brought to the attention of the Engineer for discussion and/or approval. The profile and alignment defined on the construction drawings for the bores define the minimum depth and radius of curvature. At no point in the drilled profile shall the radius of curvature of the bore be less than 600 feet. The Contractor shall maintain and provide the Engineer, upon request, the data generated by the downhole survey tools in a form suitable for independent calculation of the pilot hole profile.
- E. Where ground surface access is available the Contractor shall provide and use a separate steering system employing a ground survey grid system, such as "TRU-TRACKER" or equal wherever possible. The exit point shall fall within a rectangle 5 feet wide and 10 feet long centered on the planned exit point.
- F. During the entire operation, waste and leftover drilling fluids from the pits and cuttings shall be dewatered and disposed of in accordance with all permits and regulatory agencies requirements. Remaining water shall be cleaned by Contractor to meet permit requirements.
- G. Technical criteria for bentonite shall be as given in API Spec. 13A, Specification for Oil Well Drilling Fluids Material for fresh water drilling fluids. Any modification to the basic drilling fluid involving additives must describe the type of material to be used and be included in Contractor's drilling plan presented to the Engineer. The Owner retains the right to sample and monitor the waste drilling mud, cuttings, and water.
- H. Location and protection of underground utilities:

1. Correct location of all underground utilities that may impact the HDD installation is the responsibility of the Contractor, regardless of any locations shown on the drawings or previous surveys completed.
2. Utility location and notification services shall be contacted by the Contractor prior to the start of construction.
3. All existing lines and underground utilities shall be positively identified, including exposing those facilities that are located within an envelope of possible impact of HDD installation as determined for the project specific site conditions.

3.6 JOINING PIPE SECTIONS

- A. Each length of pipe shall be inspected and cleaned as necessary to be free of debris immediately prior to joining.
- B. Pipes shall be joined to one another by means of thermal butt-fusion. Pipe lengths to be joined by thermal butt-fusion shall be of the same type, grade, and class of compound and supplied from the same raw material supplier.
- C. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.
- D. Other equipment specifically required for the fusion process shall include the following:
 1. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, per the pipe supplier's recommendations.
 2. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.
- E. Mechanical connections of the pipe to auxiliary equipment shall be through flanged connections which shall consist of the following:
 1. A "sub end" shall be thermally butt-fused to the ends of the pipe.
 2. Provide ASTM A240, Type 304 stainless steel backing flange, 125-pound, ANSI B16.1 standard, and gaskets as required by the manufacturer.
 3. Stainless steel bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to the manufacturer's standard. Re-torque the nuts after four (4) hours.
 4. Butt-Fusion Joining: Butt fusion of pipes shall be performed in accordance with the manufacturer's recommendations as to equipment and technique. Butt-fusion joining shall be 100 percent efficient offering a joint weld strength equal to or greater than the tensile strength of the pipe.

- F. Inner beads resulting from the butt-fuse operations shall be removed using the Pipe Manufacturer's approved bead trimmer equipment.

3.7 REAM AND PULLBACK

- A. Reaming: Reaming operations shall be conducted to enlarge the pilot after acceptance of the pilot bore. The number and size of reaming operations shall be conducted at the discretion of the Contractor. In the event of a drilling fluid fracture, returns loss or other loss of drilling fluid, the Contractor shall be responsible for restoring any damaged property to original condition and cleaning up the area in the vicinity of the damage or loss.
- B. Pulling Loads: The maximum allowable pull exerted on the pipelines shall be measured continuously and limited to 90 percent of the maximum allowed by the pipe manufacturer so that the pipe or joints are not over stressed.
- C. Torsion and Stresses: A swivel shall be used to connect the pipeline to the drill pipe to prevent torsional stresses from occurring in the pipe.
- D. The lead end of the pipe shall be closed during the pullback operation.
- E. Pipeline Support: The pipelines shall be adequately supported by rollers and side booms and monitored during installation so as to prevent over stressing or buckling during the pullback operation. Such support/rollers shall be spaced at a maximum of 60 feet on centers, and the rollers to be comprised of a non-abrasive material arranged in a manner to provide support to the bottom and bottom quarter points of the pipeline allowing for free movement of the pipeline during pullback. Surface damage shall be repaired by the Contractor before pulling operations resume.
- F. The Contractor shall at all times handle the pipe in a manner that does not over stress the pipe. Vertical and horizontal curves shall be limited so that wall stresses do not exceed 50 percent of yield stress for flexural bending of the pipe. If the pipe is buckled or otherwise damaged, the damaged section shall be removed and replaced by the Contractor at his expense. The Contractor shall take appropriate steps during pullback to ensure the pipe will be installed without damage.
- G. Once pull-back operations have commenced, the operation shall continue without interruption until the pipe is completely pulled through the bore hole.

3.8 TESTING

- A. The pipe shall be hydrostatically tested after joining into continuous lengths prior to installation and again after installation. Pressure and temperature shall be monitored with certified instruments during the test. After this test, the water shall be removed with pigs. Erosion prevention procedures shall be used during removal and discharge of the water.
- B. Hydrostatic testing shall be performed in accordance with Section 33 11 13.04 – Hydrostatic Testing of Pipelines, and in accordance with the pipe manufacturer's recommendations and this Specification.

- C. Test pipe with a minimum pressure of 150 psi or the rated working pressure of the pipe, whichever is greater. The initial pressure test shall be applied and allowed to stand without makeup pressure for a sufficient time to allow for diametric expansion or pipe stretching to stabilize (approximately 2 to 3 hours). After this equilibrium period, the test section can be returned to the required testing pressure, the pump turned off and a final test pressure held for 1 to 3 hours.
- D. All costs associated with acquiring water for hydrostatic testing shall be included in the established contract unit price bid prices.

3.9 HANDLING DRILLING FLUIDS AND CUTTINGS

- A. During the drilling, reaming, or pullback operations, the Contractor shall make adequate provisions for handling the drilling fluids, or cuttings at the entry and exit pits. To the greatest extent practical, these fluids must not be discharged into waterways. When the Contractor's provisions for storage of the fluids or cuttings on site are exceeded, these materials shall be hauled away to a suitable legal disposal site. The Contractor shall conduct his directional drilling operation in such a manner that drilling fluids are not forced through the sub bottom into the waterway. After completion of directional drilling work, the entry and exit pit locations shall be restored to original conditions. The Contractor shall comply with all permit provisions.
- B. Pits constructed at the entry or exit point area shall be so constructed to completely contain the drill fluid and prevent its escape.
- C. The Contractor shall utilize drilling tools and procedures which will minimize the discharge of any drill fluids. The Contractor shall comply with all mitigation measures listed in the required permits and elsewhere in these Specifications.
- D. To the extent practical, the Contractor shall maintain a closed loop drilling fluid system. The drill fluid delivery system shall monitor and maintain constant flow rate and pressure to keep solids moving freely during drilling operations. The mixing system shall be able to ensure thorough mixing of the drilling fluid. The drilling fluid reservoir tank shall be sized for adequate storage of the fluid.
- E. The Contractor shall minimize drilling fluid disposal quantities by utilizing a drilling fluid cleaning system which allows the returned fluids to be reused.
- F. As part of the installation plan specified herein before, the Contractor shall submit a drilling fluid plan which details types of drilling fluids, cleaning and recycling equipment, estimated flow rates, and procedures for minimizing drilling fluid escape.

3.10 ENVIRONMENTAL PROVISIONS

- A. The Horizontal Directional Drilling operation is to be operated in a manner to eliminate the discharge of water, drilling mud, and cuttings to the land areas involved during the construction process. The Contractor shall provide equipment and procedures to maximize the recirculation or reuse of drilling mud to minimize waste. All excavated pits used in the drilling operation shall be lined by Contractor with heavy duty plastic sheeting with sealed joints to prevent the migration of drilling fluids and/or ground water.
- B. The Contractor shall visit the site and must be aware of all structures and site limitations at the directional drill crossing and provide a drilling plan outlining procedures to prevent drilling fluid from adversely affecting the surrounding area.
- C. Waste cuttings and drilling mud shall be processed through a solid control plant comprised as a minimum of sumps, pumps, tanks, desalter/desander, centrifuges, material handlers, and haulers all in a quantity sufficient to perform the cleaning/separating operation without interference with the drilling program. The cuttings and excess drilling fluids shall be dewatered and dried by the Contractor to the extent necessary for disposal in offsite landfills. Water from the dewatering process shall be treated by the Contractor to meet permit requirements and disposed of locally. The cuttings and water for disposal are subject to being sampled and tested. The construction site and adjacent areas will be checked frequently for signs of unplanned leaks or seeps.
- D. Equipment (graders, shovels, etc.) and materials (such as groundsheets, hay, bales, booms, and absorbent pads) for cleanup and contingencies shall be provided in sufficient quantities by the Contractor and maintained at all sites for use in the event of inadvertent leaks, seeps or spills.
- E. Waste drilling mud and cuttings shall be dewatered, dried, and stock piled such that it can be loaded by a front end loader, transferred to a truck, and hauled offsite to a suitable legal disposal site. The maximum allowed water content of these solids is 50 percent of weight.
- F. Dewatering and disposal work shall be concurrent with drilling operations. Treatment of water shall satisfy regulatory agencies before it is discharged.

3.11 CONTROL OF LINE AND GRADE

- A. Construction Controls:
 - 1. Establish or re-establish baselines and benchmarks indicated on Drawings. Check baselines and benchmarks at beginning of Work and report any errors or discrepancies to Owner's Representative.
 - 2. Use baselines and benchmarks to establish and maintain construction control points, reference lines and grades for locating casings, carrier pipe, shafts, pits, and structures.
 - 3. Establish construction control points sufficiently far from work so as not to be affected by ground movement caused by tunneling operations.

- B. Bench Mark Movement. If settlement of ground surface occurs during construction which affects accuracy of temporary benchmarks detect, report such movement to the Owner's Representative and reestablish temporary bench marks.
- C. Pipe installed by the directional drilled method must be located in plan as shown on the Drawings, and must be no shallower than shown on the Drawings, unless otherwise approved by the Owner's Representative.
- D. The Contractor shall plot the actual horizontal and vertical alignment of the pilot bore at intervals not exceeding 30 feet. This "as-built" plan and profile shall be updated as the pilot bore is advanced. The Contractor shall at all times provide and maintain instrumentation that will accurately locate the pilot hole and measure drilling fluid flow and pressure. The Contractor shall grant the Owner's Representative access to all data and readout pertaining to the position of the bore head and the fluid pressures and flows. When requested, the Contractor shall provide explanations of this position monitoring and steering equipment. The Contractor shall employ experienced personnel to operate the directional drilling equipment and, in particular, the position monitoring and steering equipment. No information pertaining to the position or inclination of the pilot bores shall be withheld from the Owner's Representative.
- E. Each entry and exit point shall be located as shown on the approved Work Plan with an over-length tolerance of 10 feet for directional drills of 1,000 linear feet or less and 40 feet for directional drills of greater than 1,000 linear feet, and an alignment tolerance of 5 feet left/right with due consideration of the position of the other exit points and the required permanent easement. In no instance will the pipe be installed outside the pipeline easement. The alignment of each pilot bore must be approved by the Owner's Representative before pipe can be pulled. If the pilot bore fails to conform to the above tolerances, the Owner's Representative may, at his option, require a new pilot boring to be made at no additional cost to the Owner.
- F. After the pipe is in place, cleaning pigs shall be used to remove residual water and debris. After the cleaning operation, the Contractor shall provide and run a sizing pig to check for anomalies in the form of buckles, dents, excessive out-of-roundness, and any other deformations. The sizing pig run shall be considered acceptable if the survey results indicate that there are no sharp anomalies (i.e. dents, buckles, gouges, and internal obstructions) greater than 2 percent of the nominal pipe diameter, or excessive ovality greater than 5 percent of the nominal pipe diameter. For gauging purposes, dent locations are those defined above which occur within a span of five feet or less. Pipe ovality shall be measured as the percent difference between the maximum and minimum pipe diameters. For gauging purposes, ovality locations are those defined above which exceed a span of five feet.

3.12 MONITORING

- A. Surface Settlement Monitoring:

1. Monitor ground surface elevation along length of trenchless operation. Locate and record settlement monitoring points with respect to construction baseline and elevations. Record elevations to accuracy of 0.01 feet for each monitoring point location.
 - a. Railroads: Track subbase (bottom of ballast) at centerline of each track, or as specified in the permit requirements.
 - b. Product pipelines: Directly above and 10 feet before and after utility or pipeline intersection, or as specified in the permit requirements.
 - c. TxDOT and County Roads: As specified in the permit requirements
 - d. At other locations requiring trenchless installation of pipes and casing in excess of 100 feet in length: At 10 feet from each end and at two additional points between each end of each installation (a minimum of 4 points but in no case at more than 50 foot intervals). Establish monitoring points referenced to curbs, or medians or other physical features and control points which can be reestablished after the completion of the Work. For other locations with trenchless installation of pipes or casings less than 100 feet in length or less than 6 inches in diameter, no monitoring points are required except as required in paragraphs a, b and c above.
2. Reading Frequency and Reporting. Take settlement survey readings:
 - a. Prior to tunnel excavation reaching monitoring point in plan
 - b. After tunnel excavation reaches monitoring point in plan
 - c. After installation of pipe or casing and backfill of pit or shaft is complete.
3. Immediately report to Owner's Representative movement, cracking, or settlement which is detected.
4. Following substantial completion, but prior to final completion, make a final survey of monitoring points and report results to Owner's Representative.

3.13 DISPOSAL OF EXCESS MATERIAL

- A. Conform to applicable provisions of Section 01 74 19 – Construction Waste Management and Disposal.

3.14 OWNER TRAINING (NOT USED)

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SECTION 33 11 10
DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ductile iron pipe and fittings for water lines, wastewater force mains, gravity sanitary sewers, and storm sewers.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for ductile iron pipe and fittings under this Section, with the exception of extra fittings in place. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standards Institute/American Water Works Association/ (ANSI /AWWA):
 - a. A 21.4/C 104 – Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings, for Water.
 - b. A 21.10/C 110 – Standard for Ductile-Iron and Gray-Iron Fittings, 3-in. through 48-in.
 - c. A 21.11/C 111 – Standard for Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - d. A 21.15/A C 115 – Standard for Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.
 - e. A21.16/C 116 – Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey iron Fittings for Water Supply Service.
 - f. A 21.50/C 150 – Standard for Thickness Design of Ductile Iron Pipe.
 - g. A 21.51/C 151 – Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water and Other Liquids.
 - h. A 21.53/A C 153 – Standard for Ductile Iron Compact Fittings, 3 inches through 24 inches and 54 inches through 64 inches for Water Service.
2. American Water Works Association (AWWA)
 - a. C 105 Polyethylene encasement for Ductile Iron Pipe Systems.
 - b. C 300 – Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and other Liquids.

- c. C 600 – Standard for Installation of Ductile Iron Water Mains and Their Appurtenances.
- 3. American Society of Mechanical Engineers (ASME):
 - a. B 16.1 – Cast Iron Pipe Flanges and Flanged Fittings.
- 4. ASTM International (ASTM):
 - a. D 1248 – Standard Specification Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable.
 - b. F 477 – Elastomeric Seals (gaskets) for Joining Plastic Pipe.
 - c. G 62 – Standard Test Methods for Holiday Detection in Pipeline Coatings.
- 5. The Society for Protective Coatings (SSPC):
 - a. SP 6 – Steel Structures Painting Council, Commercial Blast Cleaning.
- 6. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.
- 7. American Association of State Highway Transportation Officials (AASHTO).

1.4 SUBMITTALS

- A. Submit manufacturer's certifications that ductile iron pipe and fittings meet provisions of this Section and have been hydrostatically tested at factory and meet requirements of ANSI A 21.51.
- B. Submit certifications that pipe joints have been tested and meet requirements of ANSI A 21.11.
- C. Submit affidavit of compliance in accordance with ANSI A21.16 for fittings with fusion bonded epoxy coatings or linings.

1.5 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE

- A. Ductile Iron Pipe Barrels: Shall conform to AWWA C115, C150, and C151 and bear mark of Underwriters' Laboratories approval. Unless otherwise shown on Drawings, use minimum Pressure Class 150 for water lines and thickness Class 52 for sanitary sewers.
- B. Provide pipe sections in standard lengths, not less than 18 feet long, except for special fittings and closure sections as indicated on shop drawings.
- C. Provide Cathodic Protection System in accordance with Drawings.
- D. Pipe Manufacturer for large diameter water lines: Minimum of 5 years of successful pipe installations in continuous service. Manufacturer must maintain on site or in plant enough fittings to satisfy the following requirements:

Line Diameter	Required Bends*
20 and 24 inches	Four 45° bends per 5,000 LF of water line
> 24 inches	Four 22.5° bends per 10,000 LF of water line

*Based on total length of contract (minimum of four). Any combination of bends may be substituted at manufacturer's option (i.e. two 22.5° bends are equivalent to one 45° bend) and will be counted as one fitting.

- E. Manufacturer or supplier must be capable of delivering bends to job site within 12 hours of notification. Use fittings at direction of Owner's Representative where unforeseen obstacles are encountered during construction. These fittings are in addition to any fittings called out in construction documents and must be available at all times.
- F. Hydrostatic Test of Pipe: AWWA C 151, Section 5.2.1, at point of manufacture. Hold test for a minimum 2 minutes for thorough inspection of pipe. Repair or reject pipe revealing leaks or cracks.
- G. Provide flange adapter with insulating kit as required when connecting new piping to existing piping and piping of different materials, unless otherwise approved by Owner's Representative.
- H. Clearly mark pipe section to show location and thickness/pressure class color coded.
- I. No welding will be permitted on Ductile Iron Pipe except at restrained joint spigots. No field welding is allowed.

2.2 JOINTS

- A. Joint Types: ANSI A 21.11 push-on; ANSI A 21.11 mechanical joint; or ANSI A 21.16 flanged end. Provide push-on joints unless otherwise indicated on the Drawings or required by these specifications. For bolted joints, conform to requirements of AWWA C111; provide minimum 304 stainless steel for restraint joints.
- B. Where required by Drawings, provide approved restrained joints for buried service.
- C. Threaded or grooved-type joints which reduce pipe wall thickness below minimum required are not acceptable.
- D. Provide for restrained joints designed to meet test pressures, as applicable. Provide restrained joints for test pressure or maximum surge pressure as specified, whichever is greater for water lines. Do not use passive resistance of soil in determining minimum restraint lengths.
- E. Electrical Bond Wires: Use stranded, copper cable furnished with high molecular weight polyethylene insulation (HMWPE). Use wire gauge (AWG) as shown on Drawings.

- F. Make curves and bends by deflecting joints. Do not exceed maximum deflection recommended by pipe manufacturer for pipe joints or restraint joints. Submit details of other methods of providing curves and bends for consideration by Owner's Representative. When other methods are deemed satisfactory, install at no additional cost to Owner.

2.3 GASKETS

- A. Furnish, when no contaminant is identified, plain rubber (SBR) gasket material in accordance with ANSI A21.11 or ASTM F 477 (one bolt systems); for flanged joints 1/8-inch-thick gasket in accordance with ANSI A 21.15.
- B. Use appropriate gasket material for installations in potentially contaminated areas.

2.4 FITTINGS

- A. Use fittings of same size as pipe. Reducers are not permitted to facilitate an off-size fitting. Reducing bushings are also prohibited. Make reductions in piping size by reducing fittings. Line and coat fittings as specified for pipe they connect to.
- B. Push-on Fittings: ANSI A 21.10; ductile iron ANSI A 21.11 joints, gaskets, and lubricants; pressure rated at 250 psig.
- C. Flanged Fittings: ANSI 21.10; ductile iron ANSI A 21.11 joints, gaskets, and lubricants; pressure rated at 250 psig.
- D. Mechanical Joint Fittings: ANSI A 21.11; pressure rated at 250 psi.
- E. Ductile Iron Compact Fittings: Shall conform to AWWA C153 and shall be:
 - 1. Fusion bonded epoxy lined or
 - 2. Cement mortar lined
- F. For tangential flanged outlets shown on Drawings, substitute with a tee with an equivalent sized outlet unless otherwise approved by Owner's Representative.

2.5 COATINGS AND LININGS

- A. Water line Interiors: ANSI A21.4, cement lined with seal coat; ANSI A 21.16 fusion bonded epoxy coating for interior; comply with NSF 61.
- B. Sanitary Sewer and Force Main Interiors:
 - 1. Preparation: Commercial blast cleaning conforming to SSPC-SP6.
 - 2. Liner thickness: Nominal 40 mils, minimum 35 mils, for pipe barrel interior; minimum 6 to 10 mils at gasket groove and outside spigot end to 6 inches back from end.
 - 3. Testing: ASTM G 62, Method B for voids and holidays; provide written certification.
 - 4. Acceptable Lining Materials:

- a. Provide approved virgin polyethylene conforming to ASTM D 1248, with inert fillers and carbon black to resist ultraviolet degradation during storage; heat bonded to interior surface of pipe and fittings.
- b. Ceramic Epoxy - Protecto 401 or approved equal
- C. Sanitary Sewer Point Repair Pipe: For pipes which will be lined with high density polyethylene liner pipe or cured-in-place liner, provide cement-lined with seal coat in accordance with ANSI A 21.4. For pipes which will not be provided with named liner, provide pipe as specified in Paragraph 2.5B, Sanitary Sewer and Force Main Interiors.
- D. Encasement and coating requirements:
 - 1. Open cut construction method:
 - a. Provide double wrap polyethylene encasement in accordance with AWWA C105 or
- E. Polyethylene Wrap: For buried water lines not cathodically protected provide polyethylene wrap unless otherwise specified or shown.
- F. For flanged joints in buried service, provide petrolatum wrapping system, Denso, or equal, for the complete joint and alloy steel fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Conform to installation requirements, except as modified in this Section.
- B. Install in accordance with AWWA C 600 and manufacturer's recommendations.
- C. Install double wrap Polyethylene encasement in conformance with requirements of AWWA C105.
- D. Holiday Testing:
 - 1. Fusion Bonded Epoxy: Conform to requirements for new fittings in ANSI A 21.16.
- E. Provide electrical continuity bonding across buried mechanical and push-on joint assemblies, except where insulating flanges are required by Drawings.
 - 1. Provide minimum number of bond wires shown on Drawings. Remove one inch of HMWPE insulation from each end of bond wire prior to attaching.
 - 2. Secure wire onto pipe using approved Thermite Welding procedures.
 - 3. Coat bare metal and weld metal after weld is secure. Use coal-tar compound or other compatible coating. For polyurethane coated pipe, use compatible polyurethane coating.

4. Visually inspect Thermite Weld connections for electrical continuity, strength and suitable coating prior to backfilling or placing pipe in augered hole or casing.

3.2 OWNER TRAINING (NOT USED)

END OF SECTION

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SECTION 33 11 12

POLYVINYL CHLORIDE (PVC) PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyvinyl chloride pressure pipe for water transmission and distribution, in nominal diameters 4 inches through 30 inches.
2. Polyvinyl chloride pressure pipe for water transmission and distribution, in nominal diameters 4 inches through 30 inches.
3. Polyvinyl chloride pressure pipe for gravity sewers and force mains in nominal diameters 4 inches through 30 inches.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Water Works Association/American National Standards Institute (AWWA/ANSI):
 - a. C 110 – American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 Inches through 48 Inches for Water.
 - b. C 111 – American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - c. C 605– Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
 - d. C 900 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches through 12 Inches for Water Distribution.
 - e. C 905 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In., for Water Transmission and Distribution.
 - f. C 909 – Standard for Molecularly-Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 Inches through 12 Inches (100 mm through 300 mm), for Water Distribution
 - g. C 116/A 21.16 – Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey Iron Fittings for Water Supply Service.
2. ASTM International (ASTM):

- a. D 1248 – Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
 - b. D 1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - c. D 2241 – Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 - d. D 2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 - e. D 2444 – Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).
 - f. D 2680 – Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
 - g. D 3034 – Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - h. D 3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
 - i. D 3212 – Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
 - j. F 477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - k. F 679 – Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
 - l. F 794 – Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
 - m. F 949 – Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with Smooth Interior and Fittings.
 - n. F 1674 – Standard Test Method for Joint Restraint Products for Use with PVC Pipe.
- 3. PPI TR3 – Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.
 - 4. Texas Administrative Code (TAC) Rule §290.44 – Texas Commission on Environmental Quality Rules and Regulations for Public Water Systems.

1.4 SUBMITTALS

- 1. Certification that calculations and limits of thrust restraint were performed in accordance with applicable design standards.
- 2. Class and length of joint.

1.5 QUALITY CONTROL

- A. Submit manufacturer's certifications that PVC pipe and fittings meet requirements of this Section and AWWA C 900, AWWA C 909 or AWWA C 905 for pressure pipe applications, or appropriate ASTM standard specified for gravity sewer pipe.
- B. Submit manufacturer's certification that every standard length of PVC pressure pipe for water lines and force mains has been hydrostatically pressure tested in accordance with either AWWA C 900, AWWA C 909 or AWWA C 905. Hydrostatically test each length of pipe, including the integral bell, to four (4) times the rated pressure for minimum two (2) minutes. For 14-inch diameter and greater (AWWA C 905), maximum pressure for hydrostatic test shall not exceed 500 psi.
- C. Markings: All PVC pipe shall be clearly marked in accordance with the pipe standard. Intervals shall not exceed 5 feet.
- D. Acceptance: Pipe may be rejected for failure to comply with any requirement of this specification.

1.6 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Use PVC compounds in manufacture of pipe that contain no ingredient in amount that has been demonstrated to migrate into water in quantities considered to be toxic.
- B. Furnish PVC pressure pipe manufactured from Class 12454 PVC compound as defined in ASTM D 1784, latest version. PVC pipe conforming to AWWA C 900, AWWA C905, and AWWA C909 shall carry the National Sanitation Foundation (NSF) seal of approval and shall be listed with Underwriters Laboratories, Inc. (U.L.). Use compounds qualifying for rating of 4000 psi for water at 73.4 F per requirements of PPI TR3. Provide pipe which is homogeneous throughout, free of any significant voids, cracks, inclusions, and other defects, uniform as commercially practical in color, density, and other physical properties. Deliver pipe with surfaces free from nicks and scratches that are deeper than 10 percent of the minimum wall thickness. Joining surfaces of spigots and joints must be free of gouges and imperfections which could cause leakage.
- C. Water Distribution.
 - 1. Provide PVC pipe that bears Underwriters' Laboratories mark of approval and is acceptable without penalty to Texas State Fire Insurance Committee for use in fire protection lines.
- D. Gaskets:

1. Gaskets shall meet requirements of ASTM F 477. Use elastomeric factory-installed gaskets to make joints flexible and watertight.
 2. Flat Face Mating Flange: Full faces 1/8 inch thick ethylene propylene (EPR) rubber.
 3. Raised Face Mating Flange: Flat ring 1/8 inch ethylene propylene (EDR) rubber, with filler gasket between OD of raised face and flange OD to protect flange from bolting moment.
- E. Lubricant for rubber-gasketed joints: Water soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, having no deteriorating effect on PVC or rubber gaskets.
- F. Do not use PVC in potentially or known contaminated areas unless proof of acceptable chemical resistance of the pipe and gasket are provided to the Owner's Representative.
- G. Do not use PVC in areas exposed to direct sunlight unless a suitable coating is applied to the pipe.

2.2 WATER DISTRIBUTION AND TRANSMISSION PIPE

- A. Pipe 4-inch through 12-inch in diameter: AWWA C 900, AWWA C 909, Class 150, DR 18; AWWA C 900, Class 200, DR 14 as alternate to offset pipe sections; nominal 20-foot lengths; cast-iron equivalent outside diameters.
- B. Pipe 14-inch through 30-inch in diameter: AWWA C 905; Pressure Rated 150 psi; DR 25 minimum; nominal 20-foot lengths; cast-iron equivalent outside diameter.
- C. Make curves and bends by deflecting joints, using high deflection couplers, or large angle fittings, unless otherwise specified. Do not exceed maximum deflection
- D. Hydrostatic Test: Per AWWA C 900, AWWA C 905, AWWA C 909, ANSI A 21.10 (AWWA C 110); at point of manufacture; submit manufacturer's written certification. Perform hydrostatic test in accordance with Paragraph 1.5 B of this Section.

2.3 GRAVITY SEWER PIPE

- A. PVC gravity sanitary sewer pipe and storm sewer pipe shall be in accordance with provisions in following table:

Wall Construction	Manufacturer	ASTM Designation	SDR (Max.)/ Stiffness (Min.)	Diameter Size Range
Solid	JM Eagle CertainTeed Can-Tex Carlton Diamond Plastics	D3034	SDR 26 / PS 115	4" to 15"
		D3034	SDR 35 / PS 46	4" to 15"
		F679	SDR 35 / PS 46	18" to 48"
		AWWA C900	DR 18 / N/A	4" to 12"

POLYVINYL CHLORIDE (PVC) PIPE

Wall Construction	Manufacturer	ASTM Designation	SDR (Max.)/ Stiffness (Min.)	Diameter Size Range
	North American	AWWA C909	PC150 / N/A	6" to 12"
		AWWA C905	DR 18 / N/A	14" to 36"
Truss (Gasketed)	Contech	D2680	N/A /200 psi	8" to 15"
Profile	Contech A-2000	F949	N/A / 46 psi	12" to 36"
	Contech A-2026	F949	N/A / 115 psi	8" to 10"
	JM Eagle, Ultra-Rib	F794	N/A / 46 psi	8" to 24"
	JM Eagle, Ultra-Corr	F794/F949	N/A / 46 psi	21" to 36"

- B. When solid wall PVC pipe 18 inches to 48 inches in diameter is required in PS 115, provide pipe conforming to ASTM F 679, except provide wall thickness as required for SDR 26 and pipe stiffness of 115 psi.
- C. For sewers crossing water lines, conform to requirements of Texas Administrative Code (TAC) Rule § 290.44.
- D. Joints: Spigot and integral wall section bell with solid cross section elastomeric or rubber ring gasket conforming to requirements of ASTM D 3212 and ASTM F 477, or ASTM D 3139 and ASTM F 477. Gaskets shall be factory-assembled and securely bonded in place to prevent displacement. Manufacturer shall test sample from each batch conforming to requirements ASTM D 2444.
- E. Fittings: Provide PVC gravity sewer sanitary bends, tee, or wye fittings for new sanitary sewer construction. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tee or wye fittings are not acceptable.
- F. Conditioning. Conditioning of samples prior to and during tests are subject to approval by Owner's Representative. When referee tests are required, condition specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under same conditions of temperature and humidity unless otherwise specified.
- G. Pipe Stiffness. Determine pipe stiffness at 5% deflection in accordance with Test Method D 2412. Minimum pipe stiffness shall be 46psi. For diameters 4 inches through 18 inches, test three specimens, each a minimum of 6 inches (152 mm) in length. For diameters 21 inches through 48 inches, test three specimens, each a minimum of 12 inches (305 mm) in length.

- H. Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraph 2.04F, in suitable press until internal diameter has been reduced to 60 percent of original inside diameter of pipe. Rate of loading shall be uniform. Test specimens, when examined under normal light and with unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of pipe walls or bracing profiles. Perform the flattening test in conjunction with pipe stiffness test.
- I. Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except that joint shall remain watertight at minimum deflection of 15%. Manufacturer will be required to provide independent third party certification for joint testing each diameter of storm sewer pipe.
- J. Purpose of Tests. Flattening and pipe stiffness tests are intended to be routine quality control tests. Joint tightness test is intended to qualify pipe to specified level of performance.

2.4 SANITARY SEWER FORCE MAIN PIPE

- A. Provide approved PVC pressure pipe conforming to requirements for water service pipe, and conforming to minimum working pressure rating specified for Sanitary Sewage Force Mains.
- B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting requirements of ASTM F 477. In designated areas requiring restrained joint pipe and fittings, use approved joint restraint device conforming to ASTM F 1674, for PVC pipe 30-inch diameter and less.
- C. Fittings: Provide ductile iron fittings as per Section 33 11 10 – Ductile Iron Pipe and Fittings, Paragraph 2.4, except furnish fittings with one of following internal linings:
 - 1. Nominal 40 mils (35 mils minimum) virgin polyethylene complying with ASTM D 1248, heat fused to interior surface of fitting
 - 2. Nominal 40 mils (35 mils minimum) polyurethane
 - 3. Nominal 40 mils (35 mils minimum) ceramic epoxy
 - 4. Nominal 40 mils (35 mils minimum) fusion bonded epoxy
- D. Exterior Protection: Provide polyethylene wrapping of ductile-iron fittings as required by Section 33 11 10 – Ductile Iron Pipe and Fittings.
- E. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with Paragraph 2.2E.

2.5 BENDS AND FITTINGS FOR PVC PRESSURE PIPE

- A. Bends and Fittings: ANSI A 21.10 or ANSI A 21.53, ductile iron; ANSI A 21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating. PVC integral restrained joints, 250 psi, may be provided for up to 12 inches in diameter (water or sanitary).

- B. Provide approved restrained joint fittings: Integral restrained joint fittings and pipe do not require secondary restraint.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Store pipe under cover out of direct sunlight and protect from excessive heat or harmful chemicals in accordance with manufacturer's recommendations.

3.2 INSTALLATION

- A. Conform to requirements of applicable section.
- B. Install PVC pipe in accordance with Section 31 21 33 – Trenching, Backfilling, and Compacting For Utilities, AWWA C 605, ASTM D 2321 for Sewer Pipe, and manufacturer's recommendations.
- C. Install PVC water service pipe to clear utility lines and have minimum depth of cover below property line grade of street, unless otherwise required by Drawings:
 - 1. Water service pipe 12 inches in diameter and smaller 4 feet of cover.
 - 2. Water service pipe 16 inch thru 30-inch in diameter, 6 feet of cover.
- D. Avoid imposing strains that will overstress or buckle pipe when lowering pipe into trench.
- E. Hand shovel pipe bedding under pipe haunches and along sides of pipe barrel and compact to eliminate voids and ensure side support.
- F. Store PVC pipe under cover out of direct sunlight. Protect pipe from excessive heat or harmful chemicals. Prevent damage by crushing or piercing.
- G. Allow PVC pipe to cool to ground temperature before backfilling when assembled out of trench to prevent pullout due to thermal contraction.

3.3 PVC PIPE WITH INTEGRAL RESTRAINED JOINTS

- A. For low-profile coupling with spline-type joints.
 - 1. Do not apply lubricant to spline or pipe or coupling spline grooves.
 - 2. Do not use excessive force while inserting the spline through coupling.
 - 3. Insert spline until it is fully seated around circumference of pipe.
- B. Field Cutting of Pipe Ends:
 - 1. Perform by workers certified by manufacturer.
 - 2. Use a PVC pipe cutter and provide square ends.
 - 3. If disassembly of restrained joint is required after it has been locked in place, follow manufacturer's recommendations for removal.

4. For low-profile coupling with spline-type joint, use manufacturer approved power routing and grooving tool to field fabricate required pipe groove.

3.4 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 33 11 13

WATER MAIN CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Construction of water mains
2. Coordination and interface with existing facilities and utilities.
3. Connections to existing water lines.
4. Testing, flushing and disinfection.

1.2 MEASUREMENT AND PAYMENT

A. Measurement:

1. Mains: Measure along axis of pipe and including through fittings and valves.
2. Branch Pipe: Measure from axis of water main to end of branch, through fittings, bends, adapters and valves.

B. Unit Prices:

1. Payment for water lines installed by open-cut is on a linear foot basis for each size of pipe installed.
2. Payment for removal and repair/replacement of Concrete Pavement will be in accordance with Section 32 13 13 – Concrete Pavement, Curb, Sidewalks and Steps.
3. No separate payment is to be made for sanitary sewer crossings. Include cost in bid unit price for water main.
4. Payment for Air Release and Vacuum Relief Valves, Butterfly Valves, Gate Valves, Flushing Hydrants and the appurtenances associated with these items will be made in accordance with the particular Sections for each of these items.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standards Institute (ANSI)
 - a. ANSI A 21.11/AWWA C111 – Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - b. ANSI/NSF Standard 61 – Drinking Water System – Health Components.
2. ASTM International (ASTM):

- a. A 36 – Standard Specification for Carbon Structural Steel.
 - b. A 126 – Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - c. A 536 – Standard Specification for Ductile Iron Castings.
 - d. E 165 – Standard Test Method for Liquid Penetrant Examination.
 - e. E 709 – Standard Guide for Magnetic Particle Examination.
 - f. F 1674 – Standard Test Method for Joint Restraint Products for use with PVC Pipe
3. American Water Works Association (AWWA)
- a. B 300 – Standard for Hypochlorites.
 - b. B 301 – Standard for Liquid Chlorine.
 - c. C 206 – Standard for Field Welding of Steel Water Pipe.
 - d. C 207 – Standard for Steel Pipe Flanges for Waterworks Service – Sizes 4 inches through 144 inches.
 - e. C 651 – Standard for Disinfecting Water Mains.
4. NSF National Sanitation Foundation

1.4 SUBMITTALS

- D. Conform to submittal requirements of applicable Section for type of pipe used.
- E. Submit Lone Star notification transmittal number prior to beginning excavation.
- F. For pipe with bell-and-spigot ends with rubber gasket, submit complete joint details with dimensions and tolerances and performance history indicating the proposed joint has performed satisfactorily under similar conditions.
- G. Submit results of the leakage tests, identifying the specific length of pipe tested, the test pressure, the duration of test and the amount of leakage.
- H. Submit satisfactory bacteriological test reports on disinfection requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pipe materials
 - 1. Section 33 11 10 – Ductile Iron Pipe and Fittings
 - 2. Section 33 11 12 – Polyvinyl Chloride (PVC) Pipe
 - 3. Pipe Manufacturer: Selected manufacturer performance history shall be minimum 5 years of successful field installations with proposed pipe diameter and proposed type of pipe joint.

4. Pipe Material standards: Conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 and have certified by an organization accredited by ANSI.
5. Coordinating pipe materials with other contractors and differing pipe materials:
 - a. When Contractor's selected pipe material joins to pipes of different material and/or different coatings to be constructed by others, Contractor shall request the Owner's representative to identify the type of pipe in the adjoining contract.
 - b. If the adjoining contract is scheduled to complete the adjoining waterline first, Contractor shall provide an approved connection with insulating kit and isolation test station at no additional cost to the Owner.
 - c. If Contractor's pipe is scheduled to complete first the other contractor will provide the insulating kit and isolation test station.
- B. In-line isolation valves: Refer to Specification Sections.
 1. Section 33 12 16 – Gate Valves
 2. Section 33 12 17 – Butterfly Valves
- C. Air Release and Vacuum Relief Valves: Refer to Specification Section 33 12 18 – Air Release and Vacuum Relief Valves.
- D. Fire Hydrants: Refer to Section 33 12 19 – Fire Hydrant

2.2 RESTRAINED JOINTS

- A. Prestressed Concrete Cylinder Pipe, Bar-Wrapped and Steel Pipe: Welded Joints.
- B. Restrained Joints on DIP and PVC pipe are allowed with the following requirement as an alternative to the pipe with an integral restrained joint system:
 1. Restraint devices: Manufacture of high strength ductile iron, ASTM A 536 up to 24 inches, and ASTM A 36 for sizes greater than 30 inches. Working pressure rating twice that of design test pressure.
- C. Bolts and connecting hardware: High strength low alloy material in accordance with ANSI A21.11/AWWA C111.

2.3 PLUG AND CLAMP

- A. A Provide a manufactured plug device appropriate for the size and type of pipe.
 1. If used as a permanent plug and under pressure use ductile iron pipe and appropriate plug rated for the test pressure of the application.
 - a. For ductile iron pipe, plug shall be

- 1) Tyton plug or Trim Tyton plug manufactured by US Pipe and Foundry Company
 - 2) Push On Restrained plug manufactured by American Cast Iron Pipe Company
 - 3) Or approved equal
2. If used as a temporary plug and not under pressure, Contractor shall submit low pressure plugs, such as wing nut or hand tightened plugs for review and approval.

2.4 WARRANTY (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Conform to applicable installation specifications for type(s) of pipe used.
- B. Employ workmen who are skilled and experienced in laying pipe of type and joint configuration being furnished. Provide watertight pipe and pipe joints.
- C. Install water main to the line and grade on the Drawings.
 1. Water mains to be staked at a minimum 100 FT interval with depth of cuts monitored.
- D. Field verify location and depth of utilities that will be crossed.
 1. Adjust water main elevation as required during construction.
 2. The Contractor shall contact the "One-Call" system and comply with all applicable rules and regulations.
 3. Prior to the start of construction and preparation of pipe layout sheets, the Contractor shall perform Critical Location investigations at all locations shown on the Drawings in accordance with Section 31 21 33 – Trenching, Backfilling, and Compaction for Utilities. The Contractor shall complete the Critical Location report to provide the elevation and location of conflicts prior to the manufacture of the pipe.
 4. Contractor shall communicate with the local representative of the utility companies including, but not limited to the oil companies, gas company, electric company, telephone company, water utilities, sanitary sewer utilities, and any other public and private utility companies affected by proposed construction in order to obtain the assistance of the utility companies in locating utility lines and in the avoidance of conflicts with utility lines.
 5. No separate payment will be made for field verification or adjustment of main depths as required.
- E. Contractor will restore all existing structures or services damaged by Contractor's operations at no cost to Owner.

3.2 HANDLING, CLEANING AND INSPECTION

A. Handling:

1. Place pipe along project site where storm water or other water will not enter or pass through pipe.
2. Load, transport, unload, and otherwise handle pipe and fittings to prevent damage of any kind. Handle and transport pipe with equipment designed, constructed and arranged to prevent damage to pipe, lining and coating. Do not permit bare chains, hooks, metal bars, or narrow skids or cradles to come in contact with coatings. Where required, provide pipe fittings with sufficient interior strutting or cross bracing to prevent deflection under their own weight.
3. Hoist pipe from trench side into trench by means of sling of smooth steel cable, canvas, leather, nylon or similar material.
4. For large diameter water lines, handle pipe only by means of sling of canvas, leather, nylon, or similar material. Sling shall be minimum 36 inches in width. Do not tear or wrinkle tape layers.
5. Use precautions to prevent injury to pipe, protective linings and coatings.
 - a. Package stacked pipe on timbers. Place protective pads under banding straps at time of packaging.
 - b. Pad fork trucks with carpet or other suitable material. Use nylon straps around pipe for lift when relocating pipe with crane or backhoe.
 - c. Do not lift pipe using hooks at each end of pipe.
 - d. Do not place debris, tools, clothing, or other materials on pipe.
6. Repair damage to pipe or protective lining and coating before final acceptance.

B. Cleaning: Thoroughly clean and dry interior of pipe and fittings of foreign matter before installation, and keep interior clean until Work has been accepted. Keep joint contact surfaces clean until jointing is completed. Do not place debris, tools, clothing or other materials in pipe. After pipe laying and joining operations are completed, clean inside of pipe and remove debris.

C. Inspection: Before installation, inspect each pipe and fitting for defects. Reject defective, damaged or unsound pipe and fittings and remove them from site.

3.3 PIPE CUTTING

- A. Cut pipe 12 inches and smaller with standard wheel pipe cutters.
- B. Cut pipe larger than 12 inches in manner recommended by the pipe manufacturer and approved by Owner's Representative. Make cuts smooth and at right angles to axis of pipe. Where appropriate for the type of pipe, bevel plain end with heavy file or grinder to remove sharp edges.

3.4 PIPE INSTALLATION

A. General Requirements:

1. Lay pipe in excavation subgrade free of water.
2. Make adjustments of pipe to line and grade by scraping away subgrade or filling in with granular material.
3. Properly form bedding to fully support bell without wedging or blocking up bell.
4. Open Cut Construction: Keep pipe trenches free of water which might impair pipe laying operations. Grade pipe to provide uniform support along bottom of pipe. Excavate for bell holes after bottom has been graded and in advance of placing pipe.
5. Use adequate surveying methods and equipment; employ personnel competent in use of this equipment. Horizontal and vertical deviations from alignment as indicated on Drawings shall not exceed 0.10 feet. Measure and record "as-built" horizontal alignment and vertical grade at maximum of every 100 feet on record drawings.
6. Before assembling joints or couplings, lightly coat pipe ends and outside of gaskets with NSF61 approved lubricant to facilitate installation. Prior to proceeding with critical tie-ins, submit sequence of work based on findings from "Critical Location" investigations.

B. Install pipe continuously and uninterrupted along each street on which work is to be performed. Obtain approval of Owner's Representative prior to skipping any portion of Work.

C. Protection of Pipeline: Securely place stoppers or bulkheads in openings and in end of line when construction is stopped temporarily and at end of each day's work.

D. For water line smaller than 36 inches in diameter:

1. Lay not more than 300 feet of pipe in trench ahead of backfilling operations.
2. Cover or backfill laid pipe if pipe laying operations are interrupted and during non-working hours.
3. Place backfill carefully and simultaneously on each side of pipe to avoid lateral displacement of pipe and damage to joints.
4. If adjustment of pipe is required after it has been laid, remove and re-lay as new pipe.

3.5 UNDERGROUND SERVICES

A. Notify utility representative prior to construction to obtain available information on location of existing utilities.

1. Contractor shall be responsible for locating all utilities.

3.6 DRIVEWAY REMOVAL AND REPLACEMENT

- A. All pavements to be removed for water main construction shall be removed in accordance with Section 02 41 13.13 – Removing Existing Pavements and Structures for utility construction and:
 - 1. Cut by sawing, vertical cut to be one inch minimum.
 - 2. The remaining depth of section may be broken out in a manner subject to Owner's representative's approval.
 - 3. Where pavement removed is part of a traveled roadway and any portion of a lane is to be removed, pavement is to be removed and repaired/replaced to the nearest longitudinal joint.
 - 4. Where pavement removed is not part of a traveled roadway (parking lot, driveway, ditch liner) the width of section removed to be either:
 - a. As shown on the Drawings.
 - b. Width not greater than the outside diameter of the water main plus 4 feet.
- B. Replace Portland cement concrete and asphalt equal to or better than original paving plus 2 IN or remove to the nearest joint as authorized by the Owner's representative.
- C. Concrete pavement removed and repaired/replaced for water main construction shall be in accordance with Section 32 13 13 – Concrete Pavement, Curb, Sidewalks and Steps for utility construction.
- D. Remove and haul away debris resulting from the above operations in a manner that conforms with applicable laws and regulations.
- E. Include driveway removal and replacement in cost of the bid unit price of the water main.

3.7 PROTECTION OF EXISTING UTILITIES

- A. Contractor to verify the location of all underground utilities.
 - 1. Omission from, or the inclusion of utility locations on the plans is not to be considered as the nonexistence of or a definite location of existing underground utilities.
- B. Notify a representative of the underground utilities 24 HRS in advance of crossings.

3.8 TREES

- A. Do not remove trees without written instructions from the Owner's representative unless tree removal is shown on Drawings.

3.9 FENCES, SIGNS, MAILBOXES, ETC.

- A. Restore all damaged fences, signs, mailboxes, etc., to their original conditions.

- 1. No separate payment will be made for these items.

3.10 SEALING, CLEANING, FLUSHING AND DISINFECTION FIELD QUALITY CONTROL.

- A. Sealing, Flushing, and Disinfection of Potable Water Systems:

- 1. Maintain interior of all pipes, fittings and other accessories free from dirt and foreign material at all times.
 - a. If, in the opinion of the Owner's Representative, the pipe contains dirt that will not be removed by flushing, the pipe interior shall be cleaned and swabbed with bactericidal solution.
 - b. At close of each day's work or whenever workmen are absent from jobsite, plug, cap or otherwise provide watertight seal from open ends of pipe to prevent ingress of foreign material.
 - c. If water is in trench, seal shall remain in place until trench is pumped dry.

- B. Cleaning

- 1. Refer to Section 01 74 13 – Cleaning
 - 2. Remove construction debris or foreign material and thoroughly clean installed water main systems. Provide temporary connections, equipment and labor for cleaning. Owner's Representative will inspect water line for cleanliness prior to flushing and filling.

- C. Disinfection

- 1. Perform all work including preventative measures during construction in full compliance to AWWA C651.
 - 2. Flush each segment of the system to provide a flushing velocity of not less than 2.5 FT per second.
 - 3. Drain flushing water to location approved by the Owner.
 - 4. Perform disinfection using one of the following forms:
 - a. Application of chlorine gas-water mixture by means of solution-feed chlorinating device.
 - 1) Liquid chlorine shall comply with AWWA B301.
 - b. Application of calcium hypochlorite, or sodium hypochlorite.

- 1) Chlorine compounds shall comply with AWWA B300.
5. Disinfect pipe with chlorinated water as per AWWA C651.
 - a. Method of application of chlorine shall be by continuous feed method or slug method.
 - b. During disinfection procedure, ensure that initial and residual chlorine concentrations meet AWWA C651 requirements by testing by an approved method as directed by the Owner.
 - c. Cost of testing shall be included in the Bid Unit Price for water main and no separate payment will be made for this item.
6. Tag the system during the disinfection procedure.
7. Following disinfection for required contact period, neutralize chlorine residual in water by treating with reducing agent.
 - a. Refer to AWWA C651.
 - b. Flush all treated water from pipeline at its extremities until replacement water throughout pipe, upon test is proved comparable in quality to water in existing system.
 - c. Take two (2) samples to test for bacteriological quality as directed by Owner's representative.
 - d. Repeat disinfection procedure until two (2) satisfactory results are obtained.
 - e. Quality of water delivered by the new water main to remain satisfactory for a minimum period of two (2) days.
8. Secure satisfactory bacteriological reports on samples from the system.
 - a. Ensure all sampling and testing procedures are in full compliance to AWWA C651, and applicable requirements of the State of Texas.
 - b. No separate payment will be made for this item.

3.11 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 33 11 15

HIGH DENSITY POLYETHYLENE (HDPE) SOLID AND PROFILE WALL PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. High density polyethylene (HDPE) pipe for water mains and sanitary sewer force mains, including fittings.
2. High density polyethylene (HDPE) pipe for gravity sanitary sewers and drains, including fittings.
3. High density polyethylene (HDPE) pipe for gravity storm sewers and drains, including fittings.
4. High density polyethylene (HDPE) pipe for storm sewers culverts.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 – Proposing Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 – General Requirements.
3. Specification Sections:
 - a. Section 31 21 33 – Trenching, Backfilling, and Compacting For Utilities.
 - b. Section 33 05 23.13 – Water Line Horizontal Directional Drilling.
 - c. Section 33 11 10 – Ductile Iron Pipe and Fittings.
 - d. Section 33 11 13 – Water Main Construction.
 - e. Section 33 40 00 – Storm Drainage System.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
 - a. C906 – Polyethylene (PE) pressure Pipe & Fittings, 4 inch through 63 inch for water
 - b. D 618 – Standard Practice for Conditioning Plastics for Testing.
 - c. D 1248 – Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

- d. D 2321 – Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Pipe.
- e. D 2657 – Standard Practice for Heat Fusion Joining Polyolefin Pipe and Fittings.
- f. D 2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
- g. D 3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
- h. D 3212 – Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- i. D 3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- j. F 477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- k. F 714 – Standard Specification for Polyethylene Plastic (PE) Pipe (SDR-PR) Based on Outside Diameter.
- l. F 894 – Standard Specification for Polyethylene (PE) Large-Diameter Profile Wall Sewer and Drain Pipe.
- m. F 2306 – Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
- n. F 2487 – Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High Density Polyethylene Pipelines.
- o. F 2510 – Standard Specification for Resilient Connectors between Concrete Manhole Structures and Corrugated High Density Polyethylene Drainage Pipes.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01 33 00 – Submittals.
- B. Submit shop drawings showing design of pipe and fittings including specials fittings required to achieve alignment and grade as shown on the Drawings, pipe section lengths, fabrication, fittings, flanges, gasket material, and special details.
- C. Submit details of Pipe Joints and jointing procedure for HDPE pipe.

1.5 QUALITY CONTROL

- A. Provide manufacturer's certificate of conformance to Specifications.
- B. Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density, and other physical properties.

- C. Owner's Representative reserves right to inspect pipes or witness pipe manufacturing. Inspection shall in no way relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Specifications.
 - 1. Manufacturer's Notification: Should Owner's Representative wish to witness manufacture of specific pipes, manufacturer shall provide Owner's Representative with minimum three weeks notice of when and where production of those specific pipes will take place.
 - 2. Failure to Inspect. Approval of products or tests is not implied by Owner's Representative's decision not to inspect manufacturing, testing, or finished pipes.
- D. Pipe manufacturer to provide services of experienced, competent, and authorized representative to visit site to advise and consult Contractor during jointing and installation of pipe if requested by the Owner.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with documented experience of minimum 5 years of pipe installations that have been in successful, continuous service for same type of service as proposed Work.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide solid wall and profile wall HDPE pipe based on the intended service as described herein.
- B. Mark each standard and random length of pipe in compliance with these Specifications with following information:
 - 1. Pipe size.
 - 2. Pipe class.
 - 3. Production code.
 - 4. Material designation.
- C. Warranty
 - 1. The pipe shall be warranted one year by the pipe supplier.
 - 2. The fusion services (if applicable) shall be warranted for one year by the fusion service provider.

2.2 MATERIALS FOR WATER LINES

- A. HDPE pipe for water service shall be "DRISCOPLEX Series" as manufactured by Performance Pipe, or approved equal.
- B. Furnish solid wall pipe with plain end construction for heat joining (butt fusion) conforming to ASTM D 2657 for pressure applications. Utilize controlled temperatures and pressures for joining to produce fused leak-free joint.
- C. Furnish solid wall pipe for water mains and sanitary sewer force mains with minimum working pressure rating of 150 psi, and with inside diameter equal to or greater than nominal pipe size indicated on Drawings
- D. All piping system components shall be the products of one manufacturer and shall conform to the latest edition of ASTM D 1248, ASTM D 3350, ASTM F 714, and AWWA C 906.
- E. Piping and bends shall be extruded from a polyethylene compound and shall conform to the following requirements:
 - 1. The polyethylene resin shall meet or exceed the requirements of ASTM D 3350 for PE 3408 material with a cell classification of 335434C, or better.
 - 2. The polyethylene compound shall be suitably protected against degradation by ultraviolet light by means of carbon black, well dispersed by precompounding in a concentration of not less than 2 percent.
 - 3. The maximum allowable hoop stress shall be 800 psi at 73.4 degrees F.
 - 4. The pipe manufacturer shall be listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture the pipe in this project.
 - 5. The pipe and bends shall have a minimum standard dimension ration (SDR) wall thickness of SDR 11 and a minimum working pressure of 150 psi.
 - 6. Joining shall be performed by thermal butt-fusion in accordance with the manufacturer's recommendations.
 - 7. Water pipe exterior shall be blue in color or contain blue striping.
- F. Each HDPE pipe section for water service shall also be marked with:
 - 1. Dimension ratio or standard dimension ratio.
 - 2. AWWA pressure class.
 - 3. AWWA standard designation number.
 - 4. NSF-61 mark verifying suitability for potable water service.
 - 5. Extrusion production record code.
 - 6. Trademark or trade name.
 - 7. Cell classification of HDPE material code.
- G. Connections and fittings for pressure application

1. See Section 33 11 10 - Ductile Iron Pipe and Fittings.

2.3 MATERIALS FOR GRAVITY SANITARY SEWERS

- A. Furnish profile-wall gravity sanitary sewer pipe with bell-and-spigot end construction conforming to ASTM D 3212. Joining will be accomplished with elastomeric gasket in accordance with manufacturer's recommendations. Use integral bell-and-spigot gasketed joint designed so that when assembled, elastomeric gasket, contained in machined groove on pipe spigot, is compressed radially in pipe bell to form positive seal. Design joint to avoid displacement of gasket when installed in accordance with manufacturer's recommendations
- B. Pipe and Fittings: High density, high molecular weight polyethylene pipe material meeting requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248. Material meeting requirements of cell classification in accordance with ASTM D 3350 are also suitable for making pipe products under these specifications.
- C. Jointing:
 1. Gaskets:
 - a. Meet requirements of ASTM F 477. Use gasket molded into circular form or extruded to proper section and then spliced into circular form. When no contaminant is identified, use gaskets of properly cured, high-grade elastomeric compound. Basic polymer shall be natural rubber, synthetic elastomer, or blend of both.
 - b. HDPE Pipes are not allowed to be installed in potentially contaminated areas, unless submitted and approved by Owner's Representative. Where approved provide gaskets as indicated below:

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other Contaminants	As recommended by pipe manufacturer

2. Lubricant. Use lubricant for assembly of gasketed joints which has no detrimental effect on gasket or on pipe, in accordance with manufacturer's recommendations.

- D. Other Pipe Materials: Materials other than those specified may be used as part of profile construction, e.g., as core tube to support shape of profile during processing, provided that these materials are compatible with base polyethylene material and are completely encapsulated in finished product and in no way compromise performance of pipe products in intended use. Examples of suitable material include polyethylene and polypropylene.

2.4 MATERIALS FOR FORCE MAIN SANITARY SEWERS

- A. All piping system components shall be the products of one manufacturer and shall conform to the latest edition of ASTM D 1248, ASTM D 3350, ASTM F 714, and AWWA C 906.
- B. Furnish solid wall pipe with plain end construction for heat joining (butt fusion) conforming to ASTM D 2657 for pressure applications. Utilize controlled temperatures and pressures for joining to produce fused leak-free joint.
- C. Furnish solid wall pipe for sanitary sewer force mains with minimum working pressure rating of 150 psi, and with inside diameter equal to or greater than nominal pipe size indicated on Drawings
- D. Piping and bends shall be extruded from a polyethylene compound and shall conform to the following requirements:
1. The polyethylene resin shall meet or exceed the requirements of ASTM D 3350 for PE 3408 material with a cell classification of 335434C, or better.
 2. The polyethylene compound shall be suitably protected against degradation by ultraviolet light by means of carbon black, well dispersed by precompounding in a concentration of not less than 2 percent.
 3. The maximum allowable hoop stress shall be 800 psi at 73.4 degrees F.
 4. The pipe manufacturer shall be listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture the pipe in this project.
 5. The pipe and bends shall have a minimum standard dimension ration (SDR) wall thickness of SDR 11 and a minimum working pressure of 150 psi.
 6. Joining shall be performed by thermal butt-fusion in accordance with the manufacturer's recommendations.
 7. Water pipe exterior shall be blue in color or contain blue striping.

2.5 MATERIALS FOR GRAVITY STORM SEWERS AND STORM SEWER CULVERTS

- A. Furnish corrugated profile-wall polyethylene (CPP) pipe for gravity storm sewer and storm sewer culvert pipe.
- B. Pipe and Fittings High density, high molecular weight polyethylene HDPE virgin compound material meeting requirements of cell class outlined in ASTM D 3350. Manufacturing shall meet requirements of ASTM F 2306.

- C. Joints shall be installed such that connection of pipe sections will form continuous line free from irregularities in flow line. Suitable joints are:
- D. Integral Bell and Spigot. Bell shall overlap minimum of two corrugations of spigot end when fully engaged.
- E. Exterior Bell and Spigot. Bell shall be fully welded to exterior of pipe and overlap spigot end so that flow lines and ends match when fully engaged.

PART 3 - EXECUTION

3.1 TRANSPORTATION AND STORAGE

- A. All of the pipe supplier's guidelines shall be followed for transportation and storage of the pipe.
- B. Care shall be taken during transportation of the pipe to ensure that it is not cut, kinked, or otherwise damaged.
- C. Pipes shall be stored on level ground free of sharp objects which could damage the pipe.
- D. Stacking of the pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature condition.
- E. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such widths as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.
- F. Any pipe damage during transportation or storage shall be replaced by the contractor at the contractor's expense.

3.2 INSTALLATION

- A. Conform to requirements of following Sections:
 - 1. Section 33 05 23.13 – Water Line Horizontal Directional Drilling
 - 2. Section 33 11 13 – Water Main Construction
 - 3. Section 33 40 00 – Storm Drainage System
- B. Install pipe in accordance with the manufacturers recommended installation procedures and ASTM D 2774.
- C. Bedding and backfill: Conform to requirements of Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities.
- D. Use only workmen trained in the installation of HDPE Pipe.
- E. Do not store pipe uncovered direct in direct sunlight. Allow pipe temperature to approach ground temperature before each individual pipe section is terminally connected.

- F. Fusion joints: Meet minimum requirements of manufacturer for cool down time and other fusing requirements. Socket fusion and extrusion welding or hot gas welding will not be accepted. Join sections of HDPE pipe into continuous lengths above ground by thermal butt fusion method in accordance with AWWA C906 and pipe manufacturer's recommendations for specified service.
- G. Cutting pipe: Comply with pipe manufacturer's recommendations. After cutting, leave end pipe in accordance with manufacturer's recommendations.

3.3 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 33 12 16

GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gate valves

1.2 MEASUREMENT AND PAYMENT

A. Unit Price.

1. Payment for gate valves including valve box or supports is included in the price for the pipeline, component or device of which they are a sub component or part except:
 - a. Payment for 150 psig pressure rated Isolation Gate Valve Assembly for valves 14 inches and larger in diameter including valve, valve box, cover, flanges, fittings, and appurtenances and is on a unit price basis for each assembly installed.
 - b. Payment for 250 psig pressure rated Isolation Gate Valve Assembly for valves 14 inches and larger in diameter including valve, valve box, cover, flanges, fittings, and appurtenances and is on a unit price basis for each assembly installed.
 - c. Payment for 2-inch blow-off valves including box is on a unit price basis for each assembly installed.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
 - a. A 307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
 - b. B 62 – Standard Specification for Composition Bronze or Ounce Metal Casting.
 - c. D 429 – Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
 - d. B 763 – Standard Specification for Copper Alloy Sand Casting for Valve Application.
2. American Water Works Association (AWWA):
 - a. C 500 – Standard for Metal-Seated Gate Valves for Water Supply Service.

- b. C 509 – Standard for Resilient-Seated Gate Valves for Water Supply Service.
- c. C 515 – Standard for Reduced Wall, Resilient- Seated Gate Valves for Water Supply Service.
- d. C 550 – Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.

1.4 SUBMITTALS

- A. Submit manufacturer's product data for proposed valves for approval.
- B. Provide detailed drawings of gearing mechanism for 20-inch and larger gate valves.

1.5 QUALITY CONTROL

- A. Submit manufacturer's affidavit that gate valves are manufactured in the United States and conform to stated requirements of AWWA C 500, AWWA C 509, AWWA C 515, and this Section, and that they have been satisfactorily tested in the United States in accordance with AWWA C 500, AWWA C 509, and AWWA C 515.

1.6 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Gate Valves: AWWA C 500, AWWA C 509, AWWA C 515 and additional requirements of this Section. All valves open counterclockwise.
- B. If type of valve is not indicated on Drawings, use gate valves as line valves for sizes 20-inches and smaller. When type of valve is indicated, no substitute is allowed.
- C. Gate Valves 1½ Inches in Diameter and Smaller: 125 psig or 250 psig to match adjacent piping; bronze; rising-stem; single-wedge; disc type; screwed ends.
- D. Coatings for Gate Valves 2 Inches and Larger: AWWA C 550 non-toxic, imparts no taste to water, functions as physical, chemical, and electrical barrier between base metal and surroundings, minimum 8-mil-thick, fusion-bonded epoxy. Prior to assembly of valve, apply protective coating to interior and exterior surfaces of body.

- E. Gate Valves 2 Inches to 12 Inches in Diameter: Non-directional, standard-wall resilient seated (AWWA C 509), parallel seat double disc (AWWA C 500), or reduced-wall resilient seated gate valves (AWWA C 515), 225 psig pressure rating, bronze mounting, push-on bell ends with rubber joint rings, and nut-operated unless otherwise specified. Provide approved standard-wall resilient seated valves. Provide approved reduced-wall resilient seated valves. Provide double disc valves. Comply with following requirements unless otherwise specified in Drawings:
1. Design: Fully encapsulated rubber wedge or rubber seat ring mechanically attached with minimum 304 stainless-steel fasteners or screws; threaded connection isolated from water by compressed rubber around opening.
 2. Body: Cast or ductile iron, flange bonnet and stuffing box together with ASTM A 307 Grade B bolts. Manufacturer's initials, pressure rating, and year manufactured shall be cast in body.
 3. Bronze: Valve components in waterway to contain not more than 15 percent zinc and not more than 2 percent aluminum.
 4. Stems: ASTM B 763 bronze, alloy number 995 minimum yield strength of 40,000 psi; minimum elongation in 2-inches of 12 percent, non-rising.
 5. O-rings: For AWWA C 500, Section 3.12.2. For AWWA C 509, Sections 2.2.6 and 4.8.2. For AWWA C 515, Section 4.2.2.5.
 6. Stem Seals Consist of three O-rings, two above and one below thrust collar with anti-friction washer located above thrust collar for operating torque.
 7. Stem Nut: Independent or integrally cast of ASTM B 62 bronze.
 8. Resilient Wedge: Molded, synthetic rubber, vulcanized and bonded to cast or ductile iron wedge or attached with 304 stainless steel screws tested to meet or exceed ASTM D 429 Method B; seat against epoxy-coated surface in valve body.
 9. Bolts: AWWA C 500 Section 3.4, AWWA C 509 Section 4.4 or AWWA C 515 Section 4.4.4; stainless steel; cadmium plated, or zinc coated.
- F. Gate Valves 14 inch and larger in Diameter: AWWA C 500; parallel seat double disc gate valves or push-on bell ends with rubber rings and nut-operated unless otherwise specified. Provide approved double disc valves with 150 psig or 250 psig pressure rating to match adjacent piping. Comply with following requirements unless otherwise specified on Drawings:
1. Body: Cast iron or ductile iron; flange together bonnet and stuffing box with ASTM A 307 Grade B bolts. Cast following into valve body manufacturer's initials, pressure rating, and year manufactured. When horizontally mounted, equip valves greater in diameter than 12 inches with rollers, tracks, and scrapers.
 2. O-rings: For AWWA C 500, Section 3.12.2. For AWWA C 515, Section 4.2.2.5.

3. Stems: ASTM B 763 bronze, alloy number 995 minimum yield strength of 40,000 psi; minimum elongation in 2-inches of 12 percent, non-rising.
 4. Stem Nut: Machined from ASTM B 62 bronze rod with integral forged thrust collar machined to size; non-rising.
 5. Stem Seals: Consist of three O-rings, two above and one below thrust collar with anti-friction washer located above thrust collar for operating torque.
 6. Bolts: AWWA C 500 Section 3.4 or AWWA C 515 Section 4.4.4; stainless steel; cadmium plated, or zinc coated.
 7. Discs: Cast iron with bronze disc rings securely peened into machined dovetailed grooves.
 8. Wedging Device: Solid bronze or cast-iron, bronze-mounted wedges. Thin plates or shapes integrally cast into cast-iron surfaces are acceptable. Other moving surfaces integral to wedging action shall be bronze monel or nickel alloy-to-iron.
 9. Provide bypass for valve 24 inches and larger.
 10. Bronze Mounting: Built as integral unit mounted over, or supported on, cast-iron base and of sufficient dimensions to be structurally sound and adequate for imposed forces.
 11. Gear Cases: Cast iron; furnished on 18-inch and larger valves and of extended type with steel side plates, lubricated, gear case enclosed with oil seal or O-rings at shaft openings.
 12. Stuffing Boxes: Located on top of bonnet and outside gear case.
- G. Gate Valves 14 Inches to 24 Inches: Provide AWWA C 515; reduced-wall, resilient seated gate valves with 250 psig pressure rating. Furnish with spur or bevel gearing.
1. Mount valves horizontally if proper ground clearance cannot be achieved by normal vertical installation. For horizontally mounted gate valves, provide bevel operation gear mounted vertically for above ground operation.
 2. Use valve body, bonnet, wedge, and operator nut constructed of ductile iron. Fully encapsulate exterior of ductile iron wedge with rubber.
 3. Ensure wedge is symmetrical and seals equally well with flow in either direction.
 4. Provide ductile iron operator nut with four flats at stem connection to apply even input torque to the stem.
 5. Bolts: AWWA C515, Section 4.4.4, Stainless Steel; cadmium plated or zinc coated.
 6. Provide high strength bronze stem and nut.
 7. O-rings: AWWA C515, Section 4.2.2.5, pressure O-rings as gaskets.

- 8. Provide stem sealed by three O-rings. Top two O-rings are to be replaceable with valve fully open at full rated working pressure.
- 9. Provide thrust washers to the thrust collar for easy valve operation.
- H. Gate Valves Extension Stem: When shown on Drawings, provide non-rising, extension stem having coupling sufficient to attach securely to operating nut of valve. Upper end of extension stem shall terminate in square wrench nut no deeper than 4 feet from finished grade or as shown on Drawings. Support extension stem with an arm attached to wall of manhole or structure that loosely holds extension stem and allows rotation in the axial direction only.
- I. Gate Valves in Factory Mutual (Fire Service) Type Meter Installations: Conform to provisions of this specification; outside screw and yoke valves; carry label of Underwriters' Laboratories, Inc.; flanged, Class 125; clockwise to close.
- J. Gate Valves for Tapping Steel Pipe: Provide double disc gate valve. Resilient wedge gate valve not permitted unless otherwise approved by Owner's Representative.
- K. Provide flanged joints when valve is connected to steel or PCCP.
- L. Key valve stem into the operator nut.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Earthwork. Conform to applicable provisions of Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities.
- B. Operation. Do not use valves for throttling without prior approval of manufacturer.

3.2 SETTING VALVES AND VALVE BOXES

- A. Remove foreign matter from within valves prior to installation. Inspect valves in open and closed positions to verify that parts are in satisfactory working condition.
- B. Install valves and valve boxes where shown on Drawings. Set valves plumb and as detailed. Center valve boxes on valves. Carefully tamp earth around each valve box for minimum radius of 4 feet, or to undisturbed trench face when less than 4 feet. Install valves completely closed when placed in water line.
- C. For pipe section of each riser, use only 6-inch, ductile iron Class 51, or DR18 PVC pipe cut to proper length. Riser must be installed to allow complete access for operation of valve. Assemble and brace box in vertical position as indicated on Drawings.

3.3 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 33 12 17
BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Butterfly valves.

1.2 MEASUREMENT AND PAYMENT

A. Unit Price:

1. Payment for Isolation Butterfly Valve Assembly for valves 24 inches in diameter and smaller includes valve, valve box, cover, fittings, etc and is on a unit price basis for each assembly installed..

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME):
 - a. B16.1 – Cast Iron Pipe Flanges and Flanged Fittings.
2. ASTM International (ASTM):
 - a. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
3. American Water Works Association (AWWA):
 - a. C504 – Standard for Rubber-Seated Butterfly Valves.
 - b. C550 – Standard for Protective Interior Coatings for Valves and Hydrants.

1.4 SUBMITTALS

- A. Submit manufacturer's product data for proposed valves and actuators for approval.
- B. Submit manufacturer's affidavit for proposed valves and actuators certifying compliance with specifications.
- C. Submit manufacturer's affidavit that butterfly valves were manufactured in the United States, and conform to applicable requirements of AWWA C504 and that they have been satisfactorily tested in the United States in accordance with AWWA C504 using test pressure of 225 psi in both directions. Submit Proof-of-Design and hydrostatic testing procedure in accordance with AWWA C504.
- D. Submit manufacturer's affidavit that coating for interior surfaces of valves conform to applicable requirements of AWWA C550. Submit results of holiday test and thickness measurements of coatings.

- E. Furnish, at time of delivery, affidavit of compliance, as specified in Section 6.3 of AWWA C504 certifying compliance with applicable portion of AWWA C 504 and modification or supplements herein. Furnish certified drawings and material test records by manufacturer covering items included in Section 4.3 of AWWA C504, for review. Furnish certified copies of test reports covering items in Sections 4.5.8.5.5, 4.5.8.5.8, and 5.2.1 through 5.2.4.3 of AWWA C504 for review.
- F. Submit data indicating maximum torque required to open valve, maximum torsional strength of shaft and torque output of actuator.
- G. Include number of turns to operate valves to fully open/closed.

1.5 QUALITY CONTROL

- A. Perform valve leakage tests in both directions at 225 psi in factory and field. Hydrostatic field tests of 225 psi shall be made against dished head plug or similar arrangement.
- B. For purposes of interpreting referenced AWWA tests, the following shall apply: Shutoff pressure is 225 psi; cycle consists of rotating disc from fully opened to fully closed position, for valves larger than 72 inches, proof of design shall require 1,000 cycles and shall be performed on valve greater than 72 inches of like design and construction. When proof of design tests are performed on valve delivered to job site, replace disc, bushing, shaft and seals with new and unused items, and test and certify as described above.
- C. Hydrostatic Testing by Manufacturer:
 - 1. Hydrostatic testing to be performed prior to shipment of valves. Provide minimum 4 weeks notice to Owner's Representative for optional witness testing. When possible, maximize number of valves to be tested during a plant visit. Expenses for visits by Owner's Representative for defective valves, improper scheduling, or valve failures are to be paid by Contractor. Witness of hydrostatic testing by Owner's Representative will only be in regards to compliance with this specification and will not constitute approval by Owner's Representative nor relieve Contractor of obligations to comply with contract documents.
 - 2. Document serial number on valve at time of testing and reflect in certified test records furnished to Owner's Representative. Identification plate must be permanently affixed to valve and actuator prior to hydrostatic testing.
 - 3. Hydrostatic testing to conform to AWWA C504 except as modified below:
 - a. Install actuator prior to hydrostatic testing. Test actuator to verify actual number of turns match manufacturer's published number of turns. Verify valve stops are in correct positions.
 - b. Fully open and close valve prior to performing shell test and prior to each leakage test.
 - c. Perform shell test first.

BUTTERFLY VALVES

- d. When tested with water, adequately dry seat and disc.
 - e. When tested with air, fill top of valve with water to aid in viewing possible leakage.
 - f. Pressure Gauges: Calibrated within past 12 months; 0-500 psi range in increments of 5 psi, present calibration certificates prior to hydrostatic testing.
 - g. If seat adjustment is required during hydrostatic testing, perform valve leakage test again in both directions. Once seat adjustment is made, fully open and fully close valve three (3) times, and repeat leakage test.
4. Field Testing
- a. When valve arrives at the job site, Contractor is to operate valve fully open and closed twice in presence of Owner's Representative. Document number of turns to open and close each time.
 - b. Install operator nut plum.
 - c. After valve is installed, repeat the operation test and document number of turns in presence of Owner's Representative.
 - d. Manufacturer's representative must be present to witness the operation test again at the substantial walk thru. Verify valve operate fully open/closed twice at the appropriate number of turns.

1.6 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 VALVES AND ACTUATORS

- A. Butterfly Valves and Actuators: Conform to AWWA C504, except as modified or supplemented herein.
- B. If type of valve is not indicated on Drawings, use butterfly valves for line valve sizes 24-inch and larger. When type of valve is specified on Drawings, no substitute will be allowed, unless otherwise approved by Owner's Representative.
- C. Butterfly valves shall be short-body, flanged design, and installed at locations as shown on Drawings.
- D. Valves shall open counter clockwise.
- E. Provide flanged joints when valve is connected to steel or PCCP.
- F. Butterfly Valves and Actuators (Additional Requirements for Large Diameter Water Lines):
 - 1. Provide all valves for single project, from same manufacturer.

2. Valves larger than 72-inches in diameter design: Allowable stresses at rated pressure not to exceed one-third of yield strength or one-fifth of ultimate strength of material used.
3. Provide manual actuators for single project, from same manufacturer.
4. Shaft connecting actuator to valve body must be fully enclosed. Bonnet and extension to be fully enclosed and watertight.

2.2 VALVE CONSTRUCTION

- A. Valves: AWWA C504, Class 150B or 250B to match pressure class of adjacent piping. Body: Cast iron, ASTM A126, Class B. Flanges: ASME B16.1, Class 150 lb. or as required to match adjacent piping.
- B. Discs for Butterfly Valves: Either cast iron or ductile iron. Valves greater than 54" in. diameter must utilize flow through disc.
- C. Seats: Buna-N or neoprene, and may be applied to disc or body. Seats shall be mechanically secured and may not rely solely on adhesive properties of epoxy or similar bonding agent to attach seat to body. Seats on disc shall be mechanically retained by stainless steel (18-8) retaining ring held in place by stainless steel (18-8) cap screws that pass through rubber seat for added retention. When seat is on disc, seat shall be retained in position by shoulders located on both disc and stainless-steel retaining ring. Mating surfaces for seats: Type 304, stainless steel and secured to disc by mechanical means. Sprayed-on or plated mating surfaces will not be allowed. Seat must be replaceable in field for valves greater than 30 inches in diameter. Valves with segmented retaining rings will not be accepted.
- D. Coat interior wetted ferrous surfaces of valve, including disc, with epoxy suitable for potable water conditions. Epoxy, surface preparation, and epoxy application: In accordance with AWWA C550 and coating manufacturer's recommendations. Provide three coats of two component, high-build epoxy with minimum dry film thickness of 12 mils. Provide approved epoxy coating. Coatings shall be holiday tested and measured for thickness.
- E. Valve shaft and keys: 24 inches in diameter and greater valves require a minimum of two (2) taper pins used for attaching valve shaft to valve disc, use of torque plug for purposes of attaching valve shaft to valve disc is not permitted. Shaft: Type 304 stainless steel. Shaft Bearings: Stainless steel, bronze, nylon, or Teflon (supported by fiberglass mat or backing material with proven record of preventing Teflon flow under load) in accordance with AWWA C504. Sinter stainless steel bearing material. Design valve shaft to withstand 3 times amount of torque necessary to open valve.
- F. Packing: Self adjusting and wear compensating, full or split ring V-type, and replaceable without removing actuator assembly.
- G. Retaining Hardware for Seats: Type 304 stainless steel. Nuts and screws used with clamps and discs for rubber seats shall be held securely with locktight, or other approved method, to prevent loosening by vibration or cavitation effects.

- H. Valve disc shall seat in position at 90 degrees to pipe axis and shall rotate 90 degrees between full-open and tight-closed position. Install valves with valve shafts horizontal and convex side of disc facing anticipated direction of flow, except where shown otherwise on Drawings.
- I. For valves utilizing retaining rings, tighten bolts to a uniform torque. Measure torque prior to testing valve.

2.3 VALVE ACTUATOR CONSTRUCTION

- A. Provide actuators for valves with size based on line velocity of 12 feet per second and uni-directional service, and, unless otherwise shown on Drawings, equip with geared manual actuators. Provide fully enclosed and traveling-nut type, rack-and-pinion type, or worm-gear type for valves 20 inches and smaller. Provide worm-gear type for valves 24 inches and larger.
- B. Provide actuator designed for installation with valve shaft horizontal unless otherwise indicated on Drawings.
- C. Provide bonnet extensions, as required, between valve body and actuator. Space between actuator housing and valve body shall be completely enclosed so that no moving parts are exposed to soil or elements.
- D. Provide oil-tight and watertight actuator housings for valves, specifically designed for buried service or submerged service when located in valve vaults, and factory packed with suitable grease.
- E. Install valve position indicator on each actuator housing located above ground or in valve vaults. Valves shall be equipped with 2-inch actuator nut only.
- F. Indicate direction of opening of valve on exposed visible part of assembly and cast direction of open on 2 inch nut on top of valve operator extension. Paint 2 inch actuator nut and extension shaft black when counter clockwise open and red when clockwise to open.
- G. Design worm-gear or traveling-nut actuators to be self-locking and designed to transmit twice the required actuator torque, without damage to faces of gear teeth or contact faces of screw or nut. Valve stops shall be capable of withstanding a 450 ft.-lb. torque against the stop without damage to either the stop or the gear teeth.

2.4 VALVE BOXES

- A. Provide Standard Type “A” valve boxes.

2.5 VALVE SERVICE MANHOLES

- A. For large diameter water lines, provide manholes to dimensions shown on Drawings conforming to requirements of Section 33 05 16 – Precast Manhole Structures.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Conform to applicable provisions of Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities.

3.2 SETTING VALVES AND VALVE BOXES

- A. Prior to Hydrostatic testing of water line and valve:
 - 1. Test valve by opening and closing valve a minimum of two times to verify valve seats properly.
 - 2. Verify number of turns from fully open to fully closed position is same as identified in manufacturer's submittal.
 - 3. Adjust valve as required if number of turns do not match.
 - 4. Remove foreign matter from within valves.
- B. Install valves where shown on Drawings or as located by Owner's Representative. Use valve boxes for 16 inch and 24 inch valves. Set valves plumb and as detailed. Center valve boxes on valves. Carefully tamp earth around each valve box for minimum radius of 4 feet, or to undisturbed trench face when less than 4 feet.
- C. Avoid disturbing or overstressing valve body when installing valves. Perform field adjustment of valves under pressure to ensure shutoff occurs in number of rotations as described in valves operation and maintenance manual.
- D. Attach two four (4) foot lengths of pipe to each side of valve prior to installation in line.
- E. Submit certification that large diameter valve was installed, adjusted, and exercised in accordance with manufacturer's instructions. Manufacturer's certification shall state that all performance characteristics of large diameter valves, as installed, have been met. Adjustments made to valve, for any reason, must be made by manufacturer's representative.

3.3 OWNER TRAINING (NOT USED)

END OF SECTION

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SECTION 33 12 18

AIR RELEASE AND VACUUM RELIEF VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air release and vacuum relief valves.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 – Proposing Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 – General Requirements.
3. Section 31 21 33 – Trenching, Backfilling, and Compacting For Utilities.
4. Section 33 05 16 – Precast Manhole Structures.
5. Section 33 11 13.04 – Hydrostatic Testing of Pipelines.

1.2 MEASUREMENT AND PAYMENT

A. Unit Price:

1. Payment for single Combination Air Vacuum Valve Assembly in Service Manhole including manhole, gate valves, flanges, fittings, vent piping, etc is on a unit price basis for each assembly installed.
2. Payment for dual (duplex) Combination Air Vacuum Valve Assembly in Service Manhole or Vault including manhole or vault (when required), gate valves, flanges, fittings, vent piping, bollards, etc. is on a unit price basis for each assembly installed.
3. Payment for valve assembly on aerial crossing includes fittings, anti-vandalism protection, freeze protection, vent piping and appurtenances necessary for complete installation of valve.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
 - a. A 48 – Standard Specification for Gray Iron Castings.
 - b. A 126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - c. A 240 – Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
 - d. A 276 – Standard Specification for Stainless Steel Bars and Shapes.

- e. A 313 – Standard Specification for Stainless Steel Spring Wire.
- f. B 584 – Standard Specification for Copper Alloy Sand Castings for General Applications.

1.4 SUBMITTALS

- A. Conform to requirements of Section 01 33 00 – Submittals.
- B. Submit manufacturer's product data for proposed valves for approval.

1.5 QUALITY CONTROL

- A. Provide manufacturer's affidavit that air release and vacuum relief valves purchased for Work, were manufactured and tested in United States, and conform to requirements of this Section.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- A. Provide combination air valves designed to fulfill functions of air release (permit escape of air accumulated in line at high point of elevation while line is under pressure) and vacuum relief.
- B. Provide inlet and outlet connections, and orifice as shown on Drawings.
- C. Valve exterior: Painted with shop-applied primer suitable for contact with potable water.

2.2 MATERIALS

- A. Air Release Valves: Provide approved air release valves ASTM A 48, Class 30, cast iron; float and leverage mechanism, ASTM A 240 or ASTM A 276 stainless steel; orifice and seat, stainless steel against Buna-N or Viton mechanically retained with hex head nut and bolt. Other valve internals shall be stainless steel or bronze.
- B. Air Release and Vacuum Relief Valves: Provide single-body, standard combination valves or duplex-body custom combination valves as indicated on Drawings.
 - 1. For 2 inch and 3 inch, single-body valves, provide inlet and outlet size as shown on Drawings and orifice sized for 150 psi or 250 psi working pressure to match pressure class of adjacent pipe.
 - a. Valve materials: body, cover, and baffle, ASTM A 48, Class 35, or ASTM A 126, Grade B cast iron; plug or poppet, ASTM A 276 stainless steel; float, ASTM A 240 stainless steel; seat, Buna-N; other valve internals, stainless steel.
 - 2. For 3 inch and larger duplex body valves as shown on Drawings, provide approved air release valve.

- a. Air and vacuum valve materials: body and cover, ASTM A 48, Class 35, cast iron; float, ASTM A 240 stainless steel; seat, Type 304, stainless steel and Buna-N; other valve internals, stainless steel or bronze.
- b. Air release valve: Constructed as specified in paragraph above on Air Release Valves.
- C. Vacuum Relief Valves: Provide approved air inlet vacuum relief valves with flanged inlet and outlet connections as shown on Drawings. Provide air release valves in combination with inlet and outlet, and orifice as shown on Drawings. Valve shall open under pressure differential not to exceed 0.25 psi.
 - a. Materials for vacuum relief valves: valve body, ASTM A 48, Class 35, cast iron; seat and plug, ASTM B 584 bronze, copper alloy 836; spring, ASTM A 313, Type 304, stainless steel; bushing, ASTM B 584 bronze, copper alloy 932; retaining screws, ASTM A 276, Type 304, stainless steel.
- D. Manholes: As shown on Drawings conforming to requirements of Section 33 05 16 – Precast Manhole Structures.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Conform to applicable provisions of Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities.

3.2 SETTING VALVES IN MANHOLES AND VAULTS

- A. If required by Owner's Representative, provide services of technical representative of valve manufacturer available on site during installation of valves.
- B. Prior to installing valves, remove foreign matter from within valves. Inspect valves in open and closed position to verify that parts are in satisfactory working condition.
- C. Install valves and valve manholes and vaults where indicated on Drawings or as located by Owner's Representative. Set manholes and vaults plumb and as detailed. Center manholes on valves. Compact cement-stabilized sand around each manhole and vault for minimum radius of 4 feet, or to undisturbed trench face when less than 4 feet. Provide above-ground vents for manholes and vaults as indicated on Drawings.

3.3 DISINFECTION AND TESTING

- A. Disinfect valves and appurtenances and test as required by Section 33 11 13.04 – Hydrostatic Testing of Pipelines.

3.4 OWNER TRAINING (NOT USED)

END OF SECTION

SECTION 33 12 19

FIRE HYDRANT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dry-barrel fire hydrant.

MEASUREMENT AND PAYMENT

A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Water Works Association (AWWA):
 - a. C502 – Standard for Dry-Barrel Fire Hydrants.
 - b. M17 – Installation, Operation and Maintenance of Fire Hydrants.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data:
 - a. Acknowledgement that products submitted meet the requirements of the standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Acknowledge and verify dimensions and provide list of integral parts and materials.

1.5 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Mueller.
 2. American Flow Control.
 3. Waterous.

2.2 FIRE HYDRANT

A. Design and Fabrication:

1. Conform to AWWA C502
2. Provide with either compression or gate design.
3. Provide with a valve opening, and nozzle section consisting of hose nozzles and one IN steamer with dimensions to match existing.
4. Provide with water passages to permit full flow of water to minimize friction loss.
5. Furnish with multiple weep holes for positive draining to allow water to escape readily from standpipe when hydrant valve is closed.
6. Designed to throttle flow when partially opened.
7. Designed to allow removal of valve and valve stem without digging up hydrant
8. Suitable for 5 FT of bury.
9. Furnish with mechanical (gland type) joint inlet connections.
10. Connect to yard water piping with restrained mechanical joints
11. Furnish with a breakaway traffic flange of the type which allows both barrel and stem to break clean upon traffic impact from any angle. Traffic flange design shall be such that repair and replacement can be accomplished above ground
12. Furnish with O-ring packing only.
13. All working parts shall be bronze or non-corrosive metal in accordance with the requirements of AWWA C 502
14. Barrel extensions shall conform to the requirements of AWWA C502 for Dry Barrel Fire Hydrants
15. Furnish hose and steamer nozzles with threads conforming to standard threads used by Owner.
16. Furnish with direction of opening as required by Owner's representative with direction of opening cast on dome. The number of turns to open shall be in accordance with AWWA C502, Section 2.9.3.

PART 3 - EXECUTION

3.1 INSTALLATION

- ### **A. Install hydrants at locations indicated in accordance with AWWA M17 and the following:**
1. Remove foreign material from barrel of hydrant before placement.
 2. Install plumb and at same elevation as connecting pipe and main.

3. Place each hydrant on a slab of concrete not less than 6 IN thick and 18 IN SQ.
4. Block backside of hydrant, opposite pipe connection, with concrete firmly wedged between hydrant and vertical face of undisturbed trench.
5. Place granular bedding material around base of hydrant to the dimensions shown in the Drawings.
6. Firmly tamp carefully compacted backfill around hydrant to surface of ground and to a distance of 5 FT in front of hydrant.

3.2 OWNERS TRAINING (NOT USED)

END OF SECTION

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Section 33 13 00
DISINFECTION OF WATER LINES

PART 1 -GENERAL

1.1 SUMMARY

A. Section Includes

1. Disinfection of potable water lines.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Water Works Association (AWWA):
 - a. C 651 - Standard for Disinfecting Water Mains.

PART 2 -PRODUCTS (NOT USED)

PART 3 -EXECUTION

3.1 CONDUCTING DISINFECTION

- A. Promptly disinfect water lines constructed before tests are conducted on water lines and before water lines are connected to water distribution system.
- B. Water for disinfection and flushing will be furnished by the Contractor.
- C. Contractor will conduct disinfection operations.
- D. Coordinate chlorination operations through Owner's representative.

3.2 PREPARATION

- A. Provide temporary blind flanges, cast-iron sleeves, plugs, necessary service taps, copper service leads, risers and jumpers of sizes, location and materials, and other items needed to facilitate disinfection of new water lines.
- B. Install temporary blow-off valves and remove promptly upon successful completion of disinfection and testing.

- C. Slowly fill each section of pipe with water in manner approved by Owner's representative. Average water velocity when filling pipeline should be less than one foot per second and shall not, under any circumstance, exceed 2 feet per second. Before beginning disinfection operations, expel air from pipeline.
- D. Backfill excavations immediately after installation of risers or blow-offs.
- E. Install blow-off valves at end of water line to facilitate flushing of dead-end water lines. Install permanent blow-off valves according to Drawings.

3.3 DISINFECTION BY CONTRACTOR

- A. The following procedure will be used when disinfection by Contractor is required by Contract Documents:
 - 1. Use not less than 100 parts of chlorine per million parts of water.
 - 2. Introduce chlorinating material to water lines in accordance with AWWA C 651.
 - 3. After contact period of not less than 24 hours, flush system with clean water until residual chlorine is no greater than 1.0 part per million parts of water.
 - 4. Open and close valves in lines being sterilized several times during contact period.
 - 5. If chemical compound is used for sterilizing agent, place in pipes as directed by Owner's representative.

3.4 BACTERIOLOGICAL TESTING

- A. After disinfection and flushing of water lines, perform bacteriological tests by testing laboratory in accordance with Section 01 45 29 - Testing Laboratory Services. When test results indicate need for additional disinfection of water lines based upon Texas Department of Health requirements, perform additional disinfection operations.

3.5 COMPLETION

- A. Wherever possible, provide temporary blow-off on existing access manway blind flange. Upon satisfactory completion of disinfection and hydrostatic testing, remove risers and cap directly at the water line, except those approved for use in subsequent hydrostatic testing. Do not leave any portion of riser extending from water line.
- B. Where temporary blow-off is located outside access manhole or vault, backfill excavation promptly. Show blow-off locations on as-built record drawings, and note the type of cap used. If blow-off location is underneath pavement, comply with the following:
 - 1. If pavement is restored prior to completion of disinfection and hydrostatic testing, install temporary pavement over blow-off. Comply with local requirements for dimensions of temporary pavement, if applicable.

2. Backfill excavation with select fill or cement stabilized sand in accordance with Section 31 21 33 – Trenching, Backfilling and Compacting for Utilities.

END OF SECTION

SECTION 33 39 20
FRAMES, GRATES, RINGS, AND COVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Iron castings for manhole frames and covers, inlet frames and grates, catch basin frames and grates, meter vault frames and covers, adjustment rings, and extensions and ring grates.
2. Ring grates.

1.2 MEASUREMENT AND PAYMENT

- A. Unit Price. No separate payment will be made for this item. Include the cost in associated items for this project.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Association of State Highway and Transportation Officials (AASHTO)
 - a. Standard Specification for Highway Bridges
2. ASTM International (ASTM):
 - a. A 48 - Standard Specification for Gray Iron Castings
 - b. A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
3. American Welding Society (AWS).
 - a. D 12.1 Welding Reinforcing Steel.

1.4 SUBMITTALS

- A. Submit copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions.
- B. Submit shop drawings for fabrication and installation of casting assemblies. Include plans, elevations, sections, and connection details. Show anchorage and accessory items. Include setting drawings for location and installation of castings and anchorage devices.

1.5 WARRANTY (NOT USED)

PART 2 - PRODUCTS

2.1 CASTINGS

- A. Use castings for frames, grates, rings and covers conforming to ASTM A 48, Class 35B. Provide locking covers if indicated on Drawings.
- B. Use clean castings capable of withstanding application of AASHTO M306-40,000 pound proof loading without detrimental permanent deformation.
- C. Fabricate castings to conform to shapes, dimensions, and with wording or logos shown on Drawings. Standard dimensions for manhole covers are 32 inches in diameter.
- D. Use clean castings, free from blowholes and other surface imperfections. Use clean and symmetrical cast holes in covers, free of plugs.

2.2 BEARING SURFACES

- A. Machine bearing surfaces between covers or grates and their respective frames so that even bearing is provided for position in which casting may be seated in frame.

2.3 SPECIAL FRAMES AND COVERS

- A. Where indicated on Drawings, provide watertight manhole frames and covers with minimum of four bolts and gasket designed to seal cover to frame. Supply approved watertight manhole covers and frames.
- B. Where shown on Drawing, provide manhole frames and covers with 48 inch diameter clear opening, with inner cover for 22 inch diameter clear opening. Provide approved inner cover with pattern shown on Drawings.

2.4 FINISH

- A. Unless otherwise specified, uncoated cast iron.

2.5 FABRICATED RING GRATES

- A. Fabricate ring grates from reinforcing steel conforming to ASTM A 615.
- B. Conform to welds connecting bars to AWS D 12.1.

2.6 ADJUSTMENT RINGS FOR ASPHALT OVERLAYS

- A. Use castings conforming Section 2.1.
- B. One piece casting with dimensions to fit frame and cover.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install castings according to approved shop drawings, instructions in related specifications, and applicable directions from manufacturer's printed materials.

- B. Set castings accurately at required locations to proper alignment and elevation. Keep castings plumb, level, true, and free of rack. Measure location accurately from established lines and grades. Brace or anchor frames temporarily in form work until permanently set.
- C. Fabricate ring grates in accordance with standard detail. Set in mortar in mouth of pipe bell.
- D. Install adjustment rings in existing frames with clean bearing surfaces that are free from rocking.

3.2 OWNER TRAINING (NOT USED)

END OF SECTION

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**REMOVAL, HANDLING, CUTTING,
DISTURBANCE AND DISPOSAL OF
ASBESTOS CEMENT PIPE**

**REMOVAL, HANDLING, CUTTING, DISTURBANCE AND DISPOSAL
OF ASBESTOS CEMENT PIPE**

PART 1: GENERAL

1.1 Scope of Work

This document shall govern the removal, handling, disturbance, cutting, and disposal of asbestos cement (AC) pipe and other asbestos containing materials (ACM) related to the AC pipe work. AC pipe is also known as transite pipe. This material is classified as

Category II non-friable ACM. Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by forces expected to act on the material in the course of the demolition or renovation operations is subsequently re-classified as Regulated Asbestos Containing Material (RACM). The removal and/or disturbance of this material are governed by the National Emissions Standards for Hazardous Air Pollutants (NESHAP) Standard 40 CFR Part 61, Subpart M, and the Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1926.1101.

The Contractor shall be responsible for developing and implementing an asbestos removal work plan in accordance with NESHAP, OSHA and applicable state requirements.

1.2 Description:

This document shall consist of the removal, handling, cutting, disturbance, and disposal of AC water pipe, joints, wrappings, and associated ACM. To comply with NESHAP and OSHA regulations, this project requires workers with specialized training using wet method to remove AC pipe, AC pipe joints and valves (any type) containing ACM. The removal of AC pipe in good condition is subject to OSHA regulations, and is exempt from most NESHAP requirements. The AC pipe removal outside of a building is not subject to Texas Asbestos Health Protection Rules (TAHPR). Therefore, it is not required to be Texas Department of State Health Services (DSHS) licensed asbestos contractor or supervisor to conduct the asbestos removal activities. However, at a minimum, workers shall be trained in accordance with OSHA Standard 29 CFR 1926.1101 for "Class II asbestos work", and OSHA worker protection requirements shall be applied. NESHAP requirements apply during the removal of RACM above the 160 square feet, 260 linear feet, or 35 cubic feet removal threshold. OSHA

**REMOVAL, HANDLING, CUTTING,
DISTURBANCE AND DISPOSAL OF
ASBESTOS CEMENT PIPE**

requires that during any ACM disturbance, regardless of amount, the asbestos worker(s) shall be properly protected during potential asbestos exposure.

NESHAP regulations including notification submittal, procedures for asbestos emission control and disposal of ACM apply to projects when at least 260 linear feet or 35 cubic feet or 160 square feet of AC pipe becomes or will become “regulated asbestos containing material”. If the scope of this project involves exceeding the threshold amount of RACM, then a Renovation Notification Form shall be sent to TDSHS by the Contractor. This form shall be post-marked no later than 10 working days prior to the start of any asbestos disturbance.

During the disjoining operation of AC pipe removal, if the debris caused by the disjoining operation is cleaned up so that it does not contaminate a greater length of pipe, only the portion that has become RACM shall be counted toward the threshold amount. However, if the generated AC pipe debris is not properly cleaned up, then the entire pipe shall be considered contaminated and the whole length shall be treated as asbestos containing waste material (ACWM).

1.2.1 Definitions:

The following terms are defined for the nature of this work:

- **Air Monitoring:**
The process of measuring the fiber concentration of a known volume of air collected during a specific period of time. The analysis procedure utilized for asbestos is the NIOSH Standard Analytical Method for Asbestos in Air, Method 7400. Transmission electron microscopy (TEM) may be utilized for lower detection limits and/or specific fiber identification.
- **Air Monitoring Technician:**
The person licensed by TDSHS to conduct air monitoring for an asbestos abatement project or related activity. The air monitoring technician may only obtain air samples and may perform analysis of air samples if trained in the NIOSH-582 or equivalent course. The air-monitoring technician shall be an employee of a licensed asbestos laboratory or a licensed asbestos consultant agency.
- **Amended Water:**
Water to which a surfactant has been added
- **Asbestos:**
Asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these minerals that have been chemically treated and/or altered.
- **Asbestos Containing Material (ACM):**

**REMOVAL, HANDLING, CUTTING,
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Material or products that contain more than 1.0 percent of any kind of asbestos

- **Asbestos Containing Waste Material (ACWM):**
Asbestos-containing waste material means mill tailings or any waste that contains commercial asbestos and is generated by a source subject to the provisions of EPA NESHAP. This term includes filters from control devices, friable asbestos waste material, and bags or other similar packaging contaminated with commercial asbestos. As applied to demolition and renovation operations, this term also includes regulated asbestos-containing material waste and materials contaminated with asbestos including disposable equipment and clothing.
- **Authorized Personnel:**
Any person authorized by the Contractor and required by work duties to be present in the work area or other regulated areas
- **Authorized Visitor:**
Owner's representatives and any representative of a regulatory or other agency having jurisdiction over the project
- **Licensed Asbestos Consultant:**
That person licensed by TDSHS to perform the following asbestos related functions:
 - Project design
 - Asbestos surveys and condition assessment of ACM
 - Asbestos Management Planning
 - The collection of bulk material samples and airborne substance samples, and the planning of sampling strategies
 - Owner-representative services for asbestos abatement projects or O&M programs, including air monitoring and project management
 - Consultation regarding regulatory compliance, and all aspects of technical specifications and contract documents;
 - The selection, fit testing, and appropriate use of personal protective equipment, and the development of asbestos related engineering controls.
- **Licensed Abatement Contractor:**
The company, agency, or entity licensed by TDSHS that has been retained by the Contractor to perform asbestos abatement and other associated functions.
- **Category I non-friable asbestos-containing material (ACM):**
Category I non-friable ACM means asbestos-containing packing, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent asbestos as determined using the method specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy.

**REMOVAL, HANDLING, CUTTING,
DISTURBANCE AND DISPOSAL OF
ASBESTOS CEMENT PIPE**

- **Category II non-friable ACM:**
Category II non-friable ACM means any material, excluding Category I non-friable ACM, containing more than 1 percent asbestos as determined using the methods specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure. AC pipe in good condition is classified as Category II non-friable ACM.
- **Class II Asbestos Work (OSHA Standard, 29 CFR 1926.1101):**
Activities involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos-containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastics. Removal of AC pipe and appurtenances is Class II Asbestos Work.
- **Competent Person (OSHA):**
Competent person means, in addition to the definition in 29 CFR 1926.32 (f): “one who is capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them”, for Class I and Class II work who is specially trained in a training course which meets the criteria of EPA’s Model Accreditation Plan (40 CFR 763, Appendix C to Subpart E) for supervisor, or its equivalent and, for Class III and Class IV work, who is trained in a manner consistent with EPA requirements for training of local education agency maintenance and custodial staff as set forth at 40 CFR 763.92 (a)(2).
- **Encapsulant:**
A specific adhesive designed to lock down and minimize the fiber release of asbestos.
- **Friable Asbestos:**
ACM, which can be crumbled to dust, when dry, under hand pressure, and includes previously non-friable material after such previously non-friable material becomes damaged to the extent that, when dry, it may be crumbled, pulverized, or reduced to powder by hand pressure.
- **HEPA Filter:**
A high efficiency particulate air filter capable of removing particles >0.3 microns in diameter with 99.97 percent efficiency.
- **NESHAP:**
The National Emission Standards for Hazardous Air Pollutants (40 CFR Part 61)
- **NIOSH:**
The National Institute for Occupational Safety and Health

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- Non-friable asbestos-containing material
Non-friable asbestos-containing material means any material containing more than 1 percent asbestos as determined using the method specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.
- OSHA:
The Occupational Safety and Health Administration
- Owner (OSHA):
Building/facility owner is the legal entity, including a lessee, which exercises control over management and record keeping functions relating to a building and/or facility in which activities covered by this standard take place.
- Owner (NESHAP):
Owner or operator of a demolition or renovation activity means any person who owns leases, operates, controls, or supervises the facility being demolished or renovated or any person who owns leases, operates, controls, or supervises the demolition or renovation operation, or both.
- PEL:
Permissible exposure level. Refer to 29 CFR 1926.1101(c) for explanation of PEL.
- Presumed Asbestos Containing Material:
It means thermal system insulation and surfacing material found in buildings constructed no later than 1980.
- Regulated Area:
An area established by the Contractor to demarcate areas where asbestos work is conducted, and any adjoining area where debris and waste from such asbestos work accumulate; and a work area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed, the PEL.
- Regulated Asbestos Containing Material (RACM):
 - Friable asbestos material
 - Category I non-friable ACM that has become friable
 - Category I non-friable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading; or
 - Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by forces expected to act on the material in the course of the demolition or renovation operations regulated by 40 CFR Part 61, Subpart M.

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- **Staging Area:**
A pre-selected area where containerized ACWM will be placed prior to removal from the project site.
- **Surfacing Material:**
Surfacing material means material that is sprayed, troweled-on or otherwise applied to surfaces (such as acoustical plaster on ceilings and fireproofing materials on structural members, or other materials on surfaces for acoustical, fireproofing, and other purposes).
- **Surfactant:**
A chemical wetting agent added to water to improve penetration
- **Thermal System Insulation (TSI):**
Thermal System Insulation (TSI) means ACM applied to pipes, fittings, boilers, breeching, tanks, ducts or other structural components to prevent heat loss or gain.
- **Time-weighted average limit (TWA):**
The employer shall ensure that no employee is exposed to an airborne concentration of asbestos in excess of 0.1 fiber per cubic centimeter of air as an eight (8) hour time-weighted average (TWA), as determined by the method prescribed in 29 CFR 1926.1101, or by an equivalent method.
- **Excursion limit:**
The employer shall ensure that no employee is exposed to an airborne concentration of asbestos in excess of 1.0 fiber per cubic centimeter of air (1 f/cc) as averaged over a sampling period of thirty (30) minutes, as determined by the method prescribed in 29 CFR 1926.1101, or by an equivalent method.

PART 2: QUALITY ASSURANCE

2.1 Reference Standards

All work under these specifications shall be done in strict accordance with all applicable Federal, State, and local regulations, standards, and codes governing asbestos abatement, and any other trade work done in conjunction with the asbestos abatement.

The most recent edition of any relevant regulation, standard, or code shall be in effect. Where a conflict exists between the regulations, standards, codes, or these specifications, the most stringent requirements shall be utilized.

The Contractor shall comply with, at minimum, the following regulations when applicable:

2.1.1 OSHA including but not limited to:

- Title 29 Code of Federal Regulations Section 1910.1001 - General Industry Standard for Asbestos
- Title 29 Code of Federal Regulations Section 1910.134 - General Industry Standard for Respiratory Protection
- Title 29 Code of Federal Regulations Section 1926.1101 - Construction Industry Standard
- Title 29 Code of Federal Regulations Section 1910.2 - Access to Employee Exposure and Medical Records
- Title 29 Code of Federal Regulations Section 1910.1200 - Hazard Communication

2.1.2 EPA including but not limited to:

- Title 40 Code of Federal Regulations Part 61 Subpart M - National Emission Standard for Asbestos

2.1.3 TDSHS including but not limited to:

- Texas Administrative Code, Title 25, Chapter 295, Subchapter C - Texas Asbestos Health Protection
- Texas Administrative Code, Title 25, Chapter 325 Texas Solid Waste Regulations
- Texas Civil Statutes, Article 4477- A, Section 12, General Provisions 295.31 to 295.73

2.1.4 American National Standards Institute (ANSI)

2.1.5 American Society for Testing and Materials (ASTM)

2.1.6 Department of Transportation - HM 181

PART 3: EXECUTION

3.1 Construction Requirements:

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- The Contractor shall remove, seal, transport and dispose of all impacted ACM in compliance with all current Federal, State, and local regulations, laws, ordinances, rules, standards and regulatory agency requirements. Asbestos disturbance and/or removal activities shall be conducted by properly trained, accredited, and/or licensed personnel using proper personal protective equipment.
- Time is of the essence in removing ACM from the project area. All work must be completed within the time period specified.
- All required notifications to State regulatory agencies shall be made by the Contractor with copies provided to Owner's Representative, including but not limited to the TDSHS Demolition/Renovation Notification Form. If 260 linear feet or greater of AC pipe is crushed, crumbled or pulverized, then the project is subject to NESHAP regulations and a Demolition/Renovation Notification Form shall be sent to TDSHS by the Contractor. This form shall be post-marked no later than 10 working days prior to the start of any asbestos disturbance.
- The Contractor shall have an on-site supervisor, who is an OSHA Competent Person, present on the job site as described in 1926.1101(o). The supervisor shall be thoroughly familiar and experienced with asbestos disturbance and other related work, and shall be familiar with and shall enforce the use of all safety procedures and equipment. The supervisor shall be knowledgeable of all applicable EPA, OSHA, NIOSH and TDSHS requirements and guidelines.
- Prior to commencing any preparation of the work areas for asbestos disturbance, the Contractor shall post all required documents, warning signs, and as necessary, erect physical barriers to secure the work area.
- The Contractor has sole and primary responsibility for the "means and/or methods" of the work, for the inspection of the work at all stages, and for the supervision of the performance of the work.
- The Contractor shall be responsible for site safety and for taking all necessary precautions to protect the Contractor's workers, SJRA personnel, and the public from asbestos exposure and/or injury. The Contractor shall be responsible for maintaining the integrity of the work area.
- The Contractor shall confine operations at the site to the area requiring disturbance of AC pipe and the general site area associated with the proximity of the project. Portions of the

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site beyond areas, in which the indicated work is required, are not to be disturbed. The Contractor shall not unreasonably encumber the site with materials or equipment. If ACWM is required to be stored overnight, it shall be properly labeled, secured, and containerized to preclude unauthorized disturbance of the waste materials.

- The Contractor shall be responsible for the transport and disposal of ACWM to a landfill facility permitted to accept asbestos waste. The Contractor shall be responsible for obtaining and coordinating waste disposal authorization from a TCEQ permitted landfill. Waste manifests shall be used to transport the AC pipe from the project site to the final landfill disposal site. The Contractor shall sign manifests as the generator of the AC pipe and shall provide copies to the Owner's Representative.

3.2 Site Security:

- The Contractor shall demarcate the area of AC pipe disturbance ("regulated area") with barrier tape and warning signs, as per OSHA regulation 29 CFR 1926.1101. Access to the regulated area shall be limited only to authorized personnel. Authorized personnel shall have, at a minimum, 8-hour asbestos training for class II asbestos work for AC pipe in accordance with 29 CFR 1926.1101.
- Entry into the work area by unauthorized individuals shall be reported immediately to the Owner's Representatives by the Contractor.
- A logbook shall be maintained immediately outside the regulated area. Anyone who enters the regulated area must record name, affiliation, time in, and time out for each entry.

3.3 Personal Protective Equipment:

3.3.1 General:

As per 1926.1101(i)(1), the employer shall provide and require the use of protective clothing, such as coveralls or similar whole-body clothing, head coverings, gloves, and foot coverings for any employee exposed to airborne concentrations of asbestos that exceed the TWA and/or excursion limit, or for which a required negative exposure assessment is not produced, or for any employee performing Class I operations which involve the removal of over 25 linear or 10 square feet of TSI or surfacing ACM and PACM.

3.3.2 Respiratory Protection:

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The Contractor shall use removal techniques, methods and equipment that will not permit the fiber count to exceed the OSHA Permissible Exposure Level (PEL) of 0.1 fibers per cubic centimeter (f/cc) of air as an eight (8) hour time-weighted average (TWA) or thirty (30) minute excursion limit of 1.0 f/cc as detected by personal air sampling methods. Any remedial measures taken by the Contractor to meet this requirement shall be at the Contractor's expense.

Wherever the feasible engineering and work practice controls are not sufficient to reduce employee exposure to or below the permissible exposure limit and/or excursion limit, the employer shall use them to reduce employee exposure to the lowest levels attainable by these controls and shall supplement them by the use of respiratory protection that complies with the requirements of paragraph 1926.1101(h).

As per OSHA regulation 1926.1101(h)(1), respirators must be used during:

1. Class I asbestos work.
 2. Class II asbestos work when ACM is not removed in a substantially intact state.
 3. Class II and III asbestos work that is not performed using wet methods, except for removal of ACM from sloped roofs when a negative-exposure assessment has been conducted and ACM is removed in an intact state.
 4. Class II and III asbestos work for which a negative-exposure assessment has not been conducted.
 5. Class III asbestos work when TSI or surfacing ACM or PACM is being disturbed.
 6. Class IV asbestos work performed within regulated areas where employees who are performing other work are required to use respirators.
 7. Work operations for which employees are exposed above the TWA or excursion limit.
- If required by OSHA regulations, the Contractor shall ensure use of the appropriate respiratory protection for the work being performed. For minimum legal respiratory requirements, see OSHA Standards 29 CFR 1910.134(b) through (d) (except (d)(1)(iii)), and (f) through (m), and 29 CFR 1926.1101(h)(2). All respiratory equipment, such as respirators, filters, etc., shall be certified by NIOSH for use in asbestos contaminated atmospheres.
 - Unless a negative exposure assessment has been made pursuant to paragraph 29 CFR 1926.1101(f)(2)(iii), the initial exposure assessment shall, if feasible, be based on monitoring conducted pursuant to paragraph 1926.1101(f)(1)(iii). The assessment shall take into consideration both monitoring results and all observations, information or calculations which indicate employee exposure to asbestos, including any previous monitoring conducted in the workplace, or of the operations of the employer which indicate the levels of airborne asbestos likely to be encountered on the job. Negative exposure means that for any one specific asbestos job which will be performed by employees who

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have been trained in compliance with 1926.1101 standard, the employer may demonstrate that employee exposures will be below the PELs by data which conform to the criteria outlined in 29 CFR 1926.1101(f)(2)(iii).

- Workers shall be provided with personally issued, individually identified respirators.

3.4 Air Monitoring:

Personal Air Monitoring: The employer shall conduct daily monitoring that is representative of the exposure of each employee who is assigned to work within a regulated area performing Class I or II work, unless the employer pursuant to 1926.1101(f)(2)(iii), has made a negative exposure assessment for the entire operation. The employer shall conduct periodic monitoring of all work where exposures are expected to exceed a PEL, at intervals sufficient to document the validity of the exposure prediction.

The Contractor shall provide personal air sampling, if required by OSHA regulations. The OSHA TWA PEL for asbestos (0.1 f/cc) shall not be exceeded. OSHA monitoring results shall be posted at the project site and made available to all affected Contractor personnel on a daily basis. The Contractor shall provide required personal air monitoring on each worker who is cutting, (wet) sawing, breaking, or repairing AC pipe.

Area Air Monitoring: At any time that visible airborne fibers are generated or that wet work procedures are not used, all work shall immediately cease until area air monitoring has started. The Contractor's on-site Competent Person shall be responsible for making this determination; however, periodic, random site visits by the Owner's representative will field-verify the objectivity of the Competent Person in these matters. Once initiated, the sampling and frequency of the area air monitoring shall be dependent upon on the specific work practices being used by the workers at that time. However, the area air monitoring shall include, as a minimum, samples collected inside the regulated area, and upwind and downwind of the regulated area.

Area air monitoring shall be conducted in accordance with applicable Federal, State, and local requirements. The cost of area air monitoring due to failure to use adequate wet work procedures shall be borne by the Contractor. Copies of all results shall be provided to the Owner's Representative.

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Area air sampling shall be mandatory in high density areas such as schools, residential areas, and certain other locations as determined by the Owner's Representative and dictated by the bid documents/plans.

3.5 Employee Training:

- Training shall be provided by the Contractor to all employees or agents who may be required to disturb ACM for AC pipe handling and auxiliary purposes, and to all supervisory personnel who may be involved in the planning, execution or inspection of such projects. The training shall be in accordance with OSHA Standard 29 CFR 1926.1101 for "Class II asbestos work".
- At a minimum, Contractor's employees who will be potentially exposed to asbestos shall have completed within the last 12 months, an 8-hour Asbestos training course. The training course shall cover topics including, but not be limited to: Employee Information and Training outlined in 29 CFR 1926.1101(k)(9) and work practices related to the handling of AC pipe.
- The Contractor's Competent Person shall have completed within the last 12 months, a 40-hour Asbestos Contractor Supervisor training course taught by a TDSHS licensed Asbestos Training Provider. The training course shall cover topics including, but not be limited to: the health effects of asbestos, employee personal protective equipment, medical monitoring requirements for workers, air monitoring procedures and requirements for workers, work practices for asbestos abatement, personal hygiene procedures, special safety hazards that may be encountered, and other topics as required.

3.6 AC Pipe Handling:

3.6.1 General:

The Contractor shall properly remove, handle, transport and dispose all AC pipe specified in the bid documents/plans for this project. The Contractor shall remove ACM with wet methods or by other controlled techniques approved by the TDSHS, EPA and OSHA, and in accordance with these specifications and the Contractor-provided Work Plan, if any. Alternative removal methods will be considered at the time of the Contractor's submittals. The Contractor shall take special care to prevent damage to structures and materials not requiring removal/demolition to access the ACM.

The Contractor shall limit work to the area indicated. Access to the work area shall be controlled by the Contractor. All electrical equipment, etc., shall have ground limit circuit

interrupter (GFCI) protection. The Contractor shall properly demarcate, barricade, and contain the work and/or regulated areas.

The AC pipe work consists of providing GFCI protection, using approved equipment with engineering controls, sufficiently wetting the ACM using a surfactant or lock-down encapsulant, removing the ACM, HEPA vacuuming the work area, wet wiping the work area, double-bagging/double-wrapping the waste, and removing carefully as indicated herein and in accordance with OSHA and NESHAP regulations.

3.6.2 Equipment:

Equipment used to cut, break, or otherwise disturb AC pipe and associated ACM may include, but are not limited to: wet-cutting saws, saws equipped with point of cut ventilator (saw equipped with a water mister) or enclosures with HEPA filtered exhaust air, snap cutters, manual field lathes, and pressure and non-pressure tapping devices.

Equipment used to control visible emissions of fibers, contain the work area, or facilitate the clean-up of debris may include, but are not limited to: airless spray equipment, pump-up sprayers, surfactant, lock-down encapsulant, HEPA vacuums, brushes, brooms, shovels, disposable rags, polyethylene sheeting of 6-mil thickness, moisture resistant duct tape, asbestos warning signs, notices, and barrier tape. Alternative dismantling equipment may be substituted for the materials indicated herein, but must be approved by the Owner's Representative.

3.6.3 Prohibited Work Practices and Engineering Controls:

The following work practices and engineering controls shall not be used for work related to asbestos or for work that disturbs ACM, unless there are no reasonable alternatives. Wet methods must be used during asbestos related works.

- High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filtered exhaust air
- Other high-speed abrasive tools, such as disk sanders
- Electrical drills, chisels, and rasps used to make field connections in AC pipe
- Shell cutters used to cut entry holes in AC pipe
- Compressed air used to remove asbestos or ACM, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud generated by the compressed air

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- Dry sweeping, dry shoveling, or other dry clean-up of dust and debris containing ACM.
- Employee rotation as a means of reducing employee exposure to asbestos

3.6.4 A sufficient supply of disposable rags for work area decontamination shall be available.

3.6.5 Disposal bags for RACM shall be of true 6-mil polyethylene, pre-printed with labels as required by EPA regulation 40 CFR 61.150 (a)(i)(v) and OSHA requirement 29 CFR 1926.1101 (k)(8).

3.6.6 Stick-on labels identifying the Generator's name and address, and the project site location shall be applied to any asbestos waste bags that contain RACM, as per EPA or OSHA and Department of Transportation HM 181 requirements.

3.6.7 Work Area Preparation:

The Contractor shall post warning signs and barrier tape meeting the specification of OSHA 29 CFR 1926.1101 at any location and approaches to a location where airborne concentrations of asbestos may exceed the PEL. Signs shall be posted at a distance sufficiently far from the work area to permit an employee to read the sign and to take the necessary protective measures to avoid exposure. The Contractor shall maintain constant security against unauthorized entry past warning signs and barrier tape. Signs shall be post in both English and Spanish at the site.

3.6.8 Personnel Exit Procedures:

- Before leaving the work area, all personnel shall remove gross contamination from the outside of respirators and protective clothing by HEPA VAC and/or wet wiping procedures. Small HEPA vacuums with brush attachments may be utilized for this purpose. Adequate washing facilities shall be provided and utilized on-site.
- Upon completion of the work, contaminated gloves shall be disposed as ACWM. Disposable cloth gloves may be substituted for leather gloves, at the Contractor's discretion. Rubber boots shall be decontaminated at the completion of the project.

3.6.9 Specific Removal Work Practice Requirements:

- The Contractor has sole and primary responsibility for the "means and/or methods" of the work, for inspection of the work at all stages, and for supervision of the performance of the work.

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- The Contractor shall isolate the regulated area with barrier tape and asbestos warning signs.
- The Contractor shall lay and secure 6-mil polyethylene sheeting on the ground on both sides of the AC pipe for the length of the work area.
- Working within the regulated area and using wet removal methods, the Contractor shall thoroughly soak each section of AC pipe to be disturbed, prior to any removal activity, with a surfactant or lock-down encapsulant. The Contractor shall use equipment capable of producing a “mist” application to reduce the potential for release of fibers. The Contractor shall take care to use as much encapsulant or surfactant as needed to lockdown possible fallout debris from edges and joints during removal. Continuous wetting of the materials throughout the entire removal process shall be provided. The Contractor shall take care to limit the breakage of ACM and to remove these materials as intact as possible.
- Any AC pipe debris on adjacent surfaces shall be removed. The Contractor shall promptly clean up asbestos wastes and debris following AC pipe disturbance. All visible accumulations of ACM and asbestos contaminated debris shall be removed and containerized by hand. Asbestos debris mixed with soil shall be picked up with shovels. The contaminated soil shall be containerized as a regulated ACWM. Clean-up activities may also involve vacuum cleaners equipped with HEPA filtration or wet-wiping surfaces with disposable rags. Contaminated rags shall be containerized as regulated ACWM.
- After disturbance and clean-up activities but prior to removal of the AC pipe from the regulated area, the Contractor shall encapsulate damaged and exposed areas and ends of the AC pipe with a lock-down encapsulant.
- The Contractor shall then remove the Category II non-friable ACM “that is not in poor condition and is not friable,” as defined in NESHAP regulations. The Contractor shall remove all AC pipe “intact” and in whole complete sections by carefully lifting the AC pipe to the disposal container using approved equipment. The Category II non-friable AC pipe shall not be made “friable” (crumbled, pulverized, or reduced to a powder). The Contractor shall not drop, break and/or otherwise make the AC pipe susceptible to releasing asbestos fibers. If these procedures are followed and debris is cleaned up properly, then the Category II non-friable AC pipe shall be disposed as non-regulated ACM.
- Pieces of AC pipe debris shall be handled as RACM waste. The debris shall be placed in two 6-mil asbestos bags or double wrapped, with proper labeling.

3.6.10 Abandonment of AC water mains/pipes:

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The Contractor shall be responsible for isolating the existing mains to remain in service by capping, plugging, and blocking as necessary. The opening of an abandoned AC water main and all other openings or holes shall be blocked off by manually forcing cement grout or concrete, into and around the openings, in sufficient quantity to provide a permanent watertight seal. The Contractor shall inspect the visible sections that remain to insure they are intact and non-friable. The ends of the AC pipe shall be encapsulated and any friable AC pipe shall be removed. AC pipe shall NOT be crushed and left in place. If AC pipe is crushed or otherwise caused to become friable, it shall be removed.

3.6.11 Verification of Removal & Clean-up Procedures:

The Contractor's on-site Competent Person shall inspect the work area and ensure that all surfaces are free of AC pipe dust and debris.

3.6.12 Disposal Procedures

- If a dumpster/trailer is used for temporary storage, it shall be secured and closed at all times except when loading. It shall be properly marked and critical barrier tape shall be in place.
- AC pipe debris and asbestos-contaminated items shall be properly double bagged; labeled; loaded in a fully enclosed, lined, locked, placard-identified transport container; transported; and disposed in compliance with all regulatory requirements as RACM.
- After being removed from the regulated area, Category II non-friable AC pipe shall be transferred to a polyethylene-lined container. The Contractor shall remove all containers as soon as practical, but no later than the end of the work shift.
- When a dumpsters/trailer is full, it shall be hauled away to the closest EPA/TCEQ permitted landfill for proper disposal. The Contractor may dispose of Category II non-friable AC pipe waste material as non-regulated waste in a municipal solid waste landfill, as defined by TCEQ (Type I Landfill). Prior to disposal, written approval to transport and to accept the Category II non-friable material shall be obtained from a pre-approved transporter and landfill, and shall be submitted to the Owner's Representative.
- The Contractor shall submit copies of all transport manifests, trip tickets, and disposal receipts for all ACWM removed from the work area during the project to the Owner's Representative.

APPENDIX A

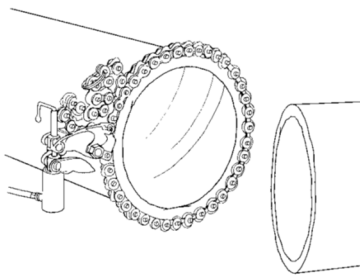
Recommended Methods to Handle AC Pipe

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AC pipe must be handled, removed and disposed of in a manner that keeps the material in predominantly whole pieces to be considered non-friable. The pipe must be kept wet during removal. Wetting minimizes asbestos fibers from being released. Followings are some of the recommended methods to handle AC pipe:

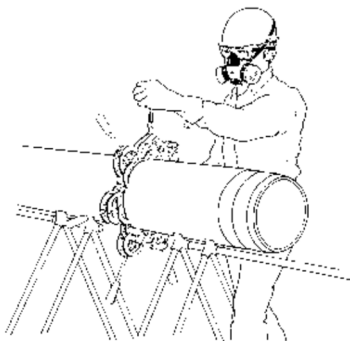
1. Snap cutters

Snap cutters (“squeeze-and-pop” equipment) operate by means of cutting wheels mounted in a chain wrapper around the pipe barrel. Hydraulic pressure, applied by means of a remote, pneumatically, or manually operated pump, squeezes the cutting wheels into the pipe wall until the cut is made.



2. Carbide-tipped blade cutters

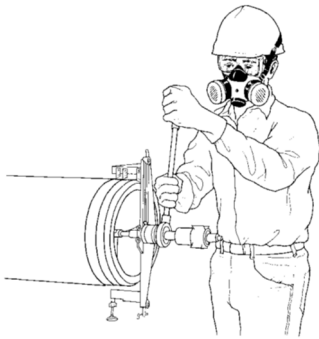
Blade cutters are frame adjustable to the circumference of the pipe and have a number of self-tracking rollers that align one or more carbide-tipped cutting blades. Because of the relatively low mechanical input and clean cutting action, hand operated blade cutters do not produce significant amounts of airborne asbestos dust.



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3. Manual field lathes

Manual field lathes are designed to end-trim and re-machine rough pipe barrels to factory-machined end profiles. The lathe consists of an adjustable, self-aligning arbor inserted into the pipe bore (which acts as a mandrel upon which the turning handle operates), a screw-fed turning frame, carbide machining blades, and manual (hand or ratchet) turning handles.



4. Wet tapping AC pressure pipe

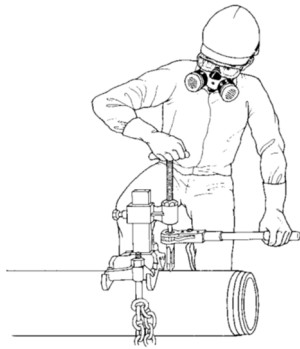
Pressure or “wet” tapping for service connections is performed in the trench while the pipe is under pressure. The equipment (manual driven) is affixed to the pipe by means of a chain yoke. A combination boring-and-inserting bar drills and taps the pipe wall and inserts a corporation stop or pipe plug. The pressure chamber, which protects against water leakage, also catches the asbestos-cement chips, so this is essentially a dust-free operation.



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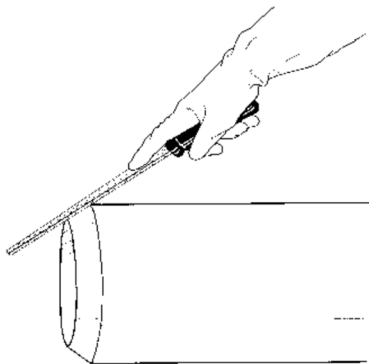
5. Dry tapping AC non-pressure pipe

Non-pressure or “dry” tapping for service connections may be performed in or out of the trench. The equipment is affixed to the pipe by means of a chain yoke. Separate drills and taps or a combination tool is used to drill and tap the pipe wall. Corporation stops or other connections may then be affixed to the pipe.



6. Manual rasp

Short lengths of AC pipe, machined-end exclusively (MEE) and machined overall (MOA), can be cut to make closures and repairs and to locate fittings exactly. Field-cut ends may be re-beveled with a coarse wood rasp to form a taper approximating the profile of the factory-beveled end.

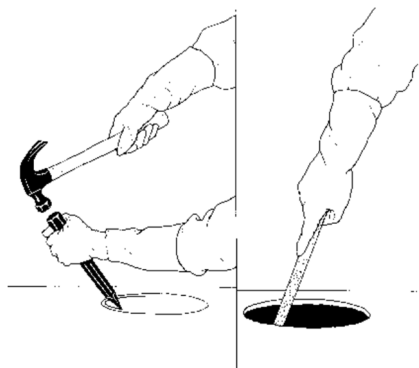


7. Chisel and rasp

Holes may be cut into AC pipe with a hammer and chisel. The edge of a plumber's wood chisel is used to cut completely around the hole outline, about ¼ in. (7 mm) from the prescribed line. The

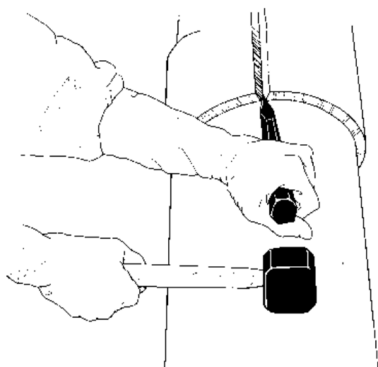
REMOVAL, HANDLING, CUTTING, DISTURBANCE AND DISPOSAL OF ASBESTOS CEMENT PIPE

operation is repeated and the cut deepened until through. The edges of the hole are then dressed with a coarse wood rasp.



8. Hammer and chisel

Replacement of damaged pipe may necessitate excavation, exposure and removal. AC coupling removal may be accomplished by gradually splitting the coupling lengthwise using a chisel and hammer. After the top of the coupling has been split, a crowbar or similar tool is used as a lever to split the bottom of the coupling.



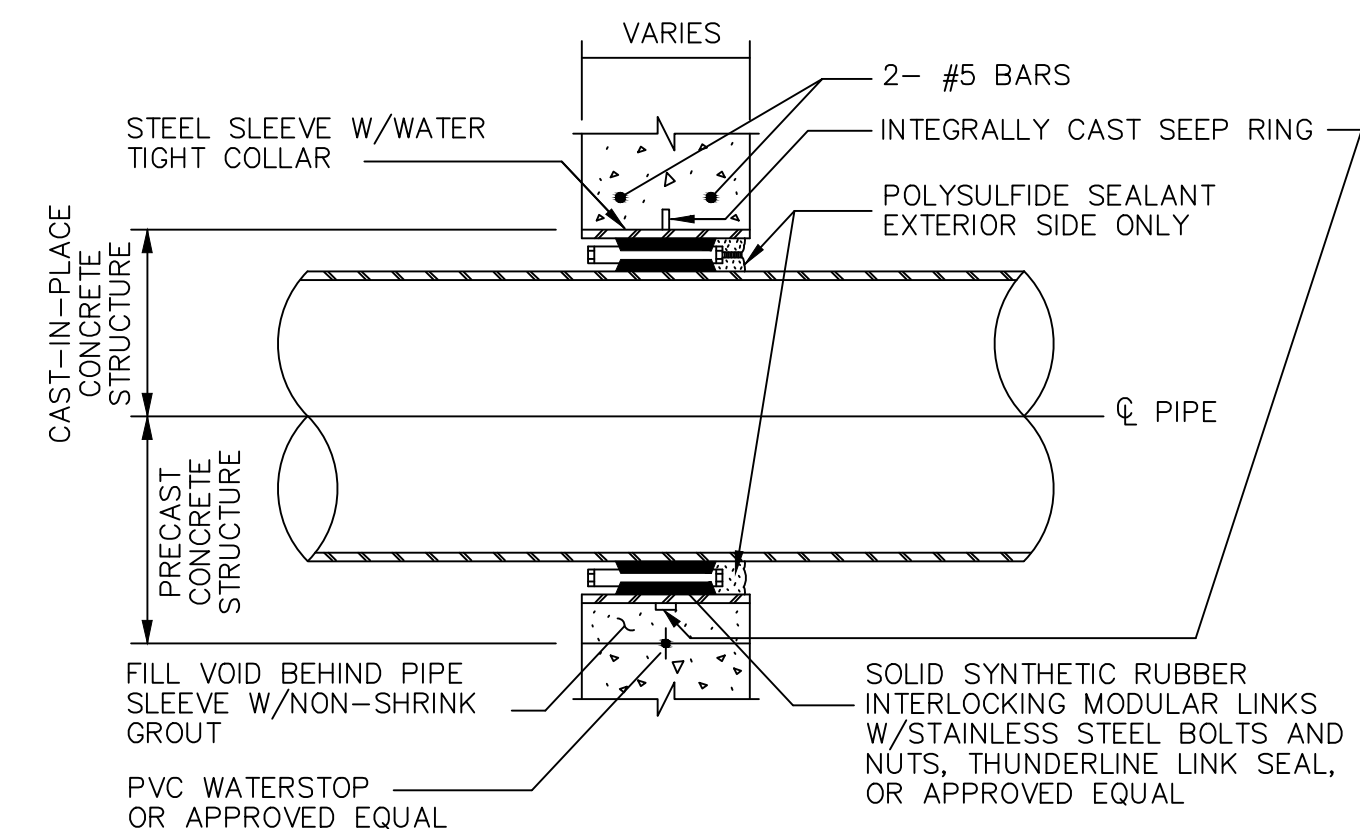
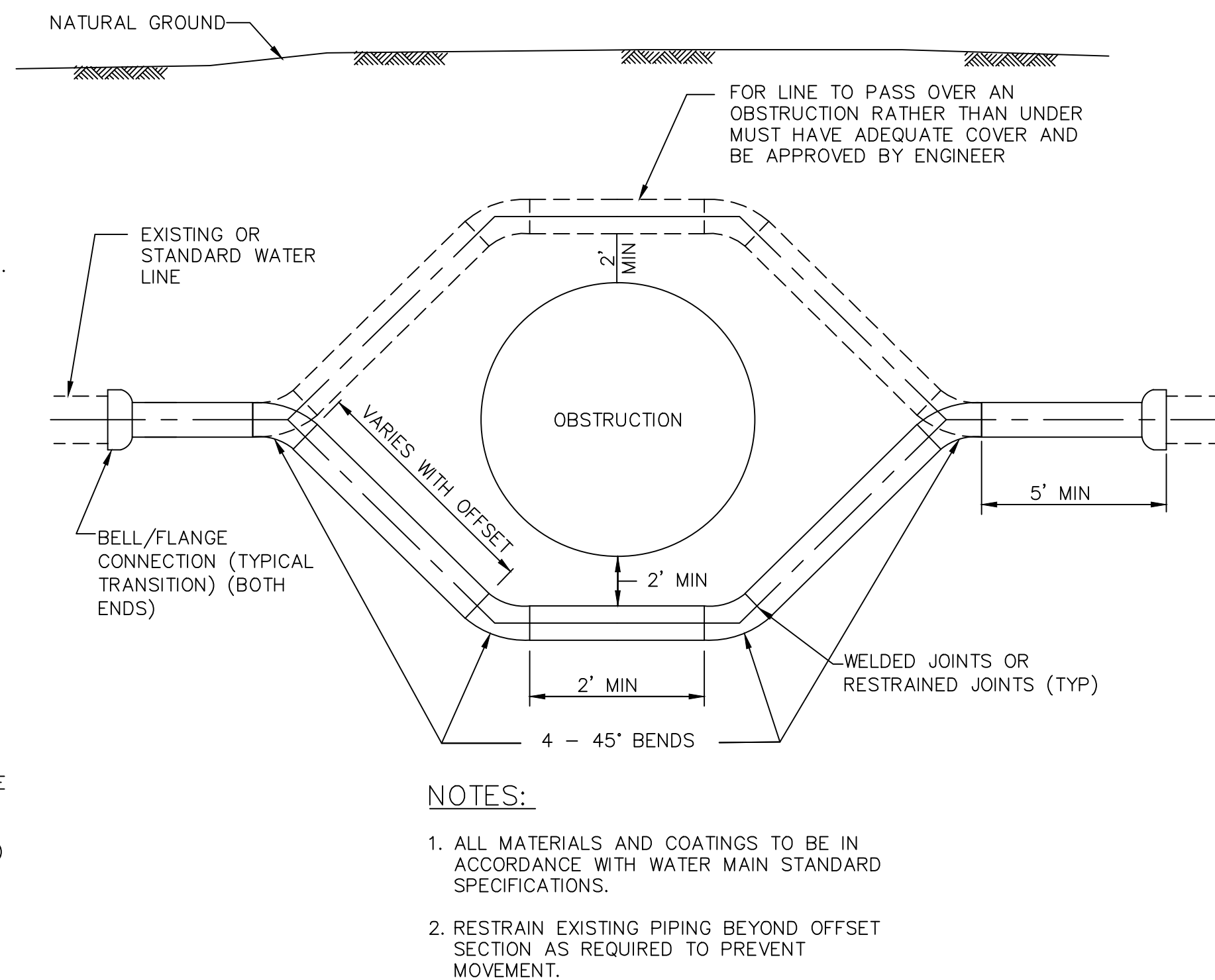
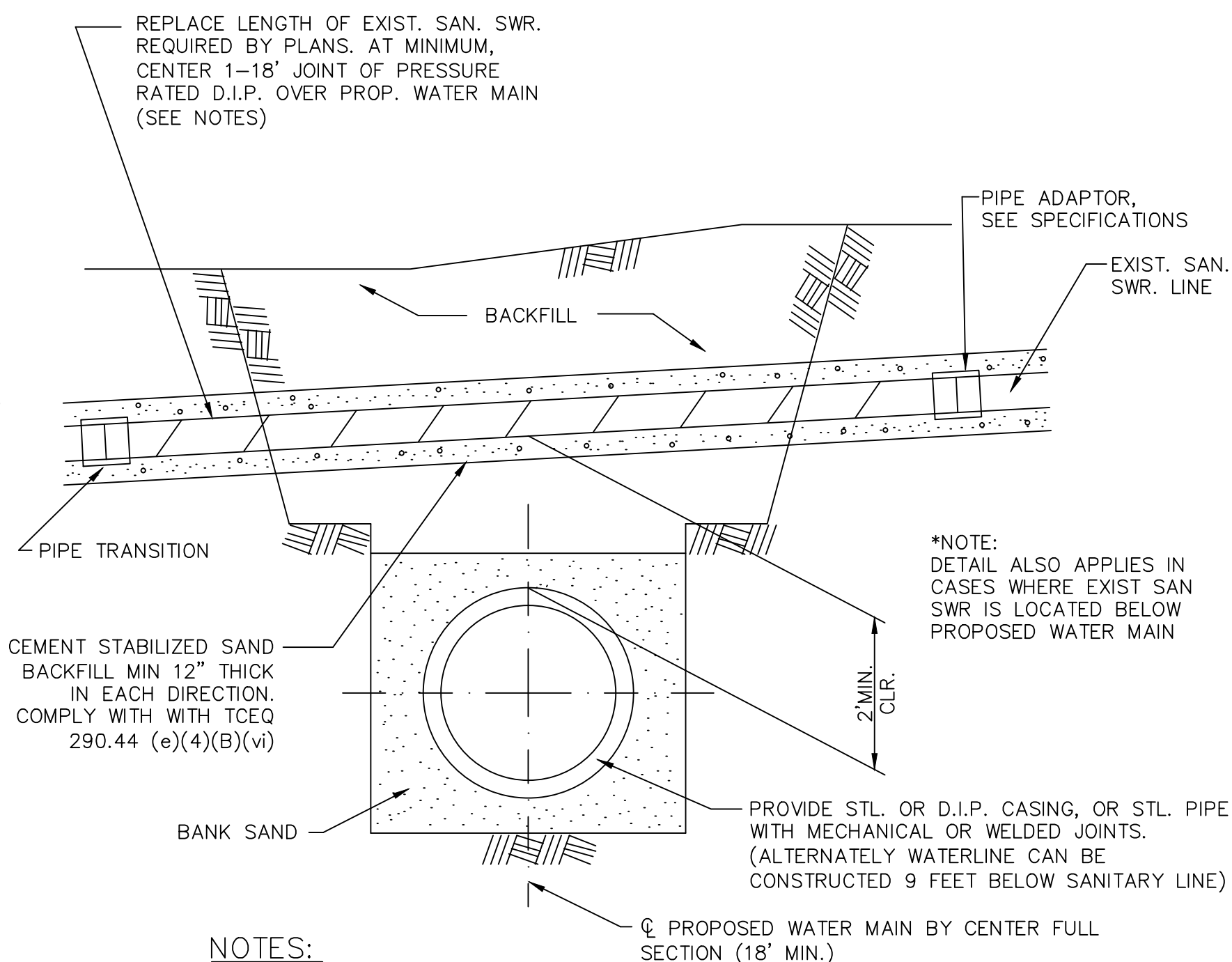
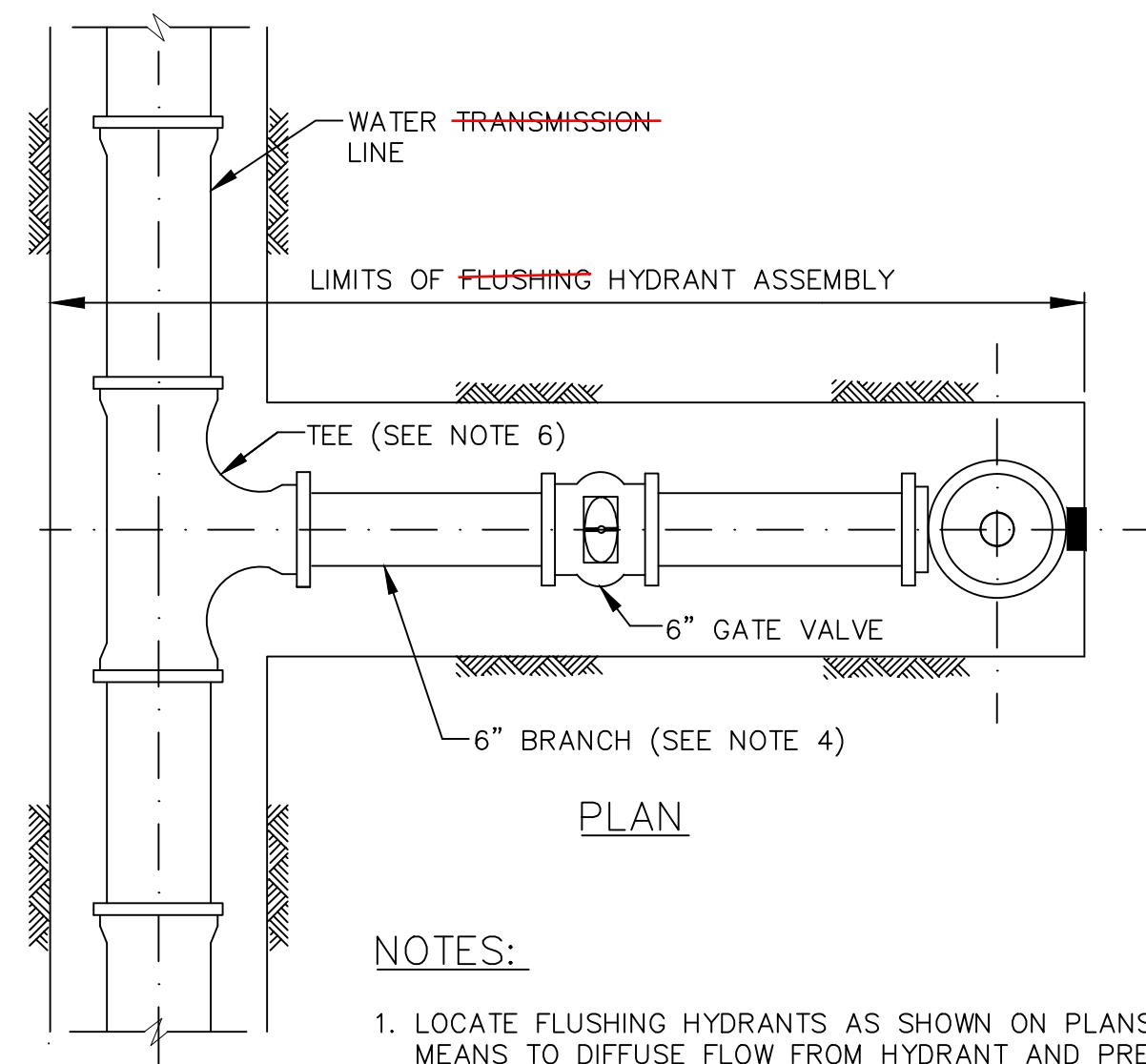
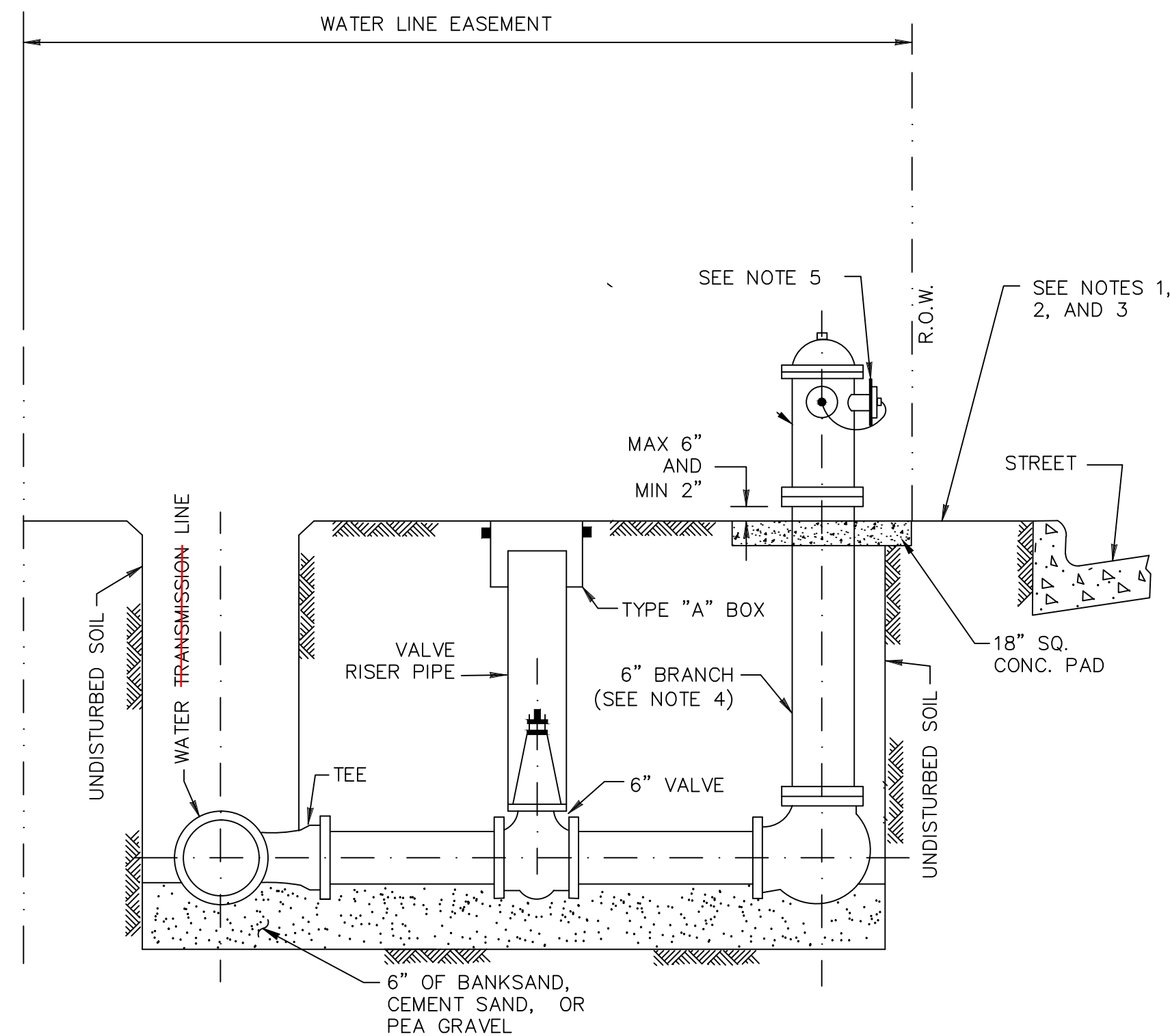


SAN JACINTO RIVER AUTHORITY

**WOODLANDS DIVISION
ON-CALL REPAIR PROJECT**

ATTACHMENT B





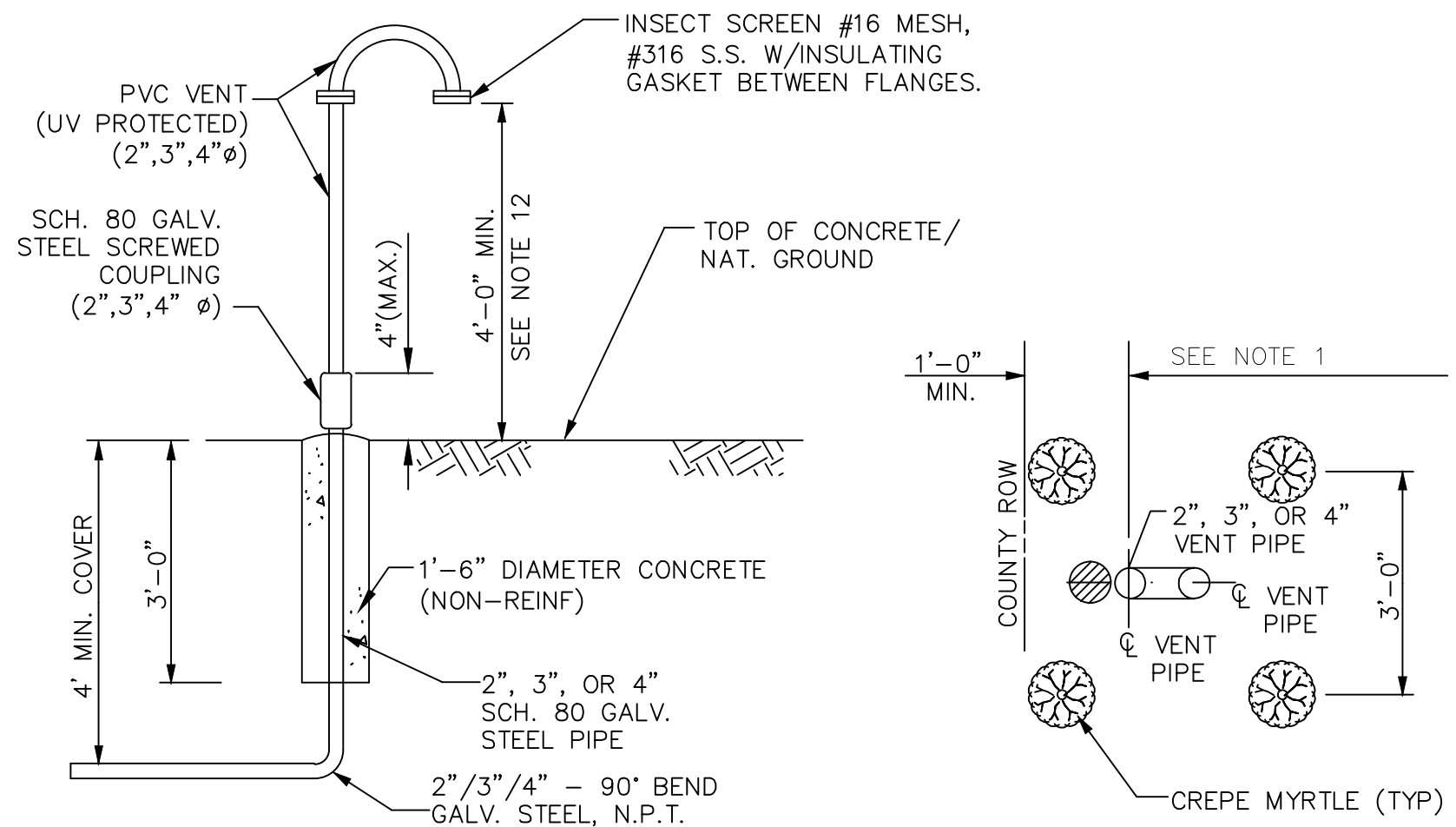
1 STANDARD ~~FLUSHING~~ HYDRANT ASSEMBLY

5 TYPICAL WALL PENETRATION DETAIL

REF. NO.
02

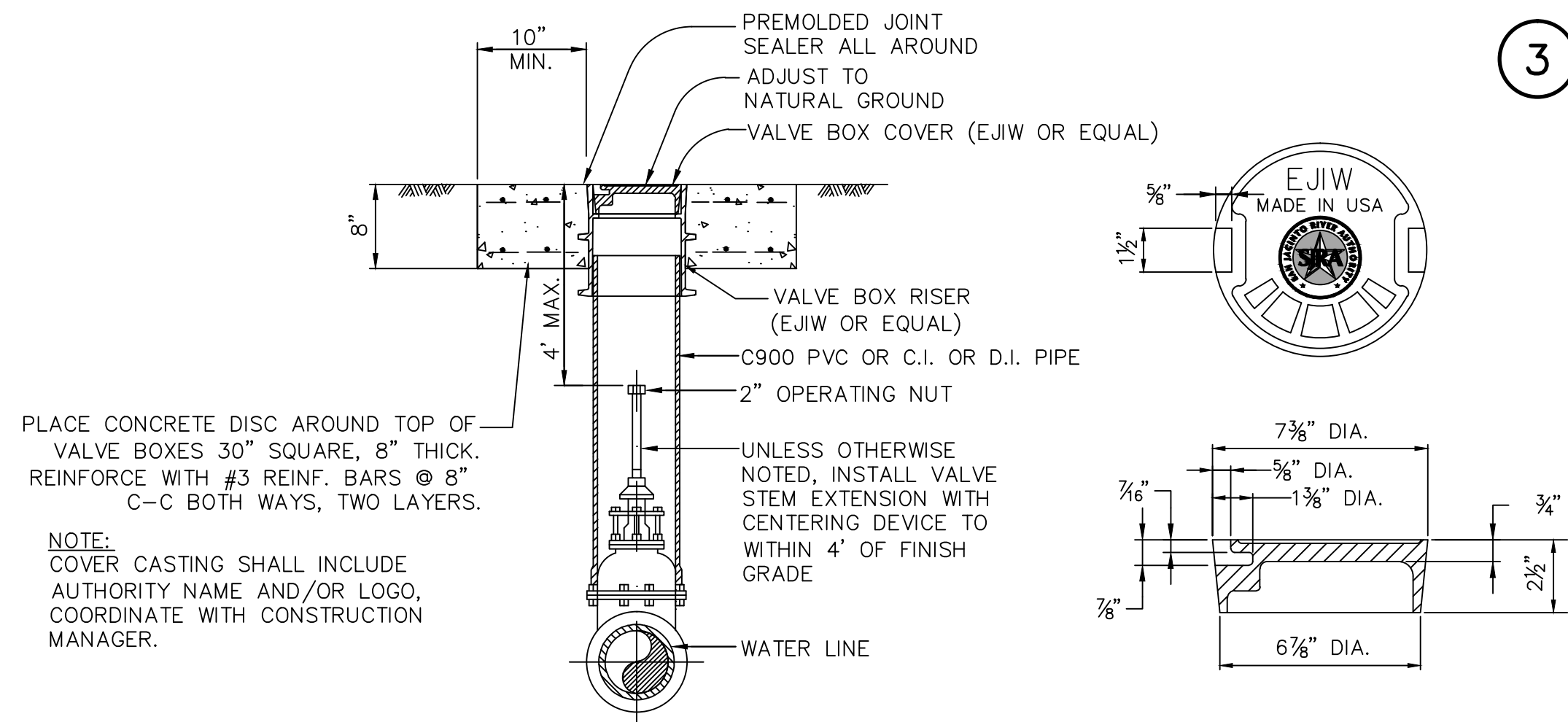
STANDARD WATER LINE DETAILS

SHEET **XX** OF **YY**



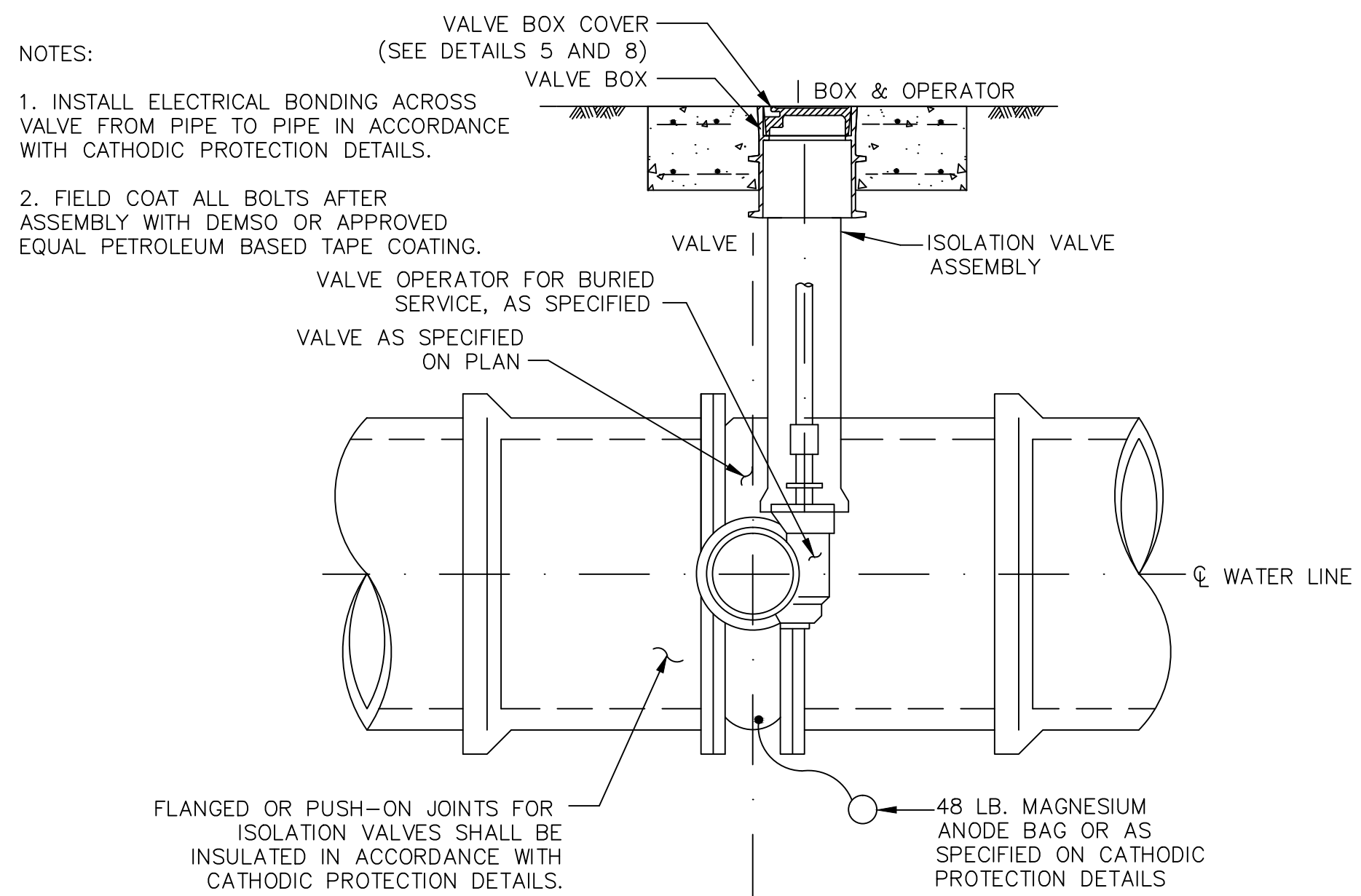
3 BREAKAWAY VENT PIPE DETAIL

(VENT PIPES WITHIN MONTGOMERY COUNTY ROW)



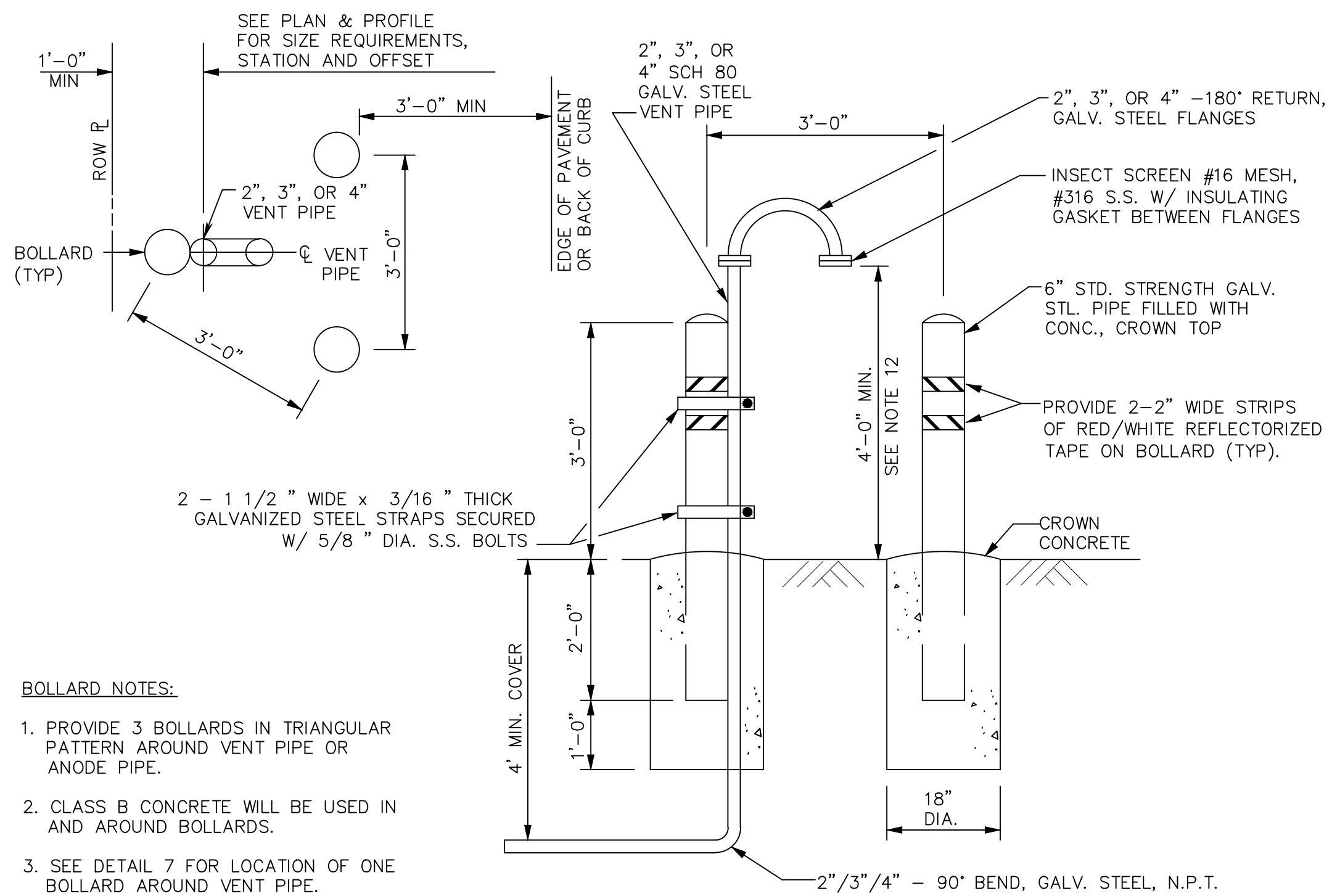
5 VALVE BOX DETAIL

8 VALVE BOX COVER DETAIL
(EAST JORDAN IRON WORKS (EJIW) OR EQUAL)

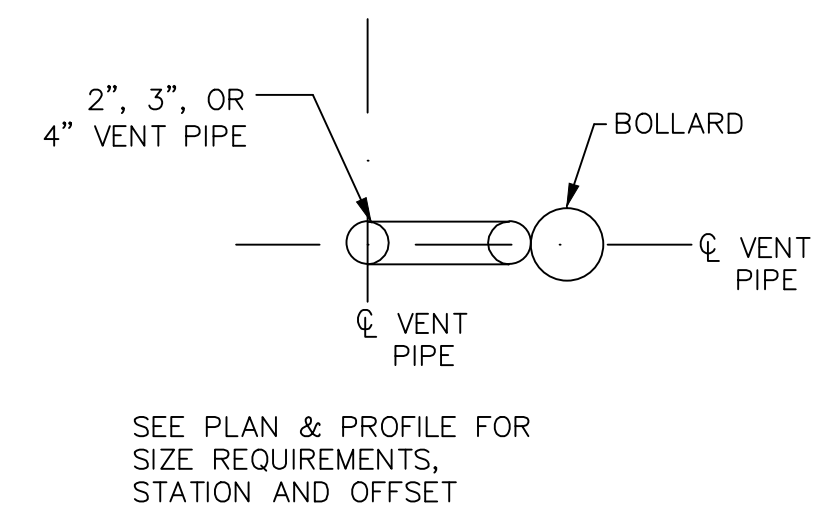


4 ISOLATION VALVE ASSEMBLY

(FOR WATER LINES 24-INCHES IN DIAMETER AND SMALLER)



6 VENT PIPE WITH 3 BOLLARDS DETAIL



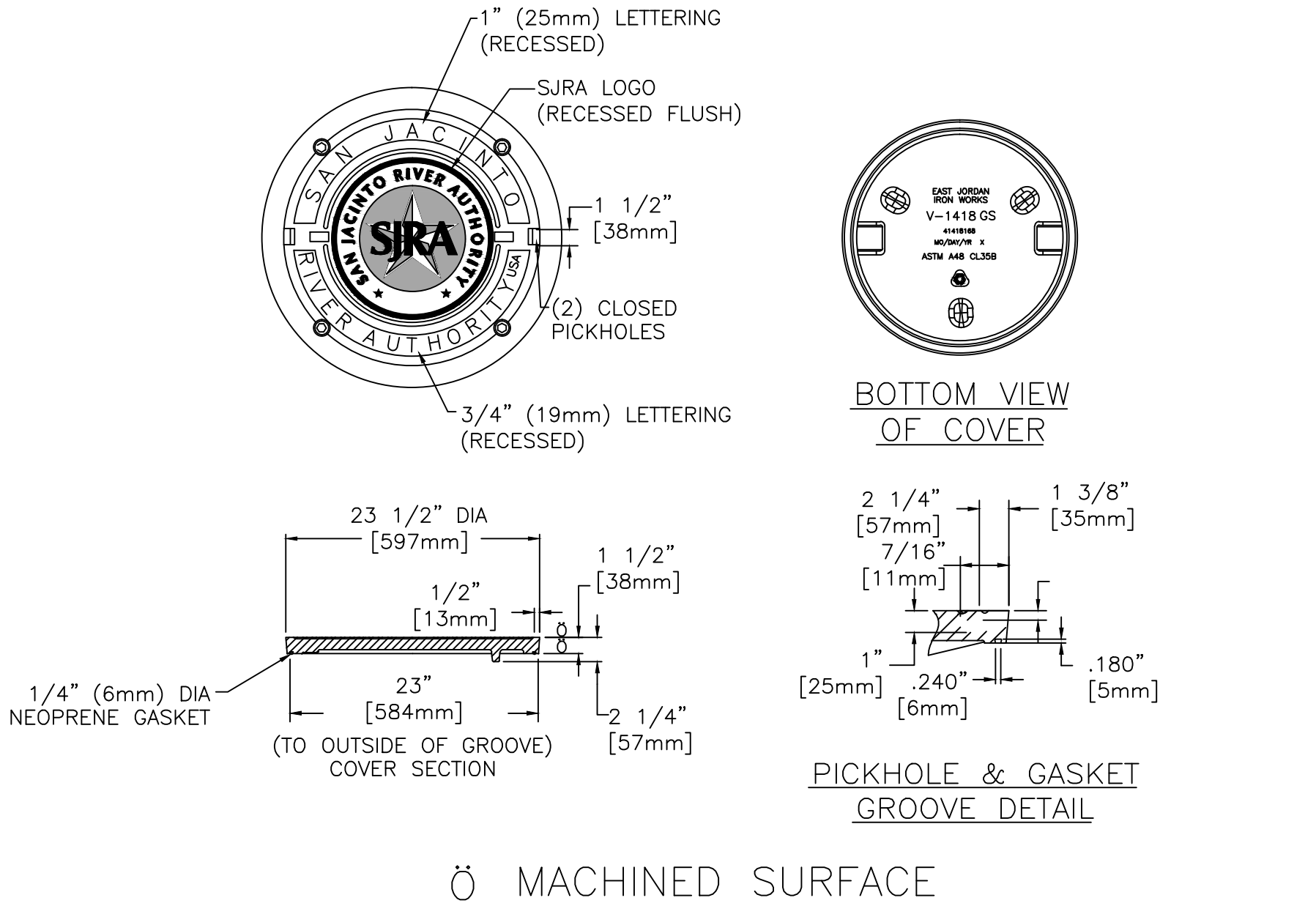
7 VENT PIPE WITH
1 BOLLARD DETAIL

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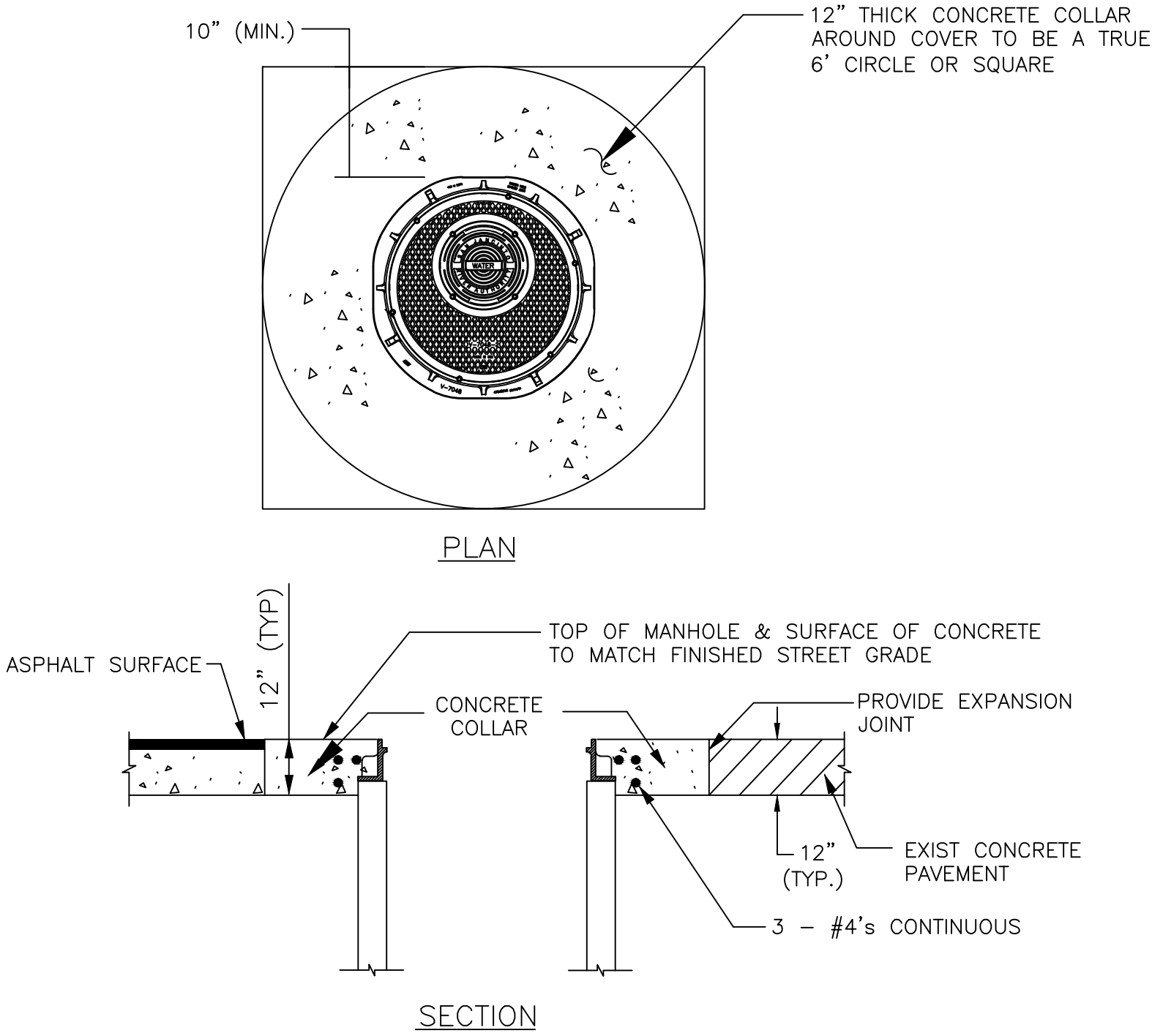
VALVE AND VENT PIPING

REF. NO.
07

SJRA - GROUNDWATER REDUCTION PROGRAM
\\FSZ-V04\Projects\SJRA\Program-Mgmt\05_Engineering\01_BCE\03_CADD\Transmission Line_Templates\08_Manhole Ring and Cover.dwg Jun 11, 2013 9:30am Vargas



2 HEAVY DUTY MANHOLE COVER
(MANHOLE RING AND COVER TO BE EAST JORDAN IRON WORKS OR EQUAL)



NOTE - MANHOLE IN PAVEMENT
1. CONSTRUCT THE FINAL TWO FEET OF THE MANHOLE AND PLACE CONCRETE WITHIN BLOCKOUT AFTER THE STREET PAVEMENT HAS BEEN INSTALLED.

4 MANHOLE IN PAVEMENT

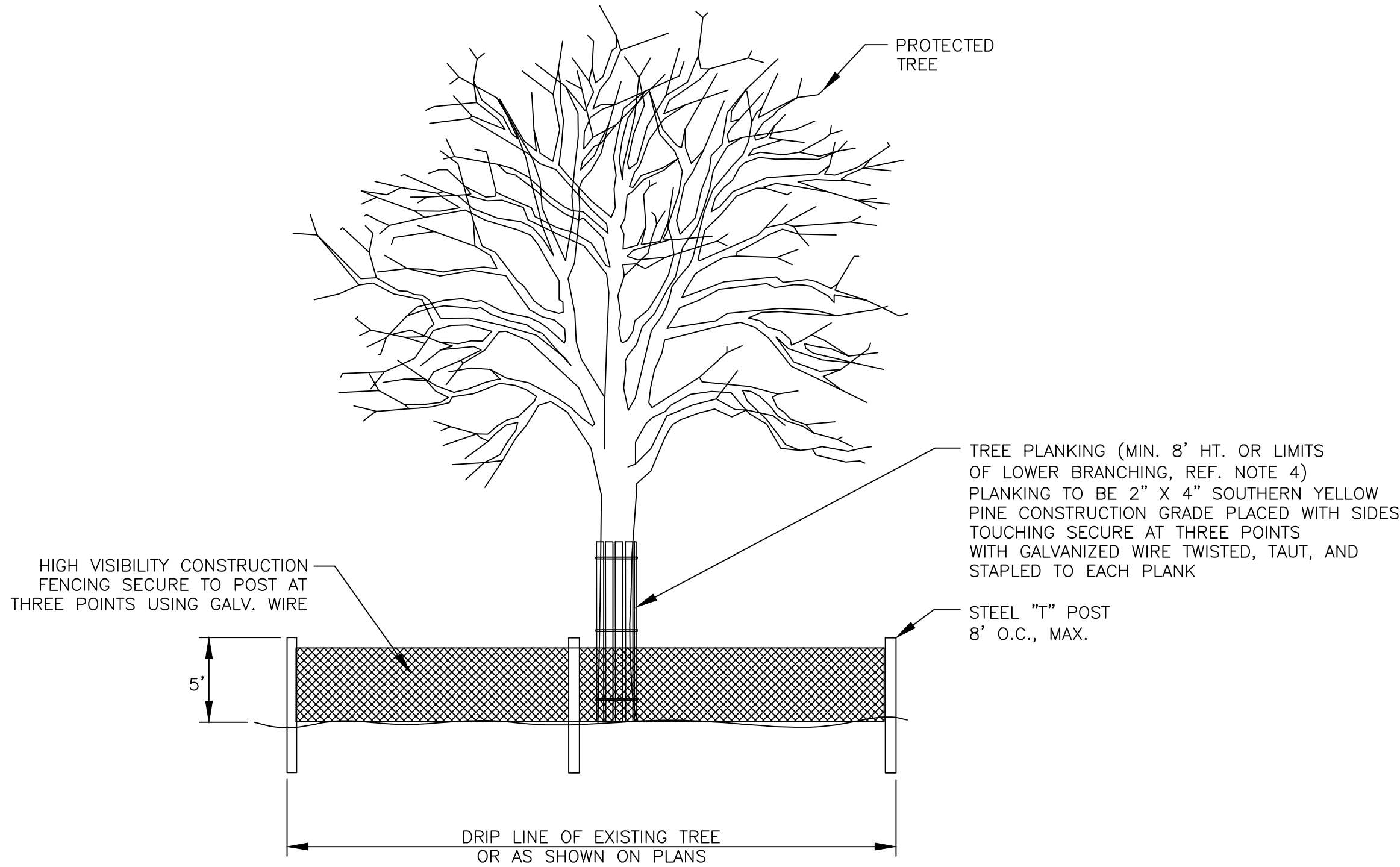


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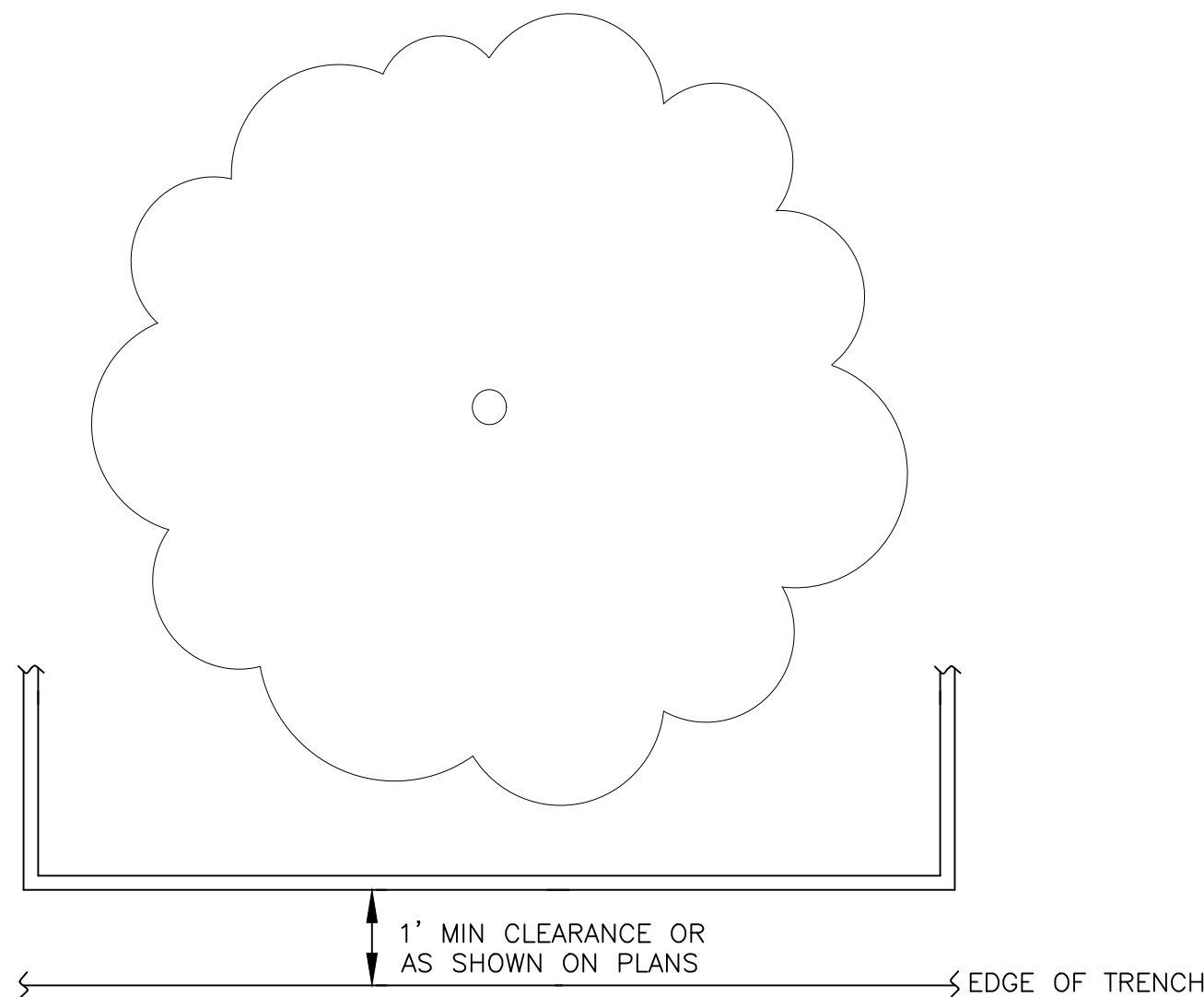
HEAVY DUTY MANHOLE DETAILS

REF. NO.
08

SJRA - GROUNDWATER REDUCTION PROGRAM
N:\FS2\04\Projects\SJRA\Program\Main\05_Engineering\01_BCE\03_CADD\Transmission Line_Templates\10_Tree Protection_Plan.dwg Jun 11, 2013 9:30am Vargas



1 TREE PROTECTION DETAIL



2 TREE PROTECTION DETAIL

NOTES:

- ALL TREES SHOWN ON THE TREE PROTECTION PLANS SHALL BE PROTECTED THROUGHOUT CONSTRUCTION WITH TREE PROTECTION.
- TREE PROTECTION FENCING SHALL BE INSTALLED PRIOR TO MOBILIZATION.
- FENCING SHALL BE LOCATED AS SHOWN ON DRAWINGS, OR COMPLETELY SURROUND THE TREE OR CLUSTERS OF TREES AND WILL BE LOCATED AT THE OUTERMOST LIMITS OF THE TREE BRANCHES (DRIPLINE). THE DRIPLINE DEFINES THE 'ROOT ZONE'. WITHIN THE LIMITS OF FENCING, THE CONTRACTOR SHALL PREVENT THE FOLLOWING FROM OCCURRING WITHOUT PRIOR WRITTEN AUTHORIZATION FROM THE OWNER'S REPRESENTATIVE:
 - SOIL COMPACTION IN THE ROOT ZONE AREA RESULTING FROM VEHICULAR TRAFFIC OR STORAGE OF EQUIPMENT OR MATERIALS.
 - ROOT ZONE DISTURBANCES DUE TO GRADE CHANGES (GREATER THAN 3" CUT OR FILL) OR TRENCHING NOT REVIEWED OR AUTHORIZED.
 - WOUNDS TO EXPOSED ROOTS, TRUNK, OR LIMBS BY MECHANICAL EQUIPMENT.
 - OTHER ACTIVITIES DETRIMENTAL TO TREES SUCH AS CHEMICAL STORAGE, CONCRETE TRUCK CLEANING, AND FIRES.
- WHERE EXCEPTIONS RESULT IN A FENCE BEING CLOSER THAN 4 FEET TO A TRUNK, PROTECT THE TRUNK WITH STRAPPED-ON PLANKING TO A HEIGHT OF 8' (OR TO THE LIMITS OF THE LOWER BRANCHING) AS INDICATED ON TREE PROTECTION PLANS.
- ALL GRADING WITHIN PROTECTED ROOT ZONE AREAS SHALL BE DONE BY HAND TO MINIMIZE ROOT DAMAGE AND SOIL COMPACTION. PRIOR TO GRADING, RELOCATE PROTECTIVE FENCING TO 2 FEET BEHIND THE GRADE CHANGE AREA. GRADE SHALL REMAIN UNCHANGED WHERE POSSIBLE.
- ANY ROOT SEVERED BY CONSTRUCTION ACTIVITY SHALL BE PRUNED FLUSH WITH THE SOIL. BACKFILL ROOT AREAS WITH GOOD QUALITY TOP SOIL AS SOON AS POSSIBLE. IF EXPOSED ROOT AREAS ARE NOT BACKFILLED WITHIN 2 DAYS, COVER THEM WITH ORGANIC MATERIAL IN A MANNER WHICH REDUCES SOIL TEMPERATURE AND MINIMIZES DRYING OF THE ROOT DUE TO EVAPORATION.
- TREES IMPACTED BY CONSTRUCTION ACTIVITIES SHALL BE WATERED THOROUGHLY ONCE A WEEK DURING PERIODS OF HOT AND/OR DRY WEATHER. TREE CROWNS SHALL BE SPRAYED WITH WATER PERIODICALLY TO REDUCE DUST ACCUMULATION ON THE LEAVES.
- NO LANDSCAPE TOPSOIL DRESSING GREATER THAN 3" MAXIMUM SHALL BE PERMITTED WITHIN THE DRIPLINE OF TREES. NO PERMANENT SOIL OR MULCH IS PERMITTED ON THE ROOT FLARE OF ANY TREE.
- PRUNING SHALL BE PERFORMED BY THE CONTRACTOR TO PROVIDE CLEARANCE FOR STRUCTURES OR CONSTRUCTION ACTIVITIES. PRUNING SHALL TAKE PLACE BEFORE CONSTRUCTION BEGINS, ONLY WITH PRIOR APPROVAL FROM AUTHORITY'S ENGINEER. ALL PRUNING MUST BE ACCORDING TO RECOGNIZED, APPROVED STANDARDS OF THE INDUSTRY (REFERENCE THE NAA PRUNING STANDARDS), AND BY AN EXPERIENCED AND QUALIFIED ARBORIST WHOSE PRIMARY BUSINESS IS TREE CARE.
- PROVIDE CORRECTIVE PRUNING AT THE COMPLETION OF CONSTRUCTION TO REMOVE ANY BROKEN OR DAMAGED LIMBS, UNDER THE DIRECTION OF THE AUTHORITY'S ENGINEER.
- IF REQUIRED, ROOT PRUNE BY TRENCHING A CLEAN 4" WIDE X 24" DEEP CUT BETWEEN THE DISTURBED AND UNDISTURBED ROOT ZONES WITH IRRIGATION TRENCHER TO MINIMIZE DAMAGE TO REMAINING ROOTS. MARK AND REVIEW TRENCH LINE WITH AUTHORITY'S ENGINEER PRIOR TO TRENCHING.
- AS SOON AS 4" WIDE X 24" DEEP TRENCH IS CUT, EXPOSED ROOTS SHALL BE HAND CUT TO CREATE CLEAN ROOT CUTS. AS SOON AS HAND CUTS ARE COMPLETE, BACKFILL TRENCH WITH A SANDY LOAM TOPSOIL PLACED IN 6" LIFTS, AND COMPACTED AS REQUIRED BY SPECIFICATIONS.
- IN AREAS WHERE LIME STABILIZATION ABUTS OR ENCROACHES UPON ROOT ZONES, AND WHERE ROOT PRUNING IS CALLED FOR, INSTALL 10-MIL. PLASTIC SHEETING TO FULL DEPTH OF ROOT PRUNING TRENCH AND 6" OVER TOP. CUT AND REMOVE EXPOSED PLASTIC AT COMPLETION OF WORK.



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TREE PROTECTION DETAILS

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